Internet of Things
Technology, Communications and Computing

Muneer Al Mubarak
Allam Hamdan *Editors*

Technological Sustainability and Business Competitive Advantage

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Internet of Things

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Foreword

Technological sustainability has received considerable attention recently from nations and businesses as it secures existing and future resources for the well-being of human and all creatures living on the planet. This type of sustainability promotes innovations and improves the whole society. It brings competitive advantage to the country and business when it is implanted in the systems and strategy. Embedding an advanced technology into business process can increase resource efficiency, achieve better business performance, and improve customer satisfaction. Thus, technological sustainability can bring innovations, manage resources efficiently, and foster economic and social developments. Going green, making better products, and having healthy society are all possible now with the strategizing and operationalization of important technological applications such as Internet of Things (IoT), artificial intelligence (AI), financial technology (Fintech), Big Data, and Blockchain.

This book covers topics on recent technologies that can improve performance and bring a sustainable competitive advantage. It explores the immense potential held by the implementation of such technologies. The book, for instance, discusses the applications of Internet of Things (IoT) in education, using computer-supported collaborative learning (CSCL) system that can help develop cooperative education for an effective educational environment. On the other hand, financial technology (Fintech) is being used immensely in the financial sector to govern financial transactions in a more cost-effective way with less risk, great accuracy, and high speed. Artificial intelligence (AI), whether for Industry 4.0 or Industry 5.0, has been used all over the world to solve problems, increase efficiency, and support humans. Blockchain technology is also discussed in this book that has ecologically improved the situation and supply chain process. Other topics covered are renewable energy, digital marketing, social media, and cloud computing.

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Preface

Technological sustainability is contributing well nowadays in businesses to survive and thrive in an ever-changing world. It is about securing existing resources and saving the planet for future generations. If used well, it can reduce time taken in the process and utilize the data in an efficient way. Technological sustainability is about promoting innovations, improving social development, and providing green products that benefit society. It reduces business risks as an enterprise can be better managed and increases profitability. Business competitive advantage is possible when technological substitutability is built into its processes and culture. Therefore, technological sustainability can bring innovations, manage resources efficiently, and foster economic and social development. It has been used in many areas such as solar power, green products, green supply chain, storage technology, internet banking, nanotechnology, and many others.

There are many approaches to technological sustainability. Among these approaches, but not limited to, are artificial intelligence (AI) and financial technology (Fintech). AI can widely perform human tasks that are required for decision-making with the aid of computer-based devices. Many processes can be automated and mimicked using sensor technology and robotics. Undoubtedly, the advancement of AI technology has enabled organizations to change their ways of doing businesses to meet the needs and wants of different stakeholders with an aim for more sustainability. On the other hand, Fintech is a technology used to support financial services and can be best functioned using the Internet of Things, Big Data, AI and Blockchain. This book shall serve as a guide not just to academia but also to the industry to adopt suitable strategies that offer insights into global best practices as well as innovations in the domain.

There are 30 chapters in the book, and each one has been evaluated by the editorial board and double-blind peer reviewed by at least two other reviewers.

The chapters of the book are divided into two main parts:

I. Applications of Internet of Things, AI, and Financial Technology
II. Digitalization Towards Improved Sustainable Business, and Society

The chapters of this book present a selection of high-quality research on theoretical and practical levels, which ground the uses of smart technologies in business, technological sustainability and business competitive advantage, healthcare, media, marketing, education, entrepreneurship, and other vital areas. We hope that the contribution of this book will be useful to academics and decision-makers at various economic and executive levels.

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About the Editors

Muneer Al Mubarak Prof. Al Mubarak received his PhD in Business and Economic Studies (Marketing) from University of Leeds, UK. Prof. Al Mubarak's expertise is in strategic management, marketing management, and relationship marketing. He held several managerial positions in Ahlia University such as Department Chairperson, Dean of College of Business and Finance, Acting Dean of Students Affairs, Acting Dean of Graduate Studies and Research, and Vice President for Administration and Finance. He contributed to several quality assurance programs and institutional accreditation over the years. He has over 35 years work experience as he contributed well to teaching and training in areas such as leadership, strategic management, relationship marketing, marketing management, marketing communications, sustainability, corporate social responsibility, customer relationship management, and service excellence. He has participated in many community activities over the years and is a reviewer of many reputable international journals. He is also a member of several high-ranked editorial advisory board journals, such as *Journal of Young Consumer* and *Social Responsibility Journal*.

Allam Hamdan Allam Hamdan is a full professor, is listed within the world's top 2% scientists list by Stanford University, and is the Dean of College of Business and Finance at Ahlia University, Bahrain. He is the author of many publications (more than 250 papers, 174 listed in Scopus) in regional and international journals that discussed several accountings as well as financial and economic issues concerning the Arab world. In addition, he has interests in educational related issues in the Arab world universities like educational governance, investment in education, and economic growth. He was awarded the First Prize of Al-Owais Creative Award, UAE, 2019 and 2017; the Second Prize of Rashid bin Humaid Award for Culture and Science, UAE, 2016; the Third Prize of Arab Prize for the Social Sciences and Humanities, 2015; and the First Prize of "Durrat Watan," UAE, 2013. He achieved the highest (1st) scientific research citation among the Arab countries according to Arcif 2018–2022. He is a member of National Qualifications Framework NQF – Validation Panel, and Appeal Committee, General Directorate of NQF, Kingdom of Bahrain. He is also a member of Steering Committee in International Arab Conference of Quality Assurance of Higher Education.

Part I
Applications of Internet of Things, Artificial Intelligence, and Financial Technology

Sustainable Competitive Advantage Through Technological Innovation: An Introduction

Muneer Al Mubarak and Allam Hamdan

1 Introduction

Sustainable development creates innovation, growth in business, and competitive advantage (Baumgartner, 2014). It is about environmental protection, social responsibility, and economic development (Nastanski & Baglione, 2014). A firm's strategy should consider sustainable development that brings social, environment, and economic benefits. It improves firm's corporate social responsibility by looking at a wider business scope that meets different stakeholders' expectations and manages their concerns (Al Mubarak, 2021). Performance can be improved and competitive advantage gained by integrating necessary internal changes required by a firm to suit Industry 4.0 innovation. Commercial innovation, economic, and technological capabilities can be used to improve internal forces. If these capabilities are widely used, it would lead to a sustainable competitive advantage (Ramadan et al., 2022). On the other hand, Industry 5.0 extends the concept of technology and puts more emphasis on the role of human in sustainable development rather than focusing only on technological capabilities (Kolasińska-Morawska et al., 2022). With Industry 5.0, firms can better use resources and gain competitive advantage as it improves workforce performance and increases stakeholders' expectations (Al Mubarak, 2022).

Customer relationship management relies on artificial intelligence (AI) and the Internet of Things (IoT) as they help in planning, analyzing, and tracking customers' requirements. These technological applications work well for human to enhance quality and output. Customers can now make e-shopping through chatbot tools and interactive voice assistant (Kaczorowska-Spychalska, 2019). AI contributes to the advancements of many human industries such as medical, industrial, and

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commercial (Lai & Ma, 2020; Mishra & Tripathi, 2021). Technological applications have improved efficiency of private and public sectors and led to more sustainable development (Al Mubarak, 2022). Blockchain is a technology that efficiently helps the process of documenting transactions and tracing tangible and intangible assets in a network with the aim of reducing risk and cutting costs. Blockchain protects and stores data in a shared database using a consensus mechanism. The entire block network is built around the concept of relying on information grid that displays the data source and the owner of the data. It is mainly used in supply chain management. Blockchain technology supports sustainable supply chain management by improving efficiency, traceability, and transparency (Alawi et al., 2022).

Firms have recently pursued a sustainable financial technology (FinTech or green) approach in their business to reduce negative impact of production on environment, society, and economy. Sustainable FinTech success factors in the business include agility, security, and innovation (Nguyen, 2022). This goes with the issue of digital economy that aims to reduce pollution for green development. Therefore, manufacturing firms need to adopt a green development approach of digital economy by introducing business model innovation (Han & Zhang, 2022). Renewable energy sources have recently received considerable attention by firms and governments. These sources can efficiently be managed by intelligent machines in areas such as electricity generation forecasting (Krechowicz et al., 2022). This paper focuses on the most recent technological advancements that support sustainable development goals and create competitive advantage in many spheres including business, health, and education. Few studies have focused on the linkage of triple dimensions which are technology, competitive advantage, and sustainable development.

2 Literature Review

Artificial intelligence (AI) has been incorporated in industrial, commercial, and medical settings to help in analyzing, sharing, and storing of knowledge in a timely manner. It focuses on process reengineering that uses technological elements of robotics functions (Ruiz-Real et al., 2021). AI is a smart agent of technology that carries out specific tasks of humans. Such technology has made business process more efficient using technological applications such as eBay and Amazon (Lu et al., 2018; Haenlein & Kaplan, 2019). AI complements human efforts with a high level of accuracy and in a timely manner in tasks such as analysis, knowledge storage, and logical interpretations of things (Ghosh et al., 2018). On the other hand, Internet of Things (IoT) applications have been intensively used in different areas including remote monitoring healthcare applications. These monitoring applications have improved healthcare services in recent years by implementing appropriate procedures, technologies, and diagnostics algorithms (Benedict, 2022). It consists of billions of network devices that are intelligently used in the areas of planning, management, and decision-making in different sectors such as healthcare, manufacturing, agriculture, telecommunications, and transportation. The use of this type of technology has been increased because of COVID-19 that has restricted movements. It has been intensively used in healthcare, transportation, and smart construction. This technology can best be adopted by most companies when certain issues are solved such as costs, security, and privacy (Umair et al., 2021).

Industry 4.0 witnessed mass technological advancements ranging from artificial intelligence, the Internet of Things, blockchain, to big data that have improved economy and society. This disruptive technology has created concerns by employees that it would replace them ending up jobless. In contrast, Industry 5.0 technology complements what humans do, rather than replacing them. In this case, cooperative technology-human work takes place for quality input and output that leads to sustainable development. Therefore, adoption of Industry 5.0 by firms brings sustainable development and competitive advantage. Firms need to prepare for such adoption by having a challenging human resource strategy, high-caliber staff that can adapt the new disruptive work environment. Legal and regulatory issues are required to regulate the activities considered in Industry 5.0. Leadership commitment makes a big difference to successfully implement new processes (Al Mubarak, 2022). Industry 5.0 is a new technological transformation that includes intelligent devices, intelligent systems, and intelligent automation to help human intelligence to accomplish the work. It is not a replacement but a complement to human efforts. In this sense, jobs are expected to increase and not the other way round. Such cooperation is expected to increase business efficiency with a minimum waste, and customizable manufacturing. Therefore, it is important to have machines and robots that help humans by means of brain-machine interface of artificial intelligence (Nahavandi, 2019).

Digital economy has recently been a hot issue that should be considered by many firms to reduce pollution and go green for sustainable development. Therefore, manufacturing firms need to adopt a green development approach using digital innovation. Han and Zhang (2022) suggested innovation paths and orientations toward green development. These orientations' paths are efficiency, value, user, and ecology. Every firm adopts an innovation path that suits it. The efficiency-oriented path improves firm's efficiency, maximizes energy, utilizes resources, and reduces pollution by adopting intelligent production and reducing costs. The value-oriented path enables a firm to transform itself in the industry using digital services for better sustainable development. The user-oriented path focuses on deepening the relationship with the user and customizes innovations that reduces waste and improves resource allocation. The ecology-oriented path uses a digital platform to develop smart connected product systems with a business ecosystem.

Khan et al. (2022) suggested a hybrid renewable energy system (HRES) to manage energy resources. It is configured to achieve both technical and economic objectives of a firm. Technical objective enhances life span and increases resources performance, while economical objective reduces costs. It was concluded that HRES can meet energy demand in remote locations using advanced software and hardware required to improve performance. A hybrid (distributed) decentralized control system is recommended as it allows using different control forms in a single system. Therefore, HRES can be managed using technological and economical techniques to improve performance and reduce costs.

The technology has contributed well to supply chain management, particularly in logistics. The last-mile service in logistics is to reach as many people as possible even if natural environment is negatively impacted. There is a need to find solutions that help improve logistics and do not harm natural environment. Incorporating digitalization in the process would make it faster with a special consideration to ecology. The couriers-express-parcel market has been redefined using technology such as online stores of logistics. Last mile in logistics is the final stage of distribution and the point of contact between customer and service provider. Implementation of technological solutions positively impacts the environment by reducing CO_2 emissions in the field of transport. Incorporating technology in logistics has optimized the last mile and reduced number of returns (Kolasińska-Morawska et al., 2022).

Using supply chain strategies such as buffering strategies and bridging strategies helps achieve resource efficiency and competitive advantage. Buffering strategies include product design and process reengineering to manage scarce natural resources by reusing, remanufacturing, and recycling these scarce resources. Bridging strategies include formal contracts based on a transaction, relational contracts based on trust and cooperation, and vertical integration where a focal company controls inputs of the other company. These two strategies lead to resource efficiency by minimizing costs and waste and securing natural resources for sustainable competitive advantage. Buffering and bridging strategies were found to have positive impacts on resource efficiency, while bridging strategies have a positive impact on competitive advantage (Kalaitzi et al., 2019).

3 Conclusion

Disruptive technology such as artificial intelligence (AI), the Internet of Things (IoT), financial technology (FinTech), and blockchain has made the world better. Its applications have been used in many spheres such as healthcare, education, and business. Firms' operations have become more efficient, and performance increased. AI is a smart agent that could be in the form of robotic that can carry out certain human tasks. It functions with a high accuracy and in a timely manner to store, analyze, and interpret information. Internet of Things (IoT) technology deals with billions of network devices that are intelligently used in many sectors such as healthcare, manufacturing, agriculture, transportation, and telecommunications. Financial technology (FinTech) has made a big transformation in financial transactions, paying more attention to environment and at the same time improving business performance. Blockchain technology cost-effectively stores data, shares information, and tracks tangible and intangible assets in a business network. All these technological applications, whether in Industry 4.0 or Industry 5.0, have improved and will advance the whole world. The focus of the technology is not to replace humans, but rather to complement their efforts. Digital economy improves the environment as firms become more conscious with the way they manufacture and recycle focusing on efficiency, value, user, and ecology. Furthermore, firms now pay more attention to the renewable energy in their production and need a technology that best control the process.

Technological innovation, undoubtedly, brings huge benefits to private and public sectors, nationally and internationally. It changes the way firms carry out their works. It also changes the way people live, study, and make shopping, to name a few. Competitive firms always seek to improve their internal and external capabilities to stay ahead of their counterparts. This requires finding that uniqueness to make it what it wants to be. That uniqueness is called competitive advantage, an advantage over rivals. Advantages include advanced technology, economies of scale in production, efficient supply chain management, excellent and prompt services, and optimum cost structure. All these advantages should first be obtained and then sustained where the real challenge lies. Firms might obtain competitive advantage of certain applications in Industry 4.0 such as an early level of artificial intelligence but does not work to sustain it in Industry 5.0. In this sense, sustainable competitive advantage should be the target of every firm that wants to pursue sustainable development. It is about managing existing resources efficiently and planning to secure future resources as well. The requirement for technological development and innovation varies from one sector to another but all should be ready to adopt it to improve inputs and outputs. This study links and discusses technology, competitive advantage, and sustainable development dimensions and highlights benefits of technological applications in private and public sectors. Few studies have mentioned such a linkage.

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Artificial Intelligence in Marketing and Organizational Decision-Making: Some Challenges and Concerns

Hasan Anwar, Muneer Al Mubarak, and Ali Bakir

1 Introduction

Artificial intelligence (AI) has been attracting much research interest following its rapid incorporation in an increasing number of contexts and appliances, such as smartphones, customer service, journalism, creative professions, music production, and marketing (Carlson, 2015; Lu et al., 2020; Makridakis, 2017; Marshall, 2018; Quackenbush, 2018; Sterne, 2017; Zhang et al., 2021). AI is undoubtedly enhancing the capabilities of businesses and industries in an increasingly competitive and aggressive global market. Most industries are using data analytics and business intelligence made possible by new AI technology in their marketing decisions. It is envisaged that the adoption of AI technology would lead to the creation of new goods and services, as well as significant increases in productivity (Makridakis, 2017). It is also suggested that AI offers marketing increased processing power, cheaper prices, availability of large data, and advancements in machine learning techniques and models (Huang & Rust, 2021). Furthermore, AI is increasingly being used in operational marketing, such as risk detection and help-desk response management, as well as consumer insights and targeting, copy formation and selection to match target customers, and pricing to maximize return from individual consumers (Marinchak et al., 2018). AI global investment in marketing enterprises has

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escalated; $2.5 billion was invested in AI marketing enterprises in 2018 and $1 billion in the second half of 2019. Globally, over $11 billion has been invested since 2014. (Martin & Writer, 2019).

Although studies are proliferating on AI in marketing, nevertheless, the findings on its role in marketing remain inconsistent and unfocused (Verma et al., 2021). The aim of this study is to discuss AI contribution to the various marketing functions, particularly those functions that were shown by Yang and Siau (2018); it will also touch upon strategic decision-making and organizational structure and will pose some concerns.

2 Literature Review

2.1 Artificial Intelligence: Definitions

In the sixth century, AI was introduced as concept by Homer's Iliad in the form of self-propelled chairs, and in 1937, Alan Turing who invented the computing machine declared that machines can be considered artificially intelligent if they are able to mimic human intelligence (McCorduck, 2004; Nilsson, 2010). Moreover, in 1955, the term "artificial intelligence" was proposed by McCarthy et al. (1955) for a summer research project investigating how intelligence can be exercised by machines, aiming to accurately characterize every aspect of intelligence for a computer to replicate. The literature displays several similar definitions of AI, for example, Simon (1955, p. 96) defined AI as "systems that exhibited intelligence, either as pure explorations into the nature of intelligence, explorations of the theory of human intelligence, or explorations of the systems that could perform practical tasks requiring intelligence." Huang and Rust (2021, p. 31) defined AI as "the use of computational machinery to emulate capabilities inherent in humans, such as, doing physical or mechanical tasks, thinking, and feeling." Technologies that imitate human intellect, machines that perform tasks that humans would perform, and human intelligence manifested by computers are more recent definitions of the term (Bolander, 2019; Huang & Rust, 2018; Shankar, 2018). Piscopo and Birattari (2008, p. 275), on the other hand, described machines with AI as artifacts that can carry out tasks in the real world without human involvement.

Davenport (2018) identified some of the core technologies that have been used within AI; these include machine learning, natural language processing, rule-based expert systems, neural networks, deep learning, physical robots, and robotic process automation. Kaplan and Haenlein (2019) also indicated that AI is capable to accurately understand external information, learn from such information, and display dynamic adaptation. Davenport and Ronanki (2018) focused on AI's software platforms, such as automating corporate operations, discovering new information from data, or connecting customers and employees. Brooks (1991) alternatively suggested that AI was intended to make computers, like people, do things, which can be described as intelligent. Intelligence here refers to the ability to understand identity, emotional knowledge, rationality, innovation, reasoning, and critical thinking (Russell & Norvig, 2016). Currently, robots can only be trained to execute a limited set of activities, such as identifying human faces or forecasting how likely an Internet visitor is to click on a banner advertisement. Often referred to as "weak AI" or "narrow AI," these algorithms are incapable of learning outside the small area of their design. However, Kurzweil (2005) pointed out that as learning is a mental activity, in principle any mental activity may be learnt; and since computers can learn to learn, it is conceivable to create machines that can "learn how to learn" in the future, a notion known as "strong AI".

2.2 Social Media, AI, and Marketing

One can hardly write about marketing and consumer behavior nowadays without bringing into the discussion social media. The latter has become an environment where consumers engage in a many-to-many communication and the creation and dissemination of content. This is further enabled by the emergence of online communities (Kaplan & Haenlein, 2010), allowing brands to permeate their presence to target audiences (Fournier & Avery, 2011; Wirtz et al., 2013). For quite a while now, business organizations have been collecting and making use of increasing quantities of data, leading to the development of successful frameworks for distributed data analysis. Such frameworks include streaming, batch, and graph processing systems (Carbone et al., 2017; Dean & Ghemawat, 2008; Gonzalez et al., 2014; Isard et al., 2007; Zaharia et al., 2012). The proven success of these frameworks encouraged businesses to delve more into analyzing large data sets which has now become a crucial part of their marketing and business decision-making; it has also ushered in the age of "Big Data."

Like their counterpart in other business functions, marketing specialists saw an opportunity in the availability of large amount of unstructured data that were created in blog posts, online reviews, and social networking sites (Wedel & Kannan, 2016). AI techniques are increasingly used to mine this data, identifying patterns to connect social media activity with firm outcomes (Goh et al., 2013; Netzer et al., 2012). Using text mining techniques on social media user-generated content, these specialists can build an econometric model that measures the impact of social media activity on consumers' purchase behavior. Similarly, text mining techniques are used to examine user-generated content related to product (e.g., online reviews) that shows how sentiment toward specific product features predicts future sales. (e.g., Archak et al., 2011).

Analytics programs are also being applied to social media data to inform business decisions and derive consumer insights in different industry contexts (Andzulis et al., 2012; Choi et al., 2018). For instance, Xiang et al. (2015) found a strong correlation between guests' experiences shared in online reviews and guest satisfaction ratings. Kwok and Yu (2013) used text analytics techniques to identify the type of content (e.g., text, link, photo, and video) and message (e.g., marketing vs. conversational) that received more engagement on Facebook in the context of restaurants. Xu et al. (2016) advanced a framework that combined insights from big data (e.g., social media) and traditional marketing sources to develop new products and provide a taxonomy on the appropriateness of relying on big data versus traditional marketing data sources. Fan et al. (2015) argued that social media content analysis can help with customer segmentation and profiling, online reviews can help build a product's brand reputation, and social media can support location-based advertising.

2.3 AI and Business Intelligence Applications

The term "AI application" does not have a precise meaning (Legg & Hutter, 2007). Various aspects of intellect are thought to exist for humans. Based on the context and the type of decision that must be made, AI applications may differ in complexity (McCarthy et al., 1955; Nilsson, 2010). It has been almost 30 years since AI was first introduced, and its use has grown dramatically. Implicitly constructed applications are those that use statistics to learn from past mistakes and so are not entirely predictable, error-free, or explainable (Simon, 1955). Human developers provide computers with reasoning rules and information retrieval to automate work tasks, sometimes referred to as automated systems. These rules result in systems that are reliable and explicable, with well-defined and well-documented capabilities (Bolander, 2019). AI has gained momentum as new applications are made possible by rapid advances in a wide range of information technologies (e.g., computer vision, machine learning, and natural language processing) and an explosion of data to train available algorithms (Bornet et al., 2021). For instance, Japan's leading convenience store 7-Eleven (SEJ) designed a new platform named "Seven Central" for the "practical data use to support the company's future IT strategies and transformational initiatives." Once a customer makes a purchase, it takes Seven Central "barely a minute" to use that data. That enables SEJ to gain real-time data insights for business intelligence as well as ensure that their data is secure (*Faster insights with real-time analytics*, Google Cloud case studies).

The scope of data applications is expanding to encompass more complex AI and machine learning (ML) techniques, capable of supervised learning, using and training deep neural networks that can be used in prediction (Jordan & Mitchell, 2015). However, the promise of AI is much bigger than supervised learning; emerging AI applications are increasingly operating in changeable environments, reacting to changes, and taking sequences of actions to accomplish long-term, designated goals (Agarwal et al., 2016; Nishihara et al., 2017). These new reinforcement learning (RL) applications are designed to learn to exploit the gathered data as well as explore the space of possible actions. RL deals with learning to operate continuously within an uncertain environment based on delayed and limited feedback, finding their way into dialogue systems, UAVs, and robotic manipulation (Gu et al., 2017; Ng et al., 2006; Van Den Berg et al., 2010). The central goal of an RL application is to learn a policy, a machine that yields effective performance over time, e.g., piloting a drone. These machine's characteristics drive new systems requirements which will support fine-grained computations, rendering actions in milliseconds when interacting with the real world. Existing frameworks that have been developed for Big Data workloads or for supervised learning workloads fall short of satisfying these new requirements for RL.

2.4 Artificial Intelligence and Marketing Functions

Artificial intelligence is an important technology that is having a significant impact on the capabilities and marketing management, as well as the optimization of marketing functions and strategies. Although AI is recognized to offer potential benefits for consumers (e.g., Pitardi et al., 2021), there are, however, inherent concerns for consumers derived from AI's increased use, including privacy, dehumanization (Lobschat et al., 2021; Puntoni et al., 2021), thought, and emotions (British Psychological Society, 2021). This is especially so, as marketing and consumer behavior have mainly drawn on psychological theories as a core source in gaining a deeper understanding of the thinking, desires, and experiences of individual consumers (Malter et al., 2020).

Nevertheless, AI associated with adaptive and dynamic big data has created capabilities that have a significant impact on marketing management; these capabilities can lead to value creation through the marketing mix (Erevelles et al., 2016). The literature is exploring the role that robotics will have in settings, such as services, service encounters, and the formation of service attitudes (Borghi & Mariani, 2021; Huang & Rust, 2018; Mariani & Borghi, 2021; Paluch & Wirtz, 2020; Pitardi et al., 2021; Van Doorn et al., 2017; Wirtz et al., 2018).

Research on AI's relevance to marketing has recently increased with consumer research, organization, and marketing strategy as emerging core areas (Mustak et al., 2021; Vlačić et al., 2021). In this paper and following Yang and Siau's (2018) marketing function classification, the use of AI will be looked at in the main marketing functions of promotion, marketing information management, customer service management, marketing decision-making, marketing operations, pricing and product place management, financing and securing transaction, and transportation.

In terms of promotion, using AI-powered conversion optimization tools, businesses may capture consumers' preferences for certain products with the aim of recommending or promoting similar products, resulting in increased business conversion (Miikkulainen et al., 2018). For example, advertisement image click-through rates may be used to score advertisements, and AI can then choose the most effective ones based on those results (Gijs et al., 2019). Promotional activities would then be issued to customers automatically through e-mail, postal mail, or media platforms; all based on data gleaned from consumer behavior research. In addition, businesses may foresee customer behavior and choose the kind and timing of the offer (Turban et al., 2018).

In relation to marketing information management, Sterne (2017) pointed out that large amounts of big data from many sources may be crunched by AI systems and then extracted for use in business decisions. By making use of AI, a company's ability to gather and analyze data will be enhanced, as well as its ability to have better understanding of its consumers' needs, wants, and interests.

Furthermore, AI has had a significant influence on customer service management; it greatly enhanced the analysis of client data to provide services and goods that are both individualized and customized (Turban et al., 2018). Kühl et al. (2019) pointed out that for the purpose of eliciting and monitoring customers' needs, AI has already shown its capacity to provide useful insights and guidance using supervised machine learning models. Since chatbots are currently commonly used in consulting and after-sales support, it is now possible to provide customer care to customers around the clock (Rozga, 2018). Customer feedback and sales marketing are other common uses for robocalls (Jarek & Mazurek, 2019). The importance of using social media platforms to communicate with clients directly cannot be overstated (Rohm et al., 2013). Prioritizing customers' problems and properly deciding which to reply to is critical since, with prevalent consumerism, it is unwise and does not make business sense to disregard customer comments (Gijs et al., 2019).

More than a century ago, Weld (1917) suggested that marketing decision-making could be improved and supported by intelligent systems, which offer options based on the knowledge of the environment that was made available to them. Selling procedures, distribution networks and product place, material or commodity rearrangement, and sales pricing and profit margins are all choices that must be made for a company to be effective in the current market conditions. According to Moreno (2009), it is possible to create a model that mimics the decision-making process of expert traders using AI, depending on the model's scalability and accuracy. A hybrid intelligence system is useful for creating marketing plans as it blends computer analysis with the opinion and inventiveness of the human mind (Li, 2000). Speeding up strategy generation, strengthening decision-making certainty, and increasing decision abundance are all potential advantages of AI-based systems for decision-making (Li & Li, 2009). Such systems would maximize efficiency by assisting in making more consistent judgments, particularly in analyzing the industry's situation, company's resources, and capabilities, as well as production planning decisions (Metaxiotis et al., 2002).

Marketing operations are as important as other marketing functions. Due to disruptive changes in marketing brought about by AI, firms need to constantly improve their performance to keep up with these developments. Using chatbots, AI-powered search engine optimization, and other AI technologies in web design allows AI website builders to develop simpler and more efficient and effective user interfaces (Bharat, 2017). AI also improves managers' creativity and allows companies to devote more time to developing new products by taking away tedious and repetitive tasks (Kumar et al., 2019), freeing up human resources for creative and innovative endeavors. AI applications can help in creating a wide range of new marketing procedures that can be implemented automatically and dynamically in a variety of scenarios. As Wirth (2018) noted, marketing is increasingly relying on technology such as speech and image processing to aid in the management of information and execution of plans at an unprecedented scale. Human activities are continuously and rapidly being replaced by an AI-assisted technique, known as natural language processing (NLP), which uses AI to develop an understanding of what people do (Dutton, 2018).

Effective management of pricing and product place is crucial for business development and survival. AI can measure market performance and product demand to effectively forecast price changes of various products and services (Milgrom & Tadelis, 2018). AI can also analyze and estimate the market's development and can therefore forecast future needs (Burgess, 2017). Armed with those business intelligence insights, companies may accordingly set the price of their products at a desirable and acceptable level, which can be automatically modified using AI-based aggregate analysis, and then delivered to the market and location in the required quantity and timing.

In the realm of financing and securing transactions, AI has already shown its ability to secure adequate cash and budget for marketing efforts, as well as to facilitate the checkout and payment process. To improve checkout and payment security and convenience, using AI has provided a range of financial help to customers. AI's capacity to mimic human cognition with its large databases enabled identifying, avoiding, or overcoming fraud and cyberattacks in the payment process. False detection AI systems must be continually updated to keep up with market trends and verify that actual customers rather than an intruder are really paying for their services (Dutt et al., 2018). Automated payments made possible by AI-based procedures not only enhanced payment security but also made payments more convenient and efficient (Jarek & Mazurek, 2019). The subscription feature, auto replenishment, and stored payment method information are all examples of automated payments.

As part of the overall consumer experience, transportation and delivery is a critical marketing arena that is heavily affected by AI. Fundamental marketing efforts might be ruined without paying attention to transportation. Refrigeration delivery trucks are being fitted with automated air temperature monitoring technology and clever sensor structures (Shan et al., 2004). Scientists and researchers have previously proposed the idea of temperature recorders and sensors that are able to discover problems, determine status, and monitor performance online (Shan et al., 2004). A growing number of companies are turning to AI to streamline and automate their delivery processes (Kumar et al., 2019). For example, Uber Eats makes use of AI to improve delivery timings by considering all relevant factors, such as projected cooking process of meals, time it takes the vehicle to collect, time it takes the business to bring food to the customer, and the presence of vehicles (Williams, 2018). Currently, there is only a dearth of studies examining the benefits and effects of AI in marketing. Furthermore, much of the available work focuses on the effects of AI, overlooking the mechanisms through which it generates such effects.

2.5 AI, Business Decision-Making, and Organizational Structure

AI is increasingly becoming crucial in supporting knowledge management. Studies show that new meanings and roles are predicted to be generated because of the interaction between people and technology systems. Scientists find that AI can be used to gather, as well as understand and evaluate data, enhancing the speed and variety of data (Shollo & Galliers, 2016). Nevertheless, Metcalf et al. (2019) noted that the development of AI may be difficult since information is always evolving and complex in nature. Research further shows that humans are critical to ensuring data accuracy and assessment (Shollo & Galliers, 2016). It has also been established that implicit knowledge is significant for the analysis of facts in making high-level strategic judgments (Acharya & Choudhury, 2016). According to Metcalf et al. (2019), the lack of conceptual frameworks and the dependency on past records to forecast trends are key limiting restrictions of AI.

Terziyan et al. (2018) presented a patentable intelligence (Pi-Mind) approach where human decision-makers are cloned, to catch sensitive information and probable values. However, the target's ability is always dependent on the input data given by people. When technology is overstated, companies tend to concentrate on data storage rather than information exchange. According to the 90/90 principle of 90/90 data use, the value of data diminishes as they age, where nearly 90% of data is rarely accessed after 90 days (except for auditing and legal purposes). In other words, roughly 90% of data lose most of their value after 3 months if not used for business intelligence. Acharya and Choudhury (2016) suggested a cross experience and understanding approach to overcome this issue. They stressed the importance of information in every phase of the decision-making process and feel that organizational resources must be made available to allow effective organizational learning.

Decision-making power may be assigned across roles and units that demonstrate varied degrees of interconnectedness to alleviate the challenge of limited human processing capacity (Von-Krogh, 2018); this challenge can be alleviated by the deployment of AI. Adaptation or development of structures is thought to be crucial for the integration of AI. As a result, organizations' procedures and functions will shift as soon as AI technologies are put into use (Von-Krogh, 2018). Rather than building new operations on top of existing ones, Bienhaus and Abubaker (2018) suggested that operations should be rebuilt and rethought from the ground up. Using Paschen et al.'s (2019) framework, researchers may determine whether the application of AI leads to new products or services and whether the introduction of AI enhances or diminishes human capabilities. Firms may generate different value-creating innovations depending on the mix of these aspects (Paschen et al., 2019). Lismont et al. (2017) reported that the more developed a corporation is in applying AI, the more applications, processes, and associated objectives they had. Tabesh et al. (2019) further suggested that a firm's sophisticated structure should only be adjusted in phases and always with close adherence to a defined methodology. These authors argued that AI may have a positive effect on corporate systems when it is used in decision-making. Furthermore, the type and location of AI to be installed are dictated by the organizational purposes for their installation, with the acknowledgement that existing decision-making processes will also be affected using AI and are likely to need some changes.

It has been shown that although AI literacy is essential for determining whether and how to incorporate AI into current business processes, nevertheless, not every decision issue has to be handled by technology (Kolbjornsrud et al., 2017). AI literacy requires a thorough understanding of the technology, including its merits and disadvantages (Whittle et al., 2019). Rather than relying just on top management, experts recommend including all employees who would be affected by the AI implementation. Being familiar with and engaged in the incorporation of technology give participants a sense of belonging and allow them to define and value their role in the project. Education, it is argued, is essential to maximize AI's potential, as well as a thorough analysis of the competencies required to use AI effectively by each person (Whittle et al., 2019). Top management plays a central role in helping their employees; this further suggests that managers themselves must be knowledgeable and have experience in AI technologies (Kolbjornsrud et al., 2017). Coordination at all levels of management, constructive information sharing, proper knowledge management practices, and a sense of business acumen all enforce a company's competitive edge in artificial and business intelligence. Moreover, AI should be implemented in stages to allow confidence in AI to be built and improved with more experience and knowledge acquisition; also, with AI introduction into corporate decision-making, soft skills like teamwork, creativity, and good judgment become more vital (Kolbjornsrud et al., 2017; Whittle et al., 2019).

Moreover, transparency is essential for the introduction and use of a new technology, providing information about the nature and flow of data and the contexts in which it is processed (Singh et al., 2019), requiring a team of top managers from current and future levels and individuals with suitable training (Watson, 2017). An appropriate team would best be identified by the leader who would be helping throughout the process.

In relation to confidentiality of data, as well as the risk of information leakage, Kolbjornsrud et al. (2017) and Whittle et al. (2019) claimed that the increased openness and literacy will help reduce prejudice; having more data accessible was also seen as an advantage (Migliore & Chinta, 2017). However, this premise is called into question, especially since gathering sufficient good-quality data has proven to be difficult (Lepri et al., 2018). Furthermore, machine learning is always seen as biased. Both AI Equality 360 (Bellamy et al., 2019) and Transparent Techniques (Lepri et al., 2018) have been offered to provide answers for fair all processing stages, but they are also thought to decrease rather than eliminate prejudice. As Canhoto and Clear (2019) noted, the quality of a choice relies on the application used, the resources available, the information supplied, and the interpretive abilities of the individuals who use it.

There is, however, evidence to suggest that learning, as well as an understanding of information confidentiality risks, may cause more openness and hence less concerns. In addition, a successful implementation has been shown to depend on active engagement of the impacted people and a step-by-step introduction. Notwithstanding the risk of active or unconscious prejudice, the importance of ethics should not be overlooked in implementing AI processes and structures.

3 Conclusion

Artificial intelligence is being increasingly considered as a very crucial concept in building industries' competencies. In this paper, AI, as the ability of robots to mimic human thinking, was touched upon. Machine learning, neural networks, deep learning, physical robots, and robotic process automation were identified as just a few of the AI technologies that are being employed today in business marketing and decision-making. It was felt that incorporating AI often overlooked the dimensions of intelligence, including self-awareness, emotional understanding, as well as reasoning, creativity, logic, and critical thinking.

This study briefly covered the marketing functions that are most affected by AI. It was shown that AI's usefulness in promotion resides mainly in enabling firms to collect client preferences and propose comparable items or promotions. Referring to market information management and customer service management, AI is seen to help companies to analyze vast volumes of data from several sources. AI stimulates the analysis of customer data to give personalized and customized services and items. Decision-making may be improved and supported by intelligent systems, offering options constrained by decision-makers' own knowledge of the environment. In generating marketing strategies, a hybrid intelligence system is seen as ideal since it combines machine analysis with the judgment and creativity of humans.

It is suggested that firms need to constantly keep up with AI and related developments. Chatbots, AI-powered search engine optimization, and other AI technologies in web design are found as popular methods for improving an organization's market presence. AI developments were most successful in pricing, product management, and financing and securing transaction, by securing adequate cash and budget for marketing efforts and facilitating the checkout and payment process. Big data analysis appears to be useful in identifying, mitigating, or overcoming corruption and breaches in online payment. Furthermore, transportation and delivery are critical marketing functions that are heavily affected by AI, as a growing number of companies are turning to AI to streamline and automate their delivery processes.

AI has also proven vital for strategic decision-making, especially in data collection, analysis, and evaluation. In relation to organizational structure and strategy, determined advancements of AI applications in a firm are more likely to change structures and increase procedures and goals. Applying AI in corporate processes requires a thorough knowledge of the technology and technologically competent top managers who must lead their teams. Many researchers have written about concerns associated with AI, particularly on information confidentiality, privacy, and algorithms' neutrality. This paper is limited to studying AI and its support to marketing functions and business decision-making. Further research may focus on how

AI impact the future of marketing, how firms need to change their marketing strategies to cope with AI evolution, and how customers' behavior will be impacted.

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Internet of Things for Healthcare: Evaluate User's Acceptance and Sustainability During Pandemics

K. P. Jaheer Mukthar, C. Nagadeepa, T. K. Satheesh Kumar, Edwin Ramirez-Asis, Juan Villanueva-Calderón, and J. K. Singh

1 Introduction to IoT

The IoT integrates everyday "Things" with the computer. The term "IoT" (Internet of Things) refers to collective networks of interconnected devices and the technology which helps to communicate between devices and cloud and also between the devices itself (Kosmatos et al., 2011). The use of software and other technologies to connect to and exchange data with other systems and devices via the Internet. With the advancement in technology and also because of cheaper computer chips and high bandwidth telecommunication, we now have billions of devices connected to the Internet. This includes everyday physical objects such as toothbrushes, lightbulbs, vacuums, cars, machines, healthcare assets like medical devices, smart watches, and now even we have smart cities (Madakam et al., 2015).

1.1 Healthcare IoT or Internet of Medical Things (IoMT)

Prior to the IoT, patient communication with their doctors limited to visits and tele or text communication. Continuous monitoring of patient health was difficult task for a doctor. But IoT-enabled devices have made it possible for a doctor to monitor

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their patient health remotely (Ha & Longnecker, 2010). Patients from remote area are monitored via IoT sensors. The IoT has a huge impact on lowering healthcare expenses and enhancing patient outcomes (Razdan & Sharma, 2021).

The Internet of Medical Things (IoMT) is a grouping of medical software and hardware that communicates with Internet computer networks to link to healthcare IT systems. Wi-Fi-enabled medical devices provide the machine-to-machine connectivity that forms the core of IoMT (Srivastava et al., 2022). IoMT devices connect to cloud infrastructures like Amazon Web Services, allowing for the storage and analysis of collected data. IoMT is another name for the IoT in healthcare. The IoT is revolutionizing the healthcare sector by changing how devices and people interact while providing healthcare solutions (Ha & Longnecker, 2010). Applications of the IoT in healthcare are advantageous to patients, families, doctors, hospitals, and insurance providers.

1.2 IoT for Patients

The IoT has tremendous impact on people's lives, especially the patients and their families by constantly monitoring the health condition.

With the use of wearables like fitness bands and other wirelessly connected medical equipment like blood pressure and heart rate monitor cuffs, glucometers, etc., patients can receive individualized care (Internet of Healthcare Things, n.d.). These devices can be set up to remind users to monitor changes in their blood pressure, appointments, and a variety of other things.

Patients can obtain individualized care with the help of wearable devices like fitness bands and other wirelessly connected equipment like blood pressure and heart rate monitor cuffs, glucometers, etc. (Internet of Healthcare Things, n.d.). These gadgets can be programmed to remind users to keep track of their blood pressure changes, appointments, appointments, and many other things.

1.3 IoT for Doctors

Doctors can monitor patients instead of physical meaning which can be done using wearables and other monitoring sensors during this COVID-19 pandemic. They can monitor a patient's improvement to decide about their treatment regimen or any urgent medical needs (Javaid & Khan, 2021).

1.4 IoT for Hospitals

In addition to patient health monitoring, hospitals may use IoT devices in a wide range of additional applications. The IoT enables the real-time data about the hospital infrastructure availably like wheelchairs, beds, oxygen cylinders, etc. using IoT cloud data management. Hospital patients are really worried about the spread of infections. IoT-enabled hygiene monitoring technology can help prevent patient infection. The usage of IoT devices for asset management functions including managing pharmacy inventories, monitoring refrigerator temperatures, and regulating environmental humidity and temperature is also beneficial.

1.5 IoT-Based Application in Healthcare Devices

In IoT market, healthcare devices represent one of the fastest growing sectors in this market. As per studies, the value of this market is estimated to reach 176 billion dollars by 2026 (IoT Medical Devices Market – Global Forecast to 2026 | MarketsandMarkets, n.d.). The usage of the IoT is drastically increasing over the years.

The IoT in healthcare enables real-time health monitoring and data access resulting in improved patient's health, experience, and enhanced healthcare operations. This way doctors have been empowered to offer healthcare service of better quality.

The following are some examples of how IoT-connected smart devices (Xu et al., 2014) are helping medical service provider to function more efficiently and patients to get better treatment.

- Virtual/remote hospitals
- Glucose/heart beat monitoring
- Wearable biosensors (WBs)
- Smart thermometers
- Connected inhalers
- Smart watch monitoring.
- AID (automated insulin delivery system)
- Robotic surgery

2 Need for IoT for Healthcare During COVID-19

2.1 Emergencies/Situations During COVID-19 and Other Pandemics

With at least 170 million victims worldwide in 2021, the COVID-19 epidemic is still wreaking devastation. The WHO designated the coronavirus disease of 2019 as "COVID-19" in February 2021. Since the first case of COVID-19 was identified, scientists have been working hard to find strategies to prevent and treat the disease in more than 30 different nations and areas. There was an emergency situation raised due to the following reasons, and there is a need for technology to control the situation.

More of affected people: During the phase, one and two people were affected by coronavirus; day by day, the no. of affected people was increasing. And moreover, people are afraid to say that they are affected, as the affected people were isolating not only the member and the entire house/building/apartment. Healthcare people who are testing and attending the coronavirus people are also infected and lost their life also. Hence, there was a critical system needed for the government to find out the affected people and monitor their movement also.

Shortage of hospital infrastructure facility: The increase no. of affected people needs more of hospital facility like oxygen, hospital bed (inpatient), doctors, nurse, etc. But as the resources were very less, the government faced a lot issue regarding facility. There was a need for a system which matches the demand and supply (availability of facility). Further, data was required by many people like patients, doctors, local bodies, and government to accommodate the affected people. Further, a number of social media organization also need the data to update their sites; hence it can be used by the followers of the social media.

Shortage of doctors/nurse/attenders: Since doctors, nurse, and healthcare workers are also affected by the virus, there was a shortage of these people. Further, people were not sure about their deceases. Health workers are not available in some of the remote place.

Availability of transport facility: There was no availability/shortage of transport facility which created a situation that people could not reach the hospital on time. Limited ambulance facility and delay in medical aid are also created an emergency situation.

Information search/availability: Social media are a source of information for the normal humans. People use to search the data or information regarding status of affected people and statistics of present and expected future situation. The statistics of the coronavirus-affected people and the status regarding the pandemic are required by the government, researchers in medical field, social media, and apex bodies of word healthcare. Based on that the concern, authority can take the necessary actions.

Hence, an increase in demand for IoT-related healthcare applications are required for the people to solve the above issues in the pandemic situations (Fig. 1).

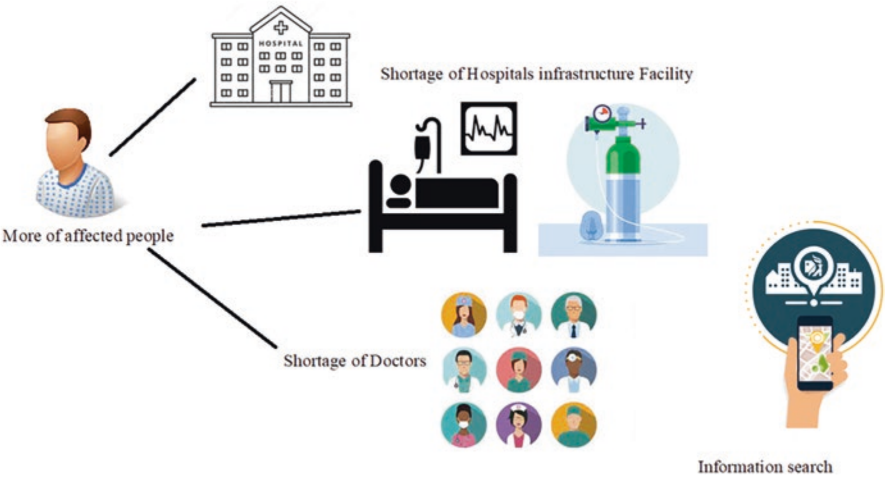


Fig. 1 Need for IoT for healthcare during the COVID-19 pandemic

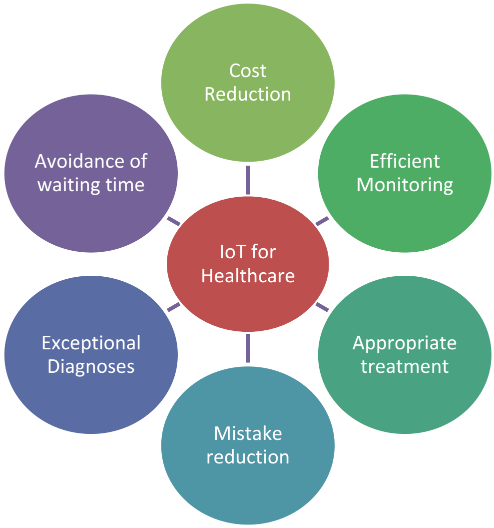
3 Key Merits of IoT for Healthcare Application and Devices to End Users

Before the emergence of the IoT for healthcare applications and devices, people could communicate physically, face-to-face, or over mobile phones or through text only. The IoT enabled the medical professional doctors and health workers to attend in remote area also and eliminated the compulsion of physical examination. Through these new IoT-enabled devices and apps, remote monitoring in the healthcare sector is now possible, unleashing the potential to keep patients safe and healthy and enabling clinicians to deliver exceptional treatment. Further, continuous monitoring of remote patients health reduces hospital stays and prevents readmissions. The IoT has a significant impact on reducing healthcare costs and improving treatment outcomes during the current COVID-19 pandemic. Patients, families, doctors, hospitals, and insurance providers all benefit from IoT applications in healthcare.

IoT device data not only facilitates efficient decision-making but also guarantees error-free, waste-free, and cost-effective healthcare operations (Javaid & Khan, 2021) (Fig. 2).

- Appropriate Treatment: The IoT makes it possible to monitor patients in real time, thereby reducing the number of pointless doctor visits, hospital stays, and readmissions. It enables the appropriate treatment on time.
- Waiting Time: IoT makes it possible to test at home, receive initial diagnosis from home, and have the results available in a phone app, allowing people to avoid traveling and waiting for doctors and results.
- Mistake reduction: It gives complete openness and empowers doctors to make decisions based on the best available data.

Fig. 2 Key merits of IoT for healthcare



- Effective monitoring: Real-time data and ongoing patient monitoring aid in early disease diagnosis—sometimes even before symptoms of the disease appear.
- Exceptional diagnosis: Continuous health monitoring makes it possible to offer preventive medical care and provide appropriate treatment on time.
- Cost reduction: These technologies are cost-effective for both the patients and the doctors/hospitals.

4 IoT for Healthcare Applications During Pandemic Situations

IoT technology provides non-clinical symptom diagnosis and data sharing with clinicians, enabling remote healthcare. IoT scenarios that are useful in pandemic events include the following (Fig. 3):

- IoT healthcare aids during pandemic situations: IoT technology provides non-clinical symptom diagnosis and data sharing with clinicians, enabling remote healthcare. IoT scenarios that are useful in pandemic events include the following:
- Monitoring your breath: Frequency and breathing patterns can be used to gauge a person's health, and aberrant breathing patterns in COVID-19 patients may be a sign of more serious problems. Therefore, respiratory monitoring is crucial in therapeutic settings. Traditional breath measuring is problematic for those in need because it necessitates hospital visits and professional medical gear linked to the body. Breathing monitoring becomes commonplace as IoT technology develops.

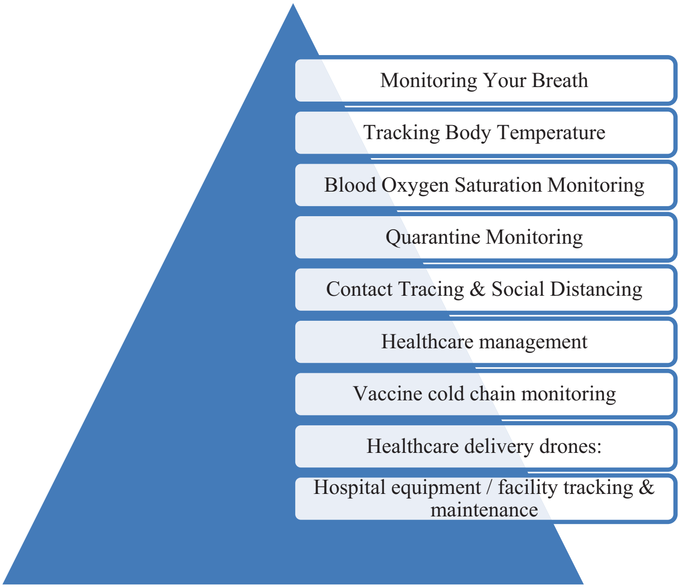


Fig. 3 IoT for healthcare applications during pandemics

- Tracking body temperature: A common sign of COVID-19 is fever, and according to clinical data, more than 80% of COVID-19 patients experience a fever. In order to identify eager individuals and separate them from other patients for additional assessment during the COVID-19 outbreak, many hospitals have installed infrared temperature sensors at the door. As a result, it's critical to keep an eye on fluctuations in body temperature in order to identify and stop COVID-19. In high-risk locations like hospitals, schools, and airports, infrared temperature sensors are frequently used to measure body temperature without making direct contact during continuous and long-term monitoring to prevent fever. Researchers have suggested employing drones equipped with infrared thermal imaging to spot COVID-19-infected individuals in outdoor settings.
- Blood oxygen saturation monitoring: Red blood cell oxygen carrying capacity is gauged by the blood oxygen saturation (SpO2) level. The SpO2 of a healthy individual is greater than 95%. Hypoglycemic SpO2 in COVID-19 patients is a symptom of the illness. In clinical settings, a pulse oximeter is applied to a patient's finger to assess SpO2 levels constantly. However, daily usage of this pulse oximeter is not recommended. Other research examines variations in the absorption of light reflected from wrist blood utilizing wrist oximeters or wrist photoplethysmography (PPG) sensors to assess SpO2 in blood. You may continuously track the relative changes in blood SpO2 by incorporating these wrist sensors into your smartwatch or Fitbit.
- Quarantine monitoring: By isolating those who have contracted the coronavirus, quarantine works to stop the spread of COVID-19. The body-mounted wearable

belt tracks and transmits real-time data to the COVID-19 quarantine facility. Similarly, during quarantine, COVID-19-related concerns are tracked and identified using IoT frameworks. Specifically, different biosensors are employed to identify COVID-19 symptoms in people and send this information to quarantine for additional assessment.

- Contact tracing and social distancing: The COVID-19 incubation period lasts from 1 to 14 days. However, it's also possible for asymptomatic individuals to spread the infection to others. Finding the persons who had touch with the sick person during the incubation period has become crucial because this virus has the ability to spread more quickly and is easily transferred. Social distancing keeps a safe space between people to prevent the spread of droplets when someone speaks or coughs due to an infectious disease such the coronavirus or influenza virus. For proximity detection, IoT devices with various sensors, like GPS, microphones, and magnetometers, are frequently employed for social distancing and contact tracing.
- Healthcare management: Inadequate hospital capacity visualization, particularly when it comes to bed availability, is frequently linked to poor healthcare management in underdeveloped nations. The IoT sensors installed on the beds give medical employees the opportunity to easily determine the availability of the beds using cloud-based technologies. Utilizing eBMS helped cut down on bed wait times significantly, giving patients in emergency rooms prompt access to care. IoT solutions like eBMS can help governments get ready for upcoming pandemics and provide crucial guidance to healthcare stakeholders.
- Vaccine cold-chain monitoring system: In developing countries, it has proven difficult to ensure necessary services during COVID-19 through vaccine cold-chain monitoring. IoT and mobile technology offer the potential to streamline the supply chain for vaccines. Cold chain data loggers send precise data of condition records via cellular data networks to the cloud via IoT sensors attached to the vaccine. The UNDP and the Indian government created the electronic vaccine intelligence network (eVIN). This app monitors the location, temperature, and vaccination stock levels using IoT sensors attached to the vaccine, assuring a secure and dependable supply.
- Healthcare delivery drones: Patients receiving care at home rather than in a hospital environment could receive medication and supplies via IoT-enabled drones for healthcare transport blood samples obtained at home to the lab. All throughout the world, drones are being tested for use in healthcare.
- Smart wheelchairs: These smart devices are invented for the physically challenged people to access with human attenders. Full automation for disabled people is one of the responses from IoT, similar to the acceleration in the pace of work.
- Hospital equipment/facility tracking and maintenance: In a busy hospital, it's common for important equipment to go missing. Because tracking the availability of expensive equipment takes up to 20% of a caregiver's time, automated track and trace systems are crucial. To provide real-time visibility into the location, condition, use, and maintenance of any medical equipment, the asset track-

ing solution uses IoT intelligence. For analysis and reporting, data is fed into reports that can be sorted by facility, department, unit, etc. This enables purchasing hospital assets with knowledge.

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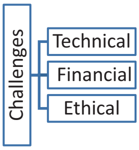
5 Users' Challenges While They Use IoT for Healthcare Applications and Devices

The IoT in healthcare is beneficial for patient, but security of healthcare devices is a serious concern due to its limited security control around IoT devices.



- *Technology-Related Challenges*

Technical issues result from the fact that the IoT is still not a common practice. In the majority of nations, 5G technology is not fully available; it is still under development process. The introduction of the IoT in healthcare is said to be facing its first technological challenge, which is 5G. Multiple antennae must be installed in order to implement 5G, which is a bit expensive and time-consuming process and has been linked to a health risk.

The integration of data presents the following technical challenge. Multiple data sources imply several devices. There are numerous wearables and data collection tools in the healthcare industry, but for technological and financial reasons, it is difficult to convert them into a unified pattern of data collection. Manufacturers have still not come to an agreement on communication standards and protocols.

- *Finance-Related Challenges*

Financially speaking, the IoT falls within the category of remote health applications. Direct and indirect healthcare expenditures are generally separated. The former include expenditures for healthcare providers, whereas the latter include costs for healthcare beneficiaries, such as time away from work, unpaid medical bills, and involvement of family members or other caregivers in their care. There is little data on the cost-effectiveness of IoT healthcare services because they have not yet been implemented in a major healthcare system.

- Ethical Challenges

The data/information management is at the center of the ethical debate around IoT in healthcare. When it comes to the administration of sensitive health-related data, the primary points of contention are privacy of information, information sharing policy, and copyright of the data (ownership of the data) and questions of uncertain value. The dehumanization and isolation of doctor-patient connection, the decontextualization of health and well-being, and the danger of unprofessional treatment are all alarming from an ethical standpoint under the care paradigm.

The major challenges faced by the healthcare industry while implementing IoT devices are described below:

Technical Challenges:
- Data security and privacy concern
- Integration with multiple devices
- Limited bandwidth and connectivity

Ethical Challenges
- Lack of standardization
- Lack of skilled professionals

Financial Challenges
- High implementation cost

- Data security and privacy concern: In healthcare always, the patient safety and security are always in priority list. If the IoT devices do not give proper security, it means that the privacy of patient data is in danger. Regarding ownership and control of data, there is a lot of confusion. As a result, the data saved in IoT-enabled devices is vulnerable to data theft and is therefore more accessible to hackers who want to compromise personal health data (Khan et al., 2018).
- Cybercriminal can misuse the patient electronic health record to purchase drugs and other medical equipment which they can sell it later.
- Integration with multiple devices: Implementing IoT in healthcare is frequently hampered by integrating several types of devices. This hurdle exists because, as was previously stated, device makers have not made equivalent progress in creating communication standards and protocols.
- Manufacturers create their products independently of one another and within their own IoT ecosystem. Because of this, their devices are incompatible with older healthcare apps and systems.
- Lack of standardization: The secret to developing protocols that are universally approved for interoperability across medical devices is standardization. There are many different languages, standards, and protocols that are used to connect IoT devices. The ownership and control of data are unclear because there are no rules that are widely acknowledged.

- Limited bandwidth and connectivity: Data transfer is slowed down because of poor connectivity. Limited connectivity is the main issue with the IoT when trying to connect devices. Although the majority of medical IoT devices are Wi-Fi-connected, many also feature cellular capabilities to mask connection failures in the event that Wi-Fi is disrupted.
- The consequences of a lost connection are too great in the healthcare industry. It may have terrible effects on the sufferer. Low latency must be taken into account because of this.
- High implementation cost: The increase in healthcare cost is concerned for everybody. The IoT has not yet made healthcare facilities accessible to the middle-class people. Making IoT healthcare devices affordable is essential for its successful implementation and complete optimization; otherwise, it will always be out of reach for everyone, and it will be applicable only for the high class.

6 Technology Acceptance of IoT for Healthcare by End Users

Many studies are conducted to find out the acceptance of a new technology by the user of that technology. The results may be helpful for the manufacturer, users, and researchers to develop further and enhance the technology so that user can be benefitted more.

The IoT for healthcare was less popular before the pandemic, because people use the traditional method more than the latest technology. But the COVID-19 has over wheeled this traditional method among the people. The lockdown made the people to take turn toward the technology. The technology acceptance of the IoT for healthcare was taken for the current study.

In order to identify influential writers and their points of view, a thorough literature review was done in the field of technological acceptance. A number of models were looked at, and two of them were selected based on their acceptance and popularity in the healthcare sector. To establish the framework for their comparison and contrast, the two most popular modern technology acceptance models are presented in this study:

- The technology acceptance model (TAM)
- The diffusion of innovation theory (DOI)

6.1 Technology Acceptance Model: Methodology

TAM – This model was first developed by Davis, 1989. This model is developed to measure the user's acceptance level by measuring the following:

- How easy this technology is to handle?
- How much effective this technology is?
- How far this technology is useful?
- Whether the technology is user-friendly.
- Whether people are intending to use the technology now and into the future.

According to the technology acceptance paradigm, consumer adoption of a technological tool depends on how easy it is for them to use and how valuable it is.

End users' perceived ease of use and perceived usefulness of the IoT for healthcare were considered for this study to measure their intention to use this technology.

6.2 The Diffusion of Innovation Theory (DOI)

One of the earliest social science theories is the diffusion of innovation (DOI) theory (Sahin, 2006), which was created by E.M. Rogers in 1962. It first appeared in communication to describe how an idea or product gathers steam and diffuses (or spreads) within a particular population or social system over time. People eventually adopt a new idea, habit, or product as a part of a social system as a result of this dissemination. When someone adopts, they do something that is different from what they previously did (i.e., purchase or use a new product, acquire and perform a new behavior, etc.). Adoption depends on a person's ability to see an idea, behavior, or product as novel or inventive. This allows for the possibility of dissemination.

End users' compatibility, trialability, and observability of the IoT for healthcare were considered for this study to measure their intention to use this technology. Further, post-COVID scenario was considered for the study to check whether people were aware and started accepting this technology because this kind of emergency situations made the people to accept the technology.

The COVID-19 spanned the definition of the IoT in healthcare, as it propagated for usage for not treating patients and also for other customer. However, the usage of IoT has benefited the customers across various spheres, reaching even the remotest parts and connecting them with health professionals. In this context the research is carried with the intention to understand the facets of diffusion of IoT technology in medical and healthcare customers.

6.3 Study Objectives

1. To know the IoT technological transition in healthcare sector due pandemic, manifested in customer smart devices.
2. To analyze and validate the theories of diffusion of technology and TAM theory with designated variables.

3. To develop a model and to validate the casual relationship that exists between endogenous variables with exogenous variables.

The variables, such as perceived ease of use, perceived usefulness, compatibility, observability, traceability, moderating factors and intention to use, are considered by end customers when evaluating smart devices, including IoT devices and brands. With the given parameters, the hypothesis was developed in line with objectives of the study.

The primary data collected for this study is quantitative, obtained through structured Likert scale surveys administered to respondents via google forms. The data is collected using survey method with 220 respondents in the background of random sampling technique. The collected data are being analyzed using various tools such as spreadsheet, SPSS, and AMOS.

In this study, the data is being analyzed with a family of statistical tools, viz., structural equation modeling, which consists of chi-square test, correlation, covariance, and multiple regression model.

Further, the analysis consists of validating the existing knowledge and reviews with the collected data; hence the research uses the multiple statistical analysis, viz., multiple regression (to know impact), correlation (association between the variables), and chi-square (observed with expected model). The objective is authenticating the conceptualized models in pursuant of erstwhile models mentioned. Hence the conceptualized model is being tested with structured equation model using AMOS.

The study is conducted in the light of post-COVID/pandemic impacting on the usage of smart devices, viz., IoT-enabled tools in maintaining the health and wellness. As discussed earlier in the reviews and theoretical background (TAM and technology diffusion), the below conceptual (theoretical) model is developed based on the synthesis of the literature and research question. This conceptual model is developed to examine the relationship between the various facets of IoT-enabled devices among the health-conscious people.

6.4 Conceptual Framework (Fig. 4)

6.5 Concepts of Proposed Model

- Compatibility: Compatibility with previously established concepts. Technology use is justified as being congruent with previously proposed theories. Considering the requirements of the client, technology utilization is promoted as being in line with client needs.

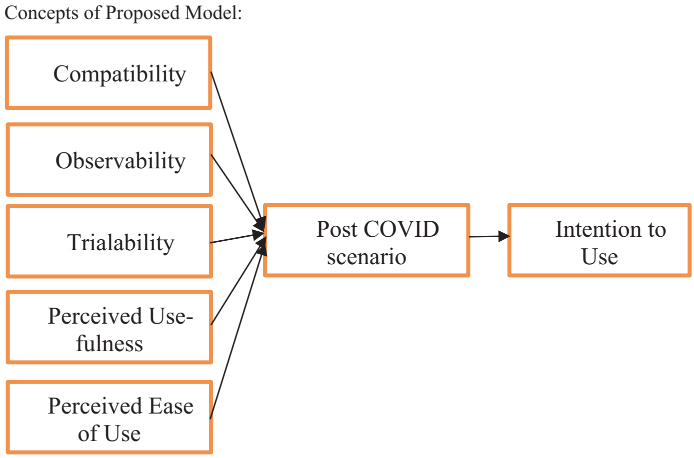


Fig. 4 Conceptual model of end user acceptance of the IoT for healthcare

- Trialability: There are processes in place that make it simple for people to test out technology, including free downloads, trial versions, and prototypes.
- Observability: Potential users can quickly see the consequences and advantages of technology.
- Perceived ease of use: How much a person thinks that using a certain technology will be simple or effortless.
- Perceived usefulness: The degree to which people think a technology will be beneficial.

The hypothesis is developed based on the reviews and research question, viz., “is any relation exists between the variables and impacting on others variables.” In other words, the first hypothesis is developed as to validate the indicators showing any relations among the variables, and the hypotheses are as follows:

H1: There is a relation between the measures (indicators) of perceived ease of use, perceived usefulness, compatibility, observability, trialability, moderating, and intention to use in post-COVID scenario.

With prevalence of IoT devices in the form of smart band sensors, the respondents were asked how the observability related to each other. The objective of the study is to measure the correlation between the latent variables (which are not observed or measured directly); hence below hypothesis is developed.

H2: There is relation between the latent variables, viz., perceived ease of use, perceived usefulness, compatibility, observability, trialability, moderating, and intention to use in post-COVID scenario.

In this study, the parameters are considered for developing a synthetic scenario, wherein researcher striving for building a relationship between the usage intention and perceived features of the IoT products. With this objective in mind, the below hypothesis (H3) is formulated.

H3: There is an association between the sample covariance matrix (theoretical model) and the hypothesized covariance (observed model) matrix.

The other objective is to build the model which can be for representing the causal relations among several variables. The below hypothesis (H4) is developed for validating the model, most suitable and appropriate for the given study area.

H4: There is no impact of "compatibility, observability, trialability, intention to use" on "perceived ease of use, perceived usefulness."

The ultimate objective is to develop a model which signifies the transition in the usage and adoption of IoT technology-enabled devices in healthcare sector. To meet this objective, many variables are identified using TAM and diffusion model. Based on this objective and variables, the below hypothesis is developed.

H5: The causal relationship exists between endogenous variables with exogenous variables moderated by post-COVID scenario.

6.6 *Data Analysis*

There are 220 respondents given their view of technology acceptance regarding the IoT-based healthcare applications. The following table shows the demographic analysis of the respondents who participated in the survey (Table 1).

The survey is conducted with objective to ascertain the casual relationship among the variables which constitute the technology adoption in the IoT, i.e., smart devices in healthcare sector in various place of the globe. The table shows the respondents composition; for the survey, it can be observed that there are female respondents who constitute 62% of the total respondents, whereas male contribute 38%.

Similar results can be observed in relation to educational attainment, as it demonstrates that individuals with higher levels of education tend to be less averse to adopting new technologies. It signifies that gender makes visible approach toward accepting new technology. The respondents comprise below graduation being 32% and above graduation 68%.

The similarity is also noticeable in the age group of respondents, viz., the age group of below 25 year consists of 22% of respondents, 35–45 years constitute

Table 1 Demographic analysis

Demographic feature		%	Total
Gender	Male	38	83
	Female	62	136
Education level	Below graduation	32	71
	Graduation	68	148
Age group	Below 25	22	48
	25–34	35	77
	35–45	25	55
	Above 45	18	40

Table 2 End user perception of IoT-healthcare applications and devices

IoT for healthcare	Means	Factor loading	Rank
It saves time – no waiting time and travel time	4.1	0.706	1
It helps to maintain social distancing/lockdown time	4.08	0.584	2
It allows contactless work and reduces manual job	3.92	0.633	3
It reduces cost	3.9	0.643	4
Medical services are convenient and available at any time	3.89	0.502	5
Facilitates location-based services	3.8	0.584	6
Reachable to any part of the place/remote place also	3.9	0.574	7

Table 3 Usage of the IoT for healthcare – applications

Usage of IoT for healthcare – applications	Means	Factor loading	Rank
Mobile IoT	3.87	0.634	1
Wearable devices	3.57	0.653	2
Community based health services	3.24	0.534	3
Healthcare information – data information	3.19	0.584	4

25%, whereas 25 to 34 years are 35% of the responses, and the rest are above 45 years old (Table 2).

End users of the IoT for healthcare are given their perception regarding their usage, plotted in the above table. The average scores are ranked according to their values. The first advantage of the technology is "Time Saving" by avoiding long queue and waiting for the report some time people use to go on a number of time to get results. The technology helps to overcome these barriers. It helps in maintaining the social distancing and can be accessible at any time from any place. The above table shows the end users' ranking of the IoT facilities according to their perception. These results were supported by the research conducted by researcher (Sultana & Tamanna, 2021) to explore the benefits and challenges of the IoT for healthcare (Table 3).

The above table shows the ranking of the usage regarding the IoT for healthcare application and devices by the respondents. The first and foremost application is mobile apps for healthcare activities. Further, most of them are health conscious and started using IoT-based smart devices like watches in their daily life also. That too, COVID-19 made the people too conscious about their health and their activities. It enhanced the users to use these kinds of devices more in their daily life.

Some of users' expectation regarding this IoT and healthcare applications are as follows:

1. GPS-enabled vehicles – During emergencies, such as accidents, an automatic alert containing relevant information is sent to nearby hospitals, enabling prompt ambulance services. Alternatively, users can avail themselves of this facility by simply clicking a single button.
2. More accurate and integrated information about the availability of hospital facility and doctor's availability.

3. A massive information are available in the social media and a lot of health-related messages are in the social media. The information are just forwarded (e-wom) by many people. There can be a special IoT-related information center that can be controlled, and authenticated information can be passed by them.
4. An awareness is needed in the rural and remote area about these technologies. The users are scared and not so tech-savvy to handle these types of apps and devices.

6.7 Users' Technology Acceptance – An Integrated Model of TAM and DoT

In the next stage, the SEM was conducted to find out the intention to use the technology. The following figure shows the result and the table shows the abbreviations of items used in the model (Fig. 5, Table 4).

The path diagram shows the relationship between the measured indicators and latent variables with construct. This path analysis under the structural equation model exhibits a group of multiple statistical tools to measure and understand the variables. This model validated with statistical significance with reference to the various earlier studies. The below table showcase the validity of the model statistically (Table 5).

Based on the above path diagram and model fit table, the aforesaid hypothesis (H4) is validated and analyzed.

H4: There is no impact of "compatibility, observability, trialability, and intention to use" on "perceived ease of use, perceived usefulness."

The path analysis indicates that there is significant association between the variables "compatibility (1.28), observability (1.35), trialability (0.88), and intention to use" impacting on perceived ease of use (1.03) and perceived usefulness (1.37). Therefore, the hypothesis is "There is a significant impact of 'compatibility, observability, trialability, and intention to use' on 'perceived ease of use, perceived usefulness."

$$\mathrm{COV}_{xy} = \frac{\sum_{i=1}^{n}\left(x_i - x\right)\left(y_i - y\right)}{n}$$

where Cov = covariance, with x and y variables and n being no. of observations.

The above indices show starting with "Absolute Fit Indices", wherein the relative to degrees of freedom with an insignificant p value ($p > 0.05$) is considered. The result so obtained consists of 1.064468 (Wheaton et al., 1977; Tabachnick & Fidell, 2007) and signifies that there is no difference between the observed (theoretical) and expected model. This also magnified with p value >0.05 (Schermelleh-Engel et al., 2003; Vandenberg, 2006).

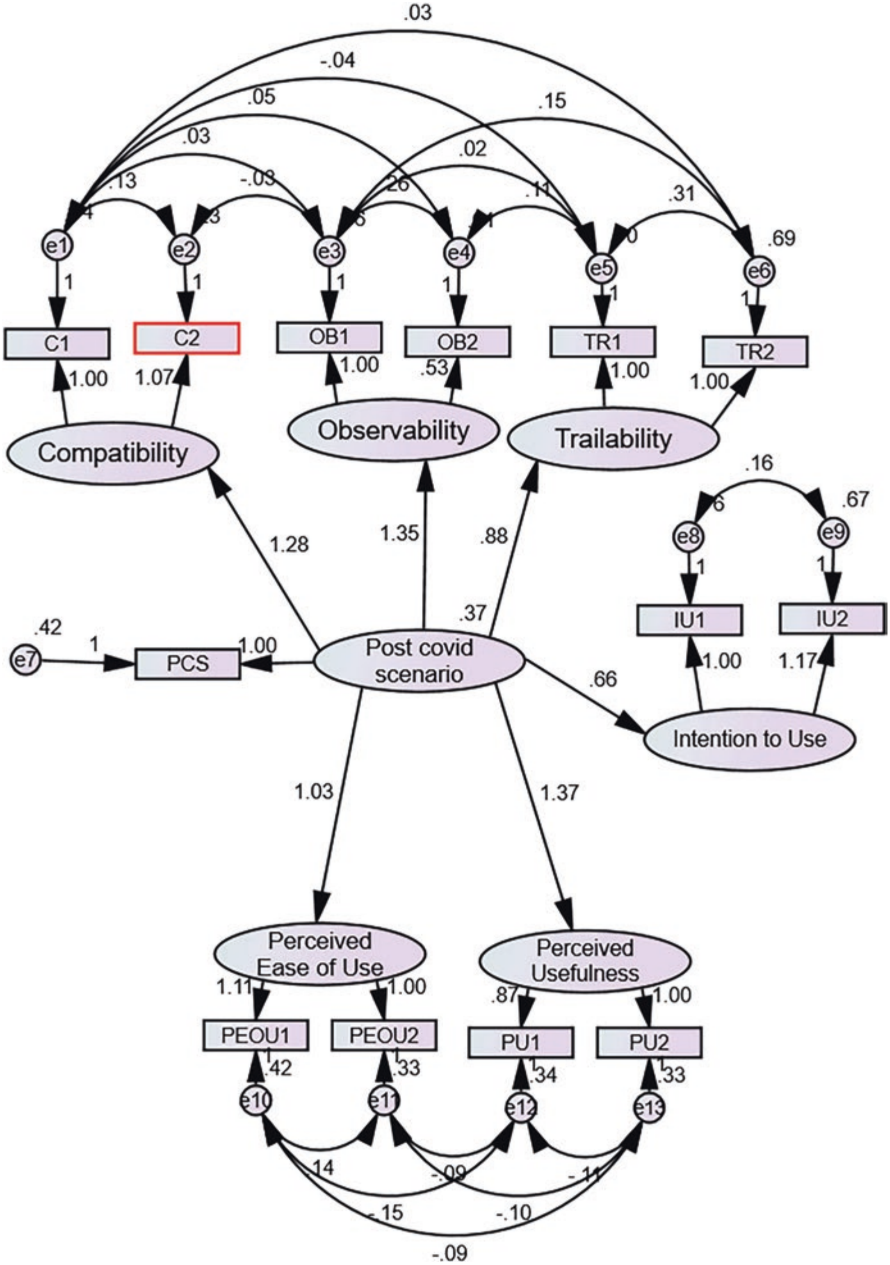


Fig. 5 Model result – user's acceptance of the IoT for healthcare

Table 4 Abbreviations and description of the items in the model

Sl. no.	Abbreviation and name	Description
1	C1	Indicators for compatibility
2	C2	Indicators for compatibility
3	Compatibility	A latent exogenous variable to measure the IoT devices compatibilities
4	OB1	Observability indicator
5	OB2	Observability indicator
6	Observability	A latent exogenous variable to measure the how respondents observe the IoT devices
7	TR1	Trail-ability indictor
8	TR2	Trail-ability indictor
9	Trialability	A latent exogenous variable, to measure the how respondents strives for using the IoT enabled devices
10	PEOU1	Perceived ease of use indicator
11	PEOU2	Perceived ease of use indicator
12	Perceived ease of use	A latent endogenous variable, which is for measuring how respondents perceive for ease of use
13	PU1	Perceived usefulness indicator
14	PU2	Perceived usefulness indicator
15	Perceived usefulness	A latent endogenous variable, which is for measuring the perceived usefulness of IoT devices.
16	PCS	Post-COVID scenario indictor
17	Post-COVID indicator	A construct developed for understanding the impact of IoT devices on the users in the post-COVID scenario
18	e1 to e 13	Error term which demonstrates the unexplained variance the model

In the same category, standardized root mean square residual (SRMR) calculated value of 0.0659, which also signifies residual of co-variance matrix of hypothesis model, in other words the difference between the hypothesized model and actual model is very minimal, hence the model is fit.

The above test result, i.e., model chi-square (χ^2/df), p value, and SRMR, reiterates the significance of theoretical model with observed model are similar; hence it promulgates the hypothesis 5 (H5). Hence, H5 is accepted.

H5: The causal relationship exists between endogenous variables with exogenous variables moderated by post-COVID scenario.

Root mean square error of approximation (RMSEA) explains the how model optimally explains with given parameters. In this model, the RMSEA with 0.041 exemplifies the selected parameters are optimally explaining the construct with variables.

$$\text{RMSEA} = \sqrt{\frac{\frac{\chi^2}{\text{df}} - 1}{N-1}}$$

Table 5 Model fit and result of the model

Sl. no.	Fit index		Acceptable threshold levels	Actual level derived	Description
1	Absolute fit indices	Model chi-square (χ^2/df)	Value 1 to 5 (Wheaton et al., 1977; Tabachnick & Fidell, 2007)	= 50.03/47 => 1.064468	Model fit
2		*P* value	$p > 0.05$; if the chi-square level is significantly less (Schermelleh-Engel et al., 2003, Vandenberg, 2006)	0.354	Model fit
3		Root mean square error of approximation (RMSEA)	Value < 0.07 (Hu & Bentler, 1999; Steiger, 2007)	0.041	Model fit
4		Standardized root mean square residual (SRMR)	SRMR < 0.08 (Hu & Bentler, 1999; Kline, 2005)	0.0659	Model fit
5	Incremental fit indices	Non-normed fit index (NNFI, also known as the Tucker-Lewis index) TLI	>0.95 (Sharma et al., 2005; McDonald & Marsh, 1990)	0.980	Model fit
6		CFI (comparative fit index)	>0.95 (Fan et al., 1999; Hu & Bentler, 1999; Tabachnick & Fidell, 2007)	0.978	Model fit
7	Parsimony fit indices	Parsimonious normed fit index (PNFI)	= ~ 0.5 (Mulaik et al., 1989; Crowley & Fan, 1997)	0.510	Mediocre fit

This RMSEA test result paves way for accepting H3; thereby the researcher infers that the selected parameters are optimally explaining the construct with variables.

H3: There is an association between the sample covariance matrix (theoretical model) and the hypothesized covariance (observed model) matrix.

In the second category, the non-normed fit index (NNFI, also known as the Tucker-Lewis index) TLI, having derived value of 0.980, indicates that all measured variables are correlated. It also assesses the comparison between the χ^2 of model with χ^2 of null model.

This NNFI (TLI) validates hypothesis one (H1), where the correlation of indicators of variables is examined. By accepting H1, it could be inferred that the selected indicators which measures the latent variables are significantly correlated.

H1: There is a relation between the measures (indicators) of "perceived ease of use, perceived usefulness, compatibility, observability, trialability, and intention to use" in post-COVID scenario.

It can reiterate that there exists a strong relation between the indicators of IoT device, viz., perceived ease of use, perceived usefulness, compatibility, observability, trialability, and intention to use in post-COVID scenario.

The CFI (comparative fit index) is the indicator for measuring the correlation between the latent variables, viz., "perceived ease of use, perceived usefulness, compatibility, observability, trialability, moderating, and intention to use." The test result shows there exists high correlation between the latent variables. By this CFI indicator, the researcher validates and accepts hypothesis two (H2).

H2: There is relation between the latent variables, viz., perceived ease of use, perceived usefulness, compatibility, observability, trialability, and intention to use in post-COVID scenario.

This deduce that there exists a strong correlation among the six latent variables and also corroborate with H1 (latent variables) and H2 (measured indicators).

Parsimonious normed fit index (PNFI), also known for narrowing the model estimation depending on the sample data. However, the result shown is not overwhelming since the sample size signifies the calculation of PNFI. Nevertheless, the model is mediocre fit.

7 Conclusion

During the COVID-19 pandemic, the IoT makes significant strides to improve medical facilities and information systems. It helped to improve management of hospital facilities, further medical operations, and the digitalization of healthcare can enable the users to overcome the difficulties faced during this period. New medical applications are made possible by the IoT when equipment and devices are connected to the Internet. Web-based tools are made available to patients in a variety of ways to improve patient health monitoring. Further, the COVID-19 pandemic made the people to use this technology to the core. The SEM model signifies the existence of casual relationship, in various model fit indices (all three categories). This model also identifies the moderating factor, i.e., "Covid scenario," which accelerates and amplifies the usage of IoT products especially in healthcare sector. Thus, this study contributes to the body of knowledge in the way how the unexpected health scenario transforms the usage of technological products (IoT and smart devices). Notwithstanding, the model also reiterate and confirm the DoT and TAM model with data being analyzed in the current study. These technologies offer quick information and communication to improve the patient's quality of life. This technology will help patients in the future receive better care and will be used in the event of a COVID-19 pandemic.

8 Implication for Researchers

This study provides academics with a framework for comprehending how users perceived their experiences with IoT-based healthcare services during COVID-19 and after the emergence of the post-new normal. Regarding IoT service experiences and adoption utilizing a combined TAM and DoI model during a pandemic crisis, there are surprisingly few researches available. This study may be useful to identify the advantages and difficulties IoT users in various industries faced during the epidemic. By expanding the sample size and include the rural population, additional study may be feasible. This may reflect a range of end users' experiences with IoT services during this pandemic period. Future studies can also take into account more variables and different range of respondents.

9 Technical/Practical Implication

Our research assists enterprises in making quick adjustments and prompt responses to the expansion of Internet-enabled healthcare services and applications via IoT-based healthcare equipment. It also aids in examining the drawbacks and advantages of IoT adoption across various industries. The IoT has made it possible to upgrade important facilities in the fields of hospitals, financial institutions, education, utilities, and other sectors, which provides a new framework for technological growth. The study's findings might aid various industries in enhancing their positive aspects and serve as a starting point for addressing their negative ones. Further applications and a rise in technology utilization will result from the IoT's use and effects in several areas during the pandemic.

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Fintech and the Changing Competitive Environment of Retail Finance: A Study on the Development of a Cross-Functional and Cross-Sectoral Financial Regulatory System

Raj Bahadur Sharma, Ijaz Ali, and Imran Ahmad Khan

1 Introduction

Fintech is an acronym for financial technology. Although academic definitions are not always clear, such as referring to advanced financial technology, advanced financial services, or a group of companies with advanced technology, depending on the context, this paper defines fintech as new business models, application methods, processes, and product innovations made possible by technological advances that have a significant impact on financial markets, financial institution management, and financial services. The term "fintech company" will be used when referring to a company with advanced technology.

It has been said for a long time that fintech will have a devastating impact on the management of financial institutions. This may be due in part to Bill Gates' statement "Banking is necessary, but banks are not" (1994), but it is also due to the statement of Jamie Dimon, CEO of JPMorgan Chase, one of the world's leading financial institutions "We're one of the largest payments systems in the world and We're going to have competition from Google and Facebook and somebody else" (2014).

The leading US platformers are called GAFA, an acronym for Google, Apple, Facebook, and Amazon. Although GAFA's full-fledged entry into the financial industry has not yet become apparent, the fact that Amazon's e-commerce and home

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delivery services have devastated the retail industry, for example, makes it easy to speculate that financial institutions will suffer a similar fate.

In the world of board games, AI has surpassed humans, with world chess champion Garry Kasparov losing to IBM's "Deep Blue" (May 1997), Go master Lee Sedol losing to "AlphaGO" (March 2016), and Shogi master Tenhiko Sato losing to "Ponanza" (May 2017). In particular, the deep learning technology used in "AlphaGO" shook the world, and the outstanding technical capabilities of its developer, Google DeepMind, became known to the world.

As we can see, it is an undeniable fact that the evolution of technology is drastically changing the conventional wisdom and the competitive environment of companies, but this does not mean that there is a logical necessity for advanced financial technology to benefit only fintech companies and platformers. It is important to calmly assess the changes in the competitive environment.

The development of fintech shows historical path dependency. For example, in the USA, the financial crisis of 2008 is said to have lowered confidence in existing financial institutions, leading to the rapid rise of fintech companies, while in emerging economies such as China and Africa, where financial institutions are still underdeveloped, there are cases where fintech companies occupy the position of the frontier of financial services. Service providers, types of services, and financial technologies vary from country to country. And the biggest difference in the social positioning of fintech companies in developed and emerging countries can be explained by the reversal of the development process of the financial system and communication and financial technology. That is to say, in developed countries, where industrial development has historically taken place early, the development of financial systems and the improvement of consumers' living standards preceded the development of communication and financial technologies, while in emerging countries, where industrial development has historically taken place lately, the development of communication and financial technologies preceded the development of financial systems. It is not uncommon for consumers to own mobile phones while not owning bank accounts.

The World Bank estimates that 1.7 billion adults do not own bank accounts, mainly in emerging and developing countries, and payment and remittance services using the capabilities of telecommunications devices have expanded rapidly in some of these countries. In the USA, there are also significant numbers of low-income people and immigrants who have given up on bank accounts because they are unable to pay account maintenance fees, and it is emotionally understandable that these consumers, who cannot get the services they need from traditional financial institutions, would support the services of fintech companies.

In India, consumer demand for advanced financial technology has been limited because there has not been the same earnest social demand for financial service innovation as in the US and emerging economies, and also because of the ATM network, and the public's preference for cash-oriented settlement and deposit-oriented asset management. The tendency for consumer needs to materialize has been limited, and while financial institutions have emphasized digital in their business strategies, there have been few drastic changes. Also, the amount of investment in fintech companies was far below that of other developed countries.

Under these circumstances, the Cabinet approved the "Future Investment Strategy 2020: Reforms to Realize Society 5.0" in June 2020, which aims to incorporate the innovations of the Fourth Industrial Revolution into the industry and social life to break through the "long-term stagnation" caused by sluggish productivity growth and lack of new demand creation common to advanced countries. The Future Investment Strategy designates fintech as one of the five strategic areas and aims to (i) introduce an open API (application programming interface) at more than 80 banks within the next three years (by June 2023); (ii) double the percentage of cashless payments to around 40% within the next 10 years (by June 2030); (iii) over the next five years (by June 2025), the ratio of small and medium-sized enterprises (SMEs) that streamline their back-office operations by utilizing cloud services, etc., while responding to the shift to IT, is expected to quadruple from the current level to around 40%; and (iv) improve the efficiency of cash circulation in India's supply chain by 5% by FY2023, as a KPI (Key Performance Indicator).

In response to the government policy, the Financial System Study Group was established by the Financial Stability and Development Council on November 16, 2020. Minister consultations include a "Study on the desirable form of the financial system in light of progress in information technology and other changes in the environment surrounding India's financial system, including the development of function-based and cross-sectional financial regulations." The study group did not necessarily focus on the competitive environment of the financial services industry, but its ideas and the process of its deliberations have a great deal to suggest, so this paper examines the changes in the competitive environment that fintech will bring to the Indian megabank groups (HDFC Bank, SBI, and ICICI Bank) with the deliberations of the group in mind.

2 Changes in the Competitive Environment Brought About by Fintech

2.1 Competitive Environment for Retail Financial Institutions

To examine the impact of fintech on the competitive environment for retail finance, we first conduct a SWOT analysis of India's megabank groups (Table 1).

Regarding strengths and weaknesses as internal conditions of a company, the VRIO framework emphasizes economic value, rarity, the difficulty of imitation, and organization. In addition to a customer base supported by a nationwide network of branches, a megabank group can provide a wide variety of products and services that meet customer needs through commercial banks, securities companies, and trust banks under the umbrella of a financial holding company. This means that the group has economic value that enables it to adapt to changes in the external environment. Financial soundness that meets the standards of international financial regulations is also an economic value and enables us to gain a relative advantage in investments and alliances with other companies in the financial industry, where

Table 1 SWOT analysis for megabanks (retail)

Strengths
Nationwide store network (customer convenience)
Customer base with full coverage of segments
Diverse products and services in banking, securities, and trust
Extensive quantitative and qualitative customer data
Financial soundness
Weaknesses
Fixed costs (stores, systems, personnel costs)
Organizational and human capability in the digital domain
Ease of imitation of products and services
Opportunities
Increasing awareness of the need to shift from saving to asset building
Expansion of investment tax incentives
Room to pursue business efficiency using digital technology
Threats
The decline in demand due to declining birthrate, aging population, and population decline
Decline in funding revenue due to negative interest rate policy
Rise of fintech companies and Internet banks
Possibility of ROE decline due to international financial regulations

there is a high degree of uncertainty about market conditions, customer demand, and technological innovation. However, it should be noted that the slump in funding revenues due to negative interest rates has led to a decline in expected revenues from the store network, and traditional strengths are turning into weaknesses as companies begin to reduce stores and store weight to curb fixed costs (stores, systems, and labor costs).

From the perspective of fintech, big data on deposits, loans, investments, settlements, etc. obtained from customer transactions can be a major weapon, as it is rare and difficult for other companies to obtain. However, it remains to be seen whether they will be able to accumulate sufficient organizational and human capabilities to accurately analyze the big data and link it to sustainable competitive advantage. The outcome of the competition with fintech companies is unpredictable. In addition, legally speaking, personal data cannot be freely shared among different business types within the same group. Even if a financial conglomerate is formed, it is necessary to recognize that there are restrictions on the utilization of customer data and cross-selling across business categories.

One of the characteristics of the products and services offered by financial institutions is that they are rarely protected by patents and can be easily copied or imitated directly. While this is a weakness of existing financial institutions, fintech companies are expected to use advanced financial technology to obtain business model patents, making their capability in the digital domain more important than ever.

Next, we will examine the opportunities and threats in the competitive market as external conditions for companies. The megatrends of declining demand due to the declining birthrate, aging population, declining population, declining returns on funds due to negative interest rate policies, and alternative products and services from fintech companies and Internet banks are all threats that stand out. However, the aging of the population, together with the expansion of preferential investment taxation schemes, is increasing the need for individuals to plan their asset formation, and this could provide an opportunity for financial institutions to earn profits by promoting "asset formation instead of savings." In addition, while "fintech companies" are positioned as a threat to financial institutions, "fintech" as financial technology is not necessarily a threat but rather an opportunity for financial institutions to increase their operational efficiency.

International financial regulations, while leading to financial soundness, can also be a factor in lowering ROE in the sense that a given level of capital must be secured regardless of profitability.

2.2 Depiction of the Competitive Environment: Technology and Services

When a fintech firm enters the financial industry, it naturally chooses an area where it believes it has a technological competitive advantage. In examining the competitive environment between financial institutions and fintech firms, one possible approach is to classify them based on technology and services. Technologies and services will emerge that stand in a "compete/substitute" relationship or a "complement/support" relationship from the perspective of traditional financial services businesses. Virtual currency and blockchain as new services are neither "competing/substituting" nor "complementing/supporting" (Table 2).

This classification method is close to the general terms used by financial institutions and fintech companies in practice and is easy to verify with a concrete image of business operations. On the other hand, "technology" and "services," which are inherently different in dimension, are mixed on the same axis, which is not suitable

Table 2 Technologies, services, and competitive environment

Competitive environment	Technology and services
Supplementation and support	AI (artificial intelligence) RPA (robotic process automation) Big data, agile, fraud prevention
Supplementation and support Competition and substitution	P2P payment and remittance, mobile remittance PFM (personal financial management) Robo-advisor
Competition and substitution	Social lending Balance sheet lending
New services	Virtual currency, blockchain

for highlighting differences in the competitive environment by dividing them into technology and services.

AI, RPA, big data, etc., which are considered to be "complementary and supportive," are generic terms for generalized technologies and system development methods, and in many cases, it would be closer to the reality if they were positioned as "business improvement tools" rather than advanced financial technologies. In other words, the implementation of these tools alone will not provide a sustainable competitive advantage but will only be a source of competitive advantage if the tools are combined with advanced strategy and marketing.

2.3 *Describing the Competitive Environment: Innovation*

SWOT is a framework for analyzing the external environment and the internal environment of a company. However, SWOT is not necessarily optimal when business is changing rapidly due to innovation, uncertainty is high, and it is difficult to predict the future business environment. This kind of sudden and unpredictable change in threats and opportunities is called Schumpeterian transformation, and the situation retail financial institutions are facing due to the development of fintech may be a case in point.

Schumpeter, known as the father of innovation, categorized the leadership functions of entrepreneurs that bring about economic development into five categories: (i) creation and realization of new products or new qualities of products, (ii) introduction of new production methods, (iii) creation of new organizations, (iv) development of new sales markets, and (v) development of new buyers. The Centre for Advanced Financial Research and Learning, with similar inspiration, presents the concept of four financial innovations by fintech (process innovation, product innovation, infrastructure innovation, and social innovation) and three gaps as challenges that financial innovation can solve (Tables 3 and 4). We want to review these one by one.

Table 3 Types of financial innovation

Innovation	The existence of gaps
Process	Within and among financial institutions
Product	Between customers and financial institutions
Infrastructure	Cross-cutting infrastructure for each financial institution
Social	Society as a whole, including the financial industry

Table 4 Gaps in financial innovation

Types of gaps	Overview
Functions and business law	The fulfillment of the various functions of a financial institution is inadequate
Business model	The business model of financial institutions is a loss of sustainable competitive advantage
Technology	The technology used by financial institutions is inferior in terms of added value such as customer convenience

1. Process innovation is considered to be an extension of the traditional IT industrialization of the financial industry. While the introduction of new technologies can be expected to improve business operations, the creation of processes that are different from those of competitors is required to lead to a sustainable competitive advantage. On the other hand, if process improvement is insufficient, there is a high possibility that the company will immediately fall into an inferior competitive position. In the field of fintech, process innovation is considered to be one of the essential conditions.
2. Regarding product innovation, as shown in the SWOT analysis, financial products and services are characterized by the ease with which they can be imitated. Therefore, even if a company does not succeed in developing a product or service on its own, it can mitigate the competitive environment by imitating the new products and services of its competitors, as long as they have not obtained patents. However, in an environment where financial technology is constantly evolving, it is unrealistic to rely on the ease of imitation as a "second-best strategy" and strategies should be considered with a view to forming alliances with other companies.
3. Virtual currency and blockchain are examples of infrastructure innovation. It is possible to assume that they will not have a significant impact on the competitive environment of financial institutions because they bring about changes equally to all firms in the same business category. On the other hand, if the new infrastructure technology is pioneering, the level of organizational and human capacity required will certainly increase, so it will be necessary to ensure that appropriate and sufficient resources are available at the time of transition to the new infrastructure.
4. Social innovation has the potential to take away the functions of traditional financial institutions in one fell swoop, as seen in the expansion of payment and remittance services using cell phone and smartphone functions in emerging countries. With deregulation and other measures in place, it is not unthinkable for financial institutions to offer their social services to compete with fintech companies, but this would complicate the organization and make it difficult to make appropriate decisions. In addition, there is the fundamental question of whether the managers of financial institutions know social services.

Therefore, if it is difficult to compete head-on with fintech companies, financial institutions can establish a position as a socially necessary company by forming alliances with fintech companies, thereby easing the competitive environment.

When adopting this strategy, it should be noted that the position of financial institutions is weaker than that of other companies' alliances as described in (2) product innovation, because fintech companies that engage in social innovation are assumed to be larger and have more bargaining power in terms of customer interface than companies that specialize only in financial technology. Strengths indicated in the SWOT analysis as bargaining chips for financial institutions, for example, "customer base with full segment coverage" is likely to be an advantage for fintech companies. If the "store network," whose future maintenance is uncertain, is not a factor in negotiations, then we can look for factors in "diverse products and services," "quantitative and qualitative customer data," and "financial soundness." In addition, although not listed as a strength in the SWOT analysis, "brand power," in terms of high recognition by consumers, is also considered to be a powerful appealing factor.

Finally, about the "gaps in financial innovation" (Table 4), it is important to confirm that "gaps in functions and business methods" are exactly what it means to "develop a system of financial regulation by function and across functions." Also, the phrase "insufficient performance of various functions" does not necessarily mean that the efforts of financial institutions are insufficient, but rather how they perform their functions should be upgraded using digital technology in light of advances in advanced financial technology.

2.4 Depiction of the Competitive Environment: Convergence Scenario of Business Restructuring

How will the changes in the competitive environment for retail financial institutions eventually converge? BIS illustrates five scenarios for banks, using (i) customer interface providers and (ii) service providers as cutoffs (Table 5).

The first scenario is the survival of existing banks through business model transformation and digitalization, the second is the emergence of new banks with digital advantages, the third is the modularization (decentralization) of financial services including existing banks, the fourth is the decline of banks due to the oligopoly of fintech/big tech customer interfaces, and the fifth is the extinction of banks due to the entry of fintech/big tech.

The historical path dependence of fintech development means that the most likely scenario will vary from country to country, but the fact that the BIS, a public institution, has already envisioned a scenario of bank extinction is a testament to the innovative and disruptive power of fintech. However, the government has

Table 5 Five scenarios of fintech development

Scenario	Service provider	Customer interface provider	
Bank retention	Digitization of existing banks	→	
New Bank	The emergence of a new, digitized bank	→	
Banking functions Dispersion	Existing banks → digital Fintech → digital Big tech → digital	→	Look at
Bank recession	Existing banks → financial services Fintech → intermediary Big tech → (tech companies)	→	Customer
Bank extinction	Fintech (full service provided)	→	
	Big tech (full service provided)	→	

introduced various policies, including deregulation, to achieve a cashless society as soon as possible, and it is natural to assume that there will be a significant change in the competitive environment between financial institutions and fintech companies, at least in the field of payments. The opening up of interbank remittance systems to fintech companies is beginning to be considered.

The BIS separates fintech from big tech and states that big tech may become an important part of the financial system by increasing its influence on the financial system through alliances with financial institutions and fintech companies. Therefore, we would like to examine the possibility of GAFA, one of the big techs, entering the financial industry in earnest, taking into account the BIS perspective.

For example, Amazon could enter the banking business because financial institutions are the main source of growth for Amazon Web Services (AWS), which is the company's main source of revenue. On the other hand, if it is necessary to improve customer convenience, there is a possibility of introducing financial services. Thus, a decision to consider entering the banking business based on overall gain or loss and business philosophy is possible, but if AWS is a superior system, not adopting it will directly lead to the financial institution's inferiority in competition, so it seems unlikely that a financial institution would decide not to adopt AWS in retaliation for competition in its core business. Therefore, we expect that Amazon's entry into the banking business will be considered honestly based on its business philosophy, but in this case, the impact of international financial regulations such as the designation of G-SIBs will be one of the key factors. In other words, if the direct and indirect regulatory costs associated with entry into the banking business are expected to constrain flexible investment in e-commerce and other areas and not lead to total customer service improvement, there seems to be no reason not to enter the market. We suspect the same is true for other GAFAs.

3 Development of a Cross-Functional and Cross-Sectoral Financial Regulatory System

3.1 Functional Perspectives

The functional perspective is a conceptual framework for analyzing the financial environment in terms of basic financial functions. It is based on two basic assumptions: (1) financial functions are more stable and less likely to change with time and region than the financial services firms that embody them, and (2) the form of a financial institution is defined by the way it performs its financial functions. Assumption (2) implies that innovation and competition among financial institutions will enable them to perform their financial functions more efficiently, which is a powerful perspective when examining the impact of fintech on the competitive environment for retail finance.

The functional perspective can be applied at the financial system level, the financial services firm level, the business level, and the product level. For example, it can be applied to the competitive environment between financial institutions and fintech companies, the performance of functions in settlement and lending operations, and comparisons of the performance of functions among settlement and lending products. Financial functions can be categorized in various ways depending on the purpose of the analysis, but it is relatively common for them to be classified into six types: (1) settlement of funds, (2) pooling and parceling of resources, (3) transfer of resources across time and place, (4) management of risk, (5) provision of information, and (6) addressing incentive problems associated with information asymmetry.

The Financial System Study Group focused on the development of a cross-functional and cross-sectoral financial regulatory system, not only because of the academic and practical effectiveness of a functional perspective but also because a functional perspective made sense when analyzing the actual business development of fintech companies. The Secretariat's briefing paper explains three case studies, mainly from other countries, from a functional perspective. (i) E-commerce companies that operate Internet malls check the business conditions of the businesses that have opened stores and use the data to provide online loans with credit scoring; (ii) social network service providers provide electronic money and mobile money transfers as part of their services; and (iii) E-commerce companies issue prepaid cards, which users store in a custodial service called an "account" and use for prepaid payments in online malls and money transfers between individuals. The prepaid cards can also be used to purchase MMFs. In addition, using the big data accumulated in the Internet malls operated by this company, loans will be provided to mall owners.

The Secretariat also points out that, under India's current legal system, money lending, prepaid card, funds transfer, and financial instruments business are all subject to registration, which effectively allows them to conduct the same business as banks without a license.

The effectiveness of the functional perspective is widely recognized. Taking into account the rise of fintech companies, it can be said that financial theory emphasizes the importance of the "functional approach," which starts from the functions of financial systems and financial institutions, rather than the "institutional approach," which considers better systems based on the premise that existing systems and financial institutions exist.

However, the changes in the competitive environment for retail finance brought about by fintech cannot be explained from a functional perspective alone. The chairperson of the study group said, "There is not much precedent in other countries for having a function-based legal system." This can be interpreted to mean that the development of fintech in other developed and emerging countries has not necessarily required a function-based legal system.

As a methodology for studying the financial system, the most promising approach is "comparative institutional analysis" which should be contrasted with the "function-oriented perspective" proposed by the Global Financial System Project at Harvard University. Comparative Institutional Analysis grasps the economic process as an application of "Repeated Game Theory" and conceptualizes institutions as to how social games are continuously played as commonly understood among people. Specifically, society is in a state where even if you try to play the game differently, you will not gain as long as other people follow the conventions, and a so-called Nash equilibrium is established. In this equilibrium, various institutions, including financial institutions, reinforce each other's existing values, and thus the institutions are robust and self-binding. In examining economic systems and institutions, we emphasize historical path dependence.

In Sect. 1, we mentioned that the development of fintech is historically path dependent and that it is not possible to apply pioneering examples from other advanced and emerging economies directly to India. However, when examining the changes in the competitive environment for retail financial institutions, which perspective should we focus on: the functional perspective or the perspective of comparative institutional analysis? The authors believe that the "functional perspective" is more effective for the following reasons. First, when a fintech company enters the financial industry, it is likely to choose areas and functions in which it has a technological competitive advantage, and the three cases presented by the Financial Institutions Study Group suggest this.

In addition, in fintech, which is undergoing a Schumpeterian transformation, it will be difficult to accurately grasp actual social phenomena if strategies and institutions are examined based on the assumption of the existence of equilibrium points with robustness and self-binding properties.

Furthermore, when considering management strategies for financial institutions, it is natural that they should take a proactive stance to overcome the equilibrium point and gain a competitive advantage, rather than starting with a system that is at the equilibrium point. If it is foreseeable that fintech companies will use their financial technology to enter a particular area or function, it makes sense for financial institutions to think about their strategies from a functional perspective.

However, the importance of a functional perspective does not mean that historical path dependency can be ignored. While understanding the historical differences in the penetration of fintech compared to other developed and emerging countries, it is important to take a bird's-eye view of government and private sector efforts to help Indian society break out of its inherent "equilibrium" and reflect this in the strategy.

3.2 Financial Regulation and the Peculiarities of the Banking Industry

Based on the premise that the same rules should be applied to the same functions and risks, the study group took into account the capture of functions and the simplicity of the regulatory system and categorized them into four functions: (1) settlement (e.g., foreign exchange transactions), (2) provision of funds (e.g., loans), (3) asset management (e.g., activities regulated across the board by the Financial Instruments and Exchange Law), and (4) risk transfer (e.g., insurance and other guarantee functions). These four categories are described in "3". These four categories differ from the perspective of economics (finance) as explained in Sect. 3.1, and the participating members had a variety of opinions.

This classification is "similar to actions or operations, such as lending under the Money Lending Business Act and the Banking Act, and investment and management under the Financial Instruments and Exchange Act," and that inherently, "informational" functions such as interest rates and stock prices should be listed independently as important functions that determine resource allocation.

Thus, although the functions were classified into four categories, taking into account their relationship with current law and brevity, the challenge was to deal with the accumulation of risks in the combination of multiple functions. The perspective is how to reconcile this with the fact that full-line banks are subject to strict regulation. If strict regulation is to be considered, a combination of 4 functions → 15 types must be considered.

Corrigan (1983) cites three special characteristics of banking: (1) settlement deposits, (2) provision of liquidity, and (3) conduit of monetary policy. He argues that such special characteristics permit the provision of a safety net and necessitate the separation of banking and commerce. This issue was also discussed in the study group, and the view was expressed that the nature of settlement deposits has changed over the past 35 years in light of the current situation where fintech companies are providing new services with high settlement potential and that the traditional way of thinking may no longer be in line with the trends of the times.

Concerning the peculiarities of the traditional banking industry, while "completeness of information" is increasing through the use of big data, etc., banks that have converted their maturities from short-term deposits to long-term loans should be able to hedge against the possibility of mounting turmoil, including rumors, but it is difficult to structure such financial products, making it difficult to achieve "market completeness." Regarding systemic risk, if the bankruptcy of one financial institution leads to the bankruptcy of other financial institutions, companies, etc., or to a decline in economic activity beyond the level that should be expected (negative externality), economic theory says that the financial institution needs to be bailed out, and the conclusion is that there can be no reason for regulation except for mismatches in maturity and problems that are too big to be crushed.

In the study group's discussion on the regulation of fund transfer companies, it was proposed to eliminate the upper limit of one million rupees for fund transfers, a limit on the length of time funds can be held in competition with settlement deposits, and consideration of the impact of rising interest rates on the business of fund transfer companies.

3.3 Fintech Companies' Requests for Deregulation

We have discussed the impact of fintech mainly from the standpoint of financial institutions, but we will also check the responses of fintech companies to get a full picture of the competitive environment.

Table 6 Requests of the fintech association

What to expect	Contents
Services for users Crossing the financial institution connection of	Bank agency, financial products brokerage Integration of bank agency, financial products brokerage, and insurance agency businesses
Cross-functional registration review	Standardization of registration items Organization of common and individual items
Removal or relaxation of upper limit regulations for money transfer operators Elimination or relaxation of	Not seen in other countries Removal of the upper limit of one million rupees
Refund of prepaid means of payment Prohibited regulations	Eliminating the hesitation of charging Spread of payment methods

Source: Fintech Association of India, "Regulatory Issues Related to Fintech," October 25, 2020

The four requests of the India Fintech Forum are included in the study group materials for the second session of the 2020 administrative year, conducted on October 25, 2020 (Table 6).

Two of these requests, the cross-connecting of services for users with financial institutions and the removal of upper limits for money transfer companies, were discussed in the study group and passed into law on June 5, 2021, to enhance the Convenience and Protection of Users of Financial Services, etc.

It is difficult to predict with a high degree of certainty the impact that this deregulation will have on the management of financial institutions. For example, we cannot deny the possibility that the financial services intermediary business will increase the sales of financial products and services, which will have a rather positive impact on the earnings of financial institutions. On the other hand, it is difficult to assume that the government will consider financial institutions in the fintech area, and it is necessary to recognize that the competitive environment may change in the future due to various deregulations.

In this case, changes in payment and cashless transactions, which are lagging behind other countries, are expected to be the most drastic. However, cashless transactions also have the merit of reducing fixed costs for financial institutions (ATMs, etc.) through a decrease in cash transactions, so it is important to examine this issue from a broad perspective.

3.4 Utilization of Information by Financial Institutions

In Sect. 2.1, "The Competitive Environment for Retail Financial Institutions," we identified "quantitatively and qualitatively rich customer data" as one of the strengths of megabanks, but on January 16, 2021, the Study Group published a report on the development of systems for the use of information by financial institutions.

The report states that banks and insurance companies, which are subject to strict regulations, are under pressure to change as the use of information by general business companies progresses and that it is appropriate to review the scope of business regulations to appropriately respond to such changes in society as a whole. The report suggested that it is necessary to take into account the purpose of the regulations, such as (1) prevention of transactions with conflicts of interest, (2) prevention of abuse of dominant positions, and (3) elimination of risks in other industries while paying attention to the effectiveness of supervision. On May 1, 2021, with the enactment of the Act for Partial Revision of the Law Concerning Funds Settlement, etc., banks and insurance companies were allowed to provide customer information held by them to third parties as an incidental business.

Furthermore, the Financial Stability and Development Council was asked by the General Meeting on June 11, 2021, to consider how the banking system should be organized, and the Working Group on the Banking System was convened on June 30. As we have repeatedly stated, it is no exaggeration to say that "quantitatively and qualitatively rich customer data" is one of the greatest sources of strength for financial institutions. It will be necessary for megabank groups, especially those that operate globally, to proactively offer their opinions to the extent they can, taking into account the status of the use of personal data by G-SIBs in other countries.

4 Conclusion

As we have seen, the competitive environment for financial institutions brought about by fintech is changing rapidly, and news related to fintech, including the aforementioned reconsideration of India's banking system, is being reported daily.

The establishment of the Digital Agency by the new cabinet is a sign of the government's determination to promote digital technology seriously and will have a significant impact on the management of financial institutions through the implementation of policies related to fintech.

On the other hand, as the source of added value for fintech is an advanced financial technology and quantitatively and qualitatively rich customer data, it goes without saying that financial institutions should not only keep pace with the government's leadership but also make their efforts to provide innovative financial services to their customers through research and innovation.

However, if a financial institution, which is exposed to declining demand due to the declining birthrate and aging population, declining funding revenues due to negative interest rate policies, and faced with fixed costs such as store costs and financial regulatory costs, makes a large investment in fintech, where business is changing rapidly, uncertainty is high, and the future business environment is difficult to predict, it may exceed its financial capacity.

One way to maximize strategic flexibility in such an uncertain environment is from the perspective of real options. Real options assume that if the uncertainty present in a transaction is uncertainty about the value of the investment, then there

Table 7 Capital and business alliances of megabank groups (example)

Banks	Fintech partners
HDFC	MobME, PayZapp, Zeta, Google Assist, Amazon's Alexa, Talview, Locobuzz, Google Tez, Niki.ai, Money View, etc.
SBI	Cashfree, Rupeek, etc.
ICICI	Visa, Marg ERP, Zoho Books, Paybooks, Greytip, Decentro, Sqrrl, etc.

is a high probability that more non-hierarchical governance will be preferred. This assumption is based on the fact that, under uncertain conditions, it is highly valuable to retain the ability to change the form of governance quickly and at a low cost.

Looking at the digital strategies of megabank groups, capital and business alliances with fintech companies, etc. are more prominent than the development of their financial technology, and the concept of real options seems to be adapted (Table 7).

And given the speed at which fintech is evolving, including the government's response, the success or failure of such a strategy will become apparent sooner rather than later.

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Impact of Digital Marketing and IoT Tools on MSME's Sales Performance and Business Sustainability

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1 Introduction

The marketing industry is always evolving. Modern marketing executives must have a reliable system in place for gathering timely and accurate data on consumers, competitors, and the external setting. The process of advertising and selling a product or service via the World Wide Web is known as "Internet marketing" (IM). The Internet and electronic commerce have made product distribution and promotion feasible. The term "electronic commerce" (or "e-commerce") is used to describe any type of market that exists solely online. E-commerce, or electronic commerce, is the practice of doing business transactions over the Internet. The discipline of Internet marketing is a subset of e-commerce as a whole.

Ikramuddin et al. (2021) identified the factors that affect MSMEs' performance in the North Aceh Regency. His study examined the connections between factors such as the existence of MSMEs during the COVID-19 epidemic, the use of the IoT by MSMEs for marketing, and the involvement of MSMEs in social media to advertise their goods and services. The capability of the marketing section heavily influences how MSME performs. According to the study's findings, marketing orientation techniques, such as customer orientation, competitor orientation, and cooperation among MSME management functions, had a greater effect on MSMEs' marketing performance in North Aceh Regency. The findings of this study are consistent with

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those of other studies that found that implementing a market orientation strategy has the greatest impact on the growth of business performance. Entrepreneurial and market orientations can boost marketing effectiveness by putting to the test the use of digital marketing technologies that have a big impact on marketing. He talked about how few MSMEs use digital marketing tools like social media and merely have generic social media profiles for business promotion. Based on their skills and visibility in social media channels, digital connections, and digital technologies, the majority of businesses utilize digital marketing media as their primary marketing tools. The findings advise management to keep an eye on service commitment to clients, client contentment, and rising superior value. Online advertising, affiliate marketing, email marketing, and social media marketing are all examples of digital marketing platforms.

The purpose of digital marketing is to broaden businesses' opportunities to reach a wider audience through more effective forms of promotion and advertising. Advertisers may contact potential customers 24/7, no matter where they are, and businesses of all sizes can utilize this tool to spread the word about their business online (Agostini et al., 2020; Maduku et al., 2016; Samoilenko & Osei-Bryson, 2017). Since then, digitalization has been connected to small business expansion, productivity, and competitiveness. Using digital marketing and social media, small businesses may attract new clients and retain existing ones (Taiminen & Karjaluoto, 2015). Small and medium-sized enterprises (SMEs) can benefit greatly from digitalization due to its simplicity in facilitating information sharing and customer connections (Wonglimpiyarat, 2015; Eze et al., 2018). For modern businesses, digital platforms are an essential marketing tool since they allow them to more effectively connect and communicate with their target audience, evoke emotions in consumers, and facilitate transactions between businesses and consumers.

In their research of MSMEs in Indonesia, Redjeki and Affandi (2021) concluded that these companies may grow and continue operating even in the event of a pandemic. MSMEs must adopt digital marketing, he said. During the COVID-19 epidemic, he suggested introducing the deployment of small and medium-sized firms in the MSME sector. According to the research, digital marketing is highly beneficial for MSME operators in Indonesia since it may raise their sales turnover thanks to its many advantages. Therefore, experts suggest a few straightforward steps for establishing a business with digital marketing, such as deciding on the digital platform to employ, setting a budget, and developing content that will grab customers' interest. The authors of this study also discuss the benefits that customers who employ digital marketing receive. However, due to several factors—including a lack of technology literacy, insufficient support services, and Indonesia's challenging geographic conditions—digital marketing has not been substantially adopted by the MSME sector there.

This paper has the standard structure of abstract, introduction, review of literature, objectives, research methodology, analysis and discussions, conclusion, and future scope for research.

2 Literature Review

Online advertising is a great way to build awareness for a brand and increase traffic to a website, two of a company's most crucial objectives (Song, 2001). Traditional forms of public relations and advertising have given way to the more modern strategies of digital marketing. Therefore, it can revitalize the economy and make government agencies more efficient (Munshi, 2012). According to Internet World Stats, there will be more than 4.5 billion Internet users in the world by March 2020. The Internet's velocity and influence have increased as a result of developments in technology and the expansion of digital infrastructure. The Internet has largely replaced more conventional means of communication. The effects of Industry 4.0 and new information and communication technologies (ICTs) including the Internet of Things, machine learning, artificial intelligence (AI), robots, and cloud computing were compared. Companies that rely on digital technology to create money believe that the three most essential marketing aspects of digital material are (1) its accessibility (2), its navigability, and (3) its speed. As a result, people's buying and consumption patterns have changed over time. Midha (2012) argues that the amount and manner in which people consume are affected by the ever-evolving psychology of consumption in response to consumer demands. So, companies in the sector must respond to the evolving demands of consumers and provide their products and services promptly (Pencarelli, 2020). As consumer expectations rise, it's natural that some businesses may struggle to stay up and eventually fall behind (Ungerman et al., 2018). There have to be strict new rules and regulations in place for traditional marketing to keep up with the rapid growth of the digital economy and the variety of new opportunities and difficulties it brings (Midha, 2012).

According to Purwanti et al. (2022), MSMEs may create digital marketing skills characterized by customer information, customer demands, customer interactions, and customer communication to enhance their business performance. As environmental dynamism grew, so did the strength of the association between digital marketing capability and MSMEs' performance. Environmental dynamism moderates the impact of digital marketing skills on MSMEs' performance. It has been demonstrated that environmental dynamism might reduce the performance impact of digital marketing skills on MSMEs. He emphasized that the success of MSMEs may be significantly influenced by digital marketing skills thanks to customer demand, technology, and innovation.

As a consequence of the different advantages that digital marketing provides, Redjeki and Affandi (2021) found that MSME players in Indonesia may enhance their sales turnover. Technology literacy and insufficient infrastructure to meet Indonesia's geographical circumstances were noted as barriers. He advised beginning a firm with digital marketing after deciding which digital platform to employ, setting a budget, and producing content that will draw in customers. The advent of digital technology has caused a sea change in conventional marketing strategies (Caliskan et al., 2021). Constantly staying ahead of the competition in today's market is challenging because of the way people's attitudes and habits have shifted in response to technological developments (Vidili, 2021). Strategic sales decisions are required to grow digital sales in the long term and use them as a competitive advantage. Sales techniques that focus on the needs of the consumer are, therefore, more vital than ever in the current economic climate (Zhu & Gao, 2019).

Digital marketing has supplanted conventional marketing and communication tactics, according to Cutinha and Mokshagundam (2022). Internet advertising is increasingly commonplace, and it is feasible to determine the objectives and advantages of digital marketing that those businesses see and use as a successful marketing channel. To properly penetrate this new market, business organizations must first understand the lives of their clients. Digital marketing has evolved into a dependable online venue for small-company communication. Due to the use of the IoT and e-commerce in recent technologies, both customers and suppliers are more productive. Despite geographic differences, there is no denying that the frequency of digital transactions is increasing. People of all ages believe that online transactions are secure and safe, and male and female purchasing behaviors are comparable in terms of the frequency of purchases, urbanity, and perceptions of online security. Digital platforms are common in contemporary society and are recognized as the greatest market for all companies, despite considerable security and privacy hazards.

B. Sivathanu (2019) explored the technology has fundamentally changed how goods are produced or processed in business. One of the main drivers of this shift is the industrial Internet of Things (IoT). According to its definition, the Internet of Things (IoT) is a "global network and service infrastructure of variable density and connectivity with self-configuring capabilities based on standard, interoperable policies and procedures and formats consisting of heterogeneous things that have identities, physical and virtual attributes, and are seamlessly and securely integrated in to the Internet. The Internet of Things (IoT) is a very comprehensive technology with cross-disciplinary uses in communication, computer science, sensor technology, and other fields. IoT with a network of computers, physical objects, software programs, platforms, and other things that can exchange intelligence and interact with one another as well as with people inside and outside of an organization. The IoT makes it possible for several linked industrial systems to coordinate and communicate data and data analytics, and it catalyzes to enhance industrial performance.

Javed et al. (2021) analyzed how the growing complexity of human demands has forced many facets of life and society to confront difficult issues and be considered. According to his research, industrial businesses must embrace technologies like the Internet of Things (IoT) and blockchain to expedite the transition from sustainability to focus. Designing incentive and tokenization mechanisms to encourage green consumer behavior, increasing visibility throughout the product life cycle, increasing system efficiency while lowering development and operating costs, and strengthening the monitoring of sustainability and performance reporting in supply chain networks are some of the capabilities of the blockchain. He offered a paradigm that would describe the interactions and outcomes of the various components of a secure supply chain system based on the Internet of Things and blockchain. To implement a sustainable supply chain based on technology, he emphasized sustainability, cooperation, and management.

Many companies have jumped on the bandwagon of digital marketing by adopting e-commerce. Traditional stores that haven't invested in an online presence have been hit particularly hard by this upswing. This connection is crucial for the successful transition from classic to digital advertising (Dong & Wang, 2018). Successful firms are finding that digitally sustainable sales provide them with an edge in the marketplace. The operational sales procedures and external environment should both be factored into a company's market positioning strategy. According to Chaffey and Smith (2008), every company serious about Internet marketing must prioritize the 5S of Internet marketing (Sell, Serve, Speak, Save, Sizzle)—sales, service, communication, savings, brand creation, and diffusion.

Some of the many benefits of online advertising include cost-effectiveness, specificity in reaching an intended audience, ease of use, and the opportunity to do one's product research before purchasing (Durmaz & Efendioglu, 2016).

Cloud computing, security, big data analytics, omnipresent data, intelligent machines, and a seamless user experience are characteristics of the IoT. The industrial, transportation and utility industries all employ IoT. The IoT is mostly employed in field service, production, asset management, and manufacturing processes. Automation technologies like manaufacturing execution system (MES), distributed control system (DCS) are programmable. Logic controllers (PLC) are widely used by firms. Robots, conveyors, and motors are managed and controlled by programmable logic controllers (PLC) during production. Manufacturing firms may benefit from the Internet of Things in several ways, including linked factory applications, asset and vehicle monitoring, air quality management, access control (security), smart measurement of radiation gases and liquid levels, and risk assessment. Manufacturing companies may exploit the power of the IoT by fusing real-time sensor data, machine learning, big data, and machine-to-machine connectivity. The sector of manufacturing and warehousing has done substantial research on IoT technology. The IoT is an emerging technology that may successfully assist next-generation industrial businesses, according to earlier studies.

For business continuation, Gabelaia and Tchelidze (2022) discovered a requirement for digital marketing knowledge. He also understood how crucial it was to find out the where, when, what, why, who, and how (6Ws marketing model) to make wise choices about the kinds of digital marketing methods to use. Whether small or large, digital marketing tools influence business continuity. The goal of the study was to examine the impact of particular digital marketing technologies on customer interaction, product lifecycle, sales growth, and buyer decision-making. A strong online presence is advised to connect with the intended audience, according to the study and in-depth interviews. Mirmahdi and Afshari (2022) researched the use of the IoT in business and concluded that it gives managers a useful tool for gaining a durable edge. It was discovered that factors influencing the adoption of the IoT for company sustainability were perceived utility, the convenience of use, trust, social acceptance, enjoyment of usage, and controllability. Routine and sustainable marketing techniques have a strategy for planning and controlling decisions that are in line with the expansion of competitive intelligence and the influence of environmental effects. The IOT energizes the organization's information and knowledge flow and enhances the efficiency of group thinking and decision-making. Along with competitive intelligence, IoT-based solutions may also contribute to further corporate expansion and customer perception of their utility.

For enhancing a company's digital marketing capabilities, Masrianto et al. (2022) proposed a model that focuses on the development of an innovation ecosystem by using adoption of digital marketing technology and digital transformation. The innovation ecosystem readiness demonstrates the degree to which the company's ecosystem is prepared to adapt to changes in its internal and external business environment. Comparatively speaking, businesses that can establish innovation ecosystem preparedness typically have stronger digital marketing skills. The degree of organizational usage of digital marketing technology is indicated by the adoption of digital marketing. Businesses that can use efficient digital marketing technologies will often have greater levels of capability. He added that the process of integrating technology into a company's business operations is known as "digital transformation," and it is directly tied to both technological and leadership competencies. Companies that can accomplish digital transformation typically have higher levels of capacity for digital marketing than other businesses.

Using digital marketing strategies like social media can help small businesses reach more people for less money. Competition for micro, small, and medium enterprises (MSMEs) is fierce. Many of the rivals provide products that are essentially the same, but at a lesser price. In exchange, they offer a wide range of benefits to their clientele. With the use of digital technologies, businesses may enhance their customer-facing processes and provide better responses to customers' requests. Digital technology is beneficial for both consumers and businesses since it increases efficiency and productivity while decreasing overhead costs (Foroudi et al., 2017).

Sun (2022) outlined the current state of the industry, the potential for future market growth in the sales profession, and the development space for digital marketing. He indicated that it may be conceivable to use decision-making for other firms to execute to improve automotive digital marketing management.

3 Objectives

- To analyze the effect of digital marketing practices on the sales performance of MSMEs
- To examine the effect of digital marketing practices on the business sustainability of MSMEs

4 Research Methodology

Descriptive surveying was used as the primary research approach for this study. Researchers often use questionnaires as a tool for data collection from the study population. This research tool was developed after reviewing the relevant literature and previous studies (Wanjiru Mobydeen, 2021). A Google Docs questionnaire was created, and its link was sent to the CEOs and managers of MSMEs, as well as any other executives with a stake in the strategy and execution of digital marketing. The first section of the survey asks for basic personal and professional information about respondents. In the second section, you'll answer questions about the study's dependent and independent variables. Respondents were given a 5-point Likert scale on which to rate their opinions, from 1 (strongly disagree) to 5 (strongly agree). Respondents were chosen from among various MSMEs in Hyderabad using a combination of expert judgment and practical considerations. After data screening, 142 out of 152 questionnaires were chosen for further research since they contained all of the necessary information.

5 Hypotheses

H1: Digital marketing practices have a significant influence on the sales performance of MSMEs.

H1a: Mobile marketing has a significant effect on the sales performance of MSMEs.

H1b: Social media marketing has a significant effect on the sales performance of MSMEs.

H1c: Search engine marketing has a significant effect on the sales performance of MSMEs.

H2: Digital marketing practices have a significant influence on the business sustainability of MSMEs.

H2a: Mobile marketing has a significant effect on the business sustainability of MSMEs.

H2b: Social media marketing has a significant effect on the business sustainability of MSMEs.

H2c: Search engine marketing has a significant effect on the business sustainability of MSMEs.

A combination of SPSS version 24 and AMOS was used to analyze the survey data collected from the participants. Descriptive statistics include summing up the study's variables by calculating their means and standard deviations. Cronbach's alpha was used to check the data's consistency. Structure equation modelling was used for the hypothesis testing (SEM).

6 Analysis and Interpretations (Tables 1 and 2)

The descriptive statistics of various statements related to predictor variables mainly mobile marketing, social media marketing, and search engine optimization indicate all the values of mean above 3 inferred agreements of respondents for these statements. The dependent variables, measured using sales performance and business sustainability, have mean values above 3 and standard deviation values near 1.

The above table also mentioned Cronbach's alpha values for research constructs, as per Nunnally (1978) the alpha value above 0.7 indicates the reliability of data. For the current study, the alpha value is higher than the threshold value of 0.7 ranging from *0.861 to 0.915*.

Table 1 Details of respondents and MSMEs

Measures	Items	Percentage (%)
Gender	Male	84
	Female	16
Age	Below 24	3
	25–30	62
	30–35	12
	35–40	23
	40 & above	8
Education	Secondary	4
	Undergraduate	54
	Postgraduate	2
	Others	21
Occupation	Business	64
	Salaried	27
	Others	9
Type of business	Micro	12
	Small	32
	Medium	66
Activities of business	Manufacturing	43
	Transport	3
	Construction	7
	Trade and commerce	10
	Service	23
	Others	14

Table 2 Descriptive and reliability of the constructs

SI. No.	Items	Mean	Standard deviation	Cronbach's alpha
1	MM1	3.32	0.894	0.874
2	MM2	3.45	0.965	
3	MM3	3.45	0.941	
4	SM1	3.47	1.000	0.915
5	SM2	3.36	0.974	
6	SM3	3.41	0.967	
7	SEM1	3.19	0.938	0.875
8	SEM2	3.18	0.909	
9	SEM3	3.18	0.946	
10	SP1	3.45	0.947	0.867
11	SP2	3.44	0.964	
12	SP3	3.62	0.872	
13	BS1	3.29	0.979	0.861
14	BS2	3.38	0.946	
15	BS3	3.37	0.921	

7 Structural Equation Modelling (SEM) for Hypothesis Testing

SEM is a multivariate technique where the structural model shows the link between the latent variables or constructs that the research model hypothesized. For the current study, mobile marketing (MM), social media marketing (SM), and search engine marketing (SEM) were considered as an exogenous variable, and their impact was tested on sales performance and business sustainability of MSMEs (endogenous variables).

The data shown in Table 3 and Fig. 1 are utilized for hypothesis testing. If the crucial ratio (t value) was more than 1.96 and the probability of a false discovery was less than 0.05 at the 5% level of significance, then the null hypothesis would be accepted. Standardized regression weights for the routes or relationships between independent and dependent variables are represented by the path coefficients. The magnitude of an independent variable's effect on a dependent variable is proportional to the square root of its beta value (the standardized regression weights).

The results showed that mobile marketing had a favorable and substantial effect on MSMEs' sales performance (beta = 0.227, p = 0.019). Therefore, H1a was accepted against the null hypothesis because the p-value was less than 0.05.

Similarly, the influence of social media marketing (beta = 0.392, p = 0.000) and search engine marketing (beta = 0.321, p = 0.000) on sales performance is positive and statistically significant. These pathways have t-values more than 1.96 and p-values less than 0.05, supporting hypotheses H1b and H1c.

In addition, the study studied the effect of three marketing strategies on the business sustainability of micro, small, and medium-sized enterprises (MSMEs), and the results supported the favorable effect of digital marketing practices on company

Table 3 Path coefficients of the structural model

Outcome variable		Independents variables	C.R.	*P*	Regression weights	Hypothesis
Sales performance	<—	Mobile marketing	2.343	0.019	0.227	Supported
Sales performance	<—	Social media marketing	4.771	***	0.392	Supported
Sales performance	<—	Search engine marketing	4.113	***	0.321	Supported
Business sustainability	<—	Mobile marketing	2.199	0.028	0.243	Supported
Business sustainability	<—	Social media marketing	2.967	0.003	0.274	Supported
Business sustainability	<—	Search engine marketing	3.027	0.002	0.268	Supported

*Note: P refers to the differential probability. ***: p < 0.000*

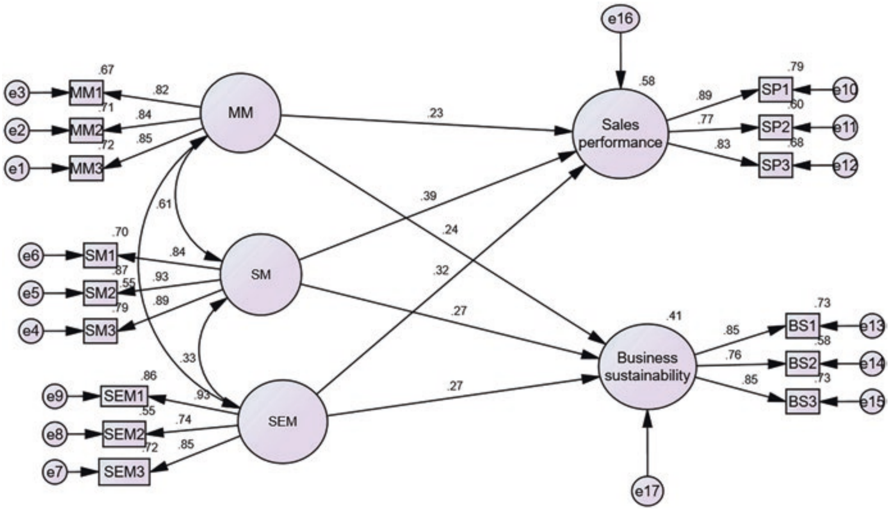

Fig. 1 SEM model: causal structure. Note: Here, *MM* mobile marketing, *SM* social media marketing, *SEM* search engine marketing

sustainability, hence supporting hypothesis H2. The path from mobile marketing to business sustainability has a beta value of 0.243 with a *p*-value of 0.028, demonstrating the validity of hypothesis H2a.

With beta = 0.274, *p* = 0.003 (*p*-value 0.05), social media marketing has a considerable impact on business sustainability, as indicated by H2b (beta = 0.274, *p* = 0.003; *p*-value 0.05). Likewise, this effect of search engine marketing on firm sustainability is substantial as beta = 0.268, *p* = 0.002, so H2c is accepted.

Moreover, the generated *R* square value of 0.58 as presented in Fig. 1 depicted that digital marketing practices (mobile marketing, social media marketing, and search engine marketing) accounted for 58% of the variation in sales performance.

The *R* square value for business sustainability is 0.41 indicating 41% of the variance is explained by three digital marketing practices. Thus, it can be concluded that digital marketing had a moderately positive effect on the performance of MSMEs.

8 Discussion and Implications

In this study, we looked at how various digital marketing strategies affected the success of small and medium-sized businesses. Some examples of digital marketing strategies employed by chosen MSMEs are discussed in this study. The research results showed that these three digital marketing strategies do have a good and significant effect on MSMEs' sales performance and business sustainability. Effectiveness can be best predicted by using social media marketing. Previous studies have looked at how various forms of digital advertising affect business outcomes. The results of this study are consistent with those of the other studies. Mail marketing, social network marketing, mobile phone marketing, and website marketing are only some of the digital marketing tactics that Mobydeen (2021) examined in his research of their effects on business outcomes.

The importance of these results lies in the fact that they demonstrate how digital marketing, in any of its forms, can have a positive impact on the performance of MSMEs and that its aims are attainable. All MSME managers/CEO/directors can benefit from the study's findings. Owners and managers are encouraged to adopt a variety of digital marketing strategies to boost the company's bottom line. There isn't a single marketing strategy that doesn't have some kind of impact on revenue growth and company viability.

According to the findings, using many social media platforms to spread a company's message to a wide audience is highly effective. Instagram and WhatsApp were also mentioned as potential tools for maintaining contact with clients.

9 Conclusion

Small and medium-sized businesses (SMBs) can choose from a variety of digital marketing tools. Websites, electronic mail, short message services, search engine optimization, social networking sites, microblogging platforms, and micro-messaging apps like WhatsApp, Twitter, Instagram, and Telegram are all on the list. From this study, researchers can infer that digital marketing and usage of the IoT through the methods like mobile marketing, social media marketing, and search engine marketing are having a positive influence on the sales performance and business sustainability of MSME companies. Facebook, WhatsApp, and Instagram are the three most widely used social networking sites today. In the 5G telecom era and Industry 4.0, business and technology are inseparable irrespective of the place, nature of business, and customer segment. Companies should be continuous learners to analyze and adopt suitable IoT and digital marketing tools in sustaining their business and planning for their business expansion or product innovations. Though investing in digital tools and training the resources and customers to adopt in business are challenging tasks, the efforts and investments will yield better returns and efficiency in any business.

10 Scope for Future Research

This study is limited to research on digital marketing tools in business performance in MSMEs. Further studies can be on performance in different functional areas like marketing, human resource, finance, exports, etc. Here study was limited to selected companies in Hyderabad only, so future studies could be from MSMEs from different states, comparative performance of different businesses, and influential studies of different tools in different areas and regions for further micro understanding which may give inputs to future entrepreneurs and SMEs' growing as MSMEs.

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The Higher Education Students' Perception on IoT Acceptance as an Educational Facilitating Medium: Perception from Omani Context

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1 Introduction

One of the prominent changes that our generation had the pleasure of witnessing is the technological revolution. This revolution keeps changing many aspects of our life at such speed that it is sometime had to catch up with. The technological evolution is going in a fast pace and affected all aspects of our lives that included the learning and teaching methods. This evolution had drastically changed many areas including how individuals learn and teach. The rapid advancement in technology has led to the communication of devices using the Internet of Things (IoT) instead of communication between humans as was the case in the past decades. On the other hand, educational institutions are no exception as they are competing to adopt the IoT to cope with the new advancements in technology as it is a new requirement for the future of education worldwide. IoT technologies' solutions allow universities and colleges to acquire data via various sources such as wearables, sensors, and actuators that can help in the provision of personalized contents and enhance the student outcome through engaging students with variety of Internet connected devices (Majeed & Ali, 2018; McKinney, 2004). Moreover, as a result of the COVID-19 pandemic and related consequences of lockdown, the online education and distance learning were intensively utilized in order to survive the pedagogical process (Taufiq-Hail et al., 2021). Thousands of training packages in different fields in addition to degrees and technical or commercial certificates were offered online

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globally. Therefore, the Internet with its related technologies such as IoT-enabled devices has become are the locus of acquiring training, education, and knowledge.

Based on the importance of the IoT and the expected huge and widespread of this technology and its applications in all aspects of our life, the study aims to shed light on the intention to use this technology among university students in Oman based on its importance and promising advantages that can affect the way we teach and learn. Additionally, IoT social science studies that cover the perceptions of university students, especially the millennials, are lacking in the context of higher education in Oman. Hence, getting some insights in this regard could enhance the understanding of this technology among university students from heterogeneous backgrounds especially with the millenniums who are technology savvy. Based on this, the main objectives of the study are as follows:

Based on the perceptions of the university students:

1. Does ease of use of the IoT-enabled devices drive the intention to use and adopt the IoT in-campus and outside campus of different learning activities?
2. Does the usefulness of the IoT as perceived by the students drive their intention to use or adopt this innovative technology in- or outside campus as a way of learning?
3. Does the ease of use of IoT-enabled devices and applications impact the perceived usefulness perceptions of the university students toward the intention to use and adopt this technology and its applications?

The reset of the study is organized as follows: the infiltration of the IoT and its advantages are explained. The hypotheses developed to achieve the objectives of the study are demonstrated. Then, methodology followed to achieve the objectives is explained. Afterward, the data analysis and discussion is further explained. Finally, the conclusion is drawn from the results obtained.

2 Literature Review

2.1 IoT Infiltration and Advantages at Higher Education Sector

The IoT is an emerging technology that connects different Internet-enabled objects (or things) in order to collect data and relaying it to specialized applications in order to create usable and actionable information (Majeed & Ali, 2018; Dutton, 2014). Devices such as digital displays, audio recorders, cameras, smartwatches, and any smart device can communicate with one another across Internet networks (Majeed & Ali, 2018). The ability to send and receive packets of data through IoT applications are widely used in a variety of fields that include education, security, industrial, agriculture, transportation, business, management, and health sectors in private or public sectors (Majeed & Ali, 2018; Ban et al., 2017; Jasim et al., 2021).

Obviously, the Internet has controlled almost everything in our life. Proliferation of smart and intelligent devices emerged where they are Internet-enabled made them part of the IoT space. The IoT has many advantages such as saving cost and time, protect environment through proper management of resources such as power and water consumption, achieve parking efficiency, and protect the environment (Abuarqoub et al., 2017). However, what is the role of the IoT in the academic field? To answer this question, we have to recognize how technology advancement and the smart and intelligent algorithms embedded in devices such as tablets, laptops, wearables, and cellphones are becoming increasingly popular among students at universities, which could enhance the teaching process. These devices are connected to the Internet as a service offered in campus. Hence, campuses must integrate IoT technology in order to establish a smart atmosphere that involves different stakeholders. Implementation of the IoT in campus has been witnessed in many campuses globally through its application in controlling lights, energy consumption, surveillance, marking attendance through smart ID cards, and access to various parts of the lecture halls through intelligent applications and appliances. As the IoT became ubiquities with all Internet-enabled devices, the method of teaching/learning has changed dramatically, and the student can now be part of participating in the knowledge base of different syllabus.

There are many advantages related to the usage of the IoT such as the increase in energy efficiency by controlling different appliances and devices, the communication between students and instructors, and the overall reduction in operational costs (Majeed & Ali, 2018). Moreover, the IoT is implemented in universities to automate the pedagogical process, to augment the students' learning outcomes, to enhance the teaching methods, to manage the surveillance in the campus, to monitor health and general hygiene of students by measuring their temperature, and to control purity and humidity of air inside classes and in the corridors (Ban et al., 2017).

Additionally, the IoT can enhance and support the education process by facilitating access to multiple resources which will help the student as well as other stakeholders in the university. More importantly, the IoT can better serve universities in terms of early warnings of any natural or unexpected human catastrophic events by notifying students and the academic staff of such emergencies.

Recent research highlighted the vital role of the IoT in imparting knowledge and developing cultures (Shaikh et al., 2019). In addition, the IoT is an intermediary medium that facilitated the communication and collaboration among students – as well as lecturers – to develop creative and innovative ideas. Saeed et al. (2021) in a recent article encouraged the move toward the digital campus that has the advantage of offering efficient educational tools to students as well as the academic and teaching staff. The authors classified the digital campus into two categories: one is an existing IT services delivery platform that offers network connectivity and security and IoT applications that support university professionals and help in improving the students' overall university experiences. They explained the role of IoT application in digital campuses as a facilitator in the location and attendance system, security and access control, energy efficiency, management information systems, and campus building control and management. Other scholars have also asserted on the importance of the IoT in the automation of education process that can be improved significantly in smart campus within universities which the positive outcome would be upon the educators and the learners (Ban et al., 2017). Facilitating the educators' efforts could immensely improve students' satisfaction by using IoT devices. For example, when using QR codes in education, the enabled devices that has special sensors can translate these codes into meaningful information that would help the educators as well as the students in searching and finding the information requested in a marginal time (Majeed & Ali, 2018).

There are various benefits of IoT technologies that can be used in educational institutions to improve the collaboration of students among themselves and with their educators' decisions (Bagheri & Movahed, 2016). COVID-19 has created many promising opportunities, despite its negative impact on various aspects of our lives. The pandemic indeed wrecked some havoc in the educational sector due to the hasty and sudden changes in the education process. However, it has also transformed education into a different platform that could make the IoT a key player in delivering educational services.

The IoT is expected to have tangible improvements in all educational institutions starting from students at school toward higher education students. It is estimated that the IoT will have an impactful role on educators and the students as indicated in literature. In this regard, McRae et al. (2018) explained that smart and IoT-enabled devices are communicating with each other, exchange information and data, process the collected data, operate based on specific conditions, and send this information to humans to take proper action or gain insights of specific information that deems necessary to his/her interest. Majeed and Ali (2018) indicated that various educational institutions benefited from the IoT to gain valuable information and perform meaningful actions based on the collected data from the actuators, sensors, as well as other smart devices.

The rapid growth of technology has transformed the paradigm of higher education. This has influenced colleges to update their teaching and learning models. The Internet and IoT support education in many ways that made different stakeholders to elevate the traditional way of teaching. These include, but not limited to, virtual reality, immersive reality, QR code, and the most innovative and recent technologies that rely on artificial intelligence. To sum up, the IoT is a promising technology that would be an essential part of our educational system, and with the rapid development of artificial intelligence and deep learning algorithms, the future of education can change fundamentally, and a new era of education would change the way we live, learn, communicate, and adapt.

2.2 Hypotheses Development and Theoretical Framework

Technology Acceptance Model (TAM) The current research focuses on the intention to use or adopt IoT technology in higher education sector in Oman within the university community by evaluating the intention to use this technology as the dependent variable, which in turn is affected by perceived ease of use and perceived usefulness, the independent variables. The technology acceptance model (TAM) which was developed by Davis (1989) and widely spread in the academia to study innovation and technology acceptance, behavior, or usage was mainly focusing on the study of human behavior (Mendell & Heath, 2005). The TAM model has a validated instrument that is applied in various contexts. Moreover, perceived ease of use and perceived usefulness are of the main focus of the current research which TAM covers these two constructs extensively to predict the intention to use the innovative technology of the IoT. Therefore, this model has been utilized to examine students' intention toward IoT technology in Omani contexts at higher education institution. Based on the aforementioned justifications, the researcher presumes the importance of TAM and takes into consideration using it as the basis of the conceptual model of the current study to find out the role of perceived usefulness and perceived ease of use on the intention to use the IoT in the higher education sector in Omani context from the students' viewpoints and perception.

Behavior Intention (BI) Reviewing the literature, BI appears to be a crucial factor in influencing the behavior (Shin, 2013). The definitions of BI can be said to be "The degree to which a person has formulated conscious plans to perform or not perform some specified future behavior" (Warshaw & Davis, 1985). However, for the purpose of this research, BI is defined as the degree in which the students using the IoT formulated sentiments to either use or not to use the services of the IoT. Many theories support the role of BI in influencing the behavior in question such as the theory of reasoned actions (TRA) (Fishbein & Ajzen, 1975), the theory of planned behavior (TPB) (Ajzen, 1991), and the decomposed theory of planned behavior (DTPB) (Taylor & Todd, 1995). Hence, BI is added to the model to reveal the perceptions of higher education students' intention to use the IoT in the academic and non-academic activities and inside or outside campus in Omani context. Former works in different contexts revealed BI's significant role on usage, adoption, or acceptance of technology (Alalwan et al., 2017; Sarea & Taufiq-Hail, 2021; Velázquez, 2014). Based on the above literature and supporting theories, the researchers assume the importance of BI in the area of the IoT and regard it as the dependent variable of the current research.

Perceived Ease of Use (PEOU) PEOU is defined in TAM by Davis et al. (1989) as "the degree to which a person believes that using a particular system would be free of effort" and further added "This follows from the definition of 'ease': freedom from difficulty or great effort" (Davis, 1989). In other words, the easier the task in using the IoT to achieve a specific academic or non-academic task, the more likely this technology is intended to be used in academic and non-academic life of students based on being free of burden in using the technology. Additionally, former works in exploring the effect of PEOU on BI to use or adopt innovative technology appear to support the significant role of PEOU on using innovative technologies (Hamid et al., 2016; Richad et al., 2019; Tahar et al., 2020); hence, the following hypothesis is assumed:

H1: PEOU is expected to have a direct and positive effect on behavior intention to use or adopt the IoT inside or outside campus to achieve academic and non-academic tasks at the Omani universities.

It is worthwhile to drive the attention to the relationship between PEOU and perceived usefulness (PU). Drawing on TAM, PEOU is believed to have a strong and significant relationship with PU. In other words, the easier to use an innovative technology such as the IoT, the more useful the students would perceive its usefulness (Venkatesh, 2000). Moreover, many former works ensure the association between PEOU and PU such as the study conducted by Venkatesh (2000). Further, a large body of literature supports this association (Hamid et al., 2016; Richad et al., 2019; Arpaci, 2016). On the other hand, other findings contradict with the previous findings and found no association between PEOU and PU such as the study conducted by Agarwal and Karahanna (2000). Also, a study conducted by Smith (2008) found no significant relationship between PEOU and PU. These inconsistencies and contradicting findings revealed have driven the researchers to test this relationship in the area of the IoT and in the context of the higher educational institutes. Moreover, when a technology is perceived difficult to be understood, used, or accessed, it is unlikely to be used, accepted, or adopted, as a negative perception is created. In contrast, when it is easy, accessible, and understandable, it would likely increase the students' acceptance and productivity in their tasks and assignments in academic life. Consequently, this creates a positive perception on them of its usefulness. Therefore, the following is hypothesized:

H1-2. PEOU is expected to have a significant positive relationship with PU toward the intention to use or adopt the IoT inside or outside campus to achieve academic and non-academic tasks at the Omani universities.

Perceived Usefulness (PU) Perceived usefulness (PU) is defined by Davis as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). This means that when the usefulness of a technology is highly perceived, then it is more likely that the user of the innovative technology, such as the IoT, will have a strong feeling and intention to use this technology to achieve the perceived tasks and activities. In the context of the current research, PU is defined as the degree to which students at Omani universities believe that using the IoT would improve their academic performance and it would have a positive and strong impact on the intention to use this innovative technology that started to spread rapidly in the few recent years.

In reviewing the literature, PU has been found as one of the influential factors to predict BI. Some of these works indicated a positive and significant relationship between PU and BI confirming the strong correlations between the two (Dong et al., 2017; Venkatesh & Davis, 2000). Based on the aforementioned explanation, the researcher finds herself to postulate the following:

H2. PU is believed to have a direct and significant positive relationship on behavior intention to use or adopt the IoT inside or outside campus to achieve academic and non-academic tasks by the Omani students.

3 Methodology

The current research is explorative in nature and based on quantitative research method utilizing purposive and snow balling techniques to collect the data from respondents. The unit of sampling is university student of different majors. That is, the targeted responses collected from university students with heterogeneous background, age, field of study, and gender. It is well-established that majority of young generation, the millennials, are the most category using the Internet heavily in Oman and the university students represent this category of the community. A questionnaire survey instrument was used to collect the perceptions of the students toward the intention to use the IoT. The items were under scrutinized process in terms of its wording, content reflecting the research topic, the language, and the easiness of the questions. The instrument was evaluated by three university doctors in the field of information system. Out of 100 responses, the total valid responses were 95, after eliminating the incomplete responses. SmartPLS version 3.3.9 statistical package was used to evaluate the measurement and structural model (i.e., the hypotheses testing).

4 Data Analyses Results and Discussion

4.1 Description of Demographics Profile

Demographics included in the questionnaire are gender, age, academic degree, institution type, governorate of permanent residence, and university type. Referring to Table 1, gender results revealed that female participants are more than male participants, 81% and 19%, respectively. The age of participants was checked, and it is found that majority of participants fall on the second category, i.e., category 20–22 (56%), followed by category 23–25 (36%), and then 17–19 (5%). In terms of academic degree, the majority of participants were from bachelor's degree (56%), followed by general diploma (32%), and then diploma (12%).

Table 1 Demographic characteristics of respondents

Characteristic	Selection	Frequency/percentage
Gender	Male	18 (19%)
	Female	77 (81%)
Age	17–19	5 (5%)
	20–22	56 (56%)
	23–25	34 (36%)
Academic degree	Diploma	11 (12%)
	General diploma	30 (32%)
	Bachelor	54 (56%)

4.2 Measurement Model Assessment Procedure

There are two types of constructs: reflective and formative constructs. In this research, the reflective measurement construct is used. The path models are developed based on two theories: the measurement theory and the structural theory (Hair et al., 2017, 2011).

4.3 Reflective Measurement Model Assessment

The assessment of the reflective measurement model consists of the convergent validity (i.e., the outer loadings of the latent variables, their reliability, and the average variance extracted (AVE)), the internal consistency reliability (i.e., composite reliability (CR), and Cronbach's alpha), and discriminant validity.

Convergent Validity The convergent validity is measured by the assessment of the outer loadings, the construct reliability, and AVE. The outer loadings equal or above the cut-off value of 0.7 are acceptable and indicate that the items have much share in common that is captured by the same construct (Hair et al., 2017). Previous literature suggests outer loadings in the range of 0.5 (Hair et al., 2010) to 0.7 or higher (Hair et al., 2017; Henseler & Chin, 2010) are acceptable and meet the thresholds of reliability and validity. In the current research, the researcher stick to the rule of thumb in the cut-off value of 0.7 as it is more applicable to confirm its strengths in most previous works (Hair et al., 2017). By examining the values, it is revealed no violations to the criteria in majority of the items except for items PEOU1 (0.56), PEOU2 (0.57), PU4 (0.58), and PU10 (0.60). Hence, these items were eliminated from the model.

It is worth mentioning that in reflective model, any item could be removed or eliminated if it has loadings less than the thresholds indicated above or if removing it increases the composite reliability/AVE of the related construct (Hair et al., 2017). Besides, items in reflective model are interchangeable and are viewed as equivalent manifestations of the same construct and removing these items is possible as long as the remaining items have sufficient content that the construct is capturing (Hair et al., 2017; Podsakoff et al., 2006). Moreover, AVE of all constructs met the criterion and exceeds the threshold of (0.5), refer to Table 2.

Measurement Model Internal Consistency Reliability Assessment Here, the assessment of internal consistency and reliability consists of the CR and Cronbach's alpha. The cut-off values that are acceptable fall in the range of 0.6–0.9 (Hair et al., 2010). Looking at the range of CR, we found that they fall in the range recommended values. Also, Cronbach's alpha are within the recommended values.

Additionally, in explorative research – such as the current study – the cut-off values in the range 0.6–0.7 are considered acceptable, values in the range of 0.7–0.95 are satisfactory, whereas values below 0.6 are considered to indicate lack of internal

Table 2 Results' summary of the measurement models

Latent variable	Indicators	Loadings >0.7	AVE > 0.5	Composite reliability 0.6 –0.9	Cronbach's alpha 0.6–0.9
BI	BI1: Intend to use IOT technology services in my academic studies and beyond.	0.79	**0.65**	**0.90**	**0.87**
	BI2: I am planning to use the IOT in communicating within my campus and at my residence smart IoT appliances.	0.85			
	BI3: I plan to use IOT technology frequently this term and onward in-campus and outside campus as long as the connection is available.	0.75			
	BI4: I am planning to use the IoT in communicating within my campus as well as my home smart appliances	0.80			
	BI5: I plan to convince my colleagues in my campus as well as friends and relatives to use and adopt IoT-enabled devices.	0.84			
PEOU	PEOU1: I believe that using IoT technology through smart devices is easy for me	**0.56***	**0.65**	**0.92**	**0.89**
	PEOU2: I will often use IoT technology.	**0.57***			
	PEOU3: I think that someday universities and educational institution will use the electronic education instead of the traditional education because it is easy to operate and compatible with IoT technology.	0.79			
	PEOU4: Using mobile screens to operate the equipment of laboratories will be much easier for me by using IoT Technology.	0.74			
	PEOU5: In my opinion, the easiness of using the IoT will have a positive impact on my academic achievements.	0.81			
	PEOU6: In my opinion using Internet of Things connected devices is easy	0.88			
	PEOU7: I find it interesting and easy to have technologies connected to the Internet using the smart phone/watch to find a lecture's hall and labs.	0.82			
	PEOU8: I will strongly recommend using IoT services to others inside my university (e.g., my colleagues) or outside in my social network because it is easy to use.	0.80			

(continued)

Table 2 (continued)

Latent variable	Indicators	Loadings >0.7	AVE > 0.5	Composite reliability 0.6 –0.9	Cronbach's alpha 0.6–0.9
PU	PU1: I feel that using IoT technology is important to improve my academic attainment.	0.74	**0.57**	**0.91**	**0.89**
	PU2: Using IoT technology will improve education performance through a variety of applications.	0.71			
	PU3: I am thinking of using IoT devices and applications as they are useful when used to communicate with my home smart appliances and the university IoT-enabled devices.	0.77			
	PU4: I find it helpful to use IoT technology during learning activities in lecture halls and laboratories.	**0.58***			
	PU5: The IoT technology will save my time to acquire information relevant to my syllabus and performing well in my courses	0.78			
	PU6: The IoT will help me perform well in my academic courses	0.77			
	PU7: Using Internet-connected technologies will increase the security inside my campus.	0.71			
	PU8: I believe that the flexibility in accessing the information presented by the IoT will be highly useful	0.80			
	PU9: IoT technology may provide me with individual attention and address my own needs	0.73			
	PU10: The credibility of the information presented by the IoT will be considerably useful.	**0.60***			

Note: *Item removed as its loading is less than the cut-off value of 0.7

consistency reliability, and values above 0.95 are not desirable (Hair et al., 2010). The results reveal no violations of the cut-off values; see Table 2 for details. Therefore, the internal consistency and reliability is established for the model proposed.

Discriminant Validity Assessment In discriminant validity evaluation, the indicators of each construct are examined against another construct to ensure that they are loaded only in the intended construct. To do so, the cross-loadings validation and the Fornell and Larcker criterion (Hair et al., 2010) tests are performed. For the cross-loading validation, the loadings of items in an intended construct are tested against other loadings with other constructs. The results revealed no violations of the criterion. For the second test, Fornell-Larcker (Sarstedt et al., 2014) criterion was used to evaluate different constructs and the results reveal that the square root

Table 3 Fornell-Larcker criterion

Construct	BI	PEOU	PU
BI	**0.865**		
PEOU	0.84	**0.808**	
PU	0.766	0.846	**0.752**

Table 4 Cross-loadings

	BI	PEOU	PU
BI1	**0.792**	0.645	0.704
BI2	**0.848**	0.664	0.57
BI3	**0.749**	0.583	0.584
BI4	**0.797**	0.661	0.576
BI5	**0.842**	0.805	0.649
PEOU3	0.642	**0.79**	0.73
PEOU4	0.626	**0.741**	0.575
PEOU5	0.615	**0.812**	0.644
PEOU6	0.667	**0.877**	0.724
PEOU7	0.655	**0.815**	0.764
PEOU8	0.842	**0.805**	0.649
PU1	0.692	0.726	**0.739**
PU2	0.445	0.518	**0.712**
PU3	0.579	0.632	**0.773**
PU5	0.595	0.725	**0.778**
PU6	0.496	0.582	**0.769**
PU7	0.567	0.527	**0.71**
PU8	0.581	0.619	**0.803**
PU9	0.599	0.699	**0.729**

of AVE of each construct in the diagonal is higher than all correlations with other constructs in all directions of the table (i.e., in the same row and same column of each construct) (Sarstedt et al., 2014). Tables 3 and 4 demonstrate the results. To conclude, the results revealed show an establishment of discriminant validity of all constructs. Therefore, proceeding to the structural model evaluation can be made.

The following is a diagram, Fig. 1, of the outcome of the measurement model evaluation of the proposed conceptual model.

4.4 *Structural Model Assessment Procedure*

In the previous sections, the evaluation is conducted for the measurement model, and now it is the second step of evaluation of the structural model (the hypotheses testing) or the inner model. Each step of the evaluation process is explained thoroughly in the following subsections.

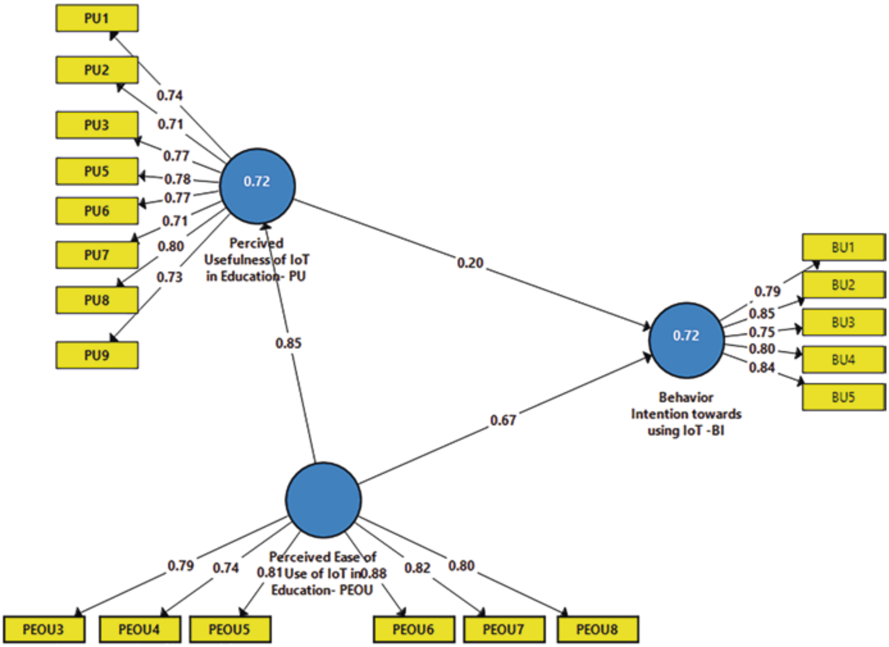

Fig. 1 Measurement model

Table 5 Collinearity assessment of the latent constructs with VIF values

	BI	PEOU	PU
BI			
PEOU	**3.521**		**1.000**
PU	**3.521**		

Collinearity Assessment First of all, in evaluation of the structural model is to start the investigation of the collinearity of the model through checking the threshold of VIF (variance inflation factor) that should be less than 5 to avoid collinearity issues of the constructs. Each set of predictor constructs are examined against their outcome constructs (Hair et al., 2014, 2017). As can be seen in Table 5, all predictors meet the criteria of having a VIF value less than 5, so the researchers proceed to the next step of the evaluation process.

Structural Model Path Coefficients Assessment The estimates for the hypothesized relationships for the structural model are obtained by running the PLS algorithm, which is the standardized values of path coefficients. The values of path coefficients close to (+1 or −1) are considered strong relationship either positive or negative. On the contrary, the values near (0) are considered weak and normally not significant (Hair et al., 2010). To estimate the significance of the path coefficients bootstrapping routine is run, which computes the t and p values in addition to con-

Table 6 Structural model significance results: path coefficient

Relationship	Path coefficient	*Sample mean*	*t* value	*p* value	95% confidence interval	Significant? Yes/No
PEOU -> BI	0.674	0.664	5.854	0.000	[0.43–0.88]	Yes
PEOU -> PU	0.846	0.848	25.557	0.000	[0.77–0.90]	Yes
PU -> BI	0.196	0.206	1.336	0.182	[−0.10–0.48]	No

fidence intervals. Further, the statistical significance is accomplished when the t values are larger than a threshold, which are for the two-tailed tests: 1.65 (at significance level of 10%), 1.96 (at significant level of 5%), and 2.57 (at significance level of 1%). On the other hand, the one tail critical values are: 1.28 (at significance level of 10%), 1.65 (at significant level of 5%), and 2.33 (at significance level of 1%). Moreover, the significance level for the studies that have explorative nature is 10% (Hair et al., 2010). In the current study, however, the significance level is selected to be of 10%. Besides, the 95% confidence interval (CI) provides additional information about the significance of the path coefficients. If the range of CI revealed does not include a zero value, it indicates that the statistical significance of the value under consideration. By referring to Table 6, the values for different hypothesized relationships between the latent constructs are presented. We only find that the relationship between PU and BI is not significant as there is a zero value in the range of CI, which indicate no statistically significant relationship between PU and BI.

Coefficient of Determination (R^2) Assessment The coefficient of determination or R^2 is particularly important to evaluate the model and testing the hypotheses, and it is called predictive power of the model. It is the amount of the combined effects of all independent constructs on the dependent construct. R^2 represents the in-sample predictive power (Rigdon, 2012; Sarstedt et al., 2014). The R^2 cut-off values suggested by Chin (1998), which are widely used in reporting the R^2, are as follows: 0.19 (weak), 0.33 (moderate), and 0.67 (substantiate). Referring to Table 7, the two constructs BI and PU have R^2 values of (0.72) and (0.72) that can be described as substantial values and therefore the predictive power of the model is substantial.

Effect Size (f^2) Assessment R^2 of each dependent construct was assessed and now the effect size f^2 of each independent construct is to be evaluated. This is to ensure whether the effect of the independent construct is substantive on the considered dependent construct (Hair et al., 2010). Actually, there are two existing guidelines for evaluating f^2 size of R, (McKinney, 2004); one is taken from (Hair et al., 2010) in which the values of 0.02, 0.15, and 0.35 represent small, medium, and large. The guideline of the effect size values are the following: f^2 (0.02), which is considered small, (0.13) is medium, and (0.26) is large effect size (Loeser et al., 2017; Wetzels et al., 2009). Consequently, values less than 0.01 indicate that there is no effect of a specific independent construct on a specific dependent construct.

Table 7 Coefficient of determination R^2

Endogenous latent variable	R^2 value
BI	0.72
PU	0.72

Table 8 *f* effect size of *R* squared

	BI	PEOU	PU
BI			
PEOU	0.45		2.52
PU	0.04		

Table 9 Summary of hypotheses

Hypothesis	Relationship	Findings
H1	PEOU -> BI	Supported
H1-2	PEOU -> PU	Supported
H2	PU -> BI	Not supported

Smart PLS M3 calculates the effect size automatically and the results are shown in Table 8. For instance, the f^2 effect size of PEOU on BI ($f^2_{PEOU\ ---BI}$) has a pronounced large effect (0.45) and higher than the f^2 effect size of PU on BI ($f^2_{PU---BI}$), which is small (0.04). This tells us that the effect of PEOU is much stronger than the effect of PU on BI. Moreover, the f^2 effect size of PEOU on PU ($f^2_{PEOU---PU}$) is large (2.52).

Table 9 provides a summary of the hypotheses' findings and Fig. 2 illustrates the output of the structural model.

5 Discussion

The use of the IoT in the pedagogical process is beneficial for both, the students and the lecturers. First, it will enable educational institutions to streamline data collection and process. Besides, it can improve the feedback process on different policies enacted through actionable information generation. Such benefits can increase the efficiency of all stakeholder and campus activities and provide holistic solutions to common education management problems. More importantly, to enhance the efficiencies in processing data and provide actionable information to achieve energy saving, facilitate the accessibility to variety of information, increase safety and productivity, find the intended lecture halls and laboratories, and control access to sensitive areas, the IoT is the solution to all these aspects. To evaluate the intention of students toward IoT usage and adoption, this research employed TAM model to evaluate the students' intention toward the adoption and usage of the IoT in Omani context.

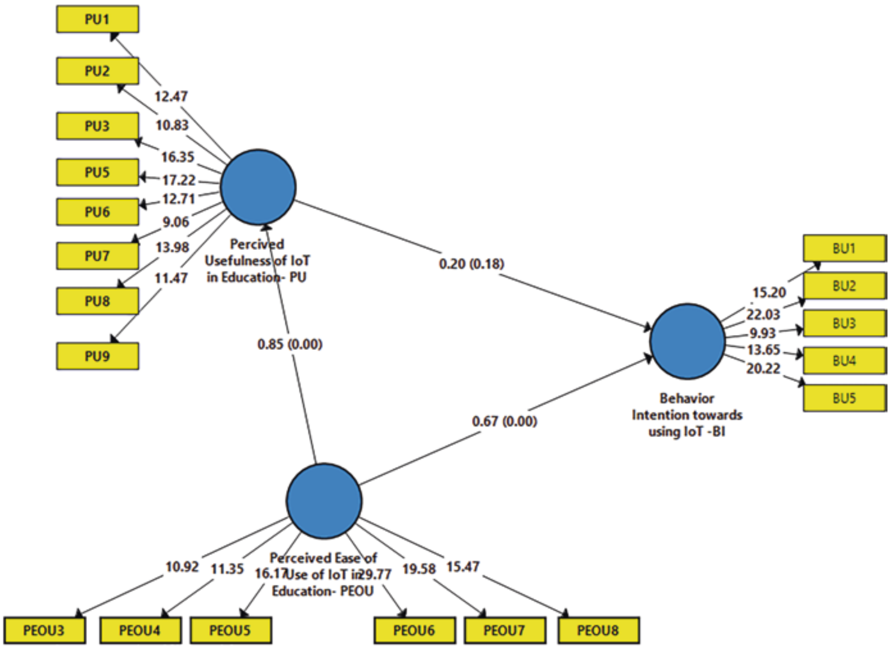

Fig. 2 Structural model

5.1 Hypothesis Discussion

The Relationship PEOU → BI The results revealed of the analyses that PEOU has a positive and statistically significant relationship with BI in the relationship PEOU -> BI. This gives support to the hypothesis H1.

Also, this means that the students feel positively about the IoT in that it could help in their academic life. Besides, it refers to the fact that PEOU is a prominent factor that has a strong effect on the future intention to adopt or use the IoT. University students are open to innovative technologies as they are technology savvy. Also, such results suggest that students believe that the IoT could contribute to improving their academic journey and their campus experience. It also indicates that Omani students welcome innovative technological tools into their knowledge-gaining journey. The relationship PEOU → PU. The results of the relationship PEOU -> PU is statistically significant and supports hypothesis H1-2. We could interpret the findings as the students perceive that the easiness of using IoT services and facilities make using them useful as no difficulties are expected to use these services or devices. Such findings indicate that Omani students factor the easiness of using IoT services into its perceived usefulness. They accept new technological tool as long as it has what they perceive to be an easy manual on how to use IoT services and facilities. The findings of the current research are aligned with previous research in the relationship between PEOU and BI (Richad et al., 2019; Arpaci, 2016; Dong et al., 2017).

The Relationship PU → BI As can be understood from the results revealed, PU showed no statistical significance with BI. The findings contradict with hypothesis H2 that states PU is believed to have a direct and significant positive relationship on behavior intention to use or adopt the IoT inside or outside campus to achieve academic and non-academic tasks by the Omani students. This result contradicts with the findings obtained from previous works that stress on the significant and positive relationship between PU and BI (Dong et al., 2017; Besbes et al., 2016).

The finding can be interpreted as university students do not have enough information and adequate understanding on the usefulness of IoT services and its devices on their academic attainment. In other words, the finding can be interpreted as university students not having adequate information on how IoT services can maximize their academic experience.

This result triggers the researchers to call for more research on the topic of the IoT in the context of human-computer interaction in Oman and surrounding Gulf Cooperative Council (G.C.C.). More importantly, this gained result might be referred to the fact that the students do not really know the real benefits of the IoT, and this might reflect that more information on this technology should be conveyed to students by the academic staff through courses in the curriculum or as webinars and activity at the university. Additionally, the management should pay more attention to inculcate the importance of IoT technology to students because the trend is going toward it in a fast pace.

5.2 Practical Implications

IoT as a New Area of Study Reviewing the literature, the researcher concedes that there is a dearth of studies that cover the IoT in higher education sector especially topics related to the human-computer interaction in the Omani universities context. Therefore, the researcher encourages the continual research in this area. Besides, IoT implementation strategies should be the center and the cornerstone objective for the management inside the universities as it is a focal point of interest in the modern world.

Inculcate IoT Culture at Omani Universities By taking into consideration the results revealed, the researcher encourages the authorities at the Ministry of Higher Education to include a subject in the syllabus on how to deal with IoT-enabled devices and how to benefit from this technology to facilitate the pedagogical process at the universities.

5.3 Managerial Implications

The results revealed in this research should draw the attention of the management at the universities in Oman on the importance to inculcate the IoT culture among the students as the results show that the students do not feel that the IoT are useful in driving their intention to adopt or use this technology. The management should ask the academic staff to covey the knowledge of this promising technology to studies in terms of its benefits on their academic achievements and future use of this technology in our near-future life. Also, the government should initiate IoT-related projects' funds for the universities to enable them join the herd to create innovative ideas that would eventually create revenue for the university and the country as a whole.

5.4 Limitations and Future Directions

The IoT is a growing area of research in recent years that captured the attention of the academia to cope with the need to employ the IoT in the academic life and different businesses. This trend is basically crucial to facilitate the communication between different stockholders in the academic process and to find better environment for the students and lecturers as well. However, in academia, the research of the IoT on the students' intention was not focused upon and was not given sufficient research in order to get the students' opinions toward adopting and using the IoT at university campuses extensively. This is apparent in the Omani context.

Generally speaking, the students are the building blocks in any academic life, and they are technology savvy, so using them as respondents of this study was justified. This research contributes to the body of knowledge and literature by providing empirical support of the model suggested with its hypotheses. However, there are a number of limitations such as not including the academic and teaching staff in this research. Furthermore, the sample size was not large enough to generalize the results obtained. Therefore, it is suggested in future studies to include the academic and teachings staff as respondents and to extend the number of respondents from different universities in Oman. Also, making a comparison between the perceptions of the academic staff and students' perception may draw more attention on how each group perceives the IoT as a crucial element in the pedagogical process at higher education sector in Oman. Another possible direction for future research is the replication of this study in other Gulf Cooperative Council countries.

Another limitation of the study is that the number of constructs is small; however, the number of items used in the survey was 25 in addition to the demographic questions, which make it challenging in requesting the respondents to answer more questions. Hence, the study recommends including other variables such as compatibility, security, and risk as elements that can influence the intention to use or adopt the IoT in the academic life. Also, subjective norms or social influence are particularly important possible moderators that can increase or decrease the above-mentioned relationships of those variables on the intention to use the IoT in education process in Oman. Furthermore, the study was based on cross-sectional quantitative research, which is conducted once and for a short time span. As we know, the human nature is changing; therefore, extending the research for longer times in longitudinal research is highly recommended to cope with human changeable nature. Extraneous variables such as gender, experience, level of education, and age can be a wealthy area of research in future studies in the area of the IoT.

6 Conclusion

The Internet is becoming a necessity for every living thing on this globe. However, the Internet of Things, which is an extension of the use of the Internet, is the language which things can communicate with each other in the era of artificial intelligence (AI). The devices communicate to pave the way to elevate the educational process in the AI era. The main purpose of the study was to probe the perceptions of university students from a heterogeneous backgrounds, age, gender, and major of study toward the intention to use the IoT at universities in Oman. In other words, to highlight the role and usefulness of IoT-enabled devices on the intention to use IoT at universities in Oman. Further, the effect of PEOU was explored to find out if it has a direct effect on PU. Based on the results found, the suggested model achieved its predictive accuracy and predictive relevance in the area of the IoT. Moreover, the investigation of the role of PEOU on BI was tested and proven to be an excellent influencer on BI, which is one of the objectives of the study. Another objective of the study is to investigate the role of PU on BI. The results emerged emphasize no significant role of this construct on BI, which contradicts with many studies found in literature. Therefore, more research has to be conducted to reveal the real reasons on these results and whether it is the same in other contexts. The last objective, which is related to the relationship between PEOU and PU, is evaluated and confirmed its positive and significant relationship. In sum, the current research has achieved the objectives.

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Artificial Intelligence in Marketing: Concerns and Solutions

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1 Introduction

Artificial intelligence (AI) is the intelligence of machines. It is a computer science and engineering field that is concerned with creating smart machines that are able to perform activities and tasks which need human intelligence to be performed. AI cannot be defined as a single technology as it includes different types of software and hardware associated with machine learning, natural language understanding and processing, and computer vision. An example of AI is in maps and navigation when AI guides car travelers on how to travel to a specific destination, where it uses machine learning to recognize roads and building numbers to direct the user with the correct direction. It can also detect any changes in the flow of traffic and recommend the best route to avoid congestion. Another example is the AI chatbots in customer services websites, where AI machines use algorithms to answer frequently asked questions by customers, receive orders, and track orders (Sabouret, 2020).

According to Ertel (2018), there are four types of AI. The first type is the reactive machines type, which is the most basic type that is not capable of using past experiences or memories for decision-making. This type, however, functions by reacting to received inputs with a programmed output. The second type is the limited memory type, which stores previous data and use it for decision-making. This type, however, cannot be implemented directly; it requires monitoring specific data over time. An example of that is when sensors are used for self-driving cars to collect data of traffic lights, traffic signals, people crossing the road, and other related data to make

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better decisions in driving the vehicle and prevent road accidents. The third type is the theory of mind type. In this AI type, machines are able to make decisions similar to humans by understanding the emotions of humans they interact with. However, this type is still under development as AI developers did not reach the stage where machines are able to make decisions exactly the same as humans because the machines are not able to fully understand the way humans are thinking. The fourth type is the self-awareness type. It involves self-aware machines that are aware of themselves and have the same human level of self-consciousness. This type is considered as the future of AI since self-aware machines are not available yet and experts are working on the development of such machines for the future.

AI is associated with the Internet of Things (IoT), which is the concept of connecting interrelated computing devices, electronic components, machines, objects, and living creatures with the Internet to communicate, interact, and perform automated functions in our daily lives. Both AI and IoT are considered as the backbone of Industry 4.0, which is the fourth industrial revolution. Industry 4.0 refers to the digitalization of manufacturing and the transformation to cyber-physical systems in the industry. It is associated with automation, remote monitoring, smart systems, cloud computing, cyber security, renewable energy, big data analytics, and artificial intelligence (Sergi et al., 2019). The idea of AI ignited in 1950 when Alan Turing published a paper on creating thinking machines (Turing, 1950). In 1956, the definition of AI was presented by John McCarthy. From 1956 to 1974 the natural language processing was developed, which provided with the ability of solving complex mathematical expressions and the ability of creating logics rules that can form sentences. It also initiated the gaming theory, which was previously used in developing computer games. In the 1980s, algorithms and logic rules were used to develop complex systems that can mimic human reasoning. From 1993 to 2009, the neural networks software was launched, which is capable of imitating the way humans are identifying complex patterns. After 2010, big data science and advanced machine learning were applied to mimic the way humans are categorizing simple patterns to complex patterns. Today, research is conducted to increase the productivity of AI technologies and reduce error. Researchers are exploring AI technology that can be used to create other AI technologies without human interference (National Institute of Justice, 2018).

1.1 Research Problem

AI is an effective tool to improve marketing as it is more efficient and less expensive than traditional marketing practices. AI can be used to collect data from customers and recommend relevant products based on the collected data. It can also be used for real-time customer services, sales forecasting, ad targeting, and improving personalization for customers. According to Jim (2017), AI has many benefits, such as availability, reducing errors, exploring hazardous, and the ability to handle multiple jobs simultaneously. However, using AI in marketing comes with some issues and risks. The main problem associated with AI in marketing is the lack of privacy of the data collected from the customers. Unfortunately, AI can be used unethically, such as private data sharing and privacy leakage of sensitive data. Therefore, marketers should take the responsibility of researching the privacy issues and figuring out solutions to use marketing in an ethical way. This research uses a literature review to conclude the main privacy concerns and problems associated with AI in marketing and highlight the solutions that can be used to solve these issues.

1.2 Research Significance

This research explores the privacy concerns related to AI in marketing in order to figure out the best practices for ethical AI marketing. This research will benefit product-based and service-based organizations to improve their marketing practices. It will also benefit software developers to reduce privacy concerns in AI marketing. Last but not least, the research will benefit marketers to use marketing in an ethical way and increase the efficiency of their marketing by relying on automation instead of manpower, which saves time and money.

2 Literature Review

2.1 Applications of AI

According to Jia et al. (2019), AI can be applied to support our daily activities, such as agriculture, education, healthcare, gaming, social media, marketing, national defense, data security, finance, etc. Below are examples of these applications.

- Education: In traditional classrooms, teachers cannot figure out if the students are listening and understanding the lecture or not unless they monitor them and participate with them in the class. Therefore, AI has been utilized for classroom monitoring to ensure that all students are listening to the lecture. The technology uses face recognition and motion recognition to automate class monitoring. Moreover, speech recognition technology is used to monitor the lecturer and evaluate his/her teaching.
- Traffic: AI image recognition is used to control traffic lights. It can also collect real-time data from the vehicles and the roads, which can be used for self-driving cars. For example, it can collect data from sensors mounted on the roads and on other cars in order to command the car to drive in the most optimum route while preventing accidents.
- Intelligent society: The aim of the intelligent society is to provide high-quality services for society through AI. It is done mostly to reduce the risk of dangerous jobs or to save time in repetitive activities. The enhancement of smart societies is

continuing to grow by developing smart buildings, smart hospitals, automated factories, and robots for human activities and customer services.

- Social governance: In social governance, AI is used to develop smart courts and smart cities. A database can be built for smart courts to combine trials, case analysis, evidence collection, and legal documents. Moreover, AI machines are used for decision-making in social governance. For example, AI can be used to predict public requirements by continuously gathering data from the public through surveys. It can also be used for risk assessment and emergency response.
- Public security: The development of AI has promoted intelligent safety monitoring and control systems. AI safety and security products, such as face recognition security cameras and detection technologies, are being introduced in the market. Moreover, AI is implemented in food safety systems, and it is also used as a warning system for natural disasters.

According to Xiang et al. (2020), the demand for AI has increased in the medical sector. AI can be used for many applications in the medical sector, such as imaging, pathology, surgery, and other medical services. A study by Patra et al. (2021) demonstrated applications of AI that can be used to provide protection in the COVID-19 pandemic. The author suggests that AI can be used as a replacement for the polymerase chain reaction (PCR) swab test that requires sufficient manpower to meet the demand of patients. AI-based tools can be used for healthcare management in the pandemic. The AI technology of machine learning is combined with an advanced bio-computational methodology to precisely detect the diagnosis of COVID-19. It can also predict the spread of the disease and send warning notifications. Moreover, the research found that AI can also be used for the development of COVID-19 vaccines. By providing the machine with worldwide data related to the disease, it can provide proposals and suggestions for the vaccines.

2.2 AI in Marketing

According to Dilmaghani et al. (2019), AI in marketing is designed to collect data from customers as the input and develop an advanced marketing tool or technique based on the input. There are many methods to implement AI in marketing. The most commonly used method of AI in marketing is machine learning. In the machine learning method, algorithms and mathematical models of computer systems are used to achieve tasks without logic-based programming or human interference. The mathematical models are developed based on the collected data, which is also called in that case, the training data. The AI machine uses the training data to learn and improve from customer experiences. Consequently, the machine will be able to detect, predict, and make strategic marketing decisions.

According to Li et al. (2021), the application of AI has a positive impact on enterprise marketing. The implementation of AI can push accurate information on targeted customers and enhance customer interaction. Customers today do not usually have enough time to browse products and services regularly. AI has the ability to understand their searching habits and most commonly used products to send relevant information. After the customer purchases a product, AI can enhance customer interaction by sending surveys to evaluate the level of customer satisfaction. AI has the ability to receive feedback from customers, analyze it, and process it much faster than the traditional marketing approach. To increase the efficiency of adopting AI in marketing, it is advised to combine it with the thinking of staff. This can significantly save time in the detailed planning of marketing activities, and it can be edited and modified by the staff. AI should also be used to manage the relationship between marketing and user needs. For example, using the function of closing unrelated or repeated marketing advertisements makes the marketing platform more convenient for users. Moreover, enterprises should improve the knowledge of their marketing staff in AI by providing them with proper training from experienced and qualified organizations.

A study by Lee (2021) examined changes in the marketing industry through the development of AI where marketing strategies are applied in order to meet market development in the future. One of these strategies is the development of the chatbot, which improves the communication with customers by relying on bots that are programmed to provide communication services for customers. By using the chatbots as a marketing tool, organizations can reduce manpower, save time, and save cost. AI has also improved customer services by allowing computers to study customers' behavior and analyze the current marketing strategies. This technology can customize ads for customers, learn from past behavior, and discover best marketing practices to implement in the future. Since using smart phone applications for advertising can significantly increase the revenues of a company, the demand for marketing purposes has increased, especially for Instagram application. On the other hand, some companies can utilize AI to improve search engine optimization and create the best and most relevant hashtags and pop-ups to easily target the customers. According to Park (2018), medical companies are implementing AI in marketing by collecting medical data such as drug purchases from their smart phone applications. Then they use machine learning to analyze the data and sell the data to medical insurance companies. This way they can understand customers' needs and target customers in different locations and different age groups.

According to Lai and Yu (2021), the development of AI has a major influence on the transformation from traditional media into digital media. The digital media changed the advertising industry, and it also changed the demand for communication talents in digital marketing and AI. For example, currently, there is more demand on communication talents with visualization ability in digital marketing, as marketers rely on tables, graphs, images, and videos, to present their products information. Another example is the demand for communication talents with the ability of scene construction in digital marketing. This ability is related to situational advertising, where interactive experience with users is added to the traditional instant attention. Scene construction is also implemented by converting static graphics into dynamic graphics to gather more of the customers' attention. The use of AI can support these talents in finding the best data and content. However, the industries are facing difficulties in cultivating these talents. The main difficulties are the lack of training in AI and digital marketing, the lack of AI and digital marketing teaching equipment, and the lack of a dynamic measurement and evaluation system for the required talents. Therefore, the author suggests several strategies to cultivate these talents, including creating an experienced teaching team, creating a curriculum for AI in digital marketing, and building a training platform for AI and digital marketing courses and lectures.

Research by Eriksson et al. (2020) suggests that AI can be utilized as a tool for creating and formulating marketing strategies by replacing humans in the decision-making process. The research concludes that AI can create marketing strategies in two steps. The first step is searching and reviewing relevant data. The second step is the decision-making. The authors implied that AI could contribute to the rational process by identifying and analyzing the relevant data or by replacing managers in the final decision-making. In addition to the rational process, AI can also be used for creative thinking. Moreover, the authors recommend the process of communicating and coordinating between AI machines and company managers for future studies.

According to Arsenijevic and Jovic (2019), the use of AI in marketing significantly increases the opportunity for marketers by tracking customers' behavior and creating personalized products or services. The author interviewed marketers about AI, where 72% of them implied that the implementation of AI has a positive advantage in business and marketing. In order to obtain better results from AI, the authors recommend focusing on data collection as the most valuable element for a company to get better results from AI is the collected data. The more amount and quality of data a company collects, the better results it will get from AI. The authors also recommend chatbots as the most efficient AI tool, which is a computer software that implements automated tasks in the messaging platforms. These tasks include communicating with customers, understanding their questions and requests, and automatically responding to them. The authors found that the advantage of chatbots over other AI methods is that it is easy to implement, easy to use, and the provision of fast information. However, there is also a small probability that customers will get false information from chatbots, which is a problem that should be solved in the future.

2.3 Privacy Issues and Concerns in AI

According to Zhu et al. (2020), the main concerns of AI from the customers' perspective are the privacy and security problems, especially that AI relies on data collection and some of the data is personal and confidential. In that case, some companies prevented implementing AI in their marketing process in order to prevent privacy and security problems and obtain customers' trust. On the other hand, other companies are implementing AI while taking these problems into consideration in order to stay relevant and gain a competitive advantage in the market.

A study by Dilmaghani et al. (2019) summarizes machine learning of AI in marketing into four phases, where each phase can be a target of privacy attacks (see

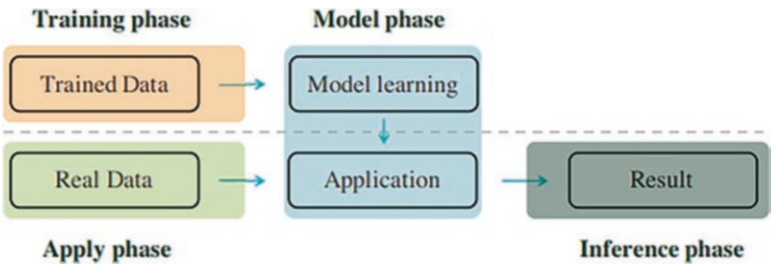

Fig. 1 Workflow of AI machine learning (Dilmaghani et al., 2019)

Fig. 1). The first phase is the training phase, where the collected data is transferred to the machine learning model in order to start the learning process. The privacy concern in the first phase is that the input data can be attacked and leaked when it is transmitted from the customer to the machine learning model. The second phase is the model phase, where a model is developed by the AI machine based on the trained data. Some attackers aim to target the trained data as it is more valuable. The third phase is the apply phase, where the new and untrained data is transferred to the training model. This phase can be penetrated by attackers where they can modify the output based on their needs. The fourth phase is the inference phase, which consists of the output of the machine learning model.

According to Dilmaghani et al. (2019), the following are the main privacy and security attacks of big data in AI.

- Data breach: This attack occurs when attackers obtain unauthorized access to personal and confidential data. Even though this attack is not limited to AI, it is a big threat to AI since it relies on big data to perform its operations. This type of attack can specifically occur in the training phase, the model phase, and the interference phase.
- Bias in data: If not used ethically, decision-making in AI can support injustice in the system. Bias in data specifically attacks the training phase because it is based on bias attitude toward an individual or a group, where the AI machine will learn this attitude and implement it in its operations. In simple terms, the injustice of humans will be learned and performed by AI machines.
- Data poisoning: This attack aims to sabotage and manipulate the training data in order to sabotage the output of the model. This attack can be used in marketing to suggest products that could harm an individual or a society.
- Model extraction: Sensitive and confidential data can be extracted from the machine learning model by reverse engineering, where another machine learning model can be created based on learning from how the inputs and outputs interact with each other. This newly created model can leak confidential data from the customers.
- Evasion: In this method, the system will not be able to detect the attacks toward the AI machine. This is done by tricking the system that it is not an attack and

classifying the attack as a non-threatening activity. Evasion occurs in the apply phase where the untrained data is transferred to the training model.

A research conducted by Sachdev (2020) studied security and privacy issues associated with AI in marketing. The following are the main privacy problems mentioned in the paper.

- Cloud-based AI models are suffering from a lack of privacy because the data collected from customers for marketing purposes is stored on a machine that is owned by another company or individual.
- If the device authentication is expansive and not used properly, the data that is collected from the customers will be at risk because more people will have access to it, especially since some of the data is personal, which is collected from the customers to provide them with personalized products.
- Privacy and confidentiality of customers' data can be compromised when AI machines are attacked by malicious software like ransomware.
- Data from sensors that are connected with AI and IoT can be leaked when one of the nodes in the control system is attacked.
- Availability of the marketing system is at risk when it is attacked by a Denial of Service (DoS) attack, which is a cyber-attack that intends to disrupt or limit access to specific websites or online applications.
- Social engineering can lead to privacy issues, where attackers can trick the customers into accessing their devices or accounts. Consequently, the attackers can steal their data and use it for offensive marketing aspects.
- Email spoofing is another security risk where the customer is not able to differentiate between real or fake marketing notifications. Fake email notifications can lead to customers losing their money to fake accounts or leaking some of their private data.

2.4 Suggested Solutions to Solve AI-Related Privacy Problems

A study by Zhu et al. (2020) suggests a mathematical model called differential privacy as a solution to the privacy problems in AI. Differential privacy works on the principle of measuring data leakage from the AI machines and figuring out a solution to prevent it from happening in the future. The study concluded that differential privacy can be beneficial especially in machine learning and multi-agent learning. However, it should be also implemented in other AI methodologies, such as robotics, natural language processing, etc.

According to Dilmaghani et al. (2019), the following table summarizes the main solutions that can be used to defend the privacy and security attacks of big data in AI, which were explained in Sect. 2.3 (Table 1).

A research conducted by Sachdev (2020) suggests the following as a solution for security and privacy issues associated with AI in marketing.

Table 1 Summary of privacy and security attacks on big data in AI and the solutions to defend these attacks

Attack	Solution
Data breach	Data privacy protection techniques were developed to maximize data protection by encrypting sensitive data so that the attackers are not able to identify and differentiate between the records in different datasets
Bias in data	This attack is defended by identifying the bias metrics in the model and mitigating the biases by machine learning of fair representation. Moreover, bias in data can be mitigated by developing tools that can identify biases in the machine learning model and removing them from the system
Data poisoning	To defend against data poisoning attacks, the poisoned data is detected by anomaly detection, which is designed to identify data points and observations that are deviating from the normal behavior, which may be caused by a data poisoning attack
Model extraction	To defend the machine from model extraction, the learning model should be protected. This is mostly done by training each part of the model individually so that the attacker will not be able to extract all modes at the same time
Evasion	Defending against evasion attacks is done by developing a program that can be used to ensure that any small changes in the input cannot significantly change the output. Hence the system will still be able to detect attacks

- Governments should formulate rules and regulations to ensure the proper and ethical use of AI in marketing, especially that AI is rapidly growing in the market.
- To prevent the risk associated with cloud-based AI models, edge AI can be used instead, which processes the AI algorithms on a local hardware device instead of connecting to the Internet or the cloud.
- The use of recommender systems can mitigate the risk. In recommender systems, marketers can develop algorithms to provide advertising recommendations based on product features and customers' interests, while keeping the customers' data local to ensure privacy.
- Privacy problems can be mitigated by isolating the sensitive data only. This can be done by keeping most of the customers' data on the cloud except for the confidential data; it should be isolated from the cloud.
- Marketers should make sure that all the software that are interacting with AI devices are secure. Marketers can use a system security manager, which can defend the software and the data from security threats and alert the cyber security engineers.
- Authentication methods such as face recognition or fingerprints can be used so that no one can access the device or account except for the individual customer.
- Marketing firms should limit the access of customers' data and allow only specific employees to access it.
- AI service providers should provide privacy-related training for marketers and customers that deal with AI in marketing.
- AI marketers should obtain consent from customers to use their data for marketing purposes. AI marketers should also obtain consent from the customers to automate their data for AI marketing. By obtaining consent from the user, AI marketing firms can reduce or prevent marketing-related privacy violations.

2.5 Literature Summary

AI machines can be used to automate our daily traditional and non-traditional tasks, including education, traffic, public security, social governance, and building smart societies. Moreover, AI had a positive outcome after implementing it in healthcare. It can be used for many applications in the medical sector, such as imaging, pathology, surgery, and other medical services. Furthermore, the spread of the coronavirus required researchers to study the possibility of using AI to support healthcare employees in the pandemic. The success of AI in many sectors encouraged marketers to use it in marketing. AI can be used to replace humans in decision-making processes in marketing by searching and reviewing the relevant data and then making decisions based on the collected data. The most commonly used method in AI in marketing is the machine learning method, which is used to build a mathematical model that collects data from customers and uses it to make strategic marketing decisions. Another method is the chatbot, which relies on bots to communicate with customers, answer their questions, and solve their problems. Moreover, AI can be used to improve marketing in websites and smartphones by improving search engine optimization and recommending relevant hashtags to easily target the customers.

Since AI depends on data collected from customers, the main problem that is facing AI is that customers are concerned about their privacy and security. The main attacks on big data in AI are data breaches, data poisoning, bias in data, model extraction, and evasion. Several companies prevented using AI and relied on the traditional way for marketing. However, other companies used AI to support them in their marketing and other human intelligence functions in order to gain a competitive advantage, while taking the privacy and security problems into consideration. To solve the privacy and security problems in AI, researchers suggested several solutions, including formulating rules and regulations by governments to ensure that AI is used ethically, keeping the customers' data local while advertising, isolating the confidential data only from the cloud, ensuring that all software interacting with AI are secure, using authentication methods, and limiting access for customers confidential data for certain employees only.

3 Conclusion

AI is a new technology that allows machines to perform activities that require human intelligence. It includes different types of software and hardware that are associated with machine learning. AI has been used in marketing to replace the less efficient and more expensive traditional marketing methods. However, with all the advantages associated with implementing AI in marketing, some privacy risks should be considered in order to ensure that AI is implemented in an ethical way. This paper studied the applications of AI, the implementation of AI in marketing, privacy issues and concerns in AI, and suggested solutions to solve AI-related privacy problems. AI can be used in many applications to assist us in our daily activities, including education, traffic, intelligent society, social governance, and public security. AI has also been implemented in the medical sector. It can assist medical staff in imaging, pathology, and surgery. Moreover, AI can be utilized to support medical staff in the COVID-19 pandemic. It can be used to reduce manpower for the PCR swab test, and it can be used for general healthcare management during the pandemic. The advanced bio-computational methodology is combined with AI machine learning to detect the diagnosis of the coronavirus and send notifications and warnings to prevent the spread of the virus. Moreover, AI can collect global data of the virus and provide suggestions for developing coronavirus vaccines.

The success of AI in many fields encouraged marketers to use it as a replacement for traditional marketing methods. Marketers are working with software developers to use machine learning algorithms and mathematical models in order to build advanced marketing tools and strategies based on data collected from customers. By gathering data on searching habits and purchases of customers, marketers use AI to target customers and enhance customer interaction based on the input data. However, to increase the efficiency of implementing AI in marketing, it is advised to combine it with the thinking of staff, which can save time in planning marketing activities, and it can be modified and updated by the staff in the future instead of creating a new marketing plan from scratch. One of the most successful AI in marketing applications is the chatbot, which uses bots that are programmed to provide communication services with customers. Another successful application is utilizing AI to improve search engine optimization for social media marketing, where it can recommend the best hashtags or pop-ups to easily target relevant customers.

The development of AI had a major influence on the transformation from the traditional media into the digital media, as AI can be utilized as a tool for creating and formulating marketing strategies by replacing humans in the decision-making process. AI can create marketing strategies in two steps. The first step is searching and reviewing relevant data, and the second step is the decision-making step. Furthermore, AI can contribute to the creative thinking and rational process by identifying and analyzing the relevant data as it can replace the managers' final decision-making. In order to get better results from AI, it is suggested to focus more on data collection as the results depend on the quality and relevance of the collected data.

The implementation of AI in marketing has many advantages, such as availability, reducing errors, reducing manpower, saving time, using more advanced technologies, and the ability to handle multiple jobs simultaneously. On the other hand, there are disadvantages and concerns associated with implementing AI in marketing. The main disadvantage is that it suffers from some privacy and security issues. Since AI focuses on the collection of big data, there is a risk of the data being attacked. The main privacy and security attacks of big data in AI are data breaches, bias in data, data poisoning, model extraction, and evasion. Furthermore, AI in marketing is facing other privacy and security problems, such as leakage of data from cloud-based AI models, attacks from malicious software, denial of service attacks, social engineering, and email spoofing.

4 Recommendations

Based on the literature review, the following recommendations are to prevent privacy and security problems of AI in marketing.

1. Developing data privacy protection techniques to encrypt sensitive data and prevent data breaches.
2. Identifying the bias metrics in the model and mitigating the biases by machine learning of fair representation to prevent bias in data.
3. Using anomaly detection to detect and prevent poisoned data.
4. Protecting the AI learning models to prevent model extraction.
5. Developing a program that can be used to ensure that any small changes in the input cannot significantly change the output to defend against evasion attacks.
6. Formulating governmental rules and regulations to ensure the proper and ethical use of AI in marketing.
7. Replacing cloud-based AI with edge AI, which is more secure.
8. Isolating the sensitive data only from the AI model to mitigate data privacy problems.
9. Ensuring that all software interacting with AI are secure.
10. Using authentication methods such as face recognition or fingerprints to maximize data security.
11. Limiting the access of customers' data and allowing only specific employees to access it.
12. Providing privacy-related training for marketers and customers that deal with AI in marketing.

5 Study Limitations and Future Studies

To make the study more accurate, data privacy protection techniques and edge AI should be tested at a large scale. Data privacy rules and regulations are not up to date in many countries making it difficult to implement ethical AI in marketing. It is recommended to study the total cost of implementing AI in marketing and compare it to the return on investment while taking maintenance and operational cost into consideration. Also, to study the development of anti-virus software that is concerned with protecting AI systems from data leakage and malicious attacks. New protocols and standards for AI in marketing are to be considered in order to increase reliability and transparency and prevent security problems.

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The Impact of Emerging Technologies on Accounting and Promises to Minimize Operational Costs

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1 Introduction

Emerging technologies bring numerous benefits to companies after implementation and may impact many areas across departmental functions. However, the accounting system is one of the most important foundations for the success of any company, as "the correct and efficient application of the accounting system contributes to enhancing the economic efficiency of the company, reduces the excess costs, and reduces the risks that the company can face" (Kamal, 2015). Therefore, the focus in this research will be to analyze the impacts on accounting functions after emerging technologies are implemented and the operational cost relationships. At the same time, accounting systems still face many obstacles due to poor implementation or delay by accountants (Jasim & Raewf, 2020) while performing their operational activities.

Conventional cost and management accounting practices were criticized for their lack of insight and their inability to support management accounting innovation to cope with the requirements of changing environments (Kamal, 2015). Moreover, the academic literature has been critical of conventional management accounting and control systems, particularly for their lack of efficiency, their inability to present comprehensive and current information, and their inability to assure decision makers and potential users of the quality of such information (Ghandour, 2021; Kamal, 2015).

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The adoption of emerging technologies is no longer avoidable for many companies, and accounting functions are not an exception to this reality. Many researchers have pointed out the benefits derived by companies after emerging technologies are employed in their accounting functions, but no proper focus has been placed on the potential inverse impacts on their operations after the adoption, especially with regard to personnel**,** financial, productivity, procurement, and information technology costs.

Therefore, it is essential to establish a solid and proper integration between the accounting functions and the emerging technologies, which will be referred to in this research as the Enterprise Resource Planning (ERP) systems. Such interactions are required to facilitate and enhance both elements and will lead to the ultimate utilization of the benefits of the employed emerging technologies in companies, the recognition of their positive contributions, and the favorable impacts on overall operational costs.

1.1 The Research Problem

Technologies bring numerous benefits to companies, and efficiencies of operations are continuously improved through the deployment of new technologies that enhance the current processes within overall functions (Estefania et al., 2018). The accounting function is one of the functions that is impacted by such technological implementations (Jasim & Raewf, 2020). However, technologies may add burdens and layers that increase operational costs while performing accounting operations, hence creating drawbacks (Sar & Santoso, 2021).

The current study attempts to answer the general research questions:

- Does the implementation of emerging technologies (ERP systems) in companies affect the operational costs of the accounting functions?
- Does the implementation of emerging technologies (ERP systems) in companies affect the personnel costs, financial cycles, productivity, procurement costs, and information and communication technology costs of the accounting functions?

1.2 Research Hypotheses

In order to assess and validate the impact of the ERP system on the operational costs of the accounting functions, five hypotheses were developed based on the relationship established for the ERP implementation for the objective of this research. Most ERP systems support the accounting functions, as pointed out in Fig. 1, “ERP Finance Module Features.”

The developed hypotheses are listed below.

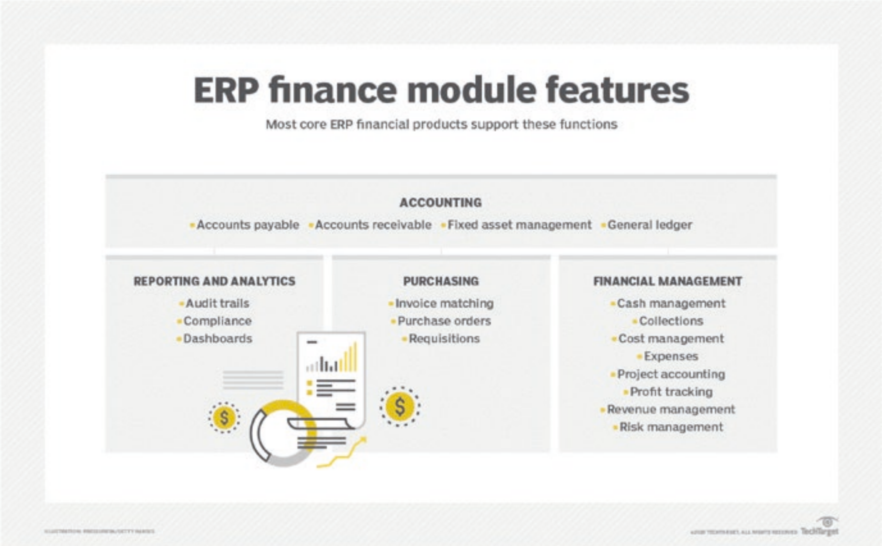

Fig. 1 ERP finance module features. (Source: ERP Finance Module, 2022)

- H_1: There is no impact of emerging technologies on personnel costs of the accounting functions.
- H_2: There is no impact of emerging technologies on the financial cycle of the accounting functions.
- H_3: There is no impact of emerging technologies on the productivity of the accounting functions.
- H_4: There is no impact of emerging technologies on the procurement costs of the accounting functions.
- H_5: There is no impact of emerging technologies on the information and communication technology costs of the accounting functions.

2 Literature Review

This part of the research will begin by defining emerging technologies, accounting functions, operational costs, and ERP systems. Then it will address the related studies that participate in assessing the impacts of ERP systems on the operational costs of the accounting functions.

2.1 Definitions

2.1.1 Emerging Technologies

In order to narrow down the discussion and establish more focus on the research aspects, the emerging technologies in this research will be discussed and explained in the context of technologies incorporated into the ERP systems. The terms emerging technologies and ERP will be used interchangeably since ERP brings the latest technology to companies under one umbrella for its core functions and for the best practices for handling accounting activities.

Rotolo et al. (2015) attempted to define emerging technologies by first defining the context of "emerging" in technology and then identifying the measures of the technological attributes. This ended in their defining five attributes of emerging technologies: (i) radical novelty, (ii) relatively fast growth, (iii) coherence, (iv) prominent impact, and (v) uncertainty and ambiguity. They ultimately defined an emerging technology as "A relatively fast growing and radically novel technology characterized by a certain degree of coherence persisting over time and with the potential to exert a considerable impact on the socio-economic domain(s) that is observed in terms of the composition of actors, institutions and the patterns of interactions among those, along with the associated knowledge production processes" (Rotolo et al. 2015).

Day and Schoemaker (2000) and Srinivasan (2008) state that emerging technologies (ETs) are science-based innovations with the potential to create a new industry or transform an existing one.

To summarize, it is noticeable that there is no apparent unique definition that represents the ultimate meaning of ETs; to some extent, it may change continuously and vary across industries.

2.1.2 Accounting Functions

Accounting has been well known since inception as the recording of economic events that occur within companies over periods of time. The economic events that are registered and tracked through the accounting function ultimately feed into the preparation of the financial statements.

Accounting is a very old discipline; it has existed and has been practiced by companies in various forms for many years (Wood & Sangster, 2007).

According to Wood and Sangster (2007), accounting can be defined as "the process of identifying, measuring, and communicating economic information to permit informed judgments and decisions by users of information." In other words, two main elements can be identified for the accounting function:

1. Process economic information through identifying, measuring, and communicating economic information

2. Provide economic information for decision-making to permit informed judgments and decisions by users of information

The first element is dealt with and managed under financial accounting, while the second element is dealt with and managed under management accounting.

According to Petkov (2020), there are two important elements that should be considered by companies when they are preparing financial statements. The first element is time, because it addresses the necessary time to prepare the financial statements. The second element is human, because it addresses the time needed to make decisions and record economic events.

Companies should consider these main elements before they deploy any ETs in their environments. They should also assure that efficiencies and advancements needed for their reporting in the accounting function are properly achieved by the deployed ETs.

Accounting as a discipline has changed over time, and the need has become more essential for ETs to be introduced into accounting. These advances in digital technology are quickly changing the way we record, store, and manage data, perform audits, and deliver other accounting services (Appelbaum et al., 2017).

On the other hand, researchers realize that changes in ETs are bringing benefits to companies: "As business information is managed by accounting, any change in this sector will have a positive impact on the company, especially in the accounting department" (Jasim & Raewf, 2020).

Most functions within an organization are currently performed by humans. Their jobs are to identify the economic events and properly record them via journal entries in accordance with the established criteria or framework, such as US GAAP or IFRS (Jasim & Raewf, 2020; Petkov, 2020).

Therefore, the assessment in this research will be devoted to examining the impact of the ERP system on the operational costs of the accounting functions. Those functions are accounts payables, accounts receivables, fixed assets management, and general ledger reporting, as shown in Fig. 1, "ERP Finance Module Features," since those areas are considered to be the core features of any ERP system.

2.1.3 Operational Costs

According to the Corporate Finance Institute (CFI), operating expenses refer to the costs incurred by a business while performing its operational activities. This is commonly referred to by businesses as operational expenditure (OPEX).

"In information technology, operational costs document the price of running of IT services on a day-to-day basis. Operational costs may include expenditures for staffing, hardware maintenance, electricity, software procurement, storage rental, and security. Operational costs are usually calculated quarterly or annually" (TechTarget, 2022).

In the context of this research, the focus of the operational costs will be addressed as the functions being operated for the accounting department.

2.1.4 Enterprise Resource Planning (ERP) System

An ERP system integrates several business domains of an organization into one by combining different business strategies with IT-supported solutions (Shtub & Karni, 2010).

Another comprehensive definition noted by Oracle Company covers the related elements of the ERP system; they state that "Enterprise resource planning (ERP) refers to a type of software that organizations use to manage day-to-day business activities such as accounting, procurement, project management, risk management and compliance, and supply chain operations. A complete ERP suite also includes enterprise performance management software that helps plan, budget, predict, and report on an organization's financial results. ERP systems tie together a multitude of business processes and enable the flow of data between them. By collecting an organization's shared transactional data from multiple sources, ERP systems eliminate data duplication and provide data integrity with a single source of truth" (Oracle, 2022).

Additionally, the definition of the ERP system can be expanded to include the aspects of its capability to link and integrate the functions of the organization to ultimately allow the users to access the software through an integrated and unified database (Salmeron & Lopez, 2010).

2.2 Related Studies

Since ERP systems have been adopted globally, numerous published studies are focused on addressing the benefits that are brought to organizations when they implement ERP systems. However, limited studies are devoted to examining the relationship between an ERP system and its impact on the accounting functions and the interlinked benefits. This is noted because most ERP systems are basically equipped with modules that support the operations of the accounting functions.

"When implementing ERP, the company hopes to increase productivity, access through information and company management performance in decision making" (Estefania et al., 2018).

"Not only the benefits can be seen from the implementation of the ERP system, but there is also evidence of project failure in the implementation of the ERP system. Competitively and technically, on the one hand the implementation of an ERP system must still be done, but on the other hand there are high enough costs that must be incurred for the ERP system implementation process. If the implementation of an ERP system is successful, of course this is very significant for the development of company resources" (Sar & Santoso, 2021).

For instance, Shuai et al. (2007) investigated the relationships between the benefits of ERP implementation and the impacts on supply chain management. Their study concludes that ERP implementation can streamline internal business processes to achieve the supply chain performance. They also add that ERP system capabilities improve information accessibility and visibility across the enterprise and allow them to make more effective operational and strategic decisions such as better manpower planning, enhanced inventory control, and radical improvement of on-time delivery.

According to Mohamed (2009), the major benefits of the ERP systems are the unified and automated business processes and functions and up-to-date information. However, there are some major difficulties associated with ERP system implementations. The software is quite expensive and requires intensive personnel training, it can be very complex and difficult to customize to fit the business processes, and centralized data stores could be a security risk (Mohamed, 2009).

A study done by Annamalai and Ramayah (2011) aims to examine the tangible and intangible benefits of the resource planning systems of two famous enterprises (SAP and Oracle). The study concluded that ERP system implementations generate tangible benefits to organizations, and those benefits are revealed in procurement costs, financial cycles, productivity, personnel costs, and information and communication technology (ICT) costs.

Based on the findings of that study, the benefit elements that were achieved by implementing ERP systems will be considered throughout this research as the basis for assessing and analyzing the impact of ERP systems on the operational costs of firms in their accounting functions.

Furthermore, the accounting industry has been tremendously transformed in the past two decades due to the implementation of ERP systems (Kanellou & Spathis, 2013). According to Fig. 1, most common ERP financial systems are equipped with features that support, at minimum, the accounting functions (accounts payables, accounts receivables, fixed assets management, and general ledgers).

In a related article, Essex (2022) explains the key features of ERP systems by stating that the ERP finance module is the main element in every ERP product, since every company needs to have the ability to record and process their financial transactions. Also, it is aimed at automating their basic accounting, invoicing, financial analytics, forecasting, and reporting transactions. Furthermore, he identifies the purchasing and procurement functions as the most commonly used ERP modules.

In another case study done by Matengu and Swami (2011), the National Development Bank was selected to validate the impact of ERP systems and the implementation of such systems in accounting aspects in general and specific terms. For data collection techniques, the researcher used both qualitative and quantitative approaches. A survey method was adopted for the primary data by targeting 60 Oracle users, and the secondary data was collected through books and peer-reviewed articles. The end users of the ERP systems have established a good reliance on the systems for handling and managing their accounting activities because they provide a centralized database, fast access to financial information, and streamlined management of data as and when deemed necessary. The limitations and drawbacks of the ERP systems in accounting are mainly due to the low budgets allocated during implementation phases of the ERP systems. This, in turn, impacts the required training and utilization of system capabilities by the system users.

In light of this, a study conducted by Kanellou and Spathis (2013) is aimed at investigating the accounting benefits entailed to the end users of ERPs after they adopt the systems. Their study assesses the ERP systems' impacts on accounting information and its practices. This study also examines the observed benefits of the ERP systems from two aspects; they have assessed the ERP accounting benefits in terms of accountants and IT professionals for end-user satisfaction. Accordingly, a group of 271 participants were surveyed from multiple companies in Greece. The results of their study proved that some of the ERP accounting benefits were perceived by companies mainly from the aspect of the accounting processes and not because of their expectations as IT professionals or accountants. The study also identified other factors relative to the cost of the ERP system and the accounting benefits that affect the satisfaction level of ERP users. It illustrates the importance of conducting additional studies in this field to further examine and determine the accounting benefits that result from the implementation of ERP systems and their impacts on satisfaction.

In the context of ERP and organizational changes and for the purpose of examining the implementation of accounting modules in public service organizations that operate in an emerging economy, Hassan and Mouakket (2016) conducted a study to explore the processes of implementing an ERP system by utilizing Laughlin's (1991) model of organizational change. The purpose was to highlight how the implementation of the accounting modules of an ERP system can disrupt the adoption of an organization's modes of thinking and the practices of its members. A case study approach was used, and data were collected from an organization that operates in the United Arab Emirates through interviews, documentary evidence, and personal observation. Together with implementation and customization issues, the study revealed that employees were forced to use the ERP system. As a result, some members have formed absorption groups that question the organizational change due to the accounting-based ERP system.

This study provides further insights to help top management when they are developing organizational change strategies and to address emerging regulations that could affect the implementation of ERP systems in organizations. This lays the foundation for ensuring proper implementation and use of ERP systems.

Considering this era of business globalization and due to the fast advancements in information technologies and communication aspects, as well as the efforts that have been made by accountants to improve the advancements and performance of their accounting processes, a study was done by Bejjar (2017) to review "the impact of the ERP on the performance of the accounting processes." It was based on an empirical study of 103 accountants who are working in the banking sector and who use ERP systems; 50% of the participants in the questionnaire have more than 5 years of experience in their field. The study concludes that the impact of the ERP on the performance of the accounting processes is valid, but it is not significant, and the analyses differ among different levels. Furthermore, it involves cost reductions of processes, results in productivity gains, and improves the quality of services and accountant work. Also, the ERP system provides accurate and timely information that meets the requirements and the needs of the respective accountants and ERP system users.

Of equal importance in the context of advantages and benefits of the ERP system to the respective users, another study was done by Nur and Irfan (2020) to examine the effects of ERP-based accounting information system implementations on users and organizations. The study focused on companies listed on the Indonesian Stock Exchange, and a sample of employees who use ERP accounting information systems were selected to meet the objective of the study. A structured equation modeling technique was used to analyze the gathered data. As a result of the analyzed data, it has been concluded that the implementation of high-quality information systems generates a high quality of information that satisfies the respective users. Furthermore, it contributes to the performance of the organization by improving personal skills.

This raised the implication that organizations may implement high-quality ERP-based accounting information systems to positively impact organizational performance.

3 Research Methodology

3.1 Population and Sample

Before conducting the survey, it was important to identify the targeted population. The purpose of this study is to assess the impact of the ERP system on the operational costs of the accounting functions. Statistics published by Statista Research Department (Schwandt & Jakob, 2022) identified and described the number of enterprises in Bahrain in 2018 by size. The statistics revealed that, out of 92,000 enterprises in Bahrain, approximately 176 and 950 enterprises were considered to be large- and medium-sized businesses, respectively. So, assuming that all of those businesses had adopted the ERP system in their accounting functions, a 10% targeted sample of those businesses would be around 112 companies.

For this research, a questionnaire survey was distributed to multiple companies in the private sector. Appropriate well-known users of the ERP system who are working in the accounting functions and/or who have experienced a role in such accounting functions were selected; 95 responses were subsequently obtained.

Table 1 Reliability of the questionnaire

Factor name	Number of questions	Cronbach's alpha	Conclusion
Personnel	5	0.8480	Reliable
Financial	5	0.8243	Reliable
Productivity	4	0.8325	Reliable
Procurement	4	0.7601	Reliable
ICT	4	0.8989	Reliable
ERP	6	0.7287	Reliable

3.2 Reliability Test

In this study, it is essential that the questionnaire's validity and reliability should be checked. To eliminate the occurrence of unrelated wrong answers, validity must be taken into consideration.

Cronbach's alpha reliability coefficient usually ranges from 0 to 1; a value close to 1.0 indicates a better internal consistency of the variables in the scale. In other words, this indicates that the survey is more reliable. Consequently, a value of Cronbach's alpha greater than 0.7 is acceptable (Khalid et al., 2012). When multiple Likert-type scale questions are used in the questionnaire, this type of statistical test is usually applied (Gliem & Gliem, 2003). Therefore, Cronbach's alpha reliability test will be applied to the six factors of the questionnaire that included Likert-type scale questions. Table 1 presents the results of the conducted statistical reliability test and confirms that all factors are reliable since their Cronbach's alpha values are greater than 0.70.

4 Findings and Analysis

4.1 Data Statistical Description

Descriptive statistics were followed by the researcher in order to measure variables and explain the mean of the dependent and the independent variables. Descriptive statistics are measures of central tendency and variability such as the mean and standard deviation measures. Overall, the mean of all factors is around 4, which specifies that, on average, the mean is close to agreeing. The standard deviation of all factors is between 0.38 and 0.55. Table 2 shows the value of the mean is 3.61 for personnel and the standard deviation is 0.50, while the mean value for financial is 4.19 and the standard deviation is 0.47. The mean value of productivity is 3.92 and the standard deviation is 0.48, whereas for procurement, the mean value is 3.97 and the standard deviation is 0.41. The mean value for ICT is 3.80 and the standard deviation is 0.55; finally, the mean value for ERP is 3.74 and the standard deviation is 0.38 (Table 2).

Table 2 Descriptive statistics

Factor name	*N*	Minimum	Maximum	Mean	Std. deviation
Personnel (DEP)	95	2.4	4.8	3.611	0.4980
Financial (DEP)	95	3.0	5.0	4.189	0.4743
Productivity (DEP)	95	2.8	5.0	3.924	0.4825
Procurement (DEP)	95	3.0	5.0	3.974	0.4101
ICT (DEP)	95	2.5	5.0	3.800	0.5489
ERP (IND)	95	2.7	5.0	3.739	0.3787
Valid *N* (listwise)	95				

4.2 Correlation

Pearson's correlation coefficient was applied by the researcher; it is used to measure the strength of the relationship between two variables (Mcalister et al., 2016). The statistical test will produce values that range between −1.0 and + 1.0. Values below 0 indicate a negative correlation, which means if one value increases, the other value decreases. The statistical results of values that are −0.5 or below indicate that there is a strong negative correlation between the variables. Statistical values above 0 indicate that there is a positive correlation between the variables; therefore, if one value increases, the other value also increases. If the value is 0.5 or greater, there is a strong positive correlation between the variables (Mcalister et al., 2016). Table 3 illustrates the Pearson's correlation coefficients for all variables.

In reference to Table 3, it can be concluded that all tested variables have positive relationships with ERP and are significant at 5%. Furthermore, the tests indicate that there is a positive relationship between ERP and procurement, and the second highest relationship is between ERP and productivity at 0.35. It can also be seen that the strongest relationship is between procurement and financial, with a result of 0.54. Therefore, it can be noted that procurement and productivity are the factors most impacted by the implementation of ERP systems. Furthermore, the review indicates that there is a strong positive relationship between productivity and financial, with a result of 0.53. Procurement and productivity are the next factors, with a result of 0.51, but still considered as a strong positive relationship. Lastly, the lowest value of Pearson's correlation coefficients test in this survey is 0.20, which illustrates the relationship between ICT and personnel, followed by ICT and financial, with a result of 0.24, and between ERP and financial, with a result of 0.29 (Table 3).

4.3 Regression

In order to achieve the objectives of this research, simple linear regressions were used by the researcher to show how strong the relationships are between each independent and dependent variable. This was achieved by testing the impact of the

Table 3 Results of Pearson's correlation

		Personnel	Financial	Productivity	Procurement	ICT	ERP
Personnel	Pearson correlation	1	0.503**	0.493**	0.488**	0.197	0.323**
	Sig. (2-tailed)		0.000	0.000	0.000	0.056	0.001
	N	95	95	95	95	95	95
Financial	Pearson correlation	0.503**	1	0.533**	0.535**	0.239*	0.291**
	Sig. (2-tailed)	0.000		0.000	0.000	0.020	0.004
	N	95	95	95	95	95	95
Productivity	Pearson correlation	0.493**	0.533**	1	0.514**	0.298**	0.351**
	Sig. (2-tailed)	0.000	0.000		0.000	0.003	0.000
	N	95	95	95	95	95	95
Procurement	Pearson correlation	0.488**	0.535**	0.514**	1	0.458**	0.420**
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000
	N	95	95	95	95	95	95
ICT	Pearson correlation	0.197	0.239*	0.298**	0.458**	1	0.217*
	Sig. (2-tailed)	0.056	0.020	0.003	0.000		0.035
	N	95	95	95	95	95	95
ERP	Pearson correlation	0.323**	0.291**	0.351**	0.420**	0.217*	1
	Sig. (2-tailed)	0.001	0.004	0.000	0.000	0.035	
	N	95	95	95	95	95	95

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

independent variable (ERP) on the dependent variables (personnel, financial, productivity, procurement, and ICT).

The results of the simple linear regressions are presented and illustrated in the following sections for each variable.

4.3.1 Impact of ERP on Personnel (Model 1)

The value of *R* square is 0.104, which indicates that 10.4% of the variation in the dependent variable can be explained by the independent variable. In other words, the impact on personnel that can be explained through ERP represents 10.4%. The standard error of the estimate is 0.4738. The statistics and summary data are shown in Table 4.

Table 4 Model summary – Model (1)

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate
1	0.323[a]	0.104	0.095	0.4738

[a]Predictors: (Constant), ERP

Table 5 ANOVA – Model (1)

Model		Sum of squares	df	Mean square	*F*	Sig.
1	Regression	2.434	1	2.434	10.843	.001[a]
	Residual	20.876	93	0.224		
	Total	23.309	94			

[a]Predictors: (Constant), ERP

The informational statistics on the significance of the model are presented in Table 5 with F statistic value of 10.84. This suggests that at least one of the variables is significant at the 1% level. Furthermore, the analysis of variance statistical test (ANOVA) indicates that the model is good (Table 5).

The values of the t-statistic are significant at 1% for personnel. Thus, the change in personnel can be explained by the implementation of ERP.

According to Kline (2005), "the regression coefficients of a value less than 0.10 could indicate a small effect; values about 0.30 could indicate a medium effect; and values more than 0.50 indicate a large effect." In this context, Model 1 shows that the coefficient $\beta = 0.425$, which indicates that ERP has a medium impact on personnel. Accordingly, there is evidence that the implementation of ERP does affect personnel costs in the accounting functions, so we reject the null hypothesis that states that ETs do not affect personnel costs of the accounting functions. This result is consistent with the studies (Annamalai & Ramayah, 2011; Petkov, 2020) (Table 6).

4.3.2 Impact of ERP on Financial (Model 2)

The value of *R* square is 0.084, which indicates that 8.4% of the variation in the dependent variable can be explained by the independent variable. In other words, the impact on financial that can be explained through ERP represents 8.4%. The standard error of the estimate is 0.4563. The statistics and summary data are shown in Table 7.

The informational statistics on the significance of the model are presented in Table 8 with *F* statistic value of 8.57. This suggests that at least one of the variables is significant at the 1% level. Furthermore, the analysis of variance statistical test (ANOVA) indicates that the model is good (Table 8).

The values of the t-statistic are significant at 1% for financial. Thus, the change in personnel can be explained by the implementation of ERP. Model 2 shows that

Table 6 Regression coefficients – Model (1)

Model		Unstandardized coefficients		Standardized coefficients		
		B	Std. error	Beta	*t*	Sig.
1	(Constant)	2.022	0.485		4.170	0.000
	ERP	0.425	0.129	0.323	3.293	0.001

Table 7 Model summary – Model (2)

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate
1	0.291[a]	0.084	0.075	0.4563

[a]Predictors: (Constant), ERP

Table 8 ANOVA – Model (2)

Model		Sum of squares	df	Mean square	*F*	Sig.
1	Regression	1.785	1	1.785	8.572	0.004[a]
	Residual	19.365	93	0.208		
	Total	21.149	94			

[a]Predictors: (Constant), ERP

Table 9 Regression coefficients – Model (2)

Model		Unstandardized coefficients		Standardized coefficients		
		B	Std. error	Beta	*t*	Sig.
1	(Constant)	2.829	0.467		6.058	0.000
	ERP	0.364	0.124	0.291	2.928	0.004

the coefficient $\beta = 0.364$, which indicates that ERP has a medium impact on the financial cycle according to Kline's (2005) ranking. Accordingly, there is evidence that the implementation of ERP does affect the financial cycle in the accounting functions, so we reject the null hypothesis that states that ETs do not affect the financial cycle of the accounting functions. This result is consistent with the studies discussed in the literature review chapter, i.e., Appelbaum et al. (2017) and Jasim and Raewf (2020) (Table 9).

4.3.3 Impact of ERP on Productivity (Model 3)

The value of *R* square is 0.123, which indicates that 12.3% of the variation in the dependent variable can be explained by the independent variable. In other words, the impact on productivity that can be explained through ERP represents 12.3%.

Table 10 Model summary – Model (3)

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate
1	0.351[a]	0.123	0.113	0.4543

[a]Predictors: (Constant), ERP

Table 11 ANOVA – Model (3)

Model		Sum of squares	df	Mean square	*F*	Sig.
1	Regression	2.690	1	2.690	13.032	0.000[a]
	Residual	19.195	93	0.206		
	Total	21.884	94			

[a]Predictors: (Constant), ERP

Table 12 Regression coefficients – Model (3)

Model		Unstandardized coefficients		Standardized coefficients		
		B	Std. error	Beta	*t*	Sig.
1	(Constant)	2.254	0.465		4.847	0.000
	ERP	0.447	0.124	0.351	3.610	0.000

The standard error of the estimate is 0.4543. The statistics and summary data are shown in Table 10.

The informational statistics on the significance of the model are presented in Table 11 with F statistic value of 13.03. This suggests that at least one of the variables is significant at the 1% level. Furthermore, the analysis of variance statistical test (ANOVA) indicates that the model is good (Table 11).

The values of the t-statistic are significant at 1% for productivity. Thus, the change in personnel can be explained by the implementation of ERP. Model 3 shows that the coefficient $\beta = 0.447$, which indicates that ERP has a medium impact on productivity according to Kline's (2005) ranking. Accordingly, there is evidence that implementation of ERP does affect productivity in the accounting functions, so we reject the null hypothesis that states that ETs do not affect productivity of the accounting functions. This result is consistent with the studies explained in the literature review chapter and more specifically in the study by Estefania et al. (2018) (Table 12).

4.3.4 Impact of ERP on Procurement (Model 4)

The value of *R* square is 0.177, which indicates that 17.7% of the variation in the dependent variable can be explained by the independent variable. In other words, the impact on procurement that can be explained through ERP represents 17.7%.

Table 13 Model summary – Model (4)

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate
1	0.420[a]	0.177	0.168	0.3741

[a]Predictors: (Constant), ERP

Table 14 ANOVA – Model (4)

Model		Sum of squares	df	Mean square	*F*	Sig.
1	Regression	2.795	1	2.795	19.972	0.000[a]
	Residual	13.014	93	0.140		
	Total	15.809	94			

[a]Predictors: (Constant), ERP

Table 15 Regression coefficients – Model (4)

Model		Unstandardized coefficients		Standardized coefficients	*t*	Sig.
		B	Std. error	Beta		
1	(Constant)	2.271	0.383		5.933	0.000
	ERP	0.455	0.102	0.420	4.469	0.000

The standard error of the estimate is 0.3741. The statistics and summary data are shown in Table 13.

The informational statistics on the significance of the model are presented in Table 14 with F statistic value of 19.97. This suggests that at least one of the variables is significant at the 1% level. Furthermore, the analysis of variance statistical test (ANOVA) indicates that the model is good (Table 14).

The values of the t-statistic are significant at 1% for procurement. Thus, the change in procurement can be explained by the implementation of ERP. Model 4 shows that the coefficient $\beta = 0.455$, which indicates that ERP has a medium impact on procurement according to Kline's (2005) ranking. Accordingly, there is evidence that implementation of ERP does affect procurement costs in the accounting functions, so we reject the null hypothesis that states that ETs do not affect procurement costs of the accounting functions. This result aligns with the studies illustrated under the literature review chapter, i.e., Shuai et al. (2007) and Annamalai and Ramayah (2011) (Table 15).

4.3.5 Impact of ERP on ICT (Model 5)

The value of *R* square is 0.047, which indicates that 4.7% of the variation in the dependent variable can be explained by the independent variable. In other words, the impact on ICT that can be explained through ERP represents 4.7%. The standard error of the estimate is 0.5387. The statistics and summary data are shown in Table 16.

Table 16 Model summary – Model (5)

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate
1	0.217[a]	0.047	0.037	0.5387

[a]Predictors: (Constant), ERP

Table 17 ANOVA – Model (5)

Model		Sum of squares	df	Mean square	*F*	Sig.
1	Regression	1.335	1	1.335	4.599	0.035[a]
	Residual	26.990	93	0.290		
	Total	28.325	94			

[a]Predictors: (Constant), ERP

Table 18 Regression coefficients – Model (5)

Model		Unstandardized coefficients		Standardized coefficients		
		B	Std. error	Beta	*t*	Sig.
1	(Constant)	2.624	0.551		4.759	0.000
	ERP	0.315	0.147	0.217	2.144	0.035

The informational statistics on the significance of the model are presented in Table 17 with F statistic value of 4.60. This suggests that at least one of the variables is significant at the 1% level. Furthermore, the analysis of variance statistical test (ANOVA) indicates that the model is good (Table 17).

The values of the t-statistic are significant at 1% for personnel. Thus, the change in ICT can be explained by the implementation of ERP. Model 5 shows that the coefficient $\beta = 0.315$, which indicates that ERP has a medium impact on ICT according to Kline's (2005) ranking. Accordingly, there is evidence that implementation of ERP does affect ICT costs in the accounting functions, so we reject the null hypothesis that states that ETs do not affect ICT costs of the accounting functions. This result is consistent with the major studies explained under the literature review, such as Sar and Santoso (2021) and Appelbaum et al. (2017) (Table 18).

5 Conclusion and Recommendation

5.1 Conclusion

The findings of this research were basically built to test the impact of the ERP system on five sub-factors: personnel costs, financial cycles, productivity, procurement costs, and information and communication technology costs. The impact is then further formulated on the main factor (operational costs).

The purpose for testing those factors is to validate and quantify the impact that is brought into companies upon implementing ERP systems, since the providers of such systems promise companies that essential benefits will be noticed in their environments. The impact on reducing the operational costs is not an exception to those benefits. The researcher chose this topic due to his involvement with three implementation teams that implemented ERP systems in private sector companies. Ultimately, based on the primary data gathered through the distributed questionnaire, the results of this research could be generalized across the population.

In this research, the researcher analyzed the data that were collected through the responses to the circulated questionnaire. Based on the analysis, the researcher concludes that the operational costs of all of the considered sub-factors are impacted by the ERP system. Those factors are personnel costs, financial cycles, productivity, procurement costs, and information and communication technology costs, and those factors cumulatively impact the operational costs of the accounting functions. The reliability level of the outcomes was measured through Cronbach's alpha. All tested factors have positive correlations with the ERP, and the correlation values are between 0.20 and 0.54, so this suggests that implementation of ERP systems affects the operational costs of the accounting functions. Regression results reveal that procurement is the factor most impacted by the implementation of the ERP, with a value of 0.455, then productivity, with a value of 0.447. ICT is the factor that is least impacted by the ERP, with a value of 0.315. As a result, there is evidence that implementation of ERPs does affect personnel costs, financial cycles, productivity, procurement costs, and information and communication technology costs in the accounting functions, so we reject the null hypothesis that states that ETs have no impact on all sub factors. The results are consistent with most of the related studies demonstrated under the literature review.

5.2 Recommendations

The following are recommendations based on the research findings. First, users of ERP systems should be trained extensively to grasp the ultimate beneficial impact of the ERP system on operational costs. Furthermore, attention should be allocated to other factors that impact the operational costs of the accounting functions. Finally, the benefits that were promised before the implementation of the ERP system should be assessed regularly after implementation to ensure the existence of such benefits, consider any required improvements, and resolve any issues encountered.

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Understanding Artificial Intelligence Through Its Applications and Concerns

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1 Introduction: Background and AI Definitions

Artificial intelligence is a widely used term although what AI exactly is and knowledge of how it works remain elusive. AI is a broad field and has been described as technologies that imitate human intellect, human intelligence being exhibited by machines, machines that perform tasks that humans would perform, human intelligence manifested by computers, and artifacts that can carry out tasks in the real world without human involvement (Helm et al., 2020). Many authors view AI as a development that "replicates" the intelligence of humans (e.g., Brooks, 1991; Clancey, 2018; Silverman, 2018), while others view it as a development that "exceeds" the human intelligence (e.g., Monett & Lewis, 2017). The most common reference to AI is machines' ability to perform tasks that normally require human intelligence (Cohen-Mekelburg et al., 2021; Fjelland, 2020). However, as there is no common understanding of AI (see Monett & Lewis, 2017), the best way to understand AI is by looking at its various forms in applications.

Artificial intelligence is changing the world that we live in, revolutionizing the future of industries and every aspect of human life. AI is linked with smartness and how machines can think, learn, act, and react as humans do. Today with the huge advancement of technology and increase of data and information, tech companies

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are using this large information in many applications. AI is now incorporated in, among other fields, transportation, healthcare, education, travel, business, and finance. This research explores AI's embeddedness in industry, focusing on the application of its various facets. The intention in this study is to present a clearer picture of AI and its applications in people's life, contribute to enhancing their knowledge about AI systems' applications, and remove the prevalent elusiveness around AI. The research will also be useful for professionals working in technology industries as it provides potential solutions and advancements offered by AI which can further improve their work practices and performance. Several AI system applications will be discussed, providing technical explanation and insights into AI.

2 Approaches to AI System Developments: Handcrafted Knowledge and Machine Learning

Technological breakthroughs over the last decade have greatly increased the diversity of applications where AI is shown to be practical, powerful, and performance enhancing. AI systems can be developed following many different approaches, grouped into two broad categories: handcrafted knowledge AI and machine learning AI (Blasch et al., 2021). Machine learning (ML) systems are the more recent of the two approaches and are responsible for the leapfrog improvements in AI capabilities and for much of the excitement (e.g., Liu et al., 2019; Lwakatare et al., 2019; Sevakula et al., 2020).

Handcrafted knowledge systems are AI that use traditional rules-based programming languages to codify knowledge of human experts about a subject into a long series of programmed rules of the "if given x input, then provide y output" type (Allen, 2020; Pruinelli & Michalowski, 2021). These systems attempt to represent human knowledge into programmed sets of rules that computers can use to process information. Combining millions of these domain-specific rules into "the program" results in a smart and useful machine, such as tax preparation software; Deep Blue, IBM-developed, chess-playing AI; language translation; and auto-pilot and feedback control system (Apte et al., 2000; Mualla et al., 2019; Pei et al., 2019).

Knowledge in the machine learning (ML) systems, on the other hand, is not programmed by humans. Rather, these systems are trained from large sets of data: a machine learning algorithm runs on a training dataset and produces an AI model (Ray, 2019). The ML systems learn from the trained datasets, and the trained system is then used operationally to produce predicted outcomes given new operational data. By running a human-generated algorithm on the training dataset, the ML system generates rules such that it can receive input x and provide correct output y (Kulagin et al., 2021). The system learns from examples (training data), making data vital in the context of AI, as it is the raw material for building high-performing ML systems. Thus, the quality, quantity, representativeness, and diversity of data directly impact the operational performance of the ML system (Jain et al., 2020).

Hence, having enough of the right data tends to be crucial. Algorithms and computing hardware are also important, but nearly all ML systems run on ordinary computing hardware, and most of the best algorithms are freely available.

Although ML systems program themselves, humans still have a critical role to play in guiding this learning process (Zhou & Chen, 2018), choosing algorithms, formatting data, setting learning parameters, and troubleshooting (Maadi et al., 2021).

Because of the increased performance and enhanced productivity which ML produces, there are currently many practical applications throughout the economy and industry. Pattern recognition, image analysis, language translation, content generation, and speech transcription are just few examples of the high performance of machine learning AI (Ammar & Ayed, 2018; Berg et al., 2019; Risi & Togelius, 2020; Wieland & Pittore, 2014; Zhou et al., 2020). Furthermore, the performance and practicality of using ML systems have witnessed a marked enhancement because of the increasing availability of huge datasets, immense computing power (both from using GPU chips as accelerators and from the cloud), open-source code libraries, and software development frameworks (Tyagi & Chahal, 2022).

3 Families of Machine Learning Algorithms and Deep Learning

There are four different families of ML algorithms, based on aspects of the data they are trained on; these are supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning (Mohammed et al., 2016). Panch et al. (2018) stressed the importance of understanding the different AI families, as knowing which family an AI system is using has implications for effectively enabling and managing the system's development.

Supervised learning uses example data that has been labeled by human supervisors; this type of data has very high performance; however, getting sufficient labeled data can be difficult, time-consuming, and expensive. Unsupervised learning, on the other hand, uses data that are not labeled; such data produces lower performance than supervised learning for many applications, but it can also be used to solve problems where supervised learning is not viable (Adorf et al., 2019). Semi-supervised learning is of great interest in ML and data mining because it can use readily available unlabeled data to improve supervised learning tasks when the labeled data is scarce or expensive (Zhu & Goldberg, 2009).

Reinforcement learning has autonomous AI agents that gather their own data and improve based on their trial-and-error interaction with the environment; this type of data appears to be promising, but so far reinforcement learning has been harder to use in the real world and remains less common than supervised and unsupervised learning applications (Mahesh, 2020). This is because the real world is not as heavily bounded as video games in terms of inputs, outputs, and interactions; time cannot be speeded up in the real world; and consequences of failure (Dulac-Arnold et al., 2021). Nevertheless, reinforcement learning systems have been increasingly used in research settings, where many researchers expect that usage to grow rapidly, and many tech companies are using reinforcement learning in operational applications (see Ostheimer et al., 2021; Zhang et al., 2018).

In summary, supervised ML systems can deliver very high performance but acquiring labeled data may be challenging (Osisanwo et al., 2017). In unsupervised ML systems, while not requiring labeled data, their performance is generally more limited than supervised ML systems (Alloghani et al. 2020). Reinforcement learning systems can generate their own data but currently they are only used for the few applications that offer access to simulators which closely resemble the operational environment (Jordan et al., 2020; Mahesh, 2020; Sarker, 2021).

4 Neural Networks and Deep Learning

Recent research breakthroughs and far-reaching improvements in the performance of AI systems have mainly been enabled by algorithms that make use of neural networks (Mirjalili, 2019). Neural networks are algorithms that are named after the biological neurons in the brain (Maind & Wankar, 2014). These algorithms require initial human training and supervision to link things together (Abiodun et al., 2018). Each algorithm consists of group of nodes that are able with time to mimic human brain in linking things that see or hear to things from previous experience. It is an algorithm which continuously, overtime builds up new information from correlated data (Kang et al., 2020). Neural network algorithms are mainly used in the robotics and IT industry, and they have several other applications that will also be discussed in this study.

Deep learning (deep neural networks) is a powerful ML technique; it is mainly associated with supervised learning, providing the best performance for many applications (see Canziani et al., 2016). With the right architecture, it can also be applied to unsupervised, semi-supervised, and reinforcement learning (Canziani et al., 2016; Siar & Teshnehlab, 2019). Deep neural networks merely refer to those neural networks that have many layers of connected neurons in sequence (Miikkulainen et al., 2019). Unlike ML which mainly involves solving linear algorithms, deep learning works in a hierarchical way involving the machine to make complex and efficient decisions which require solving more complex algorithms. An application of deep machine learning is self-driving car, virtual assistance, and many more important applications.

For many applications, achieving the required performance will require using neural networks (Samek et al., 2021). However, while using the most advanced algorithm is important for the research community; factors like feasibility, performance, and reliability are more important for policy making, applied R&D, and operations (Pan et al., 2022). Despite the challenges of safety and reliability standards for the development, testing, and operation, ML AI systems have already been considered safer and better performing than what they replace (Pan et al., 2020). It is expected that with R&D and improved program management standards, ML will also be reliably used in safety-critical and more diverse sets of applications (Li, 2021).

Program management would be mainly concerned with whether the system uses ML and whether the selected algorithm requires labeled data (Sener & Savarese, 2017). As system performance is directly influenced by data quantity, quality, and representativeness, obtaining sufficient high-quality training data is one of the big challenges in developing an operational ML AI system (Hamada et al., 2020). Furthermore, improving organizational productivity requires taking full advantage of the high-performing AI model's capability by integrating the AI model into operational technology systems, changing organizational processes, and staff workflows (Sjödin et al., 2021).

5 AI Applications

A plethora of studies using different approaches were devoted to developing a better understanding of AI. Monett and Lewis (2018) conducted a survey administered to 400 AI experts around the world, presenting statements that define AI and asking the participants to select the most appropriate definition. Their aim was to integrate the different responses of professionals in the AI field and provide a better understanding of the concept. Borana (2016) investigated the meaning of AI by relating it to real-world applications. However, he focused on the early roots of AI and how it evolved using the disciplines of philosophy, logic/mathematics, computation, and psychology/cognitive science. Recently, AI algorithms have been the central focus of researchers in finding industrial solutions for complex engineering problems that have been challenging in the past. Zhang et al. (2016) investigated the use of AI algorithms in innovative applications that solve complex problems within time and limited resource constrains. AI in all its various forms and families has applications in almost all human activities, invading most of industries. It is taking over some of human daily work or replacing the human intelligence in making complex risky decisions, using deep analysis within very short time.

This study will explore some of these AI applications, where AI algorithms had been used to build them, and how they work. The focus will be on the most rapidly developing industries and sectors with the most innovative technological advancements, namely, transportation, social media, sport, healthcare, and banking. Technically explained below are some these AI applications in the most developing industries of the twenty-first century.

5.1 Artificial Intelligence in the Transportation Industry

The transportation industry is currently one of the fastest developing industries, where AI is revolutionizing its services and products into faster, more efficient, more reliable, and safer ones (Abduljabbar et al., 2019; Sharma & De, 2022). The race for developing a smart electric car started more than 10 years ago with a fierce competition between the largest car companies like Toyota, Ford, Mercedes, and Tesla, the latter being the most advanced company in this area. AI is used in the commercial as well as the private transportation industry. Though relatively expensive at this stage, AI can automate jobs, can make decisions instead of drivers, and is soon expected to become a standard feature in the industry (Agrawal et al., 2019; Englund et al., 2021).

Self-Driving Vehicles Self-driving vehicles are equipped with automated driving systems that can take care of all aspects of the driving task, which are currently managed by a human driver, under all roadway and environment conditions (Daily et al., 2017; Rak et al., n.d.). Self-driving vehicles have moved from the domain of science fiction movies to become a technological reality. All the tasks performed by the car driver such as acceleration, steering, monitoring the road, and selecting the suitable driving mode (eco, sport, snow) are now performed using AI. Moving from point A to point B can now be accomplished with the highest level of safety, using the technique of deep machine learning, which utilizes a huge amount of data provided by the car sensors (e.g., approximate radar, video cameras, GPS, ultrasonic, pressure sensors, infrared sensors). The vehicle's AI system can make sophisticated drive or stop decisions based on the traffic light color, distance of the car in front of it, road speed limit and many other affecting factors. From this data, using deep machine learning AI, cars can self-learn, analyze information, and make all the complex decisions, outperforming the human mind and, arguably, rendering these self-driving cars relatively safer than a manned car.

Traffic Management Traffic management is one of the most important applications of AI in the transportation industry. Without a rigged traffic management system, there would be a high number of accidents and much wasted resources. Chowdhury et al. (2006) investigated AI simulation models to achieve a decision support for real-time traffic management to improve public and private transportations services. Data can be collected from traffic sensors, traffic cameras, and other devices that are connected to the Internet of Things (IoT) platform. ML AI algorithm can then be applied to this data to develop a smart traffic management system to predict traffic pattern changes and identify congested roads. Google Maps, one of the most advanced technologies, predict the traffic by using ML AI to analyze location data, historical traffic patterns, and user feedback. So, for example, when a person asks Google for the time taken to travel from point A to point B, Google Maps uses ML AI algorithm to retrieve the stored historical data for the time taken for a person to travel the same route and predicts the live traffic of the route. The historical data is stored on a server in Google and continuously receives more data from other users and learns new information. AI, using deep machine learning technique, is deployed in the self-driven vehicle because of the complexity of the task that requires huge amount of data, fast decisions, and feedback. While real-time traffic management uses the normal machine learning AI, it continuously learns new information and builds up experience leading to the high potential of development of traffic management in the coming years.

To sum up, AI has many applications in the transportation industry ranging from self-driving vehicles, traffic management, sustainable transportation, to unmanned cargo ships. Transportation is crucial in our daily life, and its AI applications will continue to develop in the coming years.

5.2 Artificial Intelligence in the Social Media and Entertainment Industry

Social media have dramatically changed in the past 10 years. Today social media have become, through ML AI algorithms, one of the most powerful tools and substantial revenue earners for large companies like Facebook, Twitter, and Instagram. Through social media, news spread faster at low cost and with easy accessibility (Ozbay & Alatas, 2020). Some social media large players use AI that gathers the large information available in their social media space to predict presidential elections in countries. There are different types of AI systems, and it is very important to know which type of AI system describes the technology. Most social media AI systems use the power of machine learning to develop into an automated smart virtual space that can predict, recommend, and make decisions to display products or services to match individual preferences.

Social Advertising Social advertising has become the most efficient way of influencing people's purchasing behavior; advertisement is now only a click of a finger away from the targeted audience. Receiving the advertisement that is customized to suit an individual's interests is not a coincidence; it is because of the deployment of AI by large companies to target the exact current needs of customers. Facebook, Instagram, and YouTube are the world largest players in this field; they use AI systems to generate enormous amount of money from targeted advertisements that grab the audience attention. Facebook relies on machine learning based on the user historical use of their services to capture the most visited product item, referred to by a simple #hashtag. These #s are stored in the user profile server and can be accessed for several purposes. Facebook uses machine learning algorithm to accumulate all the #hashtags that identify the user's interest. It would then learn and predict the advertisement's type that would attract the user and display it in the user customized platform, where there is a high probability that the user would click on it. Like Facebook, Instagram uses the same ML algorithm to display customized advertisements that would grab the user's attention. In a similar manner, YouTube continues serving people the content and advertisements that they like to watch. There is also a plethora of fake advertisements on social media that negatively affect the audience as well as the service providers. Facebook uses AI to identify advertisements that spread fake information, narrow the search by tracking the IP address of the most common fake advertisements, and ban them automatically.

Social Content Creation and Management Social content creation and management is the process of studying and evaluating the users of social media to come up with a tailor-made strategy that targets all users' interests. Today Netflix has more than 160 million members in more than 190 countries around the world (Netflix Research, n.d.). Netflix uses ML AI system to optimize the original movie and TV shows production, enabling them to develop the company's movies and TV shows catalogue. The process is triggered automatically by the AI algorithm using probabilistic graphical models that analyzes the huge data. These models and other ML algorithms are used to predict audience size who would like to watch a particular type of movie from the AI-generated analysis of audience preference.

AI has thus significantly changed the social media industry. It enabled producing targeted advertisements, creating content based on audience preferences, removing harmful and fake media and advertisement, and cleaning up the space for legitimate information. Machine learning AI systems have become the most deployed algorithms in this industry. It utilizes the huge amount of data that users provide such as selection of videos, advertisements that they click on, websites they visit, music they hear, and pictures they view, which are all used to continuously teach the machine about each person's preferences. The machine can process this data and build up an experience which is customized with a categorized content for each audience, and this has revolutionized the user experience and generated huge revenues for the AI social media companies.

5.3 *Artificial Intelligence in the Sports Industry*

Sport has been transformed from a community past time to lucrative commercial enterprises with the increasing professionalization of the game. Today sports are characterized by fierce competitions, generating substantial amount of money for the sport clubs and related businesses. Much research had discussed the impacts of AI and its influence in changing the face of the sport industry. Human action recognition (HAR) systems are becoming very popular in sports. Fok et al. (2018) developed a HAR project for the application in the surveillance system to minimize the manpower for providing security to the citizens such as public safety and crime prevention. They applied deep learning network using recurrent neural network (RNN) with long short-term memory (LSTM) to analyze dynamic video motion of sport actions and classify different types of actions and their performance. Their system could classify different types of human motion with a small number of video frames. They claimed to have achieved up to 92.9% accuracy with high potential of further improvement. Hucaljuk and Rakipović (2011) used AI to predict the results of football matches. Their model reached nearly 65% accuracy in performing correct predictions, and that had affected the gambling agencies. So today, AI had become pervasive in all sports, and because the technology is becoming cheaper, most clubs are using it.

Player Performance Player performance is the most important aspect that football and other sports managers focus on, simply because the player is the most valuable asset in a team formation. Understanding player performance helps managers to know the strength and weakness of their players and focus on improving their performance. Fok et al. (2018) used neural networks AI algorithms which collect data from cameras that detect the raw posture key points in human body in real time. These photos are then divided into many frame matrices, and the key pose positions of the human skeleton are determined automatically using seven cameras. The neural network algorithms, using 1080-time space posture points, can then determine the weak points of the human body. AI can also track players' performance during live matches. Each player's identity could be identified during the match; using motion and color detectors, the player's movement and the color of his/her team can be determined and their performance tracked. The camera detects the player's trajectories with boxes for each player as shown in Fig. 1 and using neural network algorithm (Fok et al., 2018); each player's capabilities and performance are evaluated using the tracked statistical information collected by the camera during the match. This valuable data helps managers in improving their players' abilities and advises them to decide the next match team formation.

Predicting Games Scores Predicting games scores have spread and become popular in the sports industry for fast money gains and for the adrenaline of gambling. However, with AI, betting money on football games and races is no more considered as gambling. Although it is difficult as there are many factors that cannot be quantitatively modeled, software using combination of neural networks of live information data about the players, ML from previous historical data about the team scores and player performance, prediction of a game score have since become relatively accurate. Determining the factors that have the greatest impact on the outcome is the best possible way to have accurate prediction of the match scores. Hucaljuk and Rakipović (2011) studied and classified 30 factors and then reduced them to 20 to get a prediction of 65% accuracy for game scores.

To sum up, AI in the sports industry is not simple as expected. Neural network is extensively applied in many sports industry applications, starting from player performance evaluation to live tracking of players inside the field. With all its advantages, some major clubs fear that AI sport applications might one day affect humans' abilities and make them perform similarly to robots, and that would kill the excitement of sport.

Fig. 1 Bounded boxes for player tracking

5.4 *Artificial Intelligence in the Healthcare Industry*

With the COVID-19 pandemic in 2019, investment in AI in healthcare has boomed. Yu et al. (2018) investigated the long history of AI in the healthcare. This started with medicine in the mid-twentieth century, where clinical decision support systems were developed. In 1970, AI was employed to diagnose diseases, select the appropriate treatment, and analyze patient's conditions. However, at that time AI was very expensive and not mature enough to perform these tasks automatically without human intervention. According to Yu et al. (2018), recent AI in the healthcare industry have leveraged from basic ML algorithms. The machine collects large number of training cases of patients and identifies the common symptoms, treatment program, and the patients' reactions to this program. Having this information, the AI system can diagnose the new patient's disease and suggest the best treatment. Below are some examples of AI application in the healthcare sector.

Genome Interpretation Terabytes of raw data are created by genome investigations. It is critical to analyze this statistic and recognize the differences between individuals since these differences help in the selection of the most appropriate treatment. However, because the understanding of the human genome is continuously improving, it is impossible to compare a patient's genome to known cases. Deep neural networks outperform the traditional approaches like logistic regression in identifying the roles of DNA. Neural network-based methods would convert the genome to a picture that can be used to classify individuals. Also, AI employing neural network has been used to identify complex illnesses that contain a genetic component such as cancer. This raises the hope that one day with the aid of AI advancement in genome, AI machines will be able to find cure to cancer and other diseases.

Health Status Wearable Devices Health status wearable devices represented in the modern watches and bracelets that are developed by companies such as Apple, Samsung, and Huawei. These wearable devices have several sensors that measure the heart rate, voice, skin temperature, and body movement. The huge data that these watches collect from individual health records are used in AI research to identify signs of early heart attack or infectious disease. Recently these smart wearable watches sensors have been able to detect Parkinson disease by applying machine learning that compares an individual's hand movement and speech patterns to previous people who were infected by the disease. The smart wearable devices have leveraged from AI in creating value for human that changed human behavior. Smart watches, available at affordable prices, are replacing traditional watches. People now can track their health status from applications on their phones that continuously measure in real time their health status and compare it with other people, analyze the information, and trigger alarm if something is abnormal. AI ML algorithms have made this a reality.

5.5 Artificial Intelligence in the Banking Sector

The banking sector is rapidly changing with the development of artificial intelligence. Banks use AI to detect frauds and understand and track customer behavior from their transactions in order to recommend more customized and personalized service to enhance the customer experience. Shouval et al. (2021) investigated the application of AI and ML in the banking industry focusing on the financial technology that has been innovative for several years. They claimed that ML and AI technologies were taking over the banking sector and that there was nothing one can do about it. A brief description exploring the application of AI and ML in the banking industry is given below.

Risk Management of Credit Cards Over the past years, banks would simply offer credit cards to individuals based on their salary, earnings, and any loans paid back. By using AI and especially ML, banks can collect data about everyone's habit on repaying their loans, by analyzing thousands of records using the ML algorithms, enabling them to recommend a sensible loan credit offering. Thanks to AI, banks will be able to offer customized interest rates on cards and loans and hence improve the banking business.

Personalized Banking and Automation In the banking industry today, AI application systems record personal income, monthly costs, and spending patterns and then make recommendations with an optimum plan and financial advice. The industry leaders are currently considering robotic process automation as part of their long-term strategy for lowering operating costs and increasing productivity through intelligent character recognition which uses neural network algorithms that analyze the biometrics of the customers. As such, the application of AI and ML in the banking industry can now decrease human error in high-frequency repetitive jobs.

AI ML is redefining our relationship with money. It has offered the banking industry a new approach to satisfy the expectations and needs of its consumers, who want smarter, more accessible, and safer ways to access, save, spend, and invest their money. Also, customers nowadays have realized that technology is not expensive or hard to learn; and everything is now available on a smartphone.

6 Concerns and Challenges over Deploying AI

The excitement over the opportunities of deploying AI is dampened by several ethical and human rights concerns and challenges, such as bias and discrimination; transparency, accountability, and explainability; technical accuracy; and legality and due process (e.g., Access Now, 2018; Latonero, 2018; Hashmi et al., 2019; Desouza, 2019; Fjeld et al., 2020; Mittelstadt et al., 2016).

Although the allure of algorithmic objectivity and neutrality is widespread, in the context of the use of AI, empirically based concerns about bias around gender, sex, race, and ethnicity are well documented in all aspects and walks of life (Allen, 2019; Bacchini & Lorusso, 2019; Benjamin, 2019; Gillespie, 2014; Horton, 2016). These bias outcomes arguably result from the training data that may be incomplete, inaccurate, or reflecting historical structural inequalities that get fed to the AI systems to train and build their algorithms. Similarly, technical accuracy can be a concern with the use of AI, particularly when used in a probabilistic decision-making or predictive manner, such as maltreatment and crime decision (Henman, 2017; Carney, 2019). This is because, perceived as objective, these algorithmic decisions are accepted without question.

With AI, the algorithm develops its own very complex approach to process the input data. Hence, a key issue being investigated is creating explainable AI (Adadi & Berrada, 2018). While not new, software development processes are increasingly using a "privacy by design" approach (Cavoukian, 2012), whereby legal considerations of data protection and privacy are built into the architecture of algorithmic decision-making systems rather than left to the end of the product development process. Such approaches can be made more widespread and can also be extended to incorporate other ethical considerations in AI development (Morley et al., 2019).

7 Conclusion

Many studies are devoted to explaining AI, each having a different approach of explaining the meaning of AI. The aim of this study is to provide a fuller, more comprehensive understanding of the construct. Two main AI system approaches were identified, namely, handcrafted knowledge AI and the more recent and prevalent machine learning AI. The study's focus was on machine learning AI, where most of the technological breakthroughs are taken place. Four different families of

ML algorithms were recognized based on type of data they are trained on: supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning. Furthermore, deep learning (deep neural networks) algorithm was presented as a powerful ML technique that was shown to provide the best performance for many supervised learning AI applications but can also, with some modifications, be deployed in the other AI families. AI has further been linked to its industry applications, focusing on today's most developing industries (transportation, social media, sports, healthcare, and banking). It was found that most of the applications use machine learning AI. AI applications, such as traffic management, social advertisement, social content creating, predicting sport games scores, health status wearable devices, and risk management of credit cards, all depend on processing large number of live and historical data, obtaining common patterns and coming up with recommendations, predictions, or decisions.

Due to its simplicity, machine learning AI is currently the most mature AI technology and that explains the growing number of its applications in many industries. The second most widely used AI is the neural networks; this form of AI is applied in analyzing athletes' performance, genome interpretation studies, and banking automation. Using sensory information such as video pictures and voice, neural networks are designed to interpret information and link them together mimicking the biological neurons in human brains. The rarest AI is the deep machine learning AI, deployed in complex applications and still has not matured. The only example discussed in this paper, self-driving vehicles; they have been technologically built and are currently available. However, it is still subjected to security issues as it could be hacked. Deep machine learning in self-driven cars implementation is still highly expensive technology and is subjected to machine error which possess significant safety concerns.

As a concluding statement, there is no perfect definition of AI. However, understanding AI applications throughout its various approaches, families, and algorithms provides a fuller understanding of what AI is.

The prospects of AI in business and government agencies are generating considerable concern about its possibilities for accountability, control, and the impact on social relationships. The challenge is shaping and using AI to enhance and protect social and economic objectives. To date, much of the discussion has occurred at a highly abstract level. AI, as machine learning, represents a paradigmatic shift in computer science and information systems possibilities. Yet, the many ways AI is being used, or envisaged for use, is not dissimilar to non-machine learned algorithms. Consequently, the ethical, legal, and social challenges are not unique to AI but exacerbated by it. Where AI and non-AI algorithms are generating new ethical, legal, and social challenges is in their deployment to automate current human activities (e.g., chatbots, automated vehicles) or to do things that were not previously possible at all (e.g., make decisions in human service delivery). This continuity, rather than disruption, is seen as beneficial as insights, experiences, and responses of past deployment of algorithms in government and businesses can be drawn upon, and learnings can be transferred from use of AIs in one location to another. That said, there is still many unmet or poorly managed challenges that AI is now highlighting.

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Fintech Adoption in Palestine: Bank Customers' Perspectives

Bahaa Sobhi Awwad

1 Introduction

One of the key characteristics of the human mind is creativity and innovation. A mind whose owner does not look for everything new, or at least deal with scientific progress positively, is considered by people as a negative mind, or that its owner is not qualified to live in an advanced society, on the one hand, and is unable to keep pace with the development that the world is experiencing every day, on the other hand. The world of today is experiencing a tremendous technological revolution that is developing constantly with an amazing speed; this revolution has affected almost all aspects of everyday life, including financial institutions, in general, and the banking sector, in particular (Bomod et al., 2020; Derbali, 2021).

One of the most important outputs of the current technology revolution is the concept of Fintech, which resonated and spread quickly at the global level until it swept over the Arab world. Fintech has originated in China, New York, London, Singapore, and Hong Kong. It provides various, useful services to many individuals and companies in rapid, easy, safe, and less expensive ways compared to the traditional financial services. Fintech paves the way to achieving the desired level of efficiency in different sectors (Bin Fadda & Bin Hassan, 2020).

In general, Al-Hafiz (2019) has postulated that Fintech is any technological invention and/or innovations that are employed in the financial services and banking industry; these innovations are used in this vital sector and have developed a serious technology that competes with traditional financial markets. It is worth noting that a lot of emerging companies have had a major role in the process of creating new technologies. Abdul Aziz (2017) has added that Fintech represents a set of supply and demand markets for goods and services through which companies use electronic

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applications and digital platforms to achieve communication between providers of goods and services and their consumers and thus support trade based on demand. According to the Reserve Bank of India (2017), Fintech is a set of financial innovations that can produce new business models, applications, processes, or products that directly affect financial markets, institutions, and the provision of financial services. Fintech has created a new field that has attracted banks that sought to increase their profits and achieve an economic position within a new world of competing banking systems; most of these banks have extensive experience in this field; they constantly try to create a business plan that combines software and technology to provide a distinct variety of financial services (Abdul Rahim & Bin Kaddour, 2018; Adeosun et al., 2023).

Among the most important sectors that financial institutions adopt in the field of Fintech are payments and money transfers, insurance, digital financing, lending, wealth management, and block chains and cryptocurrencies; it is worth saying that the payments sector is the most significant sector that uses Fintech the most within global markets.

Based on the foregoing, the technological revolution witnessed by all economic sectors, in general, and the banking sector, in particular, has made the necessity employing or even dealing with technology the cornerstone of all transactions in a way that contributes to survival, growth, and continuity. The current study tries to identify the barriers, advantages, components, and dangers or risks of adopting Fintech in Palestine from the perspective of bank customers (Razzaque & Hamdan, 2020). This study constitutes a strong scientific basis for potential, prospective, or future research because there is a noticeable shortage or lack of similar studies in the Palestinian field; consequently, the current study is meant to contribute to guide decision-makers toward the risks and barriers of Fintech in the Palestinian banking sector from the point of view of customers.

2 Literature Review

Abad-Segura et al. (2020) conducted a study to analyze the productivity of scientific research on Fintech worldwide during the period 1975–2019; the study findings revealed a growing and dynamic international interest and care in scientific research activity in the subject of financial technology at the global level. These findings were confirmed by Sanjiv R. Das (2019) who stated that the growing field of Fintech and various Fintech models and technologies is currently acquiring a high and advanced position scientific research domains at the international level. Schindler (2017) tried to answer two significant questions related to Fintech; the first question relates to the reason for using financial technology now. In his attempt to answer this question, Schindler stated that a lot of the technologies that support financial technology as innovations are not new, but financial institutions and entrepreneurs are now applying them only to improve and develop financial products and services. The reason could be related to the tendency to analyze the rapidly moving supply and demand factors; furthermore, the "traditional" financial innovation stresses its need for a set of factors that require a large amount of cooperation. The second question was an attempt to find out why is Fintech getting more attention than traditional innovation. Schindler argued that this could be linked with the necessity of activating the "depth" of innovation for financial technology. The deeper the innovation, the greater its ability to transform and change financial services for the better (Razzaque et al., 2020).

Accordingly, many recent studies have emerged that dealt with the merits of Fintech from a general perspective. Hussein (2020), for example, carried out a study which aimed to measure the impact of Fintech on economic justice. The study found that Fintech positively affects economic growth and the process of financial inclusion and supports and affects it whereas the principles of the liberal growth theory negatively impact the economic justice; the study recommended the need for governments and international organizations to focus on the appropriate use of technology by the poorest and most marginalized people in order to achieve the goals of economic development. Another study was conducted by Bin Fadda and Bin Hassan (2020) to investigate and scrutinize the reality and challenges of the use of technology in the Arab world in order to propose some solutions and suggestions that will contribute to activating its use. The researchers concluded that the countries of the world, such as America and China, have made great strides in this field despite its modernity while the Arab world is still behind despite the efforts made to expand its use. This could be attributed to the inadequacy of the economic and legal climate and the resistance of the financial system to the changes resulting from the use of Fintech. Therefore, Arab countries are supposed to provide the appropriate environment to benefit from the advantages of this field.

With regard to financial institutions, the study of Purnomo and Khalda (2019) aimed to analyze whether the impact of Fintech is good or bad on national financial and banking institutions. The study concluded that Fintech may hinder the development of banking business, but it may also be an opportunity that can be exploited by the banking sector itself. It can digitize banks and encourage engagement with Fintech. This is due to the fact that Fintech has captured a large part of the market share of the banking industry. Another study conducted by Ngari and Muiruri (2014) showed the extent to which the banking industry in Kenya during the past ten years participated in financial innovations, and its transition from traditional banking services to Fintech technologies to better meet the increasingly complex needs of its customers. The study was guided by the following specific objectives to determine whether credit card and banking operations, mobile phone, and Internet banking affect the financial performance of commercial banks in Kenya. The study results showed that financial innovations had significant impacts on the financial performance of banks. Furthermore, Hasan (2019) carried out a study in Sudan and sought to identify the uses of electronic banking, the reasons for its non-proliferation, and the failure to meet the needs of customers in obtaining electronic banking services with the required efficiency; the researcher also meant to find out the most important barriers and risks they face. The study concluded that banks should update and expand their electronic services and identify and prioritize the wishes as well as ambitions of customers to achieve them in order for the bank to obtain customer satisfaction; these banks are also required to conduct marketing campaigns to increase banking awareness with the need to focus on the security and confidentiality elements in electronic banking services.

On the other hand, Jerene and Sharma (2020) showed that developing countries such as Ethiopia are striving to adopt Fintech in order to modernize the financial system. However, the acceptance of Fintech by consumers faces many challenges. Fintech includes electronic platforms designed by bankers to allow their customers to access financial services, mobile banking, and bank cards. The study revealed the intent of bank customers to positively adopt Fintech; it also revealed customers' awareness toward subjective standards and the perceived usefulness of these technologies. Purba et al. (2019) also attempted to develop a framework for assessing Fintech adoption in a number of Indonesian companies and banks. The study emphasized that the emergence of technology-assisted innovations in financial services has resulted from the confluence of ambitions and customer preferences, particularly among millennials and digital native citizens regarding the convenience, speed, and cost of increasingly needed financial services. The results indicate that Fintech represented by modern technologies, especially those related to the Internet, large data, mobile technology, and computing power, has become the engine of innovations in financial services. There are also many business opportunities that have allowed new entrants in the financial sectors to use IT collaboration systems.

Within the Islamic banking domain, Bomod et al. (2020) meant to shed some light on the positive impact of Fintech innovations on developing the performance of Arab Islamic banks; Fintech technologies and innovations enable banks to easily introduce their financial products and provide their services with efficiency and high quality, which is positively reflected on their competitiveness in various financial markets. The study concluded that Arab Islamic banks have gained great achievements especially those which relate to the wide spread of these banks in various Arab countries, the continuous development in their work, and their tireless quest to avoid past mistakes, look forward to future developments, as well as face the challenge of applying Fintech innovations due to the specificity of these Islamic banks as they are supposed to handle or deal with their customers in accordance with the Islamic laws. In another study carried out by Al-Amrawi (2019), the researcher aimed to find out the extent to which Fintech platforms can be used as a means to promote the growth of the Islamic financial industry; the researcher conducted a case study of the Nasdaq Dubai CSD Murabaha platform with the aim of demonstrating its importance in promoting Islamic finance through managing the liquidity of Islamic banks and promoting the growth of the Islamic Sukuk market on Nasdaq Dubai. The study concluded that the Nasdaq Dubai Murabaha platform efficiently manages the liquidity of Islamic banks while enhancing the activity of listing sukuk on the Nasdaq Dubai stock exchange, which led to an increase in demand from local and international investors and consequently the growth of the size of the sukuk market. The study recommended Islamic banks to manage their liquidity through the Nasdaq Dubai Murabaha platform to take advantage of its components, on the one hand, and to avoid legal violations of transactions on the

London Metal Exchange, on the other hand. It also took up a study by Bilal Khan, M., Ahmad Ghafoorzai, S., Patel, I., and Mohammed Shehbaz, D. (2021) that addresses major challenges and financial problems faced by Indonesian farmers. Inadequate level of working capital and inability to access funding sources constitute major constraints to the agricultural sector. It proposes a new financing solution: the waqf-based Islamic Fintech model to fund farmers' long-term and short-term projects. The study is based on a qualitative approach. The study concludes to important recommendations. The adoption of an integrated Waqf-based Islamic Fintech model, which provides halal financing alleviates Indonesian farmers' problems in rural areas.

With regard to emerging companies, Abdul Rahim's study (2018) presented a modern concept related to the field of Fintech that attracts emerging companies, which are now competing with other financial institutions and banks especially by adopting software and technology to provide a distinguished variety of financial services. The study findings showed that the emerging companies face a number of barriers and difficulties such as the security and confidentiality of information and deceptive electronic transactions, in addition to legalizing and diverting the loyal customer's behavior to traditional institutions and trying to attract him. The researcher also found that despite the failure of all emerging companies to replace banks, they still posed a threat to the existence of a segment of customers who long for technology and digital use, especially after they have gained a lot of support by the largest universal institutions around the world such as Facebook.

In light of the growing interest in Fintech and its technical applications, it was necessary to address the barriers, advantages, components, and risks of adopting Fintech in Palestine from the perspective of bank customers in order to try to come up with appropriate recommendations that support the decisions of these banks.

3 Study Methodology

3.1 Study Population and Sample

The researcher of the current study adopted the descriptive approach to describe the study sample and its variables, in addition to the analytical approach in order to identify the barriers, advantages, components, and risks of adopting Fintech in Palestine from the perspective of bank customers. The study population consisted of customers of the largest Palestinian banks including the Arab Bank, Bank of Palestine, and Palestine Islamic Bank. The study was conducted on a random sample of (500) customers of commercial and Islamic banks that make up the study population. Table 1 below shows the distribution of the study sample based on the various study demographic variables.

Table 1 Distribution of the study sample based on demographic variables

Sample distribution based on demographic variable		
Variable	Frequency	Percentage
Distribution based on gender		
Male	356	71%
Female	144	29%
Distribution based on age		
Less than 30 years	91	18.20%
Between 30–40 years	289	57.80%
More than 40 years	120	24.00%
Distribution based on city		
Tulkarm	125	25%
Nablus	125	25%
Ramallah	125	25%
Qalqilyah	125	25%
Distribution based on bank		
Arab Bank	125	25%
Bank of Palestine	125	25%
Arab Islamic Bank	125	25%
Palestine Islamic Bank	125	25%
Distribution based on educational level		
Diploma or less	81	16%
Bachelor degree	297	59%
Higher Studies	122	24%
Total	500	100%

3.2 Study Questions

The current study aimed to identify the adoption of Fintech in Palestine from the perspective of bank customers. To achieve this goal, the main question of the study can be formulated as follows:

What are the dimensions of Fintech adoption in Palestine from the perspective of bank customers?

To answer the main question, the researcher raised a number of sub-questions which appear as follows:

– What are the barriers the use of Fintech face from the perspective of Palestinian bank customers?
– What are advantages of using Fintech from the perspective of Palestinian bank customers?
– What are components of using Fintech from the perspective of Palestinian bank customers?
– What are the dangers or risks of using Fintech from the perspective of Palestinian bank customers?

– Are there differences in the adoption of Fintech in Palestine from the perspective of bank customers that could be attributed to the demographic variables?

3.3 Study Tool

In this study, the researcher used a questionnaire which was developed to suit the purpose of the study; the five-point Likert scale was used, so that each answer was given relative importance. The validity and reliability of the tool were measured as follows:

3.3.1 Validity of the Tool

The study tool was given to a group of specialized arbitrators. The arbitrators were asked to express their opinion on the paragraphs of the questionnaire in terms of the formulation of the paragraphs, and their suitability for the field in which they were placed, either by approving, modifying their wording, deleting them for lack of importance, or adding new paragraphs. The opinion of the majority of the arbitrators' committee members was taken into consideration in the arbitration process, and thus the validity of the content of the questionnaire was achieved. For more information about the study tool in its final form.

3.3.2 Reliability of the Tool

The reliability coefficient of the tool has been extracted using Cronbach's alpha equation. Table 2 below shows the reliability coefficients of the study tool and its fields.

It is clear from Table 2 that the validity of the various fields of the survey paragraphs ranges between 0.704 and 0.746, where the total stability is 0.718, which makes it suitable and applicable for scientific research purposes as recommended for use by other economic and human studies; this means that the validity of the study tool is universally accepted.

Table 2 Cronbach's alpha coefficient

Variable	Number of paragraphs	Cronbach's alpha coefficient
Barriers of using Fintech	5	0.705
Advantages of using Fintech	5	0.704
Components of using Fintech	5	0.746
Danger or risks of using Fintech	5	0.719
Adoption of Fintech	20	0.718

4 Analysis of the Study Questions

To determine the paragraphs, arithmetic means and standard deviations were calculated, and consequently, the total score was determined; the results in the subsequent tables will show this. In order to interpret the results, means were calculated as follows:

Relative importance	Mean
High degree	3.67–5
Medium degree	2.34–3.66
Low degree	1–2.33

4.1 Analysis of the Relative Importance of the Dimensions of Using Fintech

Table 3 shows the relative importance of the paragraphs/items of barriers of financial technology were high as the arithmetic mean was 3.686; the paragraph that relates to " A preference for traditional banking operations over the use of electronic services" got the highest rank with an arithmetic mean of 3.79 and a standard deviation of 0.809. The paragraph "One feels lack of confidence in electronic banking transactions or operations" got the lowest rank with an arithmetic mean of 3.41 and a standard deviation of 0.931. This indicates that there were real barriers that hinder the use and the adoption of financial technology in Palestine.

Table 4 shows the relative importance of the paragraphs related to the advantages of using Fintech. It is clear from the table that the score was low as the mean is 2.22;

Table 3 Mean, standard deviation, and the relative importance of the barriers of using Fintech

Paragraph No.	Paragraph	Means	Standard deviations	Rank	Relative importance
1	One feels lack of confidence in electronic banking transactions and operations	3.41	0.931	5	High
2	The cost of electronic banking services is considerably high	3.69	1. 0.683	2. 3	Medium
3	There is not enough technical infrastructure in Palestine	3.76	3. 0.695	4. 4	High
4	A preference for traditional banking operations over the use of electronic services	5. 3.79	6. 0.809	7. 1	High
5	There is a slowdown in Internet services by providers, which affects use of financial technology	8. 3.78	9. 0.912	10. 2	High
Barriers of using Fintech		3.686	0.432	High	

Table 4 Mean, standard deviation, and the relative importance of the advantages of Fintech

Paragraph no.	Paragraph	Means	Standard deviations	Rank	Relative importance
6	There is ease in using electronic banking services	2.21	0.961	2	Low
7	There is speed in obtaining the electronic banking service	2.1	0.878	3	Low
8	The electronic banking service is available around the clock	2.07	0.889	4	Low
9	The electronic banking service is implemented anywhere	1.97	1.134	5	Low
10	The electronic banking service reduces transaction costs	3.92	1.021	1	Low
Advantages of using Fintech		2.22	0.769	High	

Table 5 Mean, standard deviation, and the relative importance of the components of Fintech

Paragraph no.	Paragraph	Means	Standard deviations	Rank	Relative importance
11	Government and financial institutions seek to provide basic infrastructure	2.15	0.894	2	Low
12	There are videos and brochures guiding customers on how to use electronic banking services	2.11	0.894	3	Low
13	There must be exemptions for electronic banking services from any fees so that they become free	3.12	0.826	1	Medium
14	Your bank's website is constantly improving	1.87	0.979	4	Low
15	There are laws and legislations that promote working in electronic banking services	1.69	1.07	5	Low
Components of using Fintech		2.188	0.730	Low	

and the paragraph "The electronic banking service reduces transaction costs" was considered the first and its mean is 3.92 and standard deviation is 1.021. As for the paragraph "The electronic banking service is implemented anywhere," it got the last rank with a mean as 1.97 and a standard deviation as 1.134.

Table 5 shows the relative importance of the paragraphs that relate to the components of financial technology; it had a low score with a mean of 1.69. The paragraph that states "There must be exemptions for electronic banking services from any fees so that they become free" was ranked first with an arithmetic mean of 3.12 and a standard deviation of 0.826. As for the paragraph "there are laws and legislations that promote working in electronic banking services," it got the last rank with an arithmetic mean of 1.69 and standard deviation of 1.07.

Table 6 shows the relative importance of the paragraphs that relate to the risks and dangers of using financial technology; it was high with a mean of 3.74. The

Table 6 Mean, standard deviation, and the relative importance of the dangers and risks of Fintech

Paragraph no.	Paragraph	Means	Standard deviations	Rank	Relative importance
16	The risks of dealing with electronic banking services are high	3.57	0.891	5	High
17	The degree of security in electronic banking services is low	3.77	0.882	3	High
18	There is a possibility that the privacy of the bank's customers may be breached by a third party	3.78	0.862	2	High
19	There are no clear laws to protect banking dealings with electronic services	3.89	0.997	1	High
20	There is a fear that the bank will take advantage of the lack of paper copies and deduct commission amounts from customers	3.69	1.11	4	High
Dangers and risks of using Fintech		3.74	0.739	High	

Table 7 Mean, standard deviation, and the relative importance of adopting financial technology

Dimension	Mean	Standard deviation	Rank	Relative importance
Barriers to using Fintech	3.68	0.432	2	High
Advantages of using Fintech	2.22	0.769	3	Low
Components of using Fintech	2.18	0.730	4	Low
Dangers and risks of using Fintech	3.74	0.739	1	High
Using or adopting Fintech	2.95	0.557	Medium	

paragraph "There are no clear laws to protect banking dealings with electronic services" was ranked first with an arithmetic mean of 3.89 and a standard deviation of 0.997. The paragraph "The risks of dealing with electronic banking services are high" got the last rank with an arithmetic mean of 3.57 and a standard deviation of 0.891.

Table 7 shows the relative importance of the dimensions of adopting and using financial technology in Palestine. All of them came in a medium degree with a mean of 2.95 and a standard deviation of 0.557. The results show that the financial technology risk dimension was in the first place with an arithmetic mean of 3.74 and a standard deviation of 0.739, while the components of financial technology dimension was ranked last with a mean of 2.18 and a standard deviation of 0.730.

To answer the question: Are there differences in the adoption of financial technology in Palestine from the perspective of bank customers based on demographic variables? The following tables show the results of the t-test and one-way analysis of variance (ANOVA) to indicate the adoption of financial technology according to the demographic variable (gender, age, city, bank, and educational level).

Table 8 T-test results for adopting and using Fintech based on gender variable

Male (n = 365)		Female (n = 144)		*t.*	*p.*
Mean	Standard deviation	Mean	Standard deviation	1.087	0.844
3.79	0.214	3.72	0.297		

Table 9 Numbers, means, and standard deviations for the adoption of financial technology in Palestine based on the age variable

Age	Number	Means	Standard deviations
Less than 30 years	91	3.79	0.239
Between 30–40 years	289	3.79	0.156
More than 40 years	120	3.71	0.177

Table 10 One-way analysis of variance (ANOVA) for the adoption of financial technology in Palestine based on the age variable

Source of variance	Df	Mean square	SS	*F*	*P*
Between groups	2	0.138	0.069	0.290	0.748
Among groups	484	115.15	0.238		
Total	486	115.288			

Table 11 Numbers, means, and standard deviations for the adoption of financial technology in Palestine based on the city variable

City	Number	Means	Standard deviations
Tulkarm	125	3.78	0.179
Nablus	125	3.61	0.393
Ramallah	125	3.86	0.242
Qalqilyah	125	3.69	0.652

It is evident from Table 8 that there are no statistical differences for the adoption of financial technology in Palestine based on the gender variable, because the total degree of the calculated significance level ($p = 0.844$) is higher than 0.05 (Table 9).

It is clear from Table 10 that there are no differences for the adoption of financial technology in Palestine based on the age variable because the significance level is 0.748.

It is clear based on the results shown in Table 11 above that there are differences among respondents' perspectives toward adopting Fintech in Palestine based on the city variable. To find out whether these differences were significant or not, ANOVA was carried out.

It is clear from Table 12 that there are statistically significant differences at the significance level ($a \leq 0.05$) in the averages of financial technology adoption in Palestine based on the city variable. This is because the significance level is 0.018.

It is evident from Table 13 that there is a difference in the averages of financial technology adoption in Palestine, in favor of the city of Ramallah compared to other cities in the overall field (Table 14).

Table 12 One-way analysis of variance (ANOVA) for the adoption of financial technology in Palestine based on the city variable

Source of variance	Df	Mean square	SS	*F*	*P*
Between groups	3	3.135	1.045	7.987	0.018
Among groups	492	269.402	0.546		
Total	495	272.536			

Table 13 LSD dimensional comparison analysis

	Tulkarm	Nablus	Ramallah	Qalqilyah
Tulkarm		0.16	−0.08	0.02
Nablus	−0.16		−0.25*	0.13
Ramallah	0.08	0.25		0.09
Qalqilyah	0.02	0.13	0.09	

*Means significant at the level ($a \leq 0.05$)

Table 14 Numbers, means, and standard deviations for the adoption of financial technology in Palestine based on the bank variable

Bank	Number	Means	Standard deviations
Arab Bank	125	3.25	0.178
Bank of Palestine	125	3.88	0.168
Arab Islamic Bank	125	3.18	0.198
Palestine Islamic Bank	125	3.87	0.173

Table 15 One-way analysis of variance (ANOVA) for the adoption of financial technology in Palestine based on the bank variable

Source of variance	Df	Mean square	SS	*F*	*P*
Between groups	3	0.114	0.038	0.160	0.923
Among groups	483	115.174	0.238		
Total	486	115.288			

It is clear from Table 15 that there are no differences for the adoption of financial technology in Palestine based on the bank variable because the significance level is 0.923.

It is clear based on the results shown in Table 16 above that there are differences among respondents' perspectives toward adopting Fintech in Palestine based on the educational level variable. To find out whether these differences were significant or not, ANOVA was carried out.

It is clear from Table 17 that there are statistically significant differences at the significance level ($a \leq 0.05$) in the averages of financial technology adoption in Palestine based on the educational level variable. This is because the significance level is (0.007).

It is evident from Table 18 that there is a difference in the averages of financial technology adoption in Palestine, in favor of holders of the bachelor degree compared to other educational levels in the overall field of the study.

Table 16 Numbers, means, and standard deviations for the adoption of financial technology in Palestine based on educational level variable

Bank	Number	Means	Standard deviations
Diploma or less	81	3.81	0.211
Bachelor degree	297	3.69	0.286
Higher studies	122	3.74	0.165

Table 17 One-way analysis of variance (ANOVA) for the adoption of financial technology in Palestine based on the educational level variable

Source of variance	Df	Mean square	SS	*F*	*P*
Between groups	2	0.233	0.116	9.876	0.007
Among groups	484	115.055	0.238		
Total	486	115.288			

Table 18 LSD dimensional comparison analysis

	Diploma or less	Bachelor degree	Higher studies
Diploma or less		0.12	0
Bachelor degree	−0.12		0
Higher studies	0	0	

*Means significant at the level ($a \leq 0.05$)

5 Discussion, Recommendations, and Future Studies

The aim of the study was to show the extent to which financial technology is adopted in Palestine from the perspective of bank customers; the researcher meant to do so by analyzing the dimensions represented by barriers or obstacles, advantages, components, and risks of adopting Fintech from the perspective of the customers of the four most important commercial and Islamic banks in Palestine. The results concluded that the level of total adoption of financial technology in Palestine is medium; furthermore, the results showed a high relative importance of two dimensions, i.e., barriers and risks especially with regard to the preference of traditional banking operations and transactions over the use of electronic services, due to the fact that there are no clear laws that help to protect banking dealings with electronic services. The researcher believes that the risks and the general culture of not accepting everything that is new, especially in an environment characterized by instability such as the Palestinian environment, may be reflected in the adoption of financial technology (Fintech). The researcher also noticed that the relative importance of the two dimensions of the advantages and components of financial technology was low despite the reduction in transaction costs by exempting electronic banking services from any commissions and/or fees. The researcher believes that the average/medium level of financial technology adoption in Palestine could be attributed to the balance between barriers and risks, on the one hand, and the advantages and components, on the other hand.

With regard to demographic variables, the study found that there are no differences in the adoption of financial technology in Palestine that could be attributed to the variables of gender, age, and bank, while there are differences attributed to the city and educational level variables. The researcher believes that the competitive banking environment in Palestine worked to create a general convergence in electronic services between banks for the two genders irrespective of their ages, while the large cities that have strong and large commercial and financial influence have sought to adopt financial technology in banking transactions due to its low costs and high speed. Furthermore, the high educational level of the study respondents reflects a greater level of knowledge of the Fintech system used in the banking industry; it also helps keep pace with the rapid developments.

Based on the foregoing results, the study recommends that banks should enhance the confidence of their customers in electronic banking services by providing an adequate technical infrastructure to motivate and hasten the adoption of financial technology in Palestine. In addition, the various bank managements are required to set and develop strategic plans that aim to educate customers about financial technology and electronic banking services. There is also an urgent need to develop laws and legislations that contribute to strengthening the legal process of electronic transactions while working to provide high levels of security in electronic banking services.

Finally, this study presented a general picture of the adoption of financial technology in Palestine from the perspective of bank customers. Since financial technology has become of increasing global interest, future studies – especially those that may be conducted in the Palestinian arena – should deepen the research about the various aspects of Fintech by focusing on electronic service providers in financial institutions, other sectors, and emerging companies in the field of financial technology. Finally, future studies are likely to discuss the major challenges that may hinder the complete adoption as well as implementation of Fintech in Palestine.

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Success Factors of Using Artificial Intelligence

Shahad Omar Al Hleewa and Muneer Al Mubarak

1 Introduction

The introduction of new information technology has caused a considerable number of firms to adjust, modify, or create entirely new business models. The most prominent manifestation of this trend is in conventional brick-and-mortar firms, which are increasingly depending on information technology to meet the demands of their customers (Buder et al., 2019). In general, technological innovation has far-reaching consequences; but there is a substantial body of work that demonstrates that artificial intelligence (AI) may have a significant influence on companies (e.g., Nortje & Grobbelaar, 2020). There are a variety of reasons why artificial intelligence is getting so much attention. Increasing computer capabilities are becoming accessible, allowing enterprises to make use of the promise of artificial intelligence. It has been practical to use algorithms, such as artificial neural network algorithms or genetic algorithms, in particular, because of the abundant availability of "big data" (Chen et al., 2012, 2005). As a result, artificial intelligence-based products are becoming increasingly ubiquitous as they are integrated into widely used software solutions such as Netflix (for movie recommendations), Amazon (for product suggestions), Facebook (for friend suggestions), and Google (for personalized advertising) (Adadi & Berrada, 2018). Even though there are several advantages to using artificial intelligence-based technologies, there are still significant challenges that prohibit enterprises from applying them. One explanation for this is that many

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organizations are still in the early stages of implementing artificial intelligence and are thus mainly focused on acquiring information. Furthermore, several obstacles make it difficult for enterprises to implement AI technology. While prior literature has addressed this problem and suggested various research that study (success) elements that influence the adoption of artificial intelligence, there is still a major gap in terms of a unified approach on the subject. Because of this gap, it is difficult for academics to create a theoretical viewpoint on the use of artificial intelligence. Furthermore, enterprises cannot be appropriately educated about essential elements that should be taken into account to improve their AI-related activities.

For this research, a systematic analysis of success variables that have been established in the context of artificial intelligence adoption will be provided. Our contribution is twofold: first, we provide an overview that assists scholars in expanding their theoretical perspective on success factors for the adoption of artificial intelligence by integrating the results of several previous studies; and second, we provide recommendations for future research. Second, our findings are useful to practitioners who are looking for an overview of essential elements to consider while using artificial intelligence.

2 Literature Review

Even though artificial intelligence (AI) has received a great deal of attention in both academia and business, there is still no consensus on what AI is. For starters, since the phrase is used in a variety of domains such as philosophy (Müller, 2013), biology (Yu et al., 2018), and information systems research, it is a good fit for this context (Nascimento et al., 2018). As a result, the phrase is employed in a variety of contexts and with a variety of tastes. Furthermore, there are several comparable and related phrases, such as "machine intelligence" and "intelligent systems," that are often used as synonyms for one another. The last point to mention is that academic arguments on artificial intelligence stretch back to at least the summer of 1956 when the first thoughts on the subject were addressed at the Dartmouth Summer Research Project on Artificial Intelligence (McCarthy et al., 2006). Since then, both technical improvements and the definition of the word have undergone substantial evolution.

As a result, we may discover several alternative definitions of artificial intelligence in the literature. While there is no universally accepted definition of artificial intelligence in the literature, there is a growing consensus that AI is a wide (Russell & Norvig, 2003) and multi-dimensional notion (Brachman, 2006). Furthermore, we can find similar features that appear in a number of different definitions. Despite the fact that these topics are not capable of defining all parts of the word, they do assist in better understanding the major features of AI and how they may be separated from other technologies. As a result, we will briefly discuss five issues that have been explored in earlier work starting with identifying and solving complicated challenges. Scholars of artificial intelligence have recognized the potential of artificial intelligence approaches to address complicated issues from the inception of the field. For example, Minsky (1988) defines intelligence as the capacity to do challenging activities successfully and efficiently. Kasemsap (2017) takes a step further and identifies artificial intelligence as a discipline of research that is concerned with assisting robots in the discovery of acceptable answers to complicated situations.

Today, we can discover several instances of artificial intelligence (AI) being used to tackle issues that could not previously be addressed. The chess skills of IBM Watson (Hsu, 1999); Google's AI AlphaGo, which beat the world's top Go player (Wang et al., 2016); and modern warning systems connected to COVID-19 based on camera systems are also notable instances (Dananjayan & Raj, 2020). Processing that is similar to that of a human. Many artificial intelligence systems are based on procedures that are connected to human decision-making. Using the human brain as a template, for example, neural networks may be constructed (Bogdanov et al., 2017; Jain et al., 1996), which, when combined with increased processing capacity, enables them to solve complicated issues.

As a result, it should come as no surprise that Kurzweil (1990) defines artificial intelligence as the art of building machines that do activities that would otherwise need human intellect. In a similar vein, Rich and Knight (1991) think that artificial intelligence needs computers to do tasks with the same level of intelligence as humans. Furthermore, they believe that the ultimate objective of AI research is to figure out how to program computers to do tasks that humans are now superior at. The extent to which one is intelligent. In addition to the ability to solve complicated problems, several definitions of artificial intelligence relate to the level of intellect that has been attributed to it.

To put it another way, many people believe that artificial intelligence is an essential prerequisite for a technology to be labeled as artificial intelligence. For example, Nilsson (2009) describes artificial intelligence as a field of study concerned with the development of intelligent machines. In addition, he considers intelligence to be the property that permits an entity to act effectively and predictably in its own context, according to his definition. Russell and Norvig (2003)) go so far as to suggest that artificial intelligence is composed of a number of concepts such as "machine intelligence," "intelligence agents," "intelligent systems," and "algorithms," all of which are necessary to describe the topic. In more recent years, the phrase "ambient intelligence" has been created to represent a digital environment that proactively assists humans and is based on artificial intelligence (Ramos et al., 2008).

Examples include the brain intelligence model, which mixes artificial intelligence with artificial life with the goal of developing a superintelligence brain model that can find issues on its own and autonomously enhance its capabilities in the future (Lu et al., 2020). The emphasis is on technology. AI is closely intertwined with technology in a way that is similar to the degree of intelligence. As a result, the term artificial intelligence (AI) implies that some kind of technology is involved. As a result, many definitions are quite specific about this element of their meaning. For example, according to Schalkoff (1990), artificial intelligence is a branch of study that seeks to explain and replicate intelligent behavior via the use of computing processes.

The technological factor is also brought to the fore by Alsheibani et al. (2020); they define artificial intelligence (AI) as a collection of tools and technologies that have the power to enhance and increase the performance of organizations. Notably, many writers are quite vague about the sort of technology they are referring to, leaving it unclear if they are referring to a single piece of software, a set of algorithms, or a mix of these.

As shown by AI landscapes, there has been a surge in the application of technology in the area of artificial intelligence in the industry (Turk, 2020). Handling of external data is included. The usage and treatment of external data is the subject of the last topic. In contrast to conventional technologies, artificial intelligence (AI) systems often relies on external information acquired from the surrounding environment.

A great focus has been placed on this element by Schäfer et al. (2021), who argue that artificial intelligence is capable of reading external input and learning from that data so that it may accomplish previously established objectives and activities. Crowston and Bolici (2019)) describe artificial intelligence as an application that learns to make judgments based on incoming data rather than depending on a set of rules that are clearly stated in the beginning. Current breakthroughs in autonomous driving have significantly increased the maturity of the technology, allowing for the reduction of human driver effort while simultaneously increasing the safety of the technology (Muhammad et al., 2020). Table 1 presents a summary of the topics that were analyzed. For each subject, we have included examples from the artificial intelligence area that serve as illustrations for the theme in question.

Table 1 Existing definitions of AI

Theme	Representative definition	AI examples
Solving complex problems	"Intelligence … means … the abilky to solve hard problems." (Minsky, 1988, p. 70)	IBM Watson (Hsu, 1999), AlphaGo (Wang et al., 2016) COVID-19 (Dananjayan & Raj, 2020)
Human-like processing	"[…] the art of creating machines that perform functions that require intelligence when performed by people […]" (Kurzweil, 1990, p. 117)	Neuronal networks (Jain et al., 1996)
Intelligence	"[…] artificial intelligence is that activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment" (Nilsson, 2009, p. 13)	Ambient Intelligence (Ramos et al., 2008), Brain intelligence (Lu et al., 2020)
Technology-focus	"A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes" (Schalkoff, 1990)	AI landscape (Turk, 2020)
Handling of external data	"AI refers to systems that are able to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation" (Schäfer et al., 2021. p. 2)	Autonomous driving (Muhammad et al., 2020)

2.1 Technology-Organization-Environment (TOE) Framework

In the opinion of Webster and Watson (2002), literature reviews are especially valuable in topics that have previously been examined but in which fresh and additional study is necessary. A comprehensive analysis is lacking, despite the fact that the topic of success criteria in AI has previously been examined. Boell and Cecez-Kecmanovic (2015) make a distinction between a systematic literature review (SLR) and a narrative literature review (NR). Because we are attempting to provide answers to a particular issue, a systematic literature review (SLR) is the most promising method of investigation. Vom Brocke et al. (2009) provided us with guidance for conducting our review in an organized way.

Hence, we followed their recommendations and implemented all four stages of the study as described. The scope of this review focuses on success factors and artificial intelligence. Studies that concentrate on success factors and other technologies, such as electronic data interchange (EDI) systems, are excluded from the analysis (Kuan & Chau, 2001). Similarly, research that explore artificial intelligence without taking into account success factors are excluded (Bengio, 2009). AI is a vast concept that is frequently misunderstood, which is why we offered a brief review of definitions to help you better understand what we mean by the term "AI." Also included is a working definition that will be used throughout this document. Our literature search technique consists of two complementing search patterns, namely, a keyword search in three separate databases as well as a manual backward search to find relevant literature.

The technology-organization-environment (TOE) paradigm proposed by Tornatzky and Fleischer has been extensively used in the literature on technology adoption (Tornatzky & Fleischer, 1990). Accordingly, the TOE was frequently employed as a theoretical lens in research on artificial intelligence adoption. We conducted a thorough analysis of our data and classified the found success factors into three categories based on three dimensions: technology, organizational structure, and environmental conditions. We discovered variables that have distinct names but are quite similar in their nature because of the varying publishing timings and the usage of multiple names. According to Bauer et al. (2020)), "Existing ML know-how" is a concept that is closely similar to the concept of "Competencies" used by Rana et al. (2014).

2.2 Factors That Influence the Adoption of Artificial Intelligence (Organizational)

Using the TOE framework, we found 13 success criteria that were connected to the organizational dimensions of the company (see Table 2). In the eight research reviewed here, three characteristics were identified as being important for success: top-tier management support, (technical) expertise, and resources are required.

High-level management has been identified as a critical component in the adoption of artificial intelligence, in part because it assists in the allocation of resources for AI initiatives in the organization. Moreover, Alsheibani et al. (2020) demonstrate that there is a statistically significant association between top management support and the use of artificial intelligence. Competencies (both technical and non-technical) have also been identified as crucial success factors. Increasing the skills of employees via knowledge transfer or training is necessary to fully exploit the promise of artificial intelligence applications (e.g., Schäfer et al., 2021). Kordon (2020) thinks that a large amount of competence in applying statistical approaches, as well as a thorough grasp of mathematics, is essential for the acceptance of artificial intelligence. Further, he contends that owing to the great complexity of artificial intelligence, past knowledge and experience may be critical to achieving success in the adoption of artificial intelligence. Additionally, it has been said that the capacity to apply algorithms and analyze the results is critical (Rana et al., 2014).

The availability of resources is a third issue that has been examined in eight research. Resource availability may be determined by the availability of appropriate data (e.g., Demlehner & Laumer, 2020), a budget (e.g., Kruse et al., 2019) and the availability of personnel. Moreover, as Pumplun et al. (2019) point out, without appropriate resources, there is little likelihood of achieving success in artificial intelligence projects. A large budget may provide financial independence while also assisting in the development of knowledge inside the company.

Both the topic of organization size and organizational structure came up five and four times, respectively, in the data. Previous research has shown conflicting findings, indicating that such elements might have either a favorable or negative impact on the outcome. For example, huge firms often have more access to resources while also being burdened by inflexible organizational structures (Demlehner & Laumer, 2020). As a result, favorable benefits might be reduced or eliminated. Smaller firms, on the other hand, often have fewer resources at their disposal but respond in a nimbler manner, which is advantageous.

Using the TOE framework, we found 13 success criteria that were connected to the organizational dimensions of the company (see Table 2). According to the findings of the eight research reviewed here, three success criteria were identified: top-level management support, (technical) competence, and resources. The top management has been identified as a fundamental aspect that has a beneficial impact on the adoption of artificial intelligence (AI), in part because it assists in allocating resources to AI initiatives. Moreover, Alsheibani et al. (2020) demonstrate that there is a statistically significant association between top management support and the use of artificial intelligence. Competencies (both technical and non-technical) have also been identified as crucial success factors. Increasing the skills of employees via knowledge transfer or training is necessary to fully exploit the promise of artificial intelligence applications (Chäfer et al., 2021).

Kordon (2020) thinks that a large amount of competence in applying statistical approaches, as well as a thorough grasp of mathematics, is essential for the acceptance of artificial intelligence. Further, he contends that, owing to the great complexity of artificial intelligence, past knowledge and experience may be critical

Table 2 AI success factors (organizational)

	Top management support	(Technical) competencies	Resources	Organi zational lsize	Organi zational structures	Strategy	Organi zational readiness	Culture	Organizational innovativeness	Interdisciplinary collaboration	Perceived financial cost	Organi zational secrecy policies	Knowledge and information
Rana et al. (2014)		+											
Nasirian et al. (2017)													
Alsheibani et al. (2020)													
Eljasik-Swoboda et al. (2019)		+											
Kruse et al. (2019)					+/−								
Pumplun et al. (2019)				+/−	+/−								
Alsheibani et al. (2020)							+						
Bauer et al. (2020)		+			+/−		+			+			
Demlehner and Laumer (2020)				+/−									
Eitle and Buxmann (2020)					+/−								
Kordon (2020)	+	+						+					
Nortje and Grobbelaar (2020)													
Schäfer et al. (2021)		+											
∑	*8*	*8*	*8*	*5*	*4*	*3*	*3*	*3*	*2*	*1*	*1*	*1*	*1*

(+) positive factor; (−) negative factor; (+/−) positive and negative factor to achieving success in the adoption of artificial intelligence. Additionally, it has been said that the capacity to apply algorithms and analyze the results is critical (Rana et al., 2014). The availability of resources is a third issue that has been examined in eight research, in addition to having adequate data, a budget (Kruse et al., 2019), and workers (Demlehner & Laumer, 2020). Moreover, as Pumplun et al. (2019) pointed out, without appropriate resources, there is little likelihood of achieving success in artificial intelligence projects. A large budget may provide financial independence while also assisting in the development of knowledge inside the company. Both the topic of organization size and organizational structure came up five and four times, respectively, in the data. Previous research has shown conflicting findings, indicating that such elements might have either a favorable or negative impact on the outcome.

For example, huge firms often have more access to resources while also being burdened by inflexible organizational structures (Demlehner & Laumer, 2020). As a result, favorable benefits might be reduced or eliminated. Smaller firms, on the other hand, often have less resources at their disposal but respond in a nimbler manner, which is advantageous and helps people to make the most of their available resources in a productive manner (Kruse et al., 2019). According to Alsheibani et al. (2020), the size of the organization has no relevance on the success of implementing the Al.

Finally, we highlighted strategy, organizational preparation, and culture as critical success variables that were found in three studies and discussed in detail below. It is expected that all these elements will have a good influence on Al's adoption. In addition, two studies investigated organizational innovation, and one investigated multidisciplinary cooperation. One research investigated perceived financial cost, one investigated organizational secrecy rules, and one studied knowledge and information management.

2.3 AI Adoption Success Factors (Technological)

According to the findings of the study, the most commonly stated element in the technological dimension is the compatibility of artificial intelligence and the availability of a sufficient IT infrastructure (ten studies). The degree to which an invention meets the real requirements and expectations of prospective users is referred to as compatibility (Pumplun et al., 2019). Architectural considerations such as a suitable infrastructure platform (Nortje & Grobbelaar, 2020), the performance of the IT infrastructure (Demlehner & Laumer, 2020), and standardized data interfaces (Bauer et al., 2020) are thus critical for the adoption of artificial intelligence. This is supported by Alsheibani et al. (2020), who finds a statistically significant link between compatibility and the adoption of artificial intelligence. Seven sources cite relative advantage as a significant aspect in decision-making.

The research by Alsheibani et al. (2020) found that relative advantage is the second most important factor impacting AI adoption, behind top management support, when it comes to influencing adoption. The degree to which artificial intelligence outperforms rival technology is referred to as relative advantage. The relative advantage is related with lower costs, the ability to access new markets, the ability to create higher revenues, and the ability to achieve more efficiency and effectiveness. Five research have indicated data availability and quality as important factors. It is generally agreed that having a significant amount of training data is essential for the effective learning process of artificial intelligence. Data quality should be excellent in general, but how much data is required will depend on a number of variables, including aspects such as data complexity and what sort of activity will be taken over by artificial intelligence (AI) (Kruse et al., 2019). Other considerations include the availability of tools, which is mentioned in three studies. Two studies are being conducted that are based on the variables described as business requirements, security/availability, and complexity. Each of the variables perceived hurdles, generalizability/scalability, technology management, satisfaction with current systems, and technology ready to receive are discussed once in this document (Table 3).

2.4 AI Adoption Success Factors (Environmental)

According to the findings of the study, the compatibility of artificial intelligence and the availability of a sufficient IT infrastructure are the most commonly stated factors in the technological dimension (ten studies). A measure of how well an invention meets the real requirements and expectations of prospective consumers is called compatibility (Pumplun et al., 2019). A proper infrastructure platform (Nortje & Grobbelaar, 2020), the performance of the IT infrastructure (Demlehner & Laumer, 2020), and standardized data interfaces (Bauer et al., 2020) are thus critical for the adoption of artificial intelligence. Alsheibani et al. (2020), for example, finds a significantly significant link between compatibility and the adoption of artificial intelligence. A total of seven sources considers relative advantage to be a significant factor.

According to Alsheibani et al. (2020), relative advantage is the second most significant factor in promoting AI adoption, following top management support. The degree to which AI outperforms rival technologies is referred to as relative advantage. The relative advantage is related with lower costs, the ability to access new markets, the ability to earn higher profits, and the ability to improve efficiency. Five investigations have identified the availability and quality of data. It is generally agreed that having a significant amount of training data is necessary for the effective learning process of artificial intelligence. While data quality should be excellent in general, the quantity of data required varies on aspects such as the complexity of the data or the sort of work that the AI should take over once it has been trained (Kruse et al., 2019). Other considerations include the availability of tools, which has been mentioned in three studies. Two studies are being conducted in order to address the aspects indicated as business requirements, security/availability, and complexity. The elements perceived hurdles, generalizability/scalability, technology management, satisfaction with current systems, and technological ready to receive are all discussed once (Table 4).

Table 3 AI success factors (technological)

	Compatibilty/ IT infrastructure	Relative advatange	Availability and quality of data	Tool availability	Identified business needs	Security / reliability	Complexity	Perceived barriers	Generalizibility / Scalability	Technology management	Satisfaction with existing systems	Technology readiness
Rana et al. (2014)		+		+	+			–			–	
Nasirian et al. (2017)												
Alsheibani et al. (2020)	+	+										
Eljasik-Swoboda et al. (2019)			+									
Kruse et al. (2019)	+		+	+								+
Pumplun et al. (2019)	+	+	+									
Alsheibani et al. (2020)	+	+										
Bauer et al. (2020)	+											
Demlehner and Laumer (2020)	+	+	+	+		+	–		+			
Eitle and Buxmann (2020)	+	+					–					
Kordon (2020)	+		+		+							
Nortje and Grobbelaar (2020)	+					+				+		
Schäfer et al. (2021)	+	+										
Σ	*10*	*7*	*5*	*3*	*2*	*2*	*2*	*1*	*1*	*1*	*1*	*1*

(+) positive factor; (–) negative factor; (+/–) positive and negative factor

Table 4 AI success factors (environmental)

	Competitive/ industry presuure	Governmental regulations	Customer readiness	Trust	Industry requirements / characteristics	External partners / trading partners	Perceived goverment pressure	Perceived pressure from society	Access to external expertise	Public funding	Customer and community support
Rana et al. (2014)	+										
Nasirian et al. (2017)			+	+							
Alsheibani et al. (2020)	+	+									
Eljasik-Swoboda et al. (2019)		+									
Kruse et al. (2019)	+	+/−		+	+						
Pumplun et al. (2019)	+	−	+		+/−						
Alsheibani et al. (2020)	+	+									
Bauer et al. (2020)						−					
Demlehner and Laumer (2020)	+	+							+	+	
Eitle and Buxmann (2020)	+	+/−				+					
Kordon (2020)											
Nortje and Grobbelaar (2020)											
Schäfer et al. (2021)	+						+	+			
$\sum$	*8*	*7*	*2*	*2*	*2*	*2*	*1*	*1*	*1*	*1*	*1*

(+) positive factor; (−) negative factor; (+/−) positive and negative factor

3 Discussion and Implications

In contrast, a lack of management support has a negative influence on AI adoption since it might prevent management from providing resources and cash, for example, in addition to a lack of attention on AI (Alsheibani et al., 2020). According to the general literature on innovation, the size and structure of an organization are two of the most often discussed aspects in relation to adoption of new technologies. However, there is still a shaky picture of the extent to which it has influenced society in general (Zhu et al., 2004) and the extent to which AI has been implemented. Some studies suggest that large organizations have rigid structures but have a significant number of resources at their disposal, whereas others suggest that small organizations have limited resources but are more agile and flexible (Demlehner & Laumer, 2020; Kruse et al., 2019). This paradox holds true in the realm of artificial intelligence. For example, hierarchical organizational structures and a lack of cross-process assistance prohibit firms from gaining the agility required to incorporate artificial intelligence applications in their operations (Kruse et al., 2019).

As a result, it may be claimed that both big and small organizations can take advantage of possible advantages associated with their respective scales. Compatibility is the most commonly mentioned aspect in the technical component, according to the research that was reviewed. To have a beneficial influence on the adoption of artificial intelligence in enterprises, it is required for business processes and applications to be compatible with the technology. For example, if new technologies cannot be implemented in current infrastructures due to limitations in their integration, the old infrastructures must be modified to meet the new needs, which often results in a slowing of the implementation (Pumplun et al., 2019). Therefore, firms with appropriate IT infrastructures will benefit from the speedier and more cost-effective deployment of artificial intelligence (AI). As a result, enterprises should consider upgrading their infrastructure to ensure that it is compatible with artificial intelligence technologies.

The concept of relative advantage is another crucial success element in the technological dimension. The greater the (seen) relative benefit of an invention, the greater the likelihood that it will be accepted. The previous study has given compelling evidence that choices about the adoption of innovations should be made with careful consideration of the perception of relative advantage (Choudhury & Karahanna, 2008). It is possible to determine whether or not an artificial intelligence technology should be deployed based on the evaluation of a relative benefit. For enterprises seeking to embrace new technologies in the environmental dimension, a competitive environment is one of the most important factors driving their decision to do so (Kuan & Chau, 2001; Zhu et al., 2004). In other words, the greater the market's adoption of artificial intelligence, the more probable it is that enterprises would embrace the same AI technology. Consequently, firms have the chance to outperform their rivals via the use of new technologies, thereby altering the competitive environment in their favor (Zhu et al., 2004). As an example, Nokia, although being the market leader, failed to recognize the smartphone trend and, as a consequence, steadily lost market share to rivals such as Apple and Samsung, among others (Alibage & Weber, 2018). Regulatory compliance is an environmental issue that may have both a good and a negative impact on the adoption of information technology breakthroughs (Pumplun et al., 2019; Zhu & Kraemer, 2005).

The government may have an impact on the dissemination of information technology developments by establishing or eliminating obstacles to the adoption of new technologies via legislation (Pumplun et al., 2019). On the one hand, regulation may help to promote consumer confidence in technology, which can lead to greater adoption of artificial intelligence applications. On the other hand, an excessive number of laws may result in a significant commitment of financial resources as well as organizational inertia as a result of the high constraints placed on the use of artificial intelligence in enterprises (Kruse et al., 2019; Pumplun et al., 2019). From a theoretical standpoint, we can see that numerous research make use of the TOE framework to investigate crucial elements for the adoption of artificial intelligence.

The majority of the research discussed here is exploratory in nature, and they are being undertaken to find new success criteria. However, even though past attempts have significantly widened the viewpoint on artificial intelligence adoptions, as shown below, there is currently no cohesive theory that places a focus on the most crucial aspects. This finding is supported by the fact that most researchers use an exploratory strategy (interview-based studies) and contact experts from the artificial intelligence domain to uncover crucial success criteria in the field. In contrast, only two investigations have been carried out utilizing a quantitative method (Alsheibani et al., 2020; Nasirian et al., 2017), both of which have been published recently.

4 Conclusion

The study is developed in order to present an overview of success variables that are significant for the adoption of artificial intelligence in enterprises. We discovered 36 success criteria in the course of our research. Thirteen of the TOE framework's dimensions are related to the organization, twelve are related to technology, and eleven are related to the environment. We will explore some of the most significant and fascinating findings in the next section, and we will direct you to the original research for a more in-depth examination of each success component.

In terms of the organizational dimension, top-level management support is one of the most important criteria for the effective implementation of artificial intelligence. This is noteworthy because, although senior management support does not instruct a company on how to embrace AI, it may be seen as a factor that accelerates the implementation of all other initiatives. Consequently, it is critical for managers to have a thorough grasp of artificial intelligence, which will help them to better support and assist AI. In this vein, it has also been proposed that top management may have a good impact on workers' faith in artificial intelligence, which in turn can encourage the adoption of AI.

4.1 Limitations and Suggestions for Further Studies

First and foremost, we made a conscious decision to draw lines between existing literature and new research. It is important to note that this constraint is specific to the inclusion and exclusion criteria. As a result, comparable research that explored success factors for the adoption of various technologies other than artificial intelligence is not addressed in this study. Future study might build on this body of work and include characteristics that have been recognized as being important in other fields. To begin with, we were just concerned with reviewing existing research and did not go into detail about the elements that had been determined by way of a statistical analysis.

Future studies might build on this body of work and include characteristics that have been recognized as being important in other fields. To begin with, we were just concerned with reviewing existing research and did not go into detail about the elements that had been determined by way of a statistical analysis. Consequently, future study may build on the information offered here and go one step further by evaluating the success characteristics and their applicability in the real world. In order to do this, a more condensed list of success criteria may be developed, which would be advantageous both for the development of theory and for practitioners who wish to implement these aspects in their work.

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Fintech and Financial Inclusion: Evidence from MENA Countries

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1 Introduction

Developing countries attach great importance to financial inclusion in their economic policies to enhance the level of financial stability, increase social and economic welfare, and achieve equality. In general, providing financial services makes everyday life easier, helping families and businesses plan for everything from long-term goals to unexpected emergencies. As account holders, people are more likely to use other financial services, such as credit and insurance, to start and expand businesses, invest in education or health, manage risk, and cope with financial shocks, which can improve their lives overall. Demir et al. (2022) argue that financial inclusion is a key channel through which Fintech decreases income inequality, at all quantile levels, mainly among higher-income countries. Sahay et al. (2015) defined financial inclusion as access to and use of formal financial services by households and firms. The United Nations identifies financial inclusion (FI) as comprehensive access at an affordable cost to a wide range of financial services and products offered by different and sustainable institutions.

According to Demirguc-Kunt et al. (2014), a comparison between high-income and developing countries shows that formal financial services are less accessible in developing economies than in high-income economies; 90 percent of adults in high-income countries reported holding accounts at formal financial institutions, while only 41 percent of adults in developing economies did so. The same database shows that the region with the highest percentage of unbanked working-age adults is the

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Middle East and North Africa (MENA), followed by sub-Saharan Africa and South Asia. Access to suitable financial instruments may allow these disadvantaged individuals to invest in diverse asset classes (physical assets, commodities, real estate, education, etc.), thereby reducing income inequality and boosting economic growth. This access—and the resultant global innovation (new financial instruments, institutions, markets, products, and processes) and sustained, inclusive growth—is only possible through financial inclusion. Enhancing financial inclusion also means providing high-quality, reasonably priced financial services to as many working-age adults as possible. The Consultative Group to Assist the Poor (CGAP) reports that improving financial inclusion (FI) can encourage economic development, increase job opportunities and the stability of monetary systems, and decrease individual poverty and fluctuations in income (CGAP, 2017). The realization of these gains in turn boosts social stability, facilitates market access for small and medium-sized enterprises (SMEs), and, by lessening the importance of informal financing networks, helps combat money laundering and terrorism financing.

After the global financial crisis, monetary, financial, and economic decision-makers realized the importance of financial inclusion, and the important role it plays in enabling all segments of society to get access to all financial services, without discrimination. Therefore, it promotes consumer financial protection and the stability of society on many different levels, financially, socially, and politically, in addition to improving economic development. Access to finance allows companies of all types to invest and facilitates both household consumption and the gradual accumulation of capital—not only increasing employment opportunities but also raising the standard of living. Access to finance is also essential for individuals and firms to protect themselves against shocks and better manage risk. Regulators and policymakers regionwide are addressing factors that inhibit access to the financial system and have begun integrating financial inclusion into ongoing work programs in conjunction with stability and supervisory work. It is crucial to integrate excluded groups—whether individuals or businesses—into the financial system and support them with the financial resources necessary to build their capacity to generate income.

Digital development is one of the most important pillars of the future. Financial technology (Fintech) has a real ability to change the structure of traditional financial services, as financial technology can make financial services faster, cheaper, safer, transparent, and available, especially for the large segment of the population that does not deal with the banking sector. On the other hand, the speed of development in financial technology services and emerging companies constitutes a threat that must be hedged and all precautionary measures are taken to achieve the safety, integrity, and stability of the banking and financial sector, where the technology represents finance and its various applications present opportunities and challenges at the same time for banks and financial institutions. Thus, the current study examines whether Fintech has positive or negative effect on financial inclusion in MENA countries for the years 2011, 2014, and 2017. The rest of the paper is structured as follows: the second part presents the literature review, the third part describes the methodology and data of the study followed by the discussion of the results, and the final part concludes the study.

2 Literature Review

Fintech became a serious competitor since it dominates the traditional financial services where customers are increasingly moving toward carrying out their banking transactions through electronic applications and smart solutions (Bashayreh & Wadi, 2021). Previous studies refer that the opportunities offered by financial technology to the financial and banking sector can enhance financial inclusion, providing better and more convenient banking services to customers. Besides, there is potential positive impact on financial stability due to increased competition, and the role of regulatory technology (Reg Tech) can improve compliance processes in banks. Financial inclusion (FI) refers to the ability of individuals and businesses to access beneficial and affordable financial products and services that are in line with their requirements—transactions, savings, payments, insurance, and credit—and are brought in a responsible and sustainable way (World Bank, 2017). It is a process that, in the words of Sarma (2010), confirms the ease of access, accessibility, and usage of the formal financial system for all individuals of an economy. Financial inclusion (FI) requires that individuals and institutions can access and use financial services efficiently and responsibly.

Enhancing financial inclusion does not only include increasing financial distribution to more people, but also includes providing a variety of high-quality financial services at a reasonable cost, which will, in turn, enhance comprehensive development. Adopting Fintech products and improving financial services lead to improve profit, market share, customers' confidence, and competitiveness (Amirata & Alsulimanib, 2021). The solutions provided by financial technology are low-cost solutions compared to financial services for banks and traditional financial services, and the prosperity of the field of financial technology helps to put pressure on traditional methods by reducing fees for money transfers and others, to keep pace with the development in the field of financial technology, and the tendency of most customers to these new methods.

Successfully building an inclusive financial system requires massive effort and merits more attention worldwide. Many people are excluded from formal financial services in many countries; in the past few decades, the literature on financial inclusion has taken an interest in the many reasons why this is so. Financial inclusion efforts attempt to ensure that all families and businesses, in spite of income level, have access to and can efficiently use financial services suitable for their needs. Without access to financial services, individuals cannot build up assets or handle emergencies; and small businesses cannot access working capital, invest, or hire more employees. Some groups, including women, the rural and urban poor, remote populations, and informal small firms, are subjected to financial exclusion more than others. Microfinance (including not only microcredit but also microsavings and microinsurance) can help combat these inequities.

By reviewing the related studies, it was found that while most researchers admit that the impact is positive, others provide negative evidence. Tok and Heng (2022) found a higher positive effect of Fintech on digital financial inclusion than the effect of traditional services. Bashayreh and Wadi (2021) also confirmed the significant effect of Fintech on enhancing the performance of banks and thus financial inclusion. Legowo et al. (2021) revealed that the coordination of the modern bank and the Fintech is assumed to promote financial inclusion. COVID-19 has been a catalyst for digital transformation across a range of sectors, and this is particularly true of financial services and Fintech in MENA countries. Fintech can play a vital role in enhancing the ability of emerging economies to recover from the consequences of the economic crisis caused by the spread of the coronavirus pandemic. Because the ability to provide financial services at affordable prices is important in reducing poverty, achieving economic growth, and maintaining the pace of economic activity. Besides, it paves the way for financial inclusion, especially for women, as financial technology has become one of the most important solutions to advance the financial and banking sector and it has become one of the most important tools for promoting financial inclusion. Recently, some studies explore the effect of COVID-19 on Fintech. During the COVID-19 outbreak, Landry (2020) and Hussein (2020) concluded that the impact of mobile money on financial inclusion is positive. Ozili (2020) tested the impact of financial innovation on financial inclusion in a larger group of countries and find a significant positive effect. Using the Global Findex data for a panel of 140 countries, Demir et al. (2020) argues that financial inclusion (FI) is a principal channel through which financial technology decreases income inequality.

In their paper, Murinde et al. (2022) study the growing literature on Fintech and Fintech-enabled services, aiming to explain the opportunities and risks for banks in 115 different countries. Murinde et al. (2022) uses high-quality bank level data from 115 countries around the world for the past 16 years, the study calculates statistical moments of some key indicators of the changing banking landscape in the Fintech era. Murinde et al. (2022) primary findings indicate that because of the reason that banks are improving their own Fintech platforms or operating with Fintech startups, it is doubtful that Fintech lenders will replace banks. Moreover, the study exposes how will the shape of banking future be affected by regulation, global infrastructures, and geopolitical frictions.

In general, innovation-led growth promotes inclusivity by creating jobs for less skilled individuals. The World Bank (2014) shows that broader implementation of digital payments can meaningfully improve the global financial inclusion agenda and support the priority areas of the Global Partnership for Financial Inclusion (GPFI). In developing countries, 1.3 billion adults with a bank account pay utility bills in cash and more than 500 million pay school fees in cash. In addition to being more convenient, technological innovations and payment digitization would enable account holders throughout the developing world to pay bills and fees more affordably and securely and reduce opportunities for social services fraud and leakage.

Moreover, Fouad and Younes (2018) examined data from MENA countries and concluded that the number of ATMs had a positive effect on financial inclusion and economic growth. Jagtiani and Lemieux (2018) found that Fintech had a greater positive effect on financial inclusion than traditional financial services. Khaerunnisa (2018) argued that the need for mobile money in Indonesia is substantial and that mobile money boosts financial inclusion more competitively and at a lower cost than other methods. Rahmi (2018) also confirmed the strong effect of Fintech on boosting financial inclusion in Indonesia, though noted that the degree of the boost depended on the government's efficiency. Ozili (2018) reviewed and discussed many issues regarding Fintech and financial inclusion and found and concluded that financial technology has a positive impact on financial inclusion in both emerging and advanced economies. Sun (2018) demonstrated the important role of Fintech in increasing financial inclusion by reducing the cost of financial services.

The World Bank (2017) reports that in emerging economies, more than two hundred million formal and informal micro, small, and medium-sized enterprises (MSMEs) do not have suitable financing. The World Bank (2017), noting that MSMEs are unable to open or maintain bank accounts, posits that this inability is caused by the enterprises' informality, lack of credit history, and inability to put up collateral. Klapper and Ansar (2017) pointed out that Islamic financial instruments offered via Fintech can likewise enhance financial inclusion. Scott et al. (2017) argued that digitizing financial services can boost financial inclusion and enhance the overall performance of financial institutions. Moreover, Manyika et al. (2016) confirmed the positive effect of digital technologies on enhancing financial inclusion in Ethiopia, India, and Nigeria.

On the other hand, and unexpectedly, Tidjani (2021) concluded that the effect of Fintech on financial inclusion is still not clear because Fintech solutions are not yet matured and unspecified in the future but are mandatory for excluded people from bank services in MENA countries. Allen (2021) concludes that Arab countries still lag behind many countries in the world in adopting financial inclusion, due to the inability to deliver many formal financial services to those who are unable to access them. Moreover, the study argues that digital technology is beneficial in enhancing financial inclusion in these countries. Pejkovska (2018) revealed that present regulation of Fintech in the regions of EU, the USA, and India is unsuitable and may lead to negative impacts on the world financial services sector such as deception of cybersecurity, contravention of data privacy, and using Fintech services for illegal purposes.

Using quantitative approach and two self-designed questionnaires which were examined using the structural equation modeling technique, Chen et al. (2021) investigate Fintech products (FTPs) effect on commercial bank's performance in China. Study results indicate that perceived usefulness (PU) of FTPs has positive and significant effects on customer satisfaction, low expectation of bank employee assistance, bank's service quality, and employee work efficiency. Furthermore, the perceived difficulty of use (PD) of FTPs has negative and significant effects on customer satisfaction and low expectation of assistance. Also, Chen et al. (2021) find that there is a positive and significant correlation among PD and banks' service quality and work efficiency, suggesting that the service quality and work efficiency can decrease some weaknesses of using FTPs.

Recently, some countries in MENA region have begun to keep pace with this rapid development of financial technology, as it is a fast-growing sector that allows achieving strong investment returns and supports the path of economic development throughout the region. Technology companies also provide new solutions that the financial sector can employ to improve the efficiency and effectiveness of its operations. Our study hopes to be a significant addition to the literature on Fintech and financial inclusion especially in MENA region countries that suffer from inequality and weak access to financial services.

3 Methodology

3.1 Target Sample and Its Size

The target population for this study is MENA countries as financial exclusion has been most common in developing countries. However, in the literature different studies have shown that (Bashayreh & Wadi, 2021; Tarawali, 2020; Hussein, 2020; Fouad & El Rahman, 2018). The choice of focusing into MENA countries is to try to get a specific consideration of countries that have more financial exclusion and find out how Fintech can help close the gaps in exclusion.

This study samples 11 MENA countries, namely, Algeria, Egypt, KSA, Jordan, Kuwait, Iran, Sudan, Tunisia, UAE, Yemen, and Palestine. The data covers the years 2011, 2014, and 2017, with the years in question chosen based on data availability.

3.2 Variables with Its Measurement

This study uses panel data collected from the Global Financial Inclusion database and the World Bank database. The dependent variable is financial inclusion (FI), and the independent variable is Fintech (FIN). The control variables in our model are education (EDU) and population growth (POP) which were chosen based on previous research and data availability. Financial inclusion was assumed to be represented through three dimensions: accounts, saving and borrowings. Account ownership was selected since it is most representative of financial inclusion. Additionally, ownership of an account from the Global Findex database is considered as being financially included. Financial inclusion is made up of different dimensions which can be defined by several indicators. Several models of financial inclusion apply various indicators for measurement.

In his study, Tarawali's (2020) three theoretical dimensions for usage, access, and barriers are considered for financial inclusion with several indicators for each of

Table 1 Variables measurement

	Variable	Measures
Dependent (Financial Inclusion Indicators)	Account	The percentage of respondents, ages 15+, who report having an account (by themselves or together with someone else) at a financial institution (a bank or otherwise) or using a mobile money service by themselves in the last 12 months
	Saving	The percentage of respondents, ages 15+, who report saving or setting aside any money by using an account at a financial institution (a bank or otherwise) in the last 12 months
	Borrowing	The percentage of respondents, ages 15+, who report borrowing from a financial institution (a bank or otherwise) in the last 12 months
Independent	FIN	Total number of ATMs for every 100,000 adults in a country
	EDU	School enrolment, secondary (% gross)
	POP	Population growth (annual %)

Source: https://www.worldbank.org/en/home

the theoretical dimensions. Savings or borrowings from a formal financial institution are considered as methods of usage of financial services. While customers must have overcome barriers first before one can use formal financial services, lack of account is considered as barriers that prevent one from getting an account (Tarawali, 2020).

Table 1 provides information about the variables included in the study and their measurement.

3.3 Model Specification

This study employs the traditional panel regression analysis to examine the impact of Fintech on financial inclusion through three models. Account, borrowing, and saving variables are dependent in each model. Through a literature review, the study formulates the regression model as follows:

$$\mathrm{FI}_{it} = \alpha_0 + \sum_{k}^{j=1} B_j X_{it} + \varepsilon_{it} \tag{1}$$

where X_{it} is the independent variable for the country "*i*" at a time "*t*," *C* is constant, β is the coefficient, and ε is the error term.

Panel data analysis permits the examination of many observations with heterogeneous details and provides less data multicollinearity among the independent variables. Besides, it allows the use of more data and can keep track of each unit of observation (Baltagi Badi, 2005). Accordingly, this study decides which of the two growth models, fixed effect (FE) or random effect (RE), is the best appropriate after using the Hausman test for random effects.

3.4 Data Diagnostic Tests

3.4.1 Statistical Description of Data

Before regression analysis, it is important to view the descriptive data besides statistics that show the average, maximum, minimum, and standard deviation for the variables of the study in 2019. These are shown in Table 2.

As shown in the table, an average of 42.6% of adults hold an account with a financial institution; a standard deviation of 29.33 suggests that there is extensive variation between the sample countries/years in the number of account holders. It can also be noted that the average ACC is higher than the BOR and SAV, as some countries have higher proportions of traditionally excluded groups (e.g., women, rural and urban poor, and informal firms) than others. As for borrowing and saving, it can be seen that the percentage of people who have saving accounts or loans are less than those who have financial accounts. Only 17.9% and 12.9% of adults in the sample countries have savings accounts and loans, respectively, with a maximum of 40.344% and 46.12%.

The data also show that MENA countries enjoy a high level of education; around 80% of working-age adults are educated. There is an average of three ATMs per 100,000 residents in MENA countries, which provides a sufficient basis for observing the machines' effect on financial inclusion.

3.4.2 Testing Stationery

To test whether the variables are stationary or not, this study applies the two-unit root tests (Hadri Z-stat and heteroscedastic consistent Z-stat), where the null hypothesis (H0) for these tests states the existence of a unit root (non-stationary) in the variables. The outcomes of the panel unit root tests are given in Table 3.

The outcomes in Table 3 reveal that all variables are stationary at the level. Thus, we accept the alternative hypothesis, meaning that there is a unit root in the variables of the model.

Table 2 Statistical description of MENA variables in 2019

	N	Minimum	Maximum	Mean	Std. deviation
ACC	33	3.660	93.982	42.668	29.333
BOR	29	0.603	46.127	17.938	13.086
SAV	33	0.693	40.345	12.985	10.231
FIN	33	1.272	4.337	3.009	1.020
EDU	25	37.559	107.694	80.389	19.100
POP	33	0.177	5.722	2.432	1.260

Table 3 Panel unit root results

		Level	
		Intercept	Intercept and trend
ACC	Hadri Z-stat	*** 3.19808	*** 34.3948
	Heteroscedastic Consistent Z-stat	*** 4.37474	*** 34.3948
BOR	Hadri Z-stat	*** 6.62564	*** 31.1112
	Heteroscedastic Consistent Z-stat	*** 5.96285	*** 31.1112
SAV	Hadri Z-stat	*** 4.97526	*** 34.3948
	Heteroscedastic Consistent Z-stat	*** 6.03234	*** 34.3948
EDU	Hadri Z-stat	*** 2.83569	*** 27.4375
	Heteroscedastic Consistent Z-stat	*** 3.56853	*** 27.4375
FIN	Hadri Z-stat	*** 3.91014	***32.7941
	Heteroscedastic Consistent Z-stat	*** 4.46931	*** 32.7941
POP	Hadri Z-stat	*** 4.60135	*** 34.3948
	Heteroscedastic Consistent Z-stat	*** 4.07042	*** 34.3948

Levels of significance: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. Hadri Z-stat; Lin and heteroscedastic consistent Z-stat

Table 4 Correlation matrix

	SAV	ACC	BOR	EDU	FIN	POP
SAV	1					
ACC	0.889	1				
BOR	0.823	0.913	1			
EDU	0.455	0.503	0.397	1		
FIN	0.752	0.838	0.817	0.521	1	
POP	0.146	−0.015	0.036	−0.128	0.084	1

3.4.3 Correlation

A correlation matrix finds no multicollinearity problem between the explanatory variables (Table 4).

3.5 Regression Analysis

We conduct a Hausman test in order to decide which of the two models (FE or RE) is appropriate for our study. The Hausman test for model specification built on the variation in coefficients between FE and RE models confirms the suitability of the random effect model, as the p-value acquired from the test is more than 5%. Tables 5, 6, and 7 show the results.

As stated by Chi-square statistic 3 with the probabilities 0.86, 1, and 0.82. The Hausman test reveals that RE is suitable for the three regression models. The

Table 5 Hausman test for random effects

Test summary	Chi-Sq. statistic	Chi-Sq. d.f.	Prob.
Period random	0.747767	3	0.8619

Hausman specification test (dependent: ACC): fixed effect vs. random effect for (ACC model)

Table 6 Hausman test for random effects

Test summary	Chi-Sq. statistic	Chi-Sq. d.f.	Prob.
Period random	0.000000	3	1.0000

Hausman specification test (dependent: BOR): fixed effect vs. random effect for (BORR model)

Table 7 Hausman test for random effects

Test summary	Chi-Sq. statistic	Chi-Sq. d.f.	Prob.
Period random	0.912297	3	0.8225

Hausman specification test (dependent: SAV): fixed effect vs. random effect for (SAV model)

random effects model considers the intercept as a random variable that has a weight equal to μ, as shown below:

$$\alpha_i = \mu + v_i \ldots\ldots\ldots\ldots \tag{2}$$

where the two components of intercept α_i are a constant term that is fixed for each country v_i and a random term μ that meets the prerequisites of OLS.

On the other hand, the term *vi* is a random variable with mean $E[v_i]$ and variance $(v_i) \neq 0$. The RE model includes a blending error consisting of $(v_i + \varepsilon_{it})$. Allison (2009), "In a random-effects model, the unobserved variables are assumed to be uncorrelated with all the observed variables." Thus, the RE model is given by:

$$\text{COMPG}_{it} = \mu + \sum_{k}^{j=1} B_j X_{it} + v_i + \varepsilon_{it} \ldots\ldots\ldots\ldots \tag{3}$$

The RE model applies the generalized least squares (GLS) method to evaluate the model's coefficients. We note that the random effect model is less stable than the fixed effect since it includes a compound error, but it is more efficient. The GLS method supposes the homoscedastic variance and white error (Baltagi Badi, 2005). The results of the GLS regression analysis are presented in Table 8.

The cross-country outcomes are consistent with preceding research that has discovered a positive link between Fintech and financial inclusion (Hussein, 2020; Ozili, 2020; Demir et al., 2020; Fouad & El Rahman, 2018; Jagtiani & Lemieux, 2018; Khaerunnisa, 2018; Rahmi, 2018; Ozili, 2018; Scott et al., 2017; Manyika et al., 2016). Our results reveal that financial inclusion ensures access to a wide array of financial services throughout society in our selected sample of MENA countries. Advantages of digital finance to customers consist of more control of customers' personal finance, rapid financial decision-making, and the capability to make and get payments within seconds. Fintech would increase individuals' and business'

Table 8 Panel RE model (GLS) regression results

	Model 1 (ACC)		Model 2 (BOR)		Model 3 (SAV)	
	Estimated parameters	*P*.value	Estimated parameters	*P*.value	Estimated parameters	*P*.value
Intercept	−37.26088	0.0923	−18.38628	0.1338	−15.11550	0.1218
FIN	21.47108	0.0030	12.39482	0.0002	6.975700	0.0232
EDU	0.245476	0.4526	−0.028961	0.8492	0.045446	0.7543
POP	−1.549992	0.5190	−0.406365	0.7542	1.351459	0.2650
D-W	1.859000		0.473908		2.123108	
R-square	0.627200		0.675236		0.452175	
	0.571280		0.617925		0.370001	
F-statistic	11.21602		11.78191		5.502663	
Prob (F-statistic)	0.000156		0.000204		0.006376	
Number of observations	24		21		24	

Significance level: *** <0.01; ** <0.05

welfare that it can make financial services provided through financial institution, more accessible, specially, if digital finance enhance their services to be at negligible or zero cost. Moreover, Fintech were able to deliver safer digital options to in-person banking, such as cashless payments and contactless transactions during the COVID-19 pandemic.

The results also show that a 1% increase in Fintech penetration is likely to cause an increase of 21.47%, 12.39%, and 6.97% in the number of bank accounts, borrowing accounts, and savings accounts, respectively.

The results affirm that Fintech has a significant positive impact on all determinants of financial inclusion (ACC, BOR, and SAV). The size of the Fintech coefficient is greater when using accounts as the dependent variable while little when using savings, meaning that digital finance works better for individuals who deal with formal financial institutions but not for saving issues. On the other hand, the positive relationship between Fintech and the percentage of borrowing ensures that digital finance allow customers to apply for loans more efficiently and directly, besides affording greater flexibility in the payment schemes. These results confirm that Fintech provides affordable, convenient, and secure banking services to individuals in MENA countries, which in turn benefits individuals by affording them greater control of their finances. Chandran (2011) defines technological innovation as the provision of an ideal combination of inputs and outputs through a combination of high technology and capital equipment. We may conclude that MENA countries enjoy high financial technology as a result of their use of information and communication technology, their use of electronic payment systems, and their use of ATMs for administrative and operational purposes. These technologies can increase entry to beneficial and inexpensive financial products and services that satisfy individual and company needs, ultimately generating economic activity.

The outcomes in Table 8 show that the values of R-square 62.7%, 67.5%, and 45.2%, respectively, are acceptable, meaning 62.7 percent, 67.5 percent, and 45.2

percent of the financial inclusion indicators of the MENA countries are explained by the independent variables, respectively. Durbin-Watson coefficients (DW = 1.85, 2.12) are close to 2 for models 1 and 2, referring that there is no proof of autocorrelation among the residuals as a rule of thumb. Furthermore, F-statistic and its probability reveal that the regression model is statistically significant in general. Besides, the standard error of the regression model, 1%, is very little. Liable to such circumstances, the random effect model appears to be suitable for the current study.

4 Conclusion

Recently, some countries in MENA region have begun to keep pace with this rapid development of financial technology, as it is a fast-growing sector that allows achieving strong investment returns and supports the path of economic development throughout the region. Technology companies also provide new solutions that the financial sector can employ to improve the efficiency and effectiveness of its operations. Our study hopes to be a significant addition to the literature on Fintech and financial inclusion especially in MENA region countries that suffer from inequality and weak access to financial services. This study highlights the effect of Fintech on financial inclusion in MENA countries. The study uses panel data collected from the Global Financial Inclusion database and the World Bank database. The dependent variable is financial inclusion (FI), and the independent variable is Fintech (FIN). The control variables in our model are education (EDU) and population growth (POP). The data consist of eleven MENA countries and covers 2011, 2014, and 2017. The study's results show that there is a positive relationship between Fintech (measured by the number of ATMs per 100,000 residents) and financial inclusion (measured by the percentage of residents holding various account types at formal financial institutions). Findings revealed that digital finance increases financial inclusion in terms of overall account ownership, but not savings account ownership. Our results reveal that financial inclusion ensures access to a wide array of financial services throughout society in our selected sample of MENA countries.

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Impulse Buying Behaviors in a Digital World

Maryam Husain Almahdi, Jameela Radhi, Faisal Alhawaj, and Abdulraqeeb Najeeb

1 Introduction

Impulse buying is a widespread and well-researched, albeit quite enigmatic, phenomenon (Kalla & Arora, 2011; Hausman, 2000; Rook, 1987). Research on impulse buying begun in the context of brick-and-mortar retailers in the early 1950s (Clover, 1950; Muruganantham & Bhakat, 2013) and expanded since then to cover different types of shopping environments, including electronic commerce (e-commerce) and social media (Aragoncillo & Orus, 2018). Statistics show that between 40% and 80% of customers' purchases are impulse purchases, depending on the product type and store setting (Aragoncillo & Orus, 2018; Jeffrey & Hodge, 2007; Amos et al., 2014; Verhagen & Van Dolen, 2011). The advent of the COVID-19 pandemic contributed to a spike in customer impulse buying behaviors, especially online (Lee, 2022). This explains why impulse buying is continuously regarded an important area of research from a marketing perspective (Wang & Chapa, 2022; Chen et al., 2022).

In a modern digital world, scholars and marketers continue striving to learn how to boost sales by creating shopping environments that entice impulse buying behaviors (Kalla & Arora, 2011; Amos et al., 2014; Beatty & Ferrell, 1998; Kacen & Lee, 2002; Abdelsalam et al., 2020; Parsad et al., 2017; Jones et al., 2003). Paying attention to emerging and growing shopping environments, such as social commerce, social media, and e-commerce is thus a key factor to help understand the wide array of customer impulse buying behaviors, what influences them, and how to direct them towards acheiving desired marketing outcomes (Dodoo & Wu, 2019;

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Liu et al., 2013; Huang, 2016). This gains additional importance, considering the dynamic, ever-evolving, nature of customers' online shopping preferences and experiences (Almahdi, 2018).

In this paper, an overview of the meaning and types of impulsive buying behaviors is first presented, followed by a discussion of impulse buying on different digital platforms. The physical and digital stimuli that encourage impulse buying behaviors are highlighted after. The paper is concluded with a discussion of relevant future research directions.

2 An Overview of Impulsive Buying Behavior

Dennis Rook, one of the leading researchers in the field of impulse buying, explains the concept as a strong and sudden desire by a customer to acquire a product immediately and with little regard to consequence (Rook, 1987). In other words, an impulsive buyer will feel a strong and pressing urge to purchase, that seems beyond their control, and will hence have little time to think between deciding to buy and carrying out the purchase (Rook, 1987; Wang & Chapa, 2022; Jones et al., 2003; Faber, 2010).

Impulse buying is thus defined as "a sudden, compelling, hedonically complex purchase behavior in which the rapidity of the impulse purchase decision precludes any thoughtful, deliberate consideration of alternatives or future implications" (Sharma et al., 2010, p. 277). Another, more detailed, definition of impulse buying is brought forward by Beatty and Ferrell. According to them, it is "a sudden and immediate purchase with no pre-shopping intentions either to buy the specific product category or to fulfill a specific buying task. The behavior occurs after experiencing an urge to buy and it tends to be spontaneous and without a lot of reflection" (Beatty & Ferrell, 1998, p. 170).

It is key to note that despite, sometimes, being used interchangeably in research (Stern, 1962; Cobb, 2009), the concepts of impulse buying and unplanned purchasing are conceptually different (Aragoncillo & Orus, 2018; Beatty & Ferrell, 1998; Jones et al., 2003). While the first is characterized by the customer's strong emotional urge that leads them to buy in order to seek release (Verhagen & Van Dolen, 2011; Beatty & Ferrell, 1998), the latter is simply about buying something that might not be on the shopping list, without a lot emotions tied to the purchase (Amos et al., 2014).

Four types of impulse buying are identified in the literature: pure, reminder, suggestion, and planned (Stern, 1962; Han et al., 1991). Pure impulse buying is observed when "a person breaks a normal buying pattern" (Stern, 1962, p. 59), purchasing something totally out of impulse, for fun or escapism (Muruganantham & Bhakat, 2013). Reminder impulse buying is when a buyer's impulse purchase is sparked by an external factor they were previously exposed to, like a particular marketing message, a prior shopping experience, or a product (Muruganantham & Bhakat, 2013; Stern, 1962). Suggestion impulse buying occurs when a buyer has no previous knowledge about the product but envisions a possible future need for it (Stern, 1962). Finally, planned impulse buying happens when a buyer has the intention of buying certain products when going shopping but expects they might make other purchases if swayed by offers and promotions (Muruganantham & Bhakat, 2013; Stern, 1962).

3 Online Impulsive Buying Behavior

Due to the growth of the Internet and social media technologies and their strong influence on the shopping experience of customers (Almahdi & Archer-Brown, 2022), research on impulse buying has, inevitably, extended to the context of online shopping (Wells et al., 2011; Chan et al., 2017). This research direction is especially important as 56% of people report that more than half of their online purchases are impulsive (Lee, 2022). Still, research on online impulse buying behaviors only started to gain traction in recent years and is still quite limited in comparison to research on planned online shopping and that on impulse buying in physical environments (Verhagen & Van Dolen, 2011; Shen & Khalifa, 2012).

One of the main discussion points regarding online impulse buying in prior research is whether online environments encourage impulse buying behaviors or not. One direction of research posits that online environments entice the customers to buy impulsively (Moran, 2015; Gupta, 2011; LaRose, 2001), due to their convenience, anonymity, and interactivity (Aragoncillo & Orus, 2018; Verhagen & Van Dolen, 2011; Dodoo & Wu, 2019; Dawson & Kim, 2010). The wide product assortment and advanced online marketing strategies utilized are additional reasons why online environments are thought to encourage impulse buying behaviors (LaRose, 2001; Greenfield, 1999). Online shopping environments are expected to relieve the customers from the inconveniences of physical stores and therefore encourage their impulse shopping behaviors (Chan et al., 2017). As Dodoo puts it, "impulse buying connotes immediacy in purchase behavior and e-commerce permits individuals with the ability to exert the minutest expenditure of time and effort" (Dodoo & Wu, 2019, p. 74).

Still, another line of research establishes that due to the modern customer's familiarity with online shopping, the ease of finding product information and comparisons, and the delayed gratification of having to wait to receive one's ordered products, customers are more likely make planned, unemotional purchases online (Aragoncillo & Orus, 2018; Verhagen & Van Dolen, 2011; Kacen & Lee, 2002; Moe & Fader, 2004). It is, thus, suggested that physical shopping environments are more likely to encourage impulse buying due to their immediacy and ability to stimulate the senses and foster hedonic motivations (Aragoncillo & Orus, 2018; Gupta, 2011; Peck & Childers, 2006).

Despite this discrepancy, marketers still try to imitate the physical shopping experience when designing online stores, in an attempt to encourage online impulse buying (Median News, 2020). This is achieved by designing them in a way that minimizes barriers to purchase, presenting vivid pictures and videos, sharing detailed product specifications (Aragoncillo & Orus, 2018), and offering virtual environmental cues (Dodoo & Wu, 2019), and one-click buying features (Jeffrey & Hodge, 2007; Shen & Khalifa, 2012). Marketers have also been utilizing the interactive technologies of social media to encourage impulse buying (Dodoo & Wu, 2019), which we discuss in further detail in the following section.

4 Impulsive Buying Behavior on Social Media

Despite limited research in this area, it is key to address the influence of social media on customers' impulse buying behaviors (Huang, 2016; Zafar et al., 2021; Baker Qureshi et al., 2019). Unlike the afore-discussed contradicting views on impulse buying in e-commerce environments, research is consistent in positively linking social media and impulse buying behaviors (Aragoncillo & Orus, 2018; Zafar et al., 2021; Baker Qureshi et al., 2019). This is due to customers generally spending extended periods of time using social media and constantly receiving highly personalized marketing stimuli, which encourage their impulse buying behaviors (Dodoo & Wu, 2019; Huang, 2016; Nuseir, 2020; Baker Qureshi et al., 2019). The social experiences of customers while using social media (e.g., posting and viewing shopping recommendations, reviews, and product pictures) is another important difference that sets social media apart from other online shopping platforms (Baker Qureshi et al., 2019). The impact of friends and other social media influencers on impulse buying is an additional key factor to consider (Nuseir, 2020; Baker Qureshi et al., 2019). Zafar and colleagues found that the authenticity of the product-related content posted by online influencers encouraged their followers' impulse buying behaviors (Zafar et al., 2021). This is due to their perceived believability and trustworthiness in the eyes of the customers (Almahdi et al., 2022). In line with the marketing efforts in manipulating e-shopping environments to encourage impulse buying, Nuseir recommends utilizing well-designed advertisements, multimedia formats, and social presence to achieve this goal in social media shopping environments (Nuseir, 2020).

It is interesting to note here that while the anonymous nature of e-commerce has been cited in prior research as an encouraging factor of online impulse buying (Aragoncillo & Orus, 2018), the social capabilities of social media are highlighted in more recent research as the reason such platforms encourage impulse buying behaviors (Abdelsalam et al., 2020; Huang, 2016).

This and other influencing factors of impulse buying behaviors, both in physical and digital environments, are discussed in the following part of the paper.

5 Factors Influencing Impulse Buying Behavior

Various factors are expected to influence impulse buying behavior, including the location and time of the purchase, buyers' personality traits, as well as larger economic and cultural factors (Aragoncillo & Orus, 2018; Stern, 1962; Youn & Faber, 2000). These factors do not only influence different buyers in a variety of ways, but can influence the same buyers differently in different situations (Stern, 1962). These influences are organized into four categories in the literature: external stimuli, internal stimuli, situational factors, and demographic and sociocultural factors (Muruganantham & Bhakat, 2013). Each category is discussed in more detail in the following subsections.

5.1 External Stimuli

Impulse buying is described as "buying that presumably was not planned by the customer before entering a store, but which resulted from a stimulus created… in the store" (Applebaum, 1951, p. 176). This statement reflects how external stimuli (e.g., environmental factors, sensory stimuli, and atmospheric cues) can affect the customers' impulse buying behavior (Youn & Faber, 2000). Indeed, it was found that when a shopping environment is stimulating and highly enjoyable (Milliman & Fugate, 1993), impulse buying is more likely to occur (Donovan & Rossiter, 1982; Donovan et al., 1994).

External stimuli include marketing mix elements and marketer-controlled cues that are used to alleviate barriers to purchase and entice customers to buy impulsively (Stern, 1962; Youn & Faber, 2000; Applebaum, 1951; Piron, 1991). In a physical shopping setting, such stimuli include store size and ambience (Muruganantham & Bhakat, 2013), exclusive aromas and sounds (Holbrook & Anand, 1990; Kaur & Singh, 2007; Mattila & Wirtz, 2008), advertisements and sales promotions (Youn & Faber, 2000; Applebaum, 1951), colors and other visual in-store elements (Stern, 1962; Valdez & OTROS, 1999), as well as product displays (Hultén & Vanyushyn, 2011). In a digital shopping environment (e.g., an e-commerce website or social media platform), external cues that encourage impulse buying include website design quality and visual appeal, interactivity and navigability, clear product information, and personalized marketing messages (Kalla & Arora, 2011; Dodoo & Wu, 2019; Shen & Khalifa, 2012; Nuseir, 2020; Parboteeah et al., 2009).

In addition to visual and experiential cues related to the shopping environment, social cues are considered important external stimuli that affect customers' impulse buying (Hausman, 2000; Mattila & Wirtz, 2008). These include the conduct and friendliness of store employees and customers, social comparison behaviors, and peer influences (Liu et al., 2013; Huang, 2016; Nuseir, 2020; Zafar et al., 2021; Mattila & Wirtz, 2008). Finally, the availability, security, and ease of use of credit cards and other non-cash payment methods are considered an encouraging external factor of impulse buying (Rook, 1987; Youn & Faber, 2000).

5.2 Internal Stimuli

Internal stimuli are characterized by a shopper's personality, emotions, motivations, and decision-making processes (Kalla & Arora, 2011; Muruganantham & Bhakat, 2013; Aragoncillo & Orus, 2018; Argo et al., 2005). A highly researched type of internal stimuli, tied to impulse buying, is customers' hedonic motivations (Hausman, 2000; Argo et al., 2005). In the context of this filed of research, hedonic motivations are feelings of enjoyment, amusement, and pleasure that result from the shopping experience (Hausman, 2000; Beatty & Ferrell, 1998). Going through such feelings often compels customers to buy with little or no prior planning (Hausman, 2000) due to a sense of freedom, novelty, or a desire to reward oneself (Muruganantham & Bhakat, 2013; Gardner & Rook, 1988). Indeed, Ramanathan and Menon explain that impulse buying is often "driven by hedonic, or pleasure-seeking, goals that may cause a person to experience desires for related objects or products" (Ramanathan & Menon, 2006, p. 629). Interestingly, impulse buying can also be driven by negative feelings and the customers' desire to eliminate these feelings by engaging in spontaneous shopping activities (Chen et al., 2022).

Another type of internal stimuli, which is tied to impulse buying, is customer personality characteristics, including impulsivity, stress reaction, and trust, in addition to variety seeking, mood regulating, and escapism behaviors (Rook, 1987; Liu et al., 2013; Baker Qureshi et al., 2019; Youn & Faber, 2000; Bratko et al., 2013; Atalay & Meloy, 2011). Scholars have found a relationship between impulsivity and impulse buying in prior research (Parsad et al., 2017; Dawson & Kim, 2009), where customers with greater impulsive tendencies were more likely to be influenced by external shopping stimuli, fueling their impulse buying behaviors (Youn & Faber, 2000).

5.3 Situational Factors

In addition to external and internal stimuli, situational factors have been found to similarly influence impulse buying in consumers (Rook, 1987; Aminosharieh & Mowlaie, 2017). In this sense, situational factors include the time and season of the shopping trip and types and positioning of the products, along with store location (Liu et al., 2013; Shapiro, 2001; Yu & Bastin, 2017). To highlight the importance of situational factors in influencing impulse buying, marketers address the widespread strategy of placing profitable items clearly near the store's checkout counter so they would grab the attention of the customers, who are then left with little time to deliberate before purchasing them (Shapiro, 2001). Another situational factor discussed in prior research is time, although findings are contradictory regarding the effect of time on impulse purchasing. Indeed, it has been suggested that individuals who have the leisure of more time will be more likely to carry out impulse purchasing (Jeffrey & Hodge, 2007; Beatty & Ferrell, 1998; Jeon, 1990). However, impulse buying equally "represents a rational alternative to more time-consuming search behaviors" (Hausman, 2000, p. 413). A major situational factor that disrupted the shopping sphere recently is the spread of the COVID-19 pandemic, which has been linked to increasing impulse buying behaviors in customers (Median News, 2020; Lahath et al., 2021).

5.4 Demographic and Sociocultural Factors

It has been found by various researchers that socio-cultural and demographic factors also play an important role in impulse purchase behaviors. For example, Lee and Kacen found that impulse buying varies across cultures and societies (Lee & Kacen, 2008), with people belonging to individualistic cultures more likely to purchase spontaneously than those belonging to collectivistic cultures (Lee & Kacen, 2008).

From a demographic perspective, a major difference in the motivations to engage in impulse purchasing behaviors was found between men and women (Kollat & Willett, 1967). Dittmar et al. report that men tend to engage in impulse purchasing to project their independence, while women do the same as a way to express their emotions (Dittmar et al., 1995). This is in line with an earlier study by Rook and Hoch, who found that women engage in impulse purchasing due to higher emotional motivations than those of men engaging in the same behavior (Rook & Hoch, 1985). Also from a demographic perspective, research indicates that consumers from different generations practice different buying behaviors. For example, the buying behavior of baby boomers (born between1946 and 1964) has been found to be mainly need-driven (Cortes, 2004), while millennials (generation Y, born between 1985 and 1996) have been observed to spend their money as soon as they earn it, typically on personal services and other consumer goods (Der Hovanesian, 1999). This means that millennials are more likely than their predecessors to engage in impulse buying behaviors (Xu, 2007). Other demographic and socio-cultural factors that affect impulse buying behaviors include income, education, and socio-economical status (Liu et al., 2013).

6 Summary and Future Research Directions

Based on our overview of impulse buying research in a digital world, we recommend that further research attention is dedicated to understanding customers' buying behaviors in both online and social media environments. What gives this research direction additional importance is the fact that customers are dynamic, which means that their behaviors and experiences keep evolving over time and with the introduction of new shopping technologies (Almahdi, 2018). Special attention should also be paid to investigating impulse buying behaviors on social commerce platforms (Abdelsalam et al., 2020), as they are an underexplored but promising novel shopping technology (Almahdi & Archer-Brown, 2022; Almahdi, 2021). Finally, the long-term effects of COVID-19 on customers' impulse (online and offline) buying behaviors is an interesting area of research to consider in the future (Lee, 2022; Wang & Chapa, 2022).

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Analyzing the Effects of Digital Communication on Project Management in Bahrain During the COVID-19 Pandemic (a Case Study)

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1 Introduction

In 2020, the government of Bahrain faced a difficult situation due to the COVID-19 pandemic. Quick actions were taken, and procedures were altered to comply with social distancing and ensure the safety of everyone. One of the changes was shifting to digital communication. As this was a new concept, many managers expressed their dislike due to the physical absence of their employees. However, some employees were satisfied with the new situation and felt comfortable and were more productive working from home. Unfortunately, as people were not used to the new strategy, some challenges affected the productivity of the government entities in Bahrain.

This paper focuses on digital communication within public-sector organizations and the factors that have impacted project management. Digital communication is highly important nowadays, as it is necessary for the development of any country, business, or project. Its importance is evident when compared with traditional methods. There are several factors that have enabled digitalized project management to be accepted, such as reliability, security, convenience, acceptability, anonymity, efficiency, scalability, and privacy (Sidek, 2015).

This research shows the main factors of digitalization in Bahrain during the COVID-19 pandemic. A case study is conducted to identify the effects on procurement as a part of project management due to the quick transition to

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digitalization during the pandemic. We show the effects of digital communication factors and measure which factor has an impact on e-tendering. We also identify the challenges that caused a reduction in the number of bids provided by contractors to help improve the overall situation and participation in e-tendering. Managers can use the deliverables while setting objectives and plans to strengthen weak areas.

This study provides an overview of the Kingdom of Bahrain's Tender Board's experiment in digitalization in the year 2020, followed by the problem statement. The aim is to improve project management by using online-based tools, finding solutions for the limitations faced, and considering adopting the approach of digitalization on a continuous basis. The Bahrain Tender Board's operations witnessed major developments in terms of digital tender applications, which was the first step in the transition from comprehensive automation to comprehensive digitalization in line with His Majesty King Hamad bin Isa Al Khalifa's directives to adopt and employ artificial intelligence in the production sectors.

The Tender Board is committed to achieving the goals of Bahrain Economic Vision 2030, which aims to create a more competitive and sustainable economy. Comprehensive automation processes have contributed to improving and facilitating work between suppliers, contractors, and government agencies in addition to increasing the level of participation of suppliers and contractors, especially in the current circumstances where national efforts are united to mitigate the consequences of COVID-19 in a manner that preserves the safety of citizens, residents, and their health.

In April 2020, Bahrain's Tender Board announced that it was digitalizing its services in line with the Cabinet's directives for all ministries and authorities to make quick digital shifts for their services. Suppliers would be able to participate with bids for tenders by uploading them to an integrated central online platform called the e-tendering system. All tender processes would be conducted in that system, and the winners announced on it too. During the launch, the secretary general of the Tender Board stated that the pilot stage, which included full digitalization of all its services, would allow suppliers and companies to submit their bids easily. The system would also allow more establishments to participate in the process, especially during the COVID-19 pandemic. The full digitalization of the services would begin with a complete plan designed for this target and implemented in the second half of 2020. As the tendering process would take around 6 months, the results would be reflected in the first half of 2021.

One of the main challenges faced was communication. For any organization to succeed and for strong and successful project management, communication is key to achieving integration between different levels of employees. Goals can be achieved by having strong relationships and interaction between employees, as it allows the sharing of knowledge and experiences and creates a friendly environment where an employee feels comfortable working (Khalifa et al., 2021). These elements, in addition to strong communication, lead to high productivity and improvement of the organization's performance (Robbins & Judge, 2007). Digital communication has some benefits aside from reducing administration costs, and it can be effective if an organization makes the correct decisions and implements strategies to control all the processes involved in adopting a work-from-home strategy (Bohrer, 2021).

Unfortunately, due to the sudden transition to remote working, communication problems occurred. Some of the employees were not prepared for working from home, as they did not have laptops or remote access. This resulted in late submissions, confusion, and disappointed employees. Professional and social activities and informal communications, such as communicating with work colleagues, meeting other ministries' employees or suppliers, friendly conversations, lunch break talks, and events that influenced relationships between employees, were affected. Meetings were conducted online through different applications, such as Zoom and Microsoft Teams, but the quality and outcomes were different (Khalifa et al., 2021).

Due to transitioning to digital communication (e-tendering system) during the COVID-19 pandemic, the tender's value increased by BD 733,300,756 in the first half of 2021 (Bahrain Tender Board Annual Report, 2020). The number of bids received was reduced by 24%, from 5555 in 2020 to 4561 bids in 2021, which also considered a reduction in the options available and price variety. This meant lower offers to choose from to get a product or service done and avoid work delays. Hence, the cost to conduct services or products requested increased from BD 1,557,395,691 to BD 2,290,696,447 in the year 2021. Furthermore, a lower number of contractors applied for tenders in the shift to the e-tendering system during COVID-19 and increased their prices, while the purchasing authorities were faced with the problem of a decreased number of participants in their tenders.

Thus, relationships between employees were affected, and some managers forced their employees to remain in the workplace during working hours to avoid any limitations. Studies have revealed that there are challenges with working from home, such as receiving work requests from managers and colleagues after scheduled work hours and/or at their convenience as well as colleagues not responding on time, and communication with colleagues can be more difficult by an average of 42% (Moovala, 2020). The studies illustrate the many aspects of digitalization, development, and how users perceive these new changes. As Bahrain became digitalized and many people started using this type of technology, a research gap existed in relation to how people in Bahrain were supposed to deal with the changes.

2 Literature Review

2.1 Effects of COVID-19 on Project Management Processes

The pandemic affected the work-related processes of project management, stressing employees working on projects as a team. The number of activities that had to be coordinated and managed during the pandemic could overwhelm management teams. Proper planning was therefore essential for an organization's leadership team. However, making quick and correct decisions was challenging due to the abrupt changes experienced in different sectors of the global economy (Shamim, 2022).

An article was written about this period in Bangladesh in 2022 in which the author stated that COVID-19 greatly affected various aspects of business, including strains on the entire process of managing projects from the initiation phase of a project to the end or closing stage of the project. Some of the changes that affected essential project management processes included a shift in communication, extra pressure on project teams, a need for creativity and workarounds, delays in project delivery, and vendor management risks. To solve these issues, a clear communication strategy and project team collaboration were needed in addition to the centralization of data, as it would enable the management and all employees involved to gain access to the required information.

Another study about the digital revolution published in 2020 stated that since the 1980s, the digital revolution has been both a negative and positive force. According to the authors of this article, the lockdown during COVID-19 accelerated the adoption of digital solutions at an unprecedented pace, creating unforeseen opportunities for scaling up alternative approaches to social and economic life, but it also resulted in digital risks and threats (Hantrais et al., 2021). The authors found that the pandemic supported changes in data collection techniques and dissemination practices for official statistics. They demonstrated how the ethics of artificial intelligence became a primary concern for government legislation at national and international levels and how the features enabling smart cities to act as drivers of productivity did not necessarily give them an advantage during the pandemic.

It was also illustrated that the pandemic accelerated the adoption of digital technologies in some areas where uptake had been stalled or was only slowly progressing, such as data collection techniques, online working, learning, and social interconnectedness. New challenges were created, requiring the scaling up of production, fast-tracking of digital supplies, and construction of online platforms and video-conferencing products. These transformations did not come without a cost: The pandemic exacerbated existing challenges, demanding government interventions to prevent harm and social exclusion associated with teleworking and social networking on an unprecedented scale.

In conclusion, many authors have established that COVID-19 has had a large effect on project management, and it is the main reason for the digital revolution.

2.2 Digital Project Management

Prior to the COVID-19 pandemic, project management had been undergoing a gradual shift from traditional ways of working toward embracing digitalization. The pandemic accelerated the transformation to the digitalization of project management, including the adoption of digital tools and technologies, embracing an agile approach to implementing projects, working collaboratively in remote teams, and breaking traditional barriers of geography, time zones, and, fundamentally, how project teams collaborate.

Research was conducted in Romania in 2018 about project management in the digital era. The results stated that project management in the digital age is affected by a series of influences. Among these, digitalization is one of the most important ones identified in the research (Simion et al., 2018). The author mentioned that it is likely that in the foreseeable future, nearly all project managers will be digital project managers, giving rise to the importance of understanding the challenges and benefits and building digital skills for both individuals and organizations.

Another study was conducted in Germany in 2019 about digitalization in small and medium enterprises (SMEs). The authors stated that there are several manual processes that need to be digitized. Any SME setting out to digitalize must identify which processes among the entire value chain of the company will give them the highest benefits according to their key performance indicators (e.g., improving overall equipment effectiveness, process transparency, and efficiency, customer satisfaction, and cash flow improvement). The main objective of digitalization is to improve the entire value chain and enterprise resource planning as a higher-level system for the planning and management of all of the company's organizational and technical resources, and the entire chain is only as strong as its weakest link. Thus, automation and logistic technologies are usually implemented to improve the productivity of the company (Kilimis et al., 2019).

In sum, many studies have established that digitalization affects project management.

2.3 Digital Communication During the COVID-19 Global Pandemic

Governments and public health institutions across the world set social distancing and work-from-home guidelines to battle the COVID-19 pandemic. With reduced opportunities to spend time together in person came new challenges to remain socially connected. The pandemic changed people's use of digital communication methods, and inequalities in the use of these methods may have arisen. Digital inequalities may have been further reinforced by a lack of access to digital support. As the world began to heavily rely on digital technology for communication, the less tech-savvy may have needed more support. People mostly depend on family and peer networks for digital support (Razzaque & Hamdan, 2020; Khalaf et al., 2023; Kurdy et al., 2023); however, social distancing and stay-at-home guidelines may have made it more difficult, especially for those who rely mainly on face-to-face social connections.

Older people and those with lower internet skills were more likely to reduce digital communication during the pandemic. While the internet may also function as a digital support source (e.g., search engines, social network sites, and forums), it is mostly used by those with greater internet experience and skills (Kurdy et al., 2023). During the pandemic, the less tech-savvy may have become increasingly disconnected from society with less access to sources of support for establishing new ways of communicating. At the same time, as in-person interactions were limited to a minimum, people were connecting through video chat apps and services for communication for the first time (Ayyash, 2022; Shoaib, 2022). In that sense, the pandemic with its lockdown measures could be an opportunity for people to overcome motivational barriers (Albinali & Hamdan, 2021) to try out and adopt novel ways of communicating.

A study conducted in the United States in 2020 addressed whether people changed their digital media use and how factors concerning internet access and internet skills related to changes in social contact during the pandemic. The authors observed a vast increase in digital communication, which had implications for digital inequality scholarship. Digital inequality research has suggested that people vary in their quality of internet access and skills, which may then influence the benefits they can reap from communication technologies (Nguyen et al., 2020). Beyond access quality, other challenges to engaging with technology include unstable internet connections and difficulties in maintaining the functionality of devices (More, 2023; Mary Josephine & Muninarayanappa, 2023). Furthermore, during the pandemic, some people may have lacked the know-how to use digital media effectively in replacing face-to-face communication (Karthick & Gopalsamy, 2023). People who rarely used messaging, voice, and video-conferencing apps had to learn how to download and install these on their devices and then figure out how to use them.

Therefore, it can be concluded that digital communication increased during the pandemic, but there were some challenges.

2.4 Acceptance of Digitalization

Digitalization has been studied in different ways, and with the large acceptance of digitalization, it is spreading widely. Several studies have shown that digitalized systems are preferred and accepted by users (Ary et al., 2020). A study was conducted in Morocco in 2020 with the main objective of identifying factors influencing IT acceptance by employees of human development public organizations. The results revealed the significant influence of attitudes and perceived risk on employees' intentions to accept technology. This research yielded strong conclusions about the conditions for successful digitalization in human development public organizations in Morocco and in developing countries (Oumlil & Aderkaoui, 2020).

Another study was conducted in Romania in 2020 about digitalization and e-procurement systems. It presented a practical overview of the implementation of a new technological tool for supporting the procurement process within a company, which impacted organizational change management and process changes as an adapting strategy to the automation trend within the firm. The study concluded that e-procurement technology contributed to more dynamic processing of orders and establishing a network between end customers, strategic buyers, and purchasing agents. However, it also brought challenges, such as periodic conflicts, especially between strategic buyers and purchasing agents, due to dynamic changes in regulations. This was solved in time as the process changes became the new internal rules of the procurement department.

E-procurement systems are now a trend within large companies, especially as the globalization and internationalization processes of companies are becoming more and more dominant. In terms of strategic procurement, this field is also a significant one, as ensuring cost-efficient contracts with suppliers and favorable conditions for both the procuring company and the end customers are key elements for success (Alexandra, 2020).

To summarize, these studies have established the acceptance and preference of digitalization by employees, buyers, and other parties.

2.5 Safety and Security Influence Factor

Data security protection is an essential element in any system, and the absence of security can influence the success and acceptance of any technology. Although digital transformation is geared toward achieving strategic goals, such as efficiency or competitive advantages, it involves digital threats. Information technology (IT) security is an overarching task for managers and specialists that currently receives little attention in digitalization projects. Therefore, the strategic potential of IT security mostly remains untapped due to a lack of appropriate decision-making and communication tools that support project managers to address IT security consciously (Guggenmos et al., 2022).

In addition, security is a way to decrease vulnerability and ensure the privacy and authenticity of information sources (Tounekti et al., 2017). Safety is managed by security in conducting fund transfers and online payments in addition to data entries in systems and shared folders. A study was conducted in Russia in 2020 and focused on identifying the goals and objectives of digitalization and presenting the forms of implementation of processes. It investigated the methods of ensuring information security in educational institutions and identified four basic types of risk to build a threat model. The results of the study showed a significant decline in the number of successful attacks after implementing the recommendations. The author considered the effectiveness of approaches to information security of educational processes in the context of digitalization by conducting a study of the corporate education system, which included computer facilities, network interactions, and gateways to the global internet. Automated workplaces were equipped with software for the education system and had online access services to various network infrastructures, such as online bibliographic systems. To imitate a real scenario in which an intruder attacks the network, the researchers conducted a penetration test using the “black box” method in which the intruder did not have any advanced information about the system (Almaz et al., 2020).

It has become increasingly evident that the COVID-19 pandemic not only fundamentally altered the modus operandi of many organizations but also precipitated the failure of many businesses around the globe. The range of measures, including local and national lockdowns, social distancing, government-led border closures, and quarantines, forced many firms to adapt their business models at short notice. Broadly speaking, this arose in two domains: externally (how firms interface with customers, suppliers, and other stakeholders) and internally (how firms manage employees and employer–employee relationships). One consequence of COVID-19 may have been the accelerated trend toward the digitalization of business models coupled with the shift of commercial activities from predominantly offline and brick-and-mortar outlets to online outlets.

Research from 2021 illustrated that shifting to remote working and remote operations was a driver for digitalization. Although many of the technologies for enabling remote working have existed for at least a decade, most firms chose not to adopt them; nevertheless, the pandemic forced large numbers of firms to embrace emergent technologies to shift to remote working and remote skills formation activities. The results of the study indicated that the adoption of emerging technologies could be hindered by vested external interests, nostalgia, and employer opportunism as well as negative effects on employee well-being that undermine productivity, work–life balance, and the future of work. While digitalization may bring new opportunities, the process imparts risks that may be hard to mitigate or prepare for (Amoah et al., 2021).

In conclusion, researchers have found that safety and security are the main digital communication factors. In this research, we study whether safety and security factors influence project management in the Kingdom of Bahrain.

2.6 Ease-of-Use Influence Factor

The ease of use of a system is achieved when a user can expect to use the system without effort. Many end-user customers have a reasonable understanding and can use new technologies. New technologies can be personalized to provide maximum ease of use for employees and customers, but an enormously complicated system will push them away. Ease of use can be a key factor for suppliers to accept a tendering system or apply for tenders or not. E-payments involve multiple aspects, which are ease of payment, ease of registration, and ease of access. The procedure to conduct a payment must be short and easy (Tounekti et al., 2017). Ease of use can affect a user's aim toward using a new technology and the ongoing use of it. Several studies have used the technology acceptance model (TAM) to study the ease-of-use influence factor (Barkhordari et al., 2017). Referring to TAM, ease of use is known "as the degree to which the prospective adopter expects the new technology adopted to be a free effort regarding its transfer and utilization" (Davis, 1989).

The ease-of-use factor in e-systems relates to the result of self-efficiency that a user seeks, which is the capacity to produce the mandatory results with less effort, and the technology is used without complications (Chipato, 2017). Research was conducted in Zambia in 2017 regarding the factors influencing the adoption of e-banking, a type of digitalized system provided to users, in addition to an e-tendering system facilitating e-payments. It stated that a system's ease of use is the level of effort required for using the system, and this level must be moderately low. The research found that ease of use was instrumental in forming the user's attitude toward using the system, but it was not a factor that directly determined whether the user would use the e-payment system or not. Hence, if an e-payment system has a high level of ease, it produces a positive effect on the user and creates a positive attitude toward using the system. This research highlighted that users perceive that learning to use a system is easy, that an e-payment service does not require much mental effort, and that an e-payment system can be used to achieve banking requirements (Mwiya, et al., 2017).

Another study in 2019 was about the transformation of the innovation process and how digital tools are changing work, collaboration, and organizations in new product development. This study included some interviews with engineers that reflected the early use of digital design tools. The results mentioned dissatisfaction with the complexity of some tools and that ease of use can be both a benefit and a liability to those involved in the projects (Marion & Fixson, 2021).

Multiple researchers have established that ease of use has a key influence on project management. In this research paper, a study is conducted to determine whether the ease-of-use factor affects e-tendering in the Kingdom of Bahrain.

2.7 Accessibility Influence Factor

Accessibility refers to the inclusive practice of removing barriers that prevent interaction with or access to websites, digital tools, and technologies by people with disabilities. The concept is centered around the practice of ensuring that digital resources can be used by all users with a diverse range of abilities. During the global COVID-19 pandemic, the availability of internet connectivity helped maintain business continuity, keep children in education, and ensure that people could access essential goods and services online (Runde, 2021).

A study was conducted in Tarakli in 2021 on the importance of digitalization and accessibility. It stated that it is necessary to make digital data accessible to everyone for reliability, interaction density, efficiency, and actuality. The aim of the study was to determine the opinions of individuals working in institutions in local governments about the importance of digitalization and accessibility. Results showed that much-lost data could have been recorded if digitalization had started earlier. "Priority can be given to practices that will promote the district in digital media." According to the study, the participants had positive thoughts about the use of ICH practices in the tourism industry by ensuring accessibility during the transition to digital media. Accessibility could ensure the recognition and popularity of the district in the national and international markets (Ismael, 2021).

Another study about accessibility to digital technology in 2021 stated that while the history of digital technology exhibits periodic cycles of gain and loss of accessibility, the pattern can also be observed at the much smaller level of specific projects and services (Borg et al., 2021). The most common pattern when it comes to accessibility is that corrections are made, but the production process itself is not improved. Consequently, as soon as external accessibility consultants or an especially knowledgeable developer leaves and an update is required, old and new accessibility problems are recreated (Cooper et al., 2012). In other words, fixing the result is a largely wasted effort if the software production process itself is not improved to include accessibility in the same way that it includes usability, security, and other key criteria. To the extent that accessibility is used to qualitatively rethink every aspect of the design and production process, it can improve the overall user experience for everyone (Microsoft, 2010).

To sum up, several researchers have established that accessibility has a key influence on project management. This research paper aims to determine whether the accessibility factor affects e-tendering in the Kingdom of Bahrain.

2.8 Cost Influence Factor

Nowadays, huge budgets are being invested to embody digital strategies in public organizations worldwide. One main reason behind this investment refers to its important role in empowering and ensuring the success of public policies for sustainable human development. Moreover, digitalization enables public organizations to reduce costs, ensure transparency, and optimize budget efficiency. However, these goals are not always reached (Oumlil & Aderkaoui, 2020).

As companies go international, there is an increased need for e-procurement systems to control operations, maintain relationships between buyers and suppliers, and reduce costs. Some studies have shown that e-procurement technology makes it possible for firms to lower total purchase costs on average by 8–12%. As mentioned earlier, a study conducted in Romania in 2020 about digitalization and e-procurement systems presented an overview of a new technological tool to support the procurement process of a company. There were advantages in terms of decreasing time and costs for purchase order management. The study partly confirmed that costs could be reduced by introducing part-timers or decreasing payments due to more catalogs and catalog products as well as through the responsibility of users to edit their purchase requisitions (PRs). This was because the number of part-timers increased by only one person for the whole team, but the decrease in extra hours to process PRs and payments was confirmed.

Another study was conducted in 2022 to examine the perceived value of service digitalization in France. The findings underlined the perceived benefits and costs of service digitalization for both managers and customers (Vo-Thanh et al., 2022). A third study conducted in Bahrain in 2020 showed that for the employer, remote working can boost productivity and lower organizational costs, while employees can enjoy perks like flexibility and reduced commuting. However, employees must ensure that they have the technology required, a separate workspace, and an internet service that meets their needs. All these may entail additional costs to ensure access to an online system (Moovala, 2020).

In conclusion, cost has been found to have an influence on project management. One of the goals of this research paper is to determine whether the cost factor affects e-tendering in Bahrain.

2.9 Review Outcomes

Digital communication has been implemented in many sectors before COVID-19, but this significantly increased after the pandemic (Alexandra, 2020). In this chapter, we stated that digitalized systems are being implemented and used at an increasing rate by governments and organizations. With the improvement of technology, digital communication has become more widely applied, earning employees' and users' acceptance and preference with time (Ary et al., 2020). With regard to using digital communication, various influencing factors affect users, starting from project managers to employees and customers. Through the studies on numerous factors reviewed in this research, we found that the results of each factor are distinct from the others. In this research, we focus on four factors – safety and security, accessibility, ease of use, and cost – which have been established to impact project management. Such factors play a key role in digitalization acceptance and implementation in project management processes; thus, the government of the Kingdom of Bahrain needs to motivate organizations to turn to digitalization.

3 Research Methodology

The focus of this section is the methodologies applied to interpret the data acquired from questionnaires. A survey was conducted to collect information and opinions from several points of view. This research targeted a sample of users who dealt mainly with the e-tendering system in Bahrain to analyze the effect and impact level of digitalization on e-tendering. Thus, the survey was distributed to users such as purchasing authorities, contractors, and Tender Board employees. We identified cause-and-effect relationships between two or more variables: dependent and independent variables. We then manipulated the levels of the dependent variables to gauge their effect on the dependent variable. Therefore, an investigational research design was the most suitable approach to observe the factors influencing e-tender values in the Kingdom of Bahrain and answer the main research question recognized in chapter "Sustainable Competitive Advantage Through Technological Innovation: An Introduction" of this research. Furthermore, we implemented a quantitative research approach to explore the effects by utilizing statistical data collected through the designed survey distributed electronically to the users of the e-tendering system. Statistical testing methods were added to examine the type of relations between the dependent and independent variables of this research.

3.1 Theoretical Framework

The system theory and user theory are related to this work. Below is the theoretical framework (Fig. 1).

3.2 Research Hypotheses

A hypothesis is used to investigate the relationship between dependent and independent variables. Concerning the research structure devised, the problem of the research established, and the research aim and objectives set for this study review, research assumptions were formulated to test the impact of digitalized communication factors on tender values. The analysis was used to test the following hypotheses:

H1: Safety and security affected tender values in Bahrain during the COVID-19 pandemic.
H2: Cost affected tender values in Bahrain during the COVID-19 pandemic.
H3: Ease of use affected tender values in Bahrain during the COVID-19 pandemic.
H4: Accessibility affected tender values in Bahrain during the COVID-19 pandemic.

Safety and security were important reasons for shifting to digital communication during the pandemic. To ensure social distancing while keeping data secure, the e-tendering system was implemented by Bahrain Tender Board to maintain purchasing processes around the kingdom. People were afraid of getting infected with the COVID-19 virus, and the e-system aimed to solve this issue. Unfortunately, some challenges and negative effects of this change arose.

The cost of acquiring technology was another factor that may have influenced tender values, as the technology required some extra costs, such as a PC or laptop

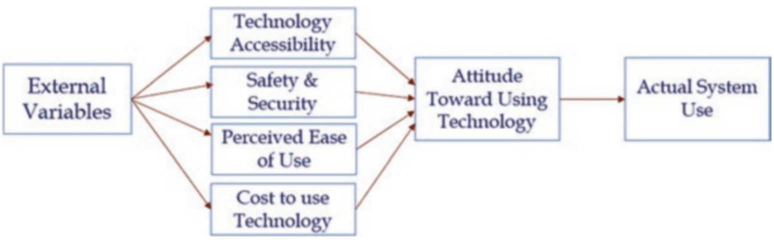

Fig. 1 Theoretical framework

and an internet connection to enter the e-tendering system and upload or review documents. Suppliers also needed to acquire the required technology, devices, and internet service to apply for tenders. The Tender Board and purchasing authorities had to provide these services and items. All these may have entailed additional costs to ensure access to the online system.

Ease of use may also have had an influence on tender values. An easier process could result in more benefits, but some users were not used to the technology and online work, especially older users. The knowledge to use the system to upload and download tender documents and the complexity of the process may have influenced the purchasing process and the values of the tenders.

The last factor, accessibility, may have affected tender values in several ways. Ease of access and the ability to access from anywhere at any time were factors that may have influenced the purchasing process and the tenders' values.

3.3 Research Population and Research Sample

The research population is often viewed as a large group of individuals or objects that is the core focus of a research study. It is a subcategory of the population that has the same characteristics as the rest of the population. The population is represented by observations and inferences drawn from the sample data. The population for this research was e-tendering system users in the Kingdom of Bahrain with access to an online questionnaire. This delivered the required results, and the targeted sample was suitable for gathering all the obligatory data and information. The expected connections and relations of the dependent variables and the independent variables were studied by analyzing the collected data. This study was limited to a selected sample as follows: Bahrain Tender Board employees who evaluate and control the tendering processes, purchasing authorities who add tenders to the system, and contractors who are registered and active in the e-tendering system within the last 12 months.

3.4 Questionnaire Design

The focal research question was articulated in an appropriate survey questionnaire with the assistance of the identified research variables, which suited a quantitative research approach. The questionnaire was taken from previous research, but some factors were added like "safety" and "cost." The questionnaire was divided into five parts. The first collected demographic or general information, such as age, gender, and education, from the respondents. The second part contained five questions aimed at gathering data to measure the e-tendering system's security and users' safety. The third part comprised four questions aimed at measuring the e-tendering system's cost. The fourth part had seven questions to measure the e-tendering system's ease of use. The final part of the questionnaire contained six questions aimed at gathering data to determine the e-tendering system's accessibility. A copy of the questionnaire is attached in Appendix A.

4 Data Analysis and Results

The survey was distributed to 350 users who dealt with the e-tendering system. A total of 127 complete and reliable responses were received from the distributed survey, resulting in a response rate of 36.2%.

4.1 Analyzing the Demographic Data

Demographic data are important, as they provide an overview of a targeted population in research. An examination of the demographic data collected from the survey conducted in this research is shown below. Table 1 illustrates the respondents' genders, ages, educational levels, and types (categories). The details of each point are discussed next.

Table 1 Responses to demographic questions

#	Categories	Options	Frequency	%
1	Gender	Male	72	56.7
		Female	53	41.7
		Prefer not to say	2	1.6
		Total	*127*	*100*
2	Age	18–34 years	46	36.3
		35–54 years	64	50.3
		55 years and greater	17	13.4
		Total	*127*	*100*
3	Educational level	High school diploma	9	7.1
		Bachelor's degree	80	63
		Master's degree	33	26
		PhD	2	1.6
		Others	3	2.3
		Total	*127*	*100*
4	Type	Tender Board employee	24	18.8
		Purchasing authority	29	22.7
		Supplier	56	43.8
		Other	18	14.7
		Total	*127*	*100*

Gender Analysis The first question of the demographic data defined the genders of the respondents. The male gender represented 56.7% of the respondents, and the second option, female, represented 41.7%. The remaining 1.6% preferred not to say.

Age Analysis The second question defined the ages of the respondents. The data were divided into three groups. The first group was aged between 18 and 34 years and represented 36.3%. The second group was 35–54 years old, which represented 50.3% or most of the participants. The third group was in the age range of 55 years and more and represented 13.4%.

Educational Level Analysis The third question described the participants' educational levels classified into four groups. The first group represented high school diploma education with 7.1% of the participants. The second category represented participants with bachelor's degrees (63%), the third educational category was labeled as master's degrees and represented 26% of the participants, and the last group comprised PhD holders (1.6%). Some participants chose "Other," and the percentage was 2.3%. From the above data, it is clear that most participants were bachelor's degree holders, which may explain why the majority age of the participants was between 35 and 54 years old.

Position Analysis The fourth question described the type of respondent. They were classified into three groups: Bahrain Tender Board employees (18.8%), purchasing authorities (22.7%), and suppliers (43.8%). The suppliers represented (43.8%) of the respondents, which represents most of the participants. Some respondents answered the question with their job titles, with a percentage of 14.7%.

4.2 Descriptive Analysis

Descriptive statistics can be used to describe single or multiple variables. This type of analysis can help summarize correlations between variables. In this case, one dependent variable was discussed, which was the value of the tenders during COVID-19, and four dependent variables were mentioned earlier. Each of these variables is descriptively analyzed in the following paragraphs.

We identified the factors representing the independent variables in the literature review. The impact of these factors is shown in the tables below with the related questions and perspectives of the participants for each one.

4.2.1 Safety and Security Factor Analysis

The results of the first question for this factor indicated that most of the respondents agreed that *safety has an effect on the quality of project management*. The responses were as follows: 69 participants agreed (54.3%), 34 strongly agreed (11.8%), and 9 disagreed (7.1%). However, no participant strongly disagreed with the first statement. The results showed a standard deviation of 0.821, which was lower than 1, and a mean of 4.008 (Table 2).

For the second question, most of the survey participants agreed that *digital communication is generally secure and safe*. Seventy-five participants agreed (59.1%), 24 were neutral (18.9%), 16 strongly agreed (12.6%), 10 disagreed (7.9%), and 2 strongly disagreed (1.6%). The standard deviation was 0.84, lower than 1, and the mean was 3.732.

The third question responses indicated that the majority of the survey participants agreed that *privacy is maintained within digitalized project management*. Of the total participants, 75 agreed (59.1%), 25 were neutral (19.7%), 15 strongly agreed (11.8%), 10 disagreed (7.9%), and 2 strongly disagreed (1.6%). The resulting standard deviation was 0.835, and the mean equaled 3.717.

The replies to the fourth question showed that most respondents agreed that *security has affected the values of the tenders*. The responses were as follows: 53 agreed (41.7%), 34 were neutral (26.8%), 21 disagreed (16.5%), 17 strongly agreed (13.4%), and 2 strongly disagreed (1.6%). The results revealed a standard deviation of 0.975, which was lower than 1, and a mean of 3.488.

The fifth question's results exhibited that most of the respondents agreed that *the risk of digital project management is minimum if not zero.* Fifty-three participants agreed (41.7), 34 were neutral (26.8%), 26 disagreed (20.5%), 9 strongly agreed (7.1%), and 5 strongly disagreed (3.9%). As shown in Table 2, the standard deviation was 0.997, lower than 1, and the mean was 3.276.

Table 2 Perspectives on digital communication safety and security

	Frequency %						
Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	SD	Mean
Safety has an effect on the quality of project management.	26.8	54.3	11.8	7.1	0	0.821	4.008
Digital communication is generally secure and safe within the project management process.	12.6	59.1	18.9	7.9	1.6	0.84	3.732
Privacy is maintained within digitalized project management.	11.8	59.1	19.7	7.9	1.6	0.835	3.717
Security has affected the values of the tenders.	13.4	41.7	26.8	16.5	1.6	0.975	3.488
The risk of digital project management is minimum if not zero.	7.1	41.7	26.8	20.5	3.9	0.997	3.276

4.2.2 Cost Factor Analysis

The results of the first question about the cost factor showed that the majority of the survey respondents agreed that *electronic devices are affordable and can be provided by the company*. The responses of the participants indicated that 79 agreed (62.2%), 22 were neutral (17.3%), 17 strongly agreed (13.4%), 8 disagreed (6.3%), and 1 strongly disagreed (0.8%), with a standard deviation of 0.774, which was lower than 1. The mean equaled 3.811.

The majority of the respondents agreed that *cost has an effect on the quality of project management*, as shown by the results of the second question. Sixty-one participants agreed (48%), 35 were neutral (27.6%), 20 strongly agreed (15.7%), 11 disagreed (8.7%), and there were no responses for strongly disagree. The results had a standard deviation of 0.837, lower than 1, and a mean of 3.709.

For the third question, the majority of the survey respondents agreed that *cost has affected the values of the tenders*. The responses were as follows: agree, 52 (40.9%); neutral, 40 (31.5%); disagree, 17 (13.4%); strongly agree, 14 (11%); and strongly disagree, 4 (3.1%). The results revealed a standard deviation lower than 1 at 0.964 and a mean that equaled 3.433.

The results of the last question showed that most respondents were neutral about the statement *digital communication tools are expensive*. There were 43 neutral responses (33.9%), 34 disagreed (26.8%), 33 agreed (26%), 11 strongly agreed (8.7%), and 6 strongly disagreed (4.7%). The standard deviation was 1.033, which was higher than 1, and the mean was 3.071.

The details for the cost factor are shown in Table 3.

4.2.3 Ease-of-Use Factor Analysis

The results of the first question for the ease-of-use factor indicated that the majority of the participants strongly agreed and agreed that *digitalized processes and services are easy to use*. The responses were as follows: 71 participants agreed (55.9%), 36

Table 3 Perspectives on digital communication cost

	Frequency %						
Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	SD	Mean
Electronic devices are affordable and can be provided by the company.	13.4	62.2	17.3	6.3	0.8	0.774	3.811
Cost has an effect on the quality of project management.	15.7	48	27.6	8.7		0.837	3.709
Cost has affected the values of the tenders.	11	40.9	31.5	13.4	3.1	0.777	3.433
Digital communication tools are expensive.	8.7	26	33.9	26.8	4.7	1.033	3.071

strongly agreed (28.3%), 16 were neutral (12.6%), 3 strongly disagreed, and 1 disagreed (0.8%). The standard deviation was lower than 1 and equaled 0.808, while the mean equaled 4.071.

The second question's responses showed that most agreed that *ease of use has an effect on the quality of project management*. Sixty-nine participants agreed (54.3%), 31 were neutral (24.4%), 24 strongly agreed (18.9%), 2 strongly disagreed (2.6%), and 1 disagreed (0.8%), with a standard deviation lower than 1 (0.773) and a mean of 3.882.

The results of the third question indicated that most of the respondents agreed that *digital services are user-friendly*. Among the participants, 65 agreed (51.2%), 29 were neutral (22.8%), 23 strongly agreed (18.1%), 6 disagreed (4.7%), and 4 strongly disagreed (3.1%). The mean equaled 3.764, and the standard deviation was 0.912, which was lower than 1.

The respondent details of the fourth question were as follows: 65 participants agreed (the majority at 51.2%), 26 were neutral (20.5%), 23 strongly agreed (18.1%), 11 disagreed (8.7%), and 2 strongly disagreed (1.6%). The mean was 3.756, and the standard deviation was lower than 1 at 0.906.

The fifth question asked whether *digitalized processes and services allowed the participants to recover from mistakes quickly and easily*. The results revealed that 58 participants agreed (47.7%), 31 were neutral (24.4%), 25 strongly agreed (19.7%), and 13 disagreed (10.2%). There are no responses for strongly disagree. The mean equaled 3.748, and the standard deviation was lower than 1 at 0.891.

The results of the sixth question showed that the majority agreed that *digitalization requires the fewest steps possible to accomplish it*. The results were as follows: 64 agreed (50.4%), 26 were neutral (20.5%), 20 strongly agreed (15.7%), 16 disagreed (12.6%), and 1 strongly disagreed (0.8%), with a standard deviation lower than 1 (0.916) and a mean of 3.677.

For the last question (*ease of use has affected the values of the tenders.*), the majority of the responses were agree and neutral. The results were as follows: 48 participants agreed (37.8%), 46 were neutral (36.2%), 19 disagreed (15%), 13 strongly agreed (10.2%), and 1 strongly disagreed (0.8%). The standard deviation was lower than 1 and equaled 0.895, and the mean equaled 3.417. Table 4 shows the details of ease of use.

4.2.4 Accessibility Factor Analysis

The results of the first question of the accessibility factor showed that the majority of the participants agreed and strongly agreed that *digitalization allows them to get or provide services quickly*. The results were as follows: 78 agreed (61.4%), 33 strongly agreed (26%), 11 were neutral (11, 8.7%), and 5 disagreed (3.9%). No participants strongly disagreed with the statement. The standard deviation equaled 0.706 (lower than 1), and the mean equaled 4.094.

The results of the second question indicated that most of the survey respondents agreed and strongly agreed that *the system can be accessed from anywhere*. The

Table 4 Perspectives on digital communication ease of use

Statement	Frequency %					SD	Mean
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree		
Overall, digitalized processes and services are easy to use.	28.3	55.9	12.6	0.8	2.4	0.808	4.071
Ease of use has an effect on the quality of project management.	18.9	54	24.4	0.8	0.016	0.773	3.882
Digital services are user-friendly.	18	51.2	22.8	4.7	3.1	0.912	3.764
I can use the system and provide or get services successfully every time.	18.1	51	20.5	8.7	1.6	0.906	3.756
Digitalized processes and services allow me to recover from mistakes quickly and easily.	0.197	0.457	0.244	0.102		0.891	3.748
Digitalization requires the fewest steps possible to accomplish it.	0.157	0.504	0.205	0.126	0.008	0.916	3.677
Ease of use has affected the values of the tenders.	0.102	0.378	0.362	0.15	0.008	0.895	3.417

responses showed that 75 participants agreed (59.1%), 33 strongly agreed (26%), 9 disagreed (7.1%), 7 were neutral (5.5%), and 3 strongly disagreed (2.4%). The standard deviation was 0.904 (lower than 1), and the mean was 3.992.

For the third question *(overall, online systems and websites are easy to access.*), the majority agreed and strongly agreed. Sixty-two participants agreed with the statement (48.8%), 37 strongly agreed (29.1%), 15 were neutral (11.8%), 10 disagreed (7.9%), and 3 strongly disagreed (2.4%). The results revealed a standard deviation of 0.970 (lower than 1) and a mean of 3.945.

The fourth question's results exhibited that the majority of the survey respondents agreed that *accessibility has an effect on the quality of project management*. The results comprised 68 participants who agreed (53.5%), 28 who strongly agreed (22%), 21 who were neutral (16.5%), 9 who disagreed (7.1%), and 1 who strongly disagreed (0.8%). The standard deviation equaled 0.857 (lower than 1), and the mean equaled 3.890.

The results of the fifth question showed that the majority agreed that *services are always online and available*. The results were as follows: 74 participants agreed (58.3%), 24 strongly agreed (18.9%), 19 were neutral (15%), 9 disagreed (7.1%), and 1 strongly disagreed (0.8%). For this question, the mean was 3.874, and the standard deviation was 0.826 (lower than 1).

Most of the survey participants agreed and were neutral about the last question *(accessibility has affected the values of the tenders)*. The results were as follows: 19 strongly agreed (15%), 44 agreed (34.6%), 43 were neutral (33.9%), 19 disagreed

Table 5 Perspectives of the participants on accessibility

Statement	Frequency %					SD	Mean	
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree			
Digitalization allows me to get or provide services quickly.	26	61.4	8.7	3.9		0.706	0.499	4.094
The system can be accessed from anywhere.	26	59	5.5	7.1	0.024	0.904	0.817	3.992
Overall, online systems and websites are easy to access.	29	48.8	11.8	7.9	2.4	0.97	0.941	3.945
Accessibility has an effect on the quality of project management.	22	54	16.5	7.1	0.8	0.857	0.734	3.89
Services are always online and available.	0.189	0.583	0.15	0.071	0.008	0.826	0.682	3.874
Accessibility has affected the values of the tenders.	0.15	0.346	0.339	0.15	0.016	0.974	0.949	3.465
Ease of use has affected the values of the tenders.	0.102	0.378	0.362	0.15	0.008	0.895	3.417	

(15%), and 2 strongly disagreed (1.6%). The standard deviation was lower than 1 (0.974), and the mean was 3.465. Table 5 shows the details for accessibility.

4.3 *Hypothesis Testing*

To answer the research question, tests were conducted to check the validity of the research hypotheses. We used the T-test for the analysis. This type of test was chosen, as it was used by other researchers in similar studies (Table 6).

4.3.1 Testing the First Hypothesis

H1: Safety and security affected tender values in Bahrain during the COVID-19 pandemic

This hypothesis illustrates the relationship between safety and security and the changes in the tenders' values. The mean equaled 3.633, which was between agree and neutral. The standard deviation was less than 1, so all of the respondents had similar responses. The significance was less than 0.05, so the null hypothesis is rejected, and the alternative hypothesis is accepted. Therefore, security and safety impacted tender values.

Table 6 T-test results

Dependent variable	Hypothesis	Mean	SD	T-test	Sig.
Safety and security	The safety and security factor affected tender values in Bahrain during the COVID-19 pandemic.	3.633	0.570	12.560	0.001
Cost	The cost factor affected tender values in Bahrain during the COVID-19 pandemic.	3.744	0.587	14.344	0.001
Ease of use	The ease-of-use factor affected tender values in Bahrain during the COVID-19 pandemic.	3.859	0.577	16.846	0.001
Accessibility	The accessibility factor affected tender values in Bahrain during the COVID-19 pandemic.	3.500	0.513	11.035	0.001

Based on the findings from the literature review, safety and security was one of the reasons for transitioning to online communication during the pandemic. As many studies have stated, COVID-19 accelerated the process of virtual communication by forcing a large fraction of the global workforce to switch to working from home, and its effects on productivity and which factors played a role in making work from home more or less productive than working in the office were investigated. Furthermore, per the study conducted in Bahrain, safety was a factor that affected employees, and it was a driver of their attitudes. The studied organization shifted to online services to promote the mental health of their employees.

4.3.2 Testing the Second Hypothesis

H2: Cost affected tender values in Bahrain during the COVID-19 pandemic
This hypothesis concerns the relationship between cost and the changes in the tenders' values. The mean equaled 3.744, which was between agree and neutral. The standard deviation was less than 1, indicating that all respondents agreed with the statements. The significance was less than 0.05, so the null hypothesis is rejected, and the alternative hypothesis is accepted. Thus, cost had an impact on the tenders' values.

The respondents regarded cost as the second most important factor affecting the value of the tenders. It is important to note that the literature review highlighted the particular significance of the cost factor; for instance, Gibbs et al. (2021) mentioned that an important source of changes in virtual workforce productivity is higher communication and coordination costs. The cost factor can be seen from two different perspectives. On the employer side, a study conducted in Bahrain stated that digital communication could boost productivity, reduce turnover, and lower organizational costs. On the system user side, a good network connection and a computer are required, which are considered extra costs (Moovala, 2020).

4.3.3 Testing the Third Hypothesis

H3: Ease of use affected tender values in Bahrain during the COVID-19 pandemic

This hypothesis examines the relationship between ease of use and the changes in the tenders' values. The mean was 3.859, which was closer to the "agree" response. The standard deviation was less than 1, indicating that all of the respondents had similar responses. The significance was less than 0.05, so the null hypothesis is rejected, and the alternative hypothesis is accepted. It can be concluded that ease of use affected the tenders' values.

The quantitative research results showed that ease of use was the most significant influence factor in relation to the change in tender value in the Kingdom of Bahrain, as it had the highest mean. This highlights the importance of the ease of use of the system. Interestingly, the findings of the study strongly aligned with the literature review. In these contexts, the ease of use of systems could be considered both a benefit and a liability to some projects (Marion & Fixson, 2021). The Kingdom of Bahrain promoted digitalization through the Cabinet's directives for all ministries and authorities, such as the Bahrain Institute of Public Administration, to make quick digital shifts for their services, as they concluded that it would be easier and more practical to provide their services online.

4.3.4 Testing the Fourth Hypothesis

H4: Accessibility affected tender values in Bahrain during the COVID-19 pandemic

This hypothesis examines the relationship between accessibility and the changes in the tenders' values. The mean was 3.500, which fell between agree and neutral. The standard deviation was less than 1, so all of the responses were similar. The significance was less than 0.05, so the null hypothesis is rejected, and the alternative hypothesis is accepted. Thus, accessibility impacted the tenders' values.

As with the previous variables, the respondents reported a positive association between this factor and tender values. Ismael (2021) acknowledged that it is necessary to make digital data accessible to everyone for reliability, interaction density, efficiency, and actuality. In Bahrain, studies have found that digital communication faces some challenges, and Moovala (2020) revealed that not having access to the tools or information needed for work and not having a workspace are the major challenges that face online jobs. In addition, communication between colleagues can be difficult.

From the above, we can confirm the relationships between the variables "safety and security," "cost," "ease of use," and "accessibility" and the dependent variable, "tender values in Bahrain during the COVID-19 pandemic." Our hypotheses can be accepted, which agrees with the study of Oumlil and Aderkaoui (2020).

5 Conclusion and Recommendations

5.1 Conclusion

This research studied the main digital communication factors that affected project management in the Kingdom of Bahrain during the COVID-19 pandemic and caused an increase in tender values. A quantitative approach was applied by distributing an online survey. The selected sample included 127 respondents representing e-tendering system users in Bahrain. Quantitative analysis and descriptive analysis were performed, and hypothesis testing demonstrated the significant influence of the digital communication factors identified. The findings of the study confirmed that all the factors – safety and security, cost, ease of use, and accessibility – impacted tenders in the Kingdom of Bahrain and increased their values.

5.2 Recommendations

This study aimed to investigate the digitalized communication factors that had a significant effect on tender values in the Kingdom of Bahrain. Great steps were taken by the kingdom to adopt digitalized services and provide adoption capabilities to different parties, such as government employees, citizens, customers, and suppliers, to ensure social distancing during the pandemic. In addition to the findings and conclusion of the study, we recommend the following to help clarify the importance of the factors and the steps to be taken in the field of digitalized communication:

The high adoption of digitalized communication in the coming years is the first element to focus on. Digitalization by the government and private sectors should be encouraged to cope with technology that is improving day by day and innovations and ideas. More than traditional methods, digitalization will create movement in the country's economy and lead to additional economic growth in the future.

Second, safety and security factors should be handled with utmost care when adopting or managing a project, as the study shows that these factors are highly effective for successful project management.

The third element to consider when adopting a new project and managing it is the cost. The study shows that e-system costs can affect the value of tenders. Hence, low costs to achieve digitalized systems and services will increase communication.

The fourth consideration in adopting a new project and managing it is the ease of use. It is one of the main points to focus on in the first stages of project management. The study shows that the ease of use of the e-tendering system is very important to users. Moreover, many users are likely to shift from one communication method to another simply because of ease of use.

The fifth element, which is accessibility, can increase the dependability and level of communication. The more accessible a digitalized communication channel (the e-tendering system in our research) is, the more likely it is that users will depend on the service and boost their level of communication.

To summarize, for successful digitalized communication and strong project management, the safety and security, cost, ease-of-use, and accessibility factors should be focused on.

This research may be of great value to the Bahrain Tender Board, and the findings can be used to evaluate the e-tendering system to control and enhance the process. As ease of use is the most influential factor, we recommend that the system should be improved to be easier for users by providing training, user manuals, and instructions.

Finally, we recommend that the Bahrain Tender Board replace the hard documents of the initial bonds with digitalized bonds (bank transfers) for more security, to prevent the loss of documents and to save time and effort.

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The Factors Affecting the Adoption of Artificial Intelligence Technologies in Organizations

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1 Introduction

Nowadays artificial intelligence is considered as a vital commercial opportunity in the fast-changing economy worldwide, where the global GDP growth is estimated to be increased by 15.7 trillion USD by 2030 (Saidl, 2019). In addition, AI has shaped a new strong market named after it "Artificial Intelligence Market". In particular, AI plays a substantial role in a country's economic growth, for instance, in the United States, China, India, and Australia (Chris Messom et al., 2019). The increasing use of AI offers the Australian business a substantial opportunity to develop, where the PwC report indicates that the Australian economy has the potential to reach a GDP 2.2 trillion USD in 2030. Several industrial reports have shown the significant benefits in adopting AI in the organization by creating a competitive advantage, improving the organization performance, reducing the cost, increasing the revenue, and improving the efficiency of business (Chris Messom et al., 2019). Kingdom of Bahrain realized the value of adopting AI on simplifying the business processes. Therefore, Bahrain has announced an Artificial Intelligence Academy at Bahrain Polytechnic, in cooperation with Microsoft Corporation and Tamkeen, where their objective is to provide a platform for youth to boost their creativity, capabilities, and innovation in artificial intelligence field, which will be in line with the Economic Vision 2030 of the Kingdom of Bahrain (eGoverment, 2020a). Bahrain is providing a strong digital

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infrastructure that allows it to be able to gradually enter the artificial intelligence sector. Moreover, it keens to increase cognition in entrepreneurs about AI by holding several programs aiming to provide students in the "technology majors" with training, AI knowledge, and relationships to establish their potential business based on the emerging sector (AI) (Alwatan, 2019). AI will affect most industries in the near future. However, waiting for expertise to step in for artificial intelligence adoption will not help the organization strategy. Based on that, the organizations have to be proactive in this adoption to be capable of entering the AI technologies to prevent any difficulties in catching up with outperforming competitors (Chris Messom et al., 2019). Therefore, the question that should be addressed is how can the firms start with this initiative? Furthermore, the research will investigate about the barriers and complications that cause the organization to avoid adopting AI by addressing the overview of potential issues that can help the organization recognize them and plan to overcome. The term of barrier is defined as "any condition that makes it difficult to make progress or to achieve an objective" (Based, 2003). In particular, barrier in this research is considered as a negative contextual factor with adoption of artificial intelligence, which can be discouraging the adoption action (Saidl, 2019).

This research suggests that there is a gap between large organizations who are spending more in information technology budgets compared to smaller organizations due to the financial capability, which makes them quickly and easily jump on the latest trends of technology (Saidl, 2019). As per Neha Soni's study, the top 5 companies out of 119 that have already adopted AI are Google, Apple, IBM, Amazon, and Microsoft, and then they performed their financial analysis to evaluate the impact of AI on global market. It was noticed that there is a significant increase in their earning per share (EPS), share prices, the investment in artificial intelligence, and the net sales for the last decade (Soni et al., 2019). Also there is an issue that argued about stemming from a lack of knowledge in high technology to understand artificial intelligence and lack of competence and support (Saidl, 2019). In Bahrain a lot of the organizations did not take the initiative to adopt. Therefore, the research will examine the gap that prevents the companies to adopt artificial intelligence.

The main intention of this research is to investigate AI from manufacturing organization's perspective in the Kingdom of Bahrain to fill the gap in their knowledge and also to investigate the factors that would impact the adoption of artificial intelligence in Kingdom within manufacturing sector. This research will also attempt to overcome the gaps from the literature review and explore solutions that would contribute to fulfill the objectives of the research.

2 Literature Review

2.1 Artificial Intelligence in Bahrain in Several Sectors

After the Kingdom of Bahrain is recognized, the extent of artificial intelligence (AI) important. Bahrain is emerging as a regional leader in artificial intelligence, until it reaches to the potential to become the center development of AI in the region.

Bahrain is keen to improve the standards of business in the country and make sure that entrepreneurs adopt the best strategies to streamline their business process by machines (eGoverment, March 2020b). Accordingly, in cooperation with Tamkeen, Bahrain Polytechnic, and Microsoft Corporation, has announced the first artificial intelligence AI academy in Bahrain, which is considered as a platform for youth entrepreneur to emerge their innovation capability in their business (eGoverment, March 2020b). In 2014, artificial intelligence was first introduced by the central bank by creating licenses for payment and card processing services and encouraged non-banking entrepreneur companies to provide banking services. In 2015, the central bank of Bahrain (CBB) introduced electronic funds services with the help of entrepreneur company Benefit Company and the impact of this on Bahrain's economy was that the non-oil sector by 3.6% in 2015, 3.7% in 2016 while 5% in 2017. Bahrain was the first country that integrated legal laws for security reason such as "Trusts Law, Investment Limited Partnership, and Protected Cells Companies." In 2017, a Fintech unit was established as regulatory body for approving and supervision of the companies for the development in the Fintech sector. Over the years strategic partnerships were seen among entrepreneurial companies and banks such partnership between Bahrain Development Bank and Rowad and Bahrain FinTech Bay (BFB). In 2017, the Kingdom of Bahrain reported a record high foreign direct investment FDI of US $733 million with 71 new companies in the region, of which the ICT sector was the most influenced sector that was led by Amazon Web Services (AWS) with a contribution of 54% of the total FDI. In 2018, the CBB established a real-time inter-bank payment settlement (RTGS) to support inter-bank communication and payments. The FDI inflows grew by 114% in 2018 and saw 76 new companies being established that accounted an investment of $ 810 million. QR code technology was standardized during 2018 in accordance with the EMV® QR Code Specifications for Payment Systems ("EMV QRCPS"). Within the same year, Tarabut Gateway became the first company to successfully graduate its regulatory sandbox by receiving an in-principle confirmation under the open banking regulatory framework that with partnership. The National Bank of Bahrain became the first to provide open banking services within the MENA region in 2019. A regulatory framework was established for crypto-asset services, 92 new companies were seen in the Fintech sector with an investment of US $830 million in 2019, and within the same year, Bahrain became the first country to ordain the Model Law on Electronic Transferable Records globally. Within these years, entrepreneurial startups like Sigma Ratings, OffrBox, Travelex, Careem, Murabaha Club, and many others (Milken, 2019). An AI-powered digital employee named Fatima was created in 2019 by Soul Machines™ to be part of ABC bank's employee, to customize the ability of Fatima to meet their customer's needs, and to provide a stimulating interface in communication in the rapidly evolving digital field (Bank, 2019).

Artificial intelligence has a significant impact on economic and social life, as this technology can greatly contribute to the economy of Bahrain and on organizations itself by improving the existing industries, and it is estimated that the global impact of this technology is projected to contribute about $16 trillion to the economy of the world (Al-Ammal & Aljawder, 2019). However, in order to fully make out the artificial intelligence technology wide in Bahrain, there is a need to encourage the largest segment of companies that have barriers to adopt AI.

2.2 Application of Artificial Intelligence in the Manufacturing Sector

In the current time, most of the manufacturing industries focus on digitizing and automation of their services. With the digitization process, now the invention and introduction of human chatbots are taking place. These chatbots are the computer programs that work by interacting with the humans in their natural language. The chatbots work by stimulating a human conversation in response to a natural language input that occurs through a text or voice. These chatbots provide a quick answer with less effort so the main reason that humans choose this is for the high productivity. These provide emotional and social support and provide information by linking human to another computer. Customer services is one of the domains in which chatbots have been growing rapidly. The interest in chatbots has also been increased due to the e-commerce and E-service developments that include the natural language interfaces. The human-like conversation that these chatbots provide help the customers to write the questions and get the answers to those questions in a meaningful way.so these chatbots are used in the routine queries of the people and the workers that make up the most service requests (Priya, 2017).

Artificial neural network works as a predicting tool too. It plays a role in the prediction of the future prices of the materials accurately. It is widely used since it is a nonlinear model and easy to understand especially when it is compared with the statistical methods. Changes in the construction prices have a great impact on the budget. It is difficult to manage the price due to fluctuations. There are different tools that help in the prediction and some of them widely used are artificial neural network and trend analysis. In the trend analysis, the historical records of the data and the results are used to predict the future outcome (Singh et al., 2023). The predicted outcome is traced by focusing on the variance in the cost and schedule performance. A trend analysis is basically an aspect of technical analysis that helps in the prediction of the movement of the stock based on the past data. The trend analysis works by giving the traders data about what has happened in the past and so what is likely to happen in the future based on the previous occurrences (Adamopoulou, 2020; Reyad et al., 2019).

The use of artificial intelligence has been increasing with time. The usage has drastically increased in speech recognition (Mathew et al., 2023). In speech recognition, an appropriate tool is used to solve problems that are related to different styles and are classified as per their type. Artificial intelligence helps in pattern recognition. Automatic recognition, classification, and grouping are widely used in several fields. In this process, templates are used that are usually the fingerprint images, handwritten word cursives, and human faces or voice signals. In speech recognition, neural networks play an important part. Neural networks consist of a set of nodes. These nodes collectively form a special account and each node plays a part in a special standard unit of that account. These nodes work in parallel and interact. In the speech recognition process, first, there is the processing of an acoustic signal that is passed through a phase where patterns are matched and classified. Then after its alignment as per the time, patterns and sequence of the word are some and the selected word is produced. In this process, the size of the neural networks influences the detection of phonemes in the word (Karsting, 2018).

Artificial intelligence and machine learning are also becoming very popular. They have become the main techniques to solve the problems in many areas like research and industry. The data in the world is increasing and the size of the data that is collected with respect to any problem is usually huge. This data is needed to be converted into useful and meaningful. Also the meaning of the data needs to be understood in terms of the context that the data is collected. So the problem is usually in first collecting a huge amount of data and then secondly converting it into knowledge, conclusion, and actions. Large data sets can be used to retrieve information. The data on climate change can be used to understand global warming, large amount of sensor readings of plants can be used to detect droughts, the data from games can be used and turn their pixels into actions with in the video games, and the observational data helps the robots in understanding the complex information and the environment in order to learn the skills. Machine learning is used here and also in blogs and media to deal with the information. In 2016 when South Korean master Lee Sedol was defeated by the alpha go in the broad game, the term machine learning as used to describe how alpha go won. Also in Gartner's list of top 10 strategic trends for 2018, AI was placed at the top for having machine learning that is highly scoped and helps in targeting specific tasks (Smadi, 2015).

Machine learning also helps in the fraud detection. Due to e-commerce and online payments, fraud has been increasing and creating problem for the dealers. Financial fraud means the use of mobile transactions that is unauthorized. It is done through credit card stealing and identity theft. This fraud usually results in a lot of financial loss. In order to detect fraud and reduce it, machine learning and artificial intelligence are being used. The unsupervised learning method is used in the machine learning to detect the fraud. The supervised method is used to accurately classify the data. In the supervised learning, the value of input data is classified and given a label (Al Kurdi, 2021), while in the unsupervised learning, the data is not labeled and it is usually called as clustering sample. In order to make fraud detective, there is data pre-processing, sampling, feature selection, and the clustering algorithm in the machine learning. In the data pre-processing process, the data is cleaned and correlated. Then the data is passed through sampling process where data is evaluated and its various ratios are verified. Further the clustering process is done where the algorithms are performed and the results are used as trainings set in the process of classification. These help in the fraud detection by using the neural networks value that gave a value of 95:1 and 99:1 ratios, which is similar to the actual ratio in the real world (Choi, 2018; Hasan & Hassan, 2021).

2.3 Barriers in Adopting AI in Organizations

"Haider (2020b) conducted studies to investigate the barriers to the adaption of AI in organizations in India where findings suggest that factors contributing toward the implementation includes cost, investment, and infrastructure, data integrity, interoperability, trust issues, regulatory implications, employment and skill set, and inequality concerns" (Haider 2020a, b).

"Chris Messom et al.'s (2019) studies show the barriers to AI adaptions in Australian organizations such as unclear business case for AI implementation, lack of leadership support, unclear which aspects of AI, limited technology capabilities, security concerns relating to AI adoption, consumer trust and regulatory acceptance, organizations lack the skills to evaluate, build and deploy AI solutions, employee fear of change, and lack of funding" (Chris Messom et al., 2019).

"Assadullah (2019) Studied the barriers of AI implementation in healthcare organizations which are algorithm opacity, trust, regulatory standards, preserve privacy and integration with legacy system are most commonly faced challenges in adaption of AI" (Assadullah, 2019).

"Duke (2019) retail industry barriers of implementing AI are change management, limited business case, data quality, cost of solution, lack of skilled workers, operationalization of AI framework, access to computing resources and GDPR compliance issues are significant barriers to AI adaption in retail chains" (Duke, 2019).

"Cubric (2020) conducted study to investigate the social considerations and barriers for artificial intelligence adoption in business sector of the UK, which included healthcare, supply chain, logistics, project management, energy, information technology, agriculture, engineering, apparel industry, smart cities, transport, and tourism. Findings of the study suggest that barriers faced by AI adaption include lack of knowledge, trust stakeholder's perspective and safety, reusability of models, and availability of data" (Cubric, 2020).

"Medaglia and Sun (2018) investigated the challenges faced by AI implementation in healthcare settings, which are ethical challenges, political legal and policy challenges data challenges, social challenges, economic challenges, managerial and organizational challenges, and technological challenges" (Medaglia & Sun, 2018).

"Dremel (2017) investigated the barriers in big data adaption in automotive sector where primary data was gathered from car manufacturers. The barriers are the lack of skilled resources, lack of collaboration between departments, lack of appropriate organizational structure and data-driven culture, and lack of relevant data pool which cars commitment and relevancy within the organization" (Dremel, 2017).

3 Research Methodology

This section presents the research method by indicating the theoretical model that was used for the purpose to answer the constructed research questions and aid with the final findings. Also the hypothesis that was built and created will be presented.

Moreover, it will explain the research design that will be used for the study and comprises the type of study that will be conducted. This chapter also discusses the instruments used as per the research approach and research design. It will provide the guidelines for the selection of population, moral and ethical issues, validity and reliability, and sampling technique by mentioning the sample size of the research.

3.1 Research Approach and Design

Top management and the technical in the manufacturing sector in Bahrain will be the setting for the current study in order to explore the factors affecting the adoption of artificial intelligence technologies in organization among manufacturing sector in the Kingdom of Bahrain. The research approach usually consists of quantitative and qualitative approaches. The research approach usually consists of quantitative and qualitative approaches. The quantitative approach refers to the approach in which the research outcomes are quantified. The quantification is done by using different statistical methods and techniques. The other is the qualitative research approach, which is more interpretative and naturalistic in nature; however a small-scale qualitative method was used, in order to investigate opinions from top management's perspective in finding solutions to overcome the barriers to adopt the artificial intelligence in their organization. In this, the data is collected by conducting interviews, observation, and content analysis (Langkos, 2014).

In this study a quantitative cross-sectional study will be used using convenience sampling method, and the sample size of the study will be $n = 234$ that will include participants from manufacturing sector in Bahrain who's consider as a top management and the technical in the organization. Finally, the responses will be analyzed in order to determine the barriers that are affecting the organization to adopt the artificial intelligence.

The collected numeric data will measure the different factors that impact AI adoption in an organization.

Secondly, the responses of the groups based on the demographics will be analyzed. The current study satisfies the three criteria so it will be considered quantitative in nature. In addition to this, a cross-sectional design is used in the current study to determine the factors affecting the adopting artificial intelligence technologies in organizations among the manufacturing sector in the Kingdom of Bahrain.

3.2 Study Hypotheses

The study hypothesized the following three hypotheses:

H01: There is no significant impact of the technological factor and the adoption of AI among manufacturing organizations in the Kingdom of Bahrain.

H1: There is a significant impact of the technological factor and the adoption of AI among manufacturing organizations in the Kingdom of Bahrain.
H02: There is no significant impact of the organizational factor and the adoption of AI among manufacturing organizations in the Kingdom of Bahrain.
H2: There is a significant impact of the organizational factor and the adoption of AI among manufacturing organizations in the Kingdom of Bahrain.
H03: There is no significant impact of the environment factor and the adoption of AI among manufacturing organizations in the Kingdom of Bahrain.
H3: There is a significant impact of the environment factor and the adoption of AI among manufacturing organizations in the Kingdom of Bahrain.

3.3 Data Types and Sources

In the current research, the main primary data will be collected from the participants in manufacturing sector in Bahrain. A questionnaire will be used to collect the data. The questionnaire consists of two parts. The first part is related to demographic information related to the descriptive statistics. The questions are related to the type of ownership, nationality of the organization, establishment time period of the organizations, location of the organization, manufacturing activity of the organization, and the number of employees of the organization.

The second part consists of ten questions related to factors affecting the artificial intelligence in the organizational, technological, and environmental context. There are three steps to conducting quantitative research. These include collecting and analyzing the numerical data, measuring the different attributes of the subject matter, and comparing the groups to relating factors. Lastly in the third section, it is consisting of general questions about artificial intelligence and COVID-19. The current research data will be collected by using an instrument in numeric form. The questionnaire items have been derived from the previous studies including as shown in the table below, with a Likert scale of 1–5, where 1 is strongly agree and 5 is strongly disagree.

4 Empirical Analysis

4.1 Descriptive Analysis

4.1.1 Descriptive Analysis for Demographic Questions

This section will examine the data collected from the survey. Table 4 presents the collected demographic information, such as ownership type, organization's origin, organization age, organization's location, organization's activity, no. of employees the organization has, and the participant position.

Table 1 Participants' responses to demographic questions (ownership type of organization analysis)

No. of Q.	Question	Answer choices	Frequency	Percent
1.0	What type of ownership your origination has?	Bahraini joint stock companies (public)	12	5.0
		Bahraini joint stock companies (closed)	27	11.2
		Limited liability companies	141	58.3
		Partnership companies	19	7.9
		Companies limited by shares	9	3.7
		Foreign company branches	3	1.2
		Sole proprietorship	31	12.8
		Total	*242*	*100*

4.1.1.1 Ownership Type of Organization Analysis (Table 1)

The outcome of the first question in the survey is relative to the ownership type of the organization. The ownership type is divided into seven different types according to the Ministry of Industry, Commerce and Tourism classification. The first type was "Bahraini joint stock companies (public)" (5.0%), second type is "Bahraini joint stock companies (closed)" (11.2%), third type is "limited liability companies" (58.3%), fourth type is "partnership companies" (7.9%), fifth type is "companies limited by shares" (3.7%), sixth type is "foreign company branches" (1.2%), and lastly the "sole proprietorship" type (12.8%).

4.1.1.2 Origin of Organization Analysis (Table 2)

The origin of the organization was divided into three groups. The majority of responses was from the first group "National (Bahraini organization)" (78.5%), followed by "multinational organization" (14.0%) and the "international organization" (7.4%).

4.1.1.3 Age of Organization Analysis (Table 3)

The outcome of the third question in the survey revealed the age of the organization, which was divided into five groups. Table 4 shows that the majority of the respondents their organization's age is more than 20 years, and they represent 56.6%. The second highest organization's age group of respondents is 11–15 years, and they represent 14.5%. Moreover, respondents classifying to the group of 0–5 years are representing 11.2%, and 26 of the respondents with an organization age are between 16 and 20 years, and they represent 10.7%. Lastly, the least number of respondents are the organization 6–10 years representing by 7.0%.

Table 2 Participants' responses to demographic questions (origin of organization analysis)

No. of Q.	Question	Answer choices	Frequency	Percent
2.0	What is the nationality of your organization?	National (Bahraini organization)	190	78.5
		Multinational organization	34	14.0
		International organization	18	7.4
		Total	*242*	*100*

Table 3 Participants' responses to demographic questions (origin of organization analysis)

No. of Q.	Question	Answer choices	Frequency	Percent
3.0	Since when your organization has been established?	0–5 years	27	11.2
		6–10 years	17	7.0
		11–15 years	35	14.5
		16–20 years	26	10.7
		More than 20 years	137	56.6
		Total	*242*	*100*

4.1.1.4 Location of Organization Analysis (Table 4)

The locations were categorized based on the most common industrial areas in Bahrain. The majority of the participants were from South Alba/Asker/Almazra Industrial Park (27.3%), and second highest respondent percentage is from Hidd Industrial City (17.4%), and the third ranked are from Sitra Industrial Park, which represent 14.9%, followed by Ma'meer Industrial Park (9.1%), Bahrain International Investment Park (BIIP) (8.7%), Mina Salman Industrial Park (5.8%), Sitra Roundabout/Al-Lehsy Industrial Park (5.0%), and Hafeera Industrial Park (1.7%), and 10.3% of the respondents were from other areas.

4.1.1.5 Activity of Organization Analysis (Table 5)

The outcome of the fifth question in the survey revealed the main activity that the organization is practicing, and it was noticed a variety in participant selection where there are 14 listed activities. The majority of participants (11.6%) are in field of furniture and fixtures, the second majority (9.9%) are in steel field, followed by a 9.5% from the field of food processing, and 9.5% were in the aluminum field as well. The lowest majority are in the field of electronics (1.2%).

Table 4 Participants' responses to demographic questions (location of organization analysis)

No. of Q.	Question	Answer choices	Frequency	Percent
4.0	Where is your organization's location?	Hidd Industrial City	42	17.4
		Bahrain International Investment Park (BIIP)	21	8.7
		Mina Salman Industrial Park	14	5.8
		Sitra Roundabout/Al-Lehsy Industrial Park	12	5.0
		South Alba/Asker/Almazra Industrial Park	66	27.3
		Hafeera Industrial Park	4	1.7
		Ma'meer Industrial Park	22	9.1
		Sitra Industrial Park	36	14.9
		Other	25	10.3
		Total	*242*	*100*

Table 5 Participants' responses to demographic questions (activity of organization analysis)

No. of Q.	Question	Answer choices	Frequency	Percent
5.0	Select the manufacturing activity your organization in	Aluminum	23	9.5
		Fiberglass	9	3.7
		Paper industry	9	3.7
		Industrial equipment	11	4.5
		Furniture and fixtures	28	11.6
		Steel	24	9.9
		Petrochemicals	9	3.7
		Plastic	22	9.1
		Electronics	3	1.2
		Chemical industry	8	3.3
		Pharmaceutical industry	4	1.7
		Printing and publishing	8	3.3
		Building materials	18	7.4
		Food processing	23	9.5
		Other	43	17.8
		Total	*242*	*100*

4.1.1.6 Number of Employees in the Organization Analysis (Table 6)

The outcome of the sixth question in the survey revealed the number of the employees in the organization. The number of employees was divided into five different groups. The first group was between 1 and 9 employees (31.8%), the second group was 10–49 employees (37.0%), the third group belongs to between 50 and 249 employees (38.0%), the fourth group was 250–499 employees (8.3%), and the last group was 500 or more employees (14.0%).

Table 6 Participants' responses to demographic questions (number of employees in the organization analysis)

No. of Q.	Question	Answer choices	Frequency	Percent
6.0	How many employees does your organization have?	1–9	19	7.9
		10–49	77	31.8
		50–249	92	38.0
		250–499	20	8.3
		500 or more	34	14.0
		Total	*242*	*100*

4.1.1.7 Position of Participant in the Organization Analysis

No. of Q.	Question	Answer choices	Frequency	Percent
7.0	What is your position in the firm?	CEO/Top management level	128	52.9
		Middle Level Manager/technical manager	63	26.0
		Supervisor/front Line Manager/ Engineer	31	12.8
		Other	20	8.3
		Total	*242*	*100*

The majority of participant (52.9%) are "CEO/Top management level," and the second highest group are "Middle Level Manager/technical manager representing" (26.0%). While (12.8%) of participants are "Supervisor/front Line Manager/ Engineer", and (8.3%) from the participant percentage are from other positions.

4.1.2 Descriptive Analysis of Dependent Variables Questions

This will be the second section to examine data collected from survey. Table 5 presents the information collected from the general questions; the status of the organizations in adopting AI, the applications they used it for or whether they have a future plan to use them, in addition to the role of artificial intelligent during the COVID-19 pandemic.

4.1.2.1 Artificial Intelligent Adoption Analysis (Table 7)

Most of the participant organization (68.2%) stated that they are currently not using AI, while 31.8% of the organizations stated that they are using it in their manufacturing activities and other areas such as in admin, inventory, etc.

Table 7 Participants' responses to dependent questions (artificial intelligence adoption analysis)

No. of Q.	Question	Answer choices	Frequency	Percent	Chi-square	Sig.
9.0	Does your organization currently adopt artificial intelligence?	Yes	77	31.8	28.32	0.00
		No	165	68.2		
		Total	*242*	*100*		

4.1.2.2 Considered Areas to Invest AI in Analysis (Table 8)

Question no. 10 examined the most areas within each organization that may consider in adopting the artificial intelligence in, and it was divided into Designing, Production, Maintenance, and Inventory. The majority of participants (59.9%) stated that they consider Production as a most important area to invest artificial intelligent in, 11.2% of the participants stated that Inventory is considered as the most important to invest AI in. In addition 3.7% of participants choose Designing area as the most important area, 3.7% of participants as well choose Maintenance, and 15.7% of the participants did not believe in investing in artificial intelligence in the organization.

4.1.2.3 Current State of AI Applications Adoption Analysis (Table 9)

In this particular section, it will be identifying the current AI applications adoption level of artificial intelligence within the manufacturing sector in Bahrain.

- Speech recognition: Most of the manager level/technical levels (68.6%) stated that they do not use it or have no plans to use it, while 16.1% of them stated that they currently use it, and 15.3% of them stated that they have plans to start using it in the future.
- Automated communications machine translation or chatbots: Most of the participant (58.7%) stated that they do not use it or have no plans to use it, and 24.4% of them stated that they have plans to start using it in the future, while 16.9% are currently using it already.
- Visual diagnostics face or image recognition, (computer vision): Most of the participants (58.7%) stated that they do not use it or have no plans to use it, and 24.4% of them stated that they have plans to start using it in the future, while 16.9% are currently using it already.
- Autonomous machines, such as smart and autonomous robots or vehicles: 47.9% of the participants stated that they do not use such that AI technology, while 18.2% of the participant stated that they are currently using this technology in their organization, and 33.9% do not have plans to start using it in the future.
- Digital twins, e.g., product development/design customization/shop floor performance improvement/logistics optimization: Most of the participant (51.7%) stated that they do not use it or have no plans to use it, and 28.9% of them stated

Table 8 Participants' responses to dependent questions (considered areas to invest AI in analysis)

No. of Q.	Question	Answer choices	Frequency	Percent	Chi-square	Sig.
10.0	Which area your organization considers investing AI in?	Designing	9	3.7	198.73	0.00
		Production	145	59.9		
		Maintenance	9	3.7		
		Inventory	27	11.2		
		None	38	15.7		
		Other	14	5.8		
		Total	*242*	*100*		

Table 9 Participants' responses to dependent questions (current state of AI applications adoption)

No. of Q.	Question	Answer choices	Frequency	Percent	Chi-Square	Sig.
11.0	Based on your knowledge, what is the current state of AI adoption in your organization for each of the following AI applications?					
11.1	Current state of AI applications adoption "speech recognition"	We do not use it or have no plans to use it	166	68.6	66.09	0.00
		We currently use it	39	16.1		
		We have plans to start using it in the future	37	15.3		
		Total	*242*	*100*		
11.2	Current state of AI applications adoption "automated communications machine translation or chatbots"	We do not use it or have no plans to use it	142	58.7	34.02	0.00
		We currently use it	41	16.9		
		We have plans to start using it in the future	59	24.4		
		Total	*242*	*100*		
11.3	Current state of AI applications adoption "visual diagnostics face or image recognition (computer vision)"	We do not use it or have no plans to use it	126	52.1	18.01	0.00
		We currently use it	67	27.7		
		We have plans to start using it in the future	49	20.2		
		Total	*242*	*100*		

(continued)

Table 9 (continued)

No. of Q.	Question	Answer choices	Frequency	Percent	Chi-Square	Sig.
11.4	Current state of AI applications adoption “autonomous machines, such as smart and autonomous robots or vehicles”	We do not use it or have no plans to use it	116	47.9	21.81	0.00
		We currently use it	44	18.2		
		We have plans to start using it in the future	82	33.9		
		Total	*242*	*100*		
11.5	Current state of AI applications adoption “digital twins, e.g., product development/design customization/shop floor performance improvement/ logistics optimization”	We do not use it or have no plans to use it	125	51.7	17.81	0.00
		We currently use it	47	19.4		
		We have plans to start using it in the future	70	28.9		
		Total	*242*	*100*		
11.6	Current state of AI applications adoption “predictive maintenance, e.g., quality assurance”	We do not use it or have no plans to use it	103	42.6	3.47	0.17
		We currently use it	64	26.4		
		We have plans to start using it in the future	75	31.0		
		Total	*242*	*100*		
11.7	Current state of AI applications adoption “machine learning, e.g., fraud detection or risk analysis (anomaly detection)/forecasting, price optimization and decision-making using machine learning algorithms/generative design/inventory management”	We do not use it or have no plans to use it	118	48.8	16.07	0.00
		We currently use it	46	19.0		
		We have plans to start using it in the future	78	32.2		
		Total	*242*	*100*		
11.8	Current state of AI applications adoption “automated data analyst, e.g., price forecasting of raw material/process optimization/automated operational/efficiency analyst/predictive analytics/edge analytics”	We do not use it or have no plans to use it	103	42.6	3.39	0.18
		We currently use it	60	24.8		
		We have plans to start using it in the future	79	32.6		
		Total	*242*	*100*		

that they have plans to start using it in the future, while 19.4% are currently using it already.

- Predictive maintenance: The majority of the participants (42.6%) stated that they do not use it or have no plans to use it, and 31.0% of them stated that they have plans to start using it in the future, while 26.4% are currently using it already.
- Machine learning: The majority of the participants (48.8%) stated that they do not use it or have no plans to use it, and 32.2% of them stated that they have plans to start using it in the future, while 32.2% are currently using it already.
- Automated data analyst: 42.6% of the participants stated that they do not use it or have no plans to use it, 24.8% of the participants are currently using it, and 32.6% of the participants stated that they have plans to start using it in the future.

4.1.3 Descriptive Analysis for Independent Variables Questions

4.1.3.1 Frequency Testing

Three variables "independent variables" contain 13 sub-variables that affect the adoption of artificial intelligence in manufacturing organization in Bahrain were identified from literature review. Tables below identify the impact about each factor:

Technological Factor Analysis (Table 10)
In the technological factor for the "Incompatibility of an AI solution with an organization's legacy IT system or process," participants have strongly agreed (10.7%), and those who agreed were 34%, which is considered the highest, followed by neutral (32.6%), 20.2% of the participants disagreed, and finally 1.7% only for participants that strongly disagreed. The overall mean was 3.33 and the standard deviation is 0.971, which is below 1.0.

The "lack of IT competence or knowledge" is the second sub-variable, and 12.0% of the participants strongly agreed, while the majority of them agreed (34.7%), followed by 32.6% who were neutral, while 14.0% disagreed, and finally 6.6% only strongly disagreed. The mean here is 3.31 and the standard deviation is 1.067.

Organizational Factor Analysis (Table 11)
The organizational factor has nine sub-variables. The "lack of AI understanding" comes first in this analysis as 38.8% of the participants strongly agreed, while 45.5% of them agreed, followed by participants who were neutral (15.3%). None of the participant disagreed (0%) and only 0.4% strongly disagreed. The overall mean for this sub-variable is 4.22 and the standard deviation is 0.729.

The second sub-variable is "no or little prior AI experience" have indicated that 16.5% of the participants strongly agreed, and the majority agreed (34.7%). Neutral resulted 30.2%, which is slightly near to those who agreed (16.5%) disagreed and they are equivalent to the number of participant that strongly agreed, and 2.1% was the result for those whom strongly disagreed. The overall mean is 3.47 and the standard deviation is 1.019.

Table 10 Perspectives on factors of adopting artificial intelligence (independent variables – technological factors)

Variable	No. of Q.	Mediating variable	Statement	Frequency %					Total	Mean	Std. deviation	Chi-square	Sig.
				Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)					
Technological factors	13.2	Incompatibility of an AI solution with an organization's legacy IT systems or processes	AI technology is compatible to the existing operations of the organization	26 10.7%	84 34.7%	79 32.6%	49 20.2%	4 1.7%	242 100%	3.33	0.971	56.45	0.00
	13.4	Lack of IT competence or knowledge	The employees in the organization are competent (i.e., having the skills and the know-how) to use AI.	29 12.0%	84 34.7%	79 32.6%	34 14.0%	16 6.6%	242 100%	3.31	1.067	31.87	0.00

Table 11 Perspectives on factors of adopting artificial intelligent (independent variables – organization factors)

Variable	No. of Q.	Mediating variable	Statement	Frequency %					Total	Mean	Std. deviation	Chi-square	Sig.
				Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)					
Orginizational factors	8.0	"Lack of AI Understanding"	According on the given definition above? I know what artificial intelligence is	94 38.8%	110 45.5%	37 15.3%	0 0%	1 0.4%	242 100%	4.22	0.729	28.32	0.00
	13.3	"No or little prior AI experience"	The organization has an experience in implementing AI	40 16.5%	84 34.7%	73 30.2%	40 16.5%	5 2.1%	242 100%	3.47	1.019	39.19	0.00
	13.1	"No or little prior AI experience"	I think adopting AI solution will add value and benefit the organization	88 36.4%	112 46.3%	40 16.5%	2 0.8%	0 0%	242 100%	4.18	0.729	25.53	0.00
	15.2	"Change resistance"	I believe that there is a resistance to change in the organization in regards of adopting AI applications	31 12.8%	80 33.1%	76 31.4%	44 18.2%	11 4.5%	242 100%	3.31	1.055	40.32	0.00
	15.3	"Competing priorities"	Adopting AI technology is not a priority in the organization	34 14.0%	66 27.3%	78 32.2%	51 21.1%	13 5.4%	242 100%	3.24	1.100	24.69	0.00
	15.4	Lack of clear business case and strategy	The organization has a clear business case and strategy in terms of adopting AI technology	26 10.7%	82 33.9%	89 36.8%	37 15.3%	8 3.3%	242 100%	3.33	0.972	47.29	0.00
	15.5	"Top management support"	I believe that the "Top Management support" is a barrier to adopt AI application	26 10.7%	47 19.4%	70 28.9%	81 33.5%	18 7.4%	242 100%	2.93	1.121	35.25	0.00
	15.1	"Financial constraints"	I believe that cost of AI application is a barrier to adopt AI	65 26.9%	106 43.8%	61 25.2%	10 4.1%	0 0%	242 100%	3.93	0.827	39.23	0.00

Variable	No. of Q.	Mediating Variable	Question	Answer choices	Frequency	Percent	Chi-Square	Sig.
Orginizational factors	14.1	Resources constraints	What is the infrastructure needed to implement AI in your organization? Please select a maximum of three.	Machine learning or modeling skills	171	70.7	128.71	0.00
				Cloud computing skills	29	12.0		
				Big data management skills	24	9.9		
				Programming skills	5	2.1		
				Robotics skills	11	4.5		
				Other	2	0.8		
				Total	*242*	*100*		
	14.2		What is the infrastructure needed to implement AI in your organization? Please select	Machine learning or modelling skills	0	0	1.87	0.39
				Cloud computing skills	52	21.5		
				Big data management skills	60	24.8		
				Programming skills	46	19.0		
				Robotics skills	11	4.5		
				Other	0	0		
				Total	*169*	*69.8*		
	14.3		What is the infrastructure needed to implement AI in your organization? Please select	Machine learning or modeling skills	0	0	7.155	0.028
				Cloud computing skills	0	0		
				Big data management skills	35	14.5		
				Programming skills	48	19.8		
				Robotics skills	60	24.8		
				Other	0	0		
				Total	*143*	*59.1*		

The following sub-variable for this factor is "no or little prior AI experience" where participants responded (36.4%) strongly agreed, and the highest results are for those who agreed (46.3%). Neutral has 16.5%, and 0.8% of them disagreed and none strongly agreed (0%). The overall mean shows as 4.18 and the standard deviation is 0.729, which is equal to the "lack of AI understanding" sub-variable.

"*Change in resistance*" sub-variable resulted in 12.8% of the participants strongly agreed, 33.1% agreed, and slightly lower were neutral (31.4%). 18.2% disagreed and 4.5% only strongly disagreed. The overall mean is 3.31 and the standard deviation is 1.055.

"*Competing priorities*" sub-variable showed 14.0% of those who strongly agreed and agreed by 27.3%. Those who were neutral are the highest in this sub-variable (32.2%). Disagreeing participants were 21.1% and strongly disagreeing were 5.4%. The overall mean is 3.24 and the standard deviation is 1.100.

The sixth sub-variable is "lack of clear business case and strategy" that showed the result of 10.7% for those who strongly agreed and 33.9% agreed, neutral is slightly higher (36.8%). For those who disagreed resulted in 15.3% and strongly disagreed in 3.3%. The overall mean is 3.33 and the standard deviation is 0.972.

"Top management support" is the seventh sub-variable where participants strongly agreed (10.7%) and agreed (19.4%). Neutral resulted in 28.9%. The highest result was for those who disagreed (33.5%), while the lowest for those who strongly disagreed (7.4%). The overall mean is 2.93 and the standard deviation is 1.121.

With regard to "financial constraint" that showed that 26.9% of the participants that strongly agreed and the majority agreed (43.8%). The result for the neutral is (25.2%) and only (4.1%) disagreed, while none strongly agreed (0%). The overall mean is 3.93 and the standard deviation is 0.827, which is below 1.

The last sub-variable for this factor is "resources constraints" as it was measured on how frequent the participants chose the listed answers. Starting with participant who chose "machine learning or modeling skills" were 171 of 242 participants. "Big data management skills" was the second with 119 of 242 participants answer choice, followed by "programing skills" with 99 of 242 participants. After that, "robotic skills" had 82 of 242 participants and slightly behind with 82 of 242 participants was for "cloud computing skills" and only 2 answers of 242 participants for "Others."

Environmental Factors Analysis (Table 12)

The first sub-variable "Dependency on external help" showed (19.0%) of the participants strongly agreed followed by (33.1%) agreed, and the majority for those who were neutral (38.0%). (6.6%) disagreed and (3.3%) strongly disagreed. The overall mean is 3.58 and the standard deviation is 0.979.

The second and final sub-variable is "Legislation, regulation and compliance constraints" resulted in (12.0%) strongly agreed and the majority agreed (34.7%) and slightly lower was the participants who were neutral (32.6%). Participants who disagreed were 14.0% and strongly disagreed were 6.6%. The overall mean is 3.12 and the standard deviation is 1.013.

Table 12 Perspectives on factors of adopting artificial intelligence (independent variables – environmental factors)

Variable	No. of Q.	Mediating variable	Statement	Frequency %					Total Sig.	Mean	Std. deviation	Chi-square	Sig.
				Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Chi-Square					
Enviromental factors	15.6	"Dependency on external help"	There is a sufficient support from external entities (such as: Tamkeen government support programs, others) to support our organization in adopting AI	46 19.0%	80 33.1%	92 38.0%	16 6.6%	8 3.3%	242 100%	3.58	0.979	79.26	0.00
	15.7	"Legislation, regulation and compliance constraints"	"Legislation, regulation and compliance constraints" within the government are a barrier to adopt AI in your organization	29 12.0%	84 34.7%	79 32.6%	34 14.0%	16 6.6%	242 100%	3.12	1.013	91.16	0.00

Table 13 Participants' responses to general questions (role of AI in the COVID-19 pandemic)

No. of Q.	Question	Statement	Frequency % Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)	Total
17	Role of AI during the COVID-19 pandemic	I see that COVID-19 has a role to impact AI adoption?	37 15.3%	92 38.0%	50 20.7%	35 14.5%	28 11.6%	242 100%
18		I think that adopting AI in your organization will improve the operation during COVID-19	30 12.4%	111 45.9%	62 25.6%	21 8.7%	18 7.4%	242 100%

4.1.4 Descriptive Analysis for Questions of COVID-19 (Table 13)

In questions 17 and 18, it is examining the role of COVID-19 in adopting AI, as well as the role of the artificial intelligence during the pandemic COVID-19, and how can artificial intelligent can facilitate the work in the organization in current situation. Therefore, 15.3% of the participants strongly agreed on that COVID-19 has a role in adopting artificial intelligence, while the majority of them agreed (38.0%), followed by 20.7% who were neutral, while 14.5% disagreed, and finally, 11.6% only strongly disagreed.

Moreover, 12.4% of the participants stated that they strongly agree that artificial intelligence will improve and facilitate the operation during the pandemic, while the majority of them agreed (45.9%), followed by 25.6% who were neutral, while 8.7% disagreed, and finally, 7.4% only strongly disagreed.

4.2 *Empirical Study and Testing of Hypothesis*

Regression analyses used to explain the relationship between "Adoption of Artificial Intelligence in Manufacturing Organization in Kingdom of Bahrain" and the independent variable factors, which are technological factor, organizational factors, and environmental factor to test hypotheses. Furthermore, Chi-square test was used to confirm the result of the variables.

The follow model used for the testing:

$$\text{IMOB} = \alpha + \beta_1 \text{TF} + \beta_2 \text{OF} + \beta_3 \text{EF} + \varepsilon_i$$

where:

AAIMOB = Adoption of artificial intelligence in manufacturing organization in the Kingdom of Bahrain
α = Constant
β (1–4) = $/OP
ε_i = random error

The regression results are shown in Table 14:

As shown above, empirical testing model was used, and the results of *F*-statics test and constant have proven that the model is valid in Bahrain since the (sig. 0.000 < 0.05).

R is 94.8% reflects a positive correlation between the dependent variable between "Adoption of Artificial Intelligence in Manufacturing Organization in Kingdom Of Bahrain" and the independent variables factors, which are technological factor, organizational factor, and environmental factor.

R Square (*R*2) is 89.9% measure the aggregate intensity of the relationship and the variance ratio in the dependent variable "Adoption of Artificial Intelligence in Manufacturing Organization in Kingdom Of Bahrain," which can be clarified by the independent variables: technological factor, organizational factor, and environmental factor in the regression model.

Moreover, to confirm the result of each it was used Chi square, and it noticed that the result all frequency is less than 5%, that mean there is a high correlation between the dependent variables and independent variable (Table 15).

Table 14 Results of multiple regression analysis

Variable	β	*T*-Test	Sig.
(Constant)	0.274	3.296	0.001
Technological factors (H1)	0.001	0.044	0.965
Organizational factors (H2)	0.082	2.980	0.003
Environmental factors (H3)	0.754	45.568	0.003
F			702
Sig.			0.000
R			94.8%
R^2			89.9%

Table 15 Results of testing hypothesis

Main hypotheses	Sig.	Result
H1: Technological factor serves as a significant barrier for AI adaption among manufacturing organizations on the Kingdom of Bahrain.	0.965 > 0.05	Reject
H2: Organizational factor serves as a significant barrier for AI adaption among manufacturing organizations on the Kingdom of Bahrain.	0.003 < 0.05	Accept
H3: Environmental factor serves as a significant barrier for AI adaption among manufacturing organizations on the Kingdom of Bahrain.	0.003 > 0.05	Accept

4.2.1 Testing First Hypothesis

It is worth noting that the results of the literature review have demonstrated the crucial position of the "technological factor" according to Haider (2020a, b), Chris Messom et al. (2019), Duke (2019), Medagliaand Sun (2018), and Dremel (2017). The authors have discussed that the companies have to improve the limited technology capabilities they have, provide a sufficient data and development of a big data analytics competence, and provide accessible data sources and unified IT landscape.

Given the findings of the literature review, "technological factor" was a key element where respondents that the need for the technology infrastructure for adopting the artificial intelligence is so essential. The majority of the respondents to the survey agreed for the need for adopting such AI applications to compatibility of an artificial intelligent solution with the system and process of the organization. Also require for an IT competence in staff has a strong knowledge in the IT. This hypothesis for the factor of "technological factor" was rejected due to a high significance value (H1 > 0.5), and according to Beta's statistical finding that had the lowest Beta results (0.001) among the other two variables, this adverse view can be justified by the fact that this factor is not a big dilemma for adopting AI, because the organization can come up with an easy solution if they have the intention for the adoption, such as providing a good IT structure and hiring employees with good experience in IT. So, this factor does not affect the adoption of artificial intelligence in manufacturing organizations in the Kingdom of Bahrain.

4.2.2 Testing Second Hypothesis

As for "organizational factor," respondents have reported a positive correlation between this aspect and adoption of artificial intelligence on manufacturing organization in the Kingdom of Bahrain.

More precisely, the statistical findings (Beta) have put the organizational factor component at the second level in terms of its positive effects in adoption of artificial intelligence in manufacturing organization in Bahrain with a rate of 0.082.

Author (Haider, 2020a, b) have addressed the barriers that faced the organizations to adopt artificial intelligence, and it found that the major barriers are cost, investment, trust issues, employment, and skills set. Chris Messom et al., (2019) found that the lack of leadership support, security concerns relating to AI adoption, and employee fear of change are the main challenges facing the organizations to adopt artificial intelligence. Moreover, Cubric (2020) has added that he found the lack of knowledge and trust and stakeholder's perspective and safety are major barriers faced to adopt the artificial intelligence. Moreover, Dremel (2017) agreed to the other authors' finding and added that barriers to adopt artificial intelligent are the lack of skilled resources, lack of collaboration between departments, and lack of appropriate organizational structure.

4.2.3 Testing Third Hypothesis

Respondents classified “environmental factor” as the first most important factor affecting the adoption of artificial intelligence in manufacturing organization in Bahrain with beta (0.754). This optimistic impression may have arisen from the strong need of the external need from the government to support the manufacturing organization to ease the adoption of AI, such as funds, free training courses for their employees, etc.

Despite the finding from the literature review, most of the authors have not addressed the “environmental factor” as a barrier to adopt the artificial intelligence. One of the minorities stated that political legal and policy, and economic, are challenges to consider to adopt artificial intelligence (Medaglia & Sun, 2018).

4.2.4 Multiple Regression Result Summary

Multiple regression analyses tested the validity of each of the three hypotheses. The three hypotheses are based on the variables that affect the adoption of artificial intelligence in manufacturing organization in the survey measuring the participants’ opinion about if the factors are considered as a barrier to them in adopting artificial intelligence within their organization.

A definite conclusion on the research hypothesis can be drawn based on the results of the multiple regression analysis, and on the basis of the parameters for the dependent variables, the significance was greater than 0.05 in relation to “technological factor” and that this variable does not have a statistically significant relationship to adopt artificial intelligence. The results, however, showed less than 0.05 for “organizational factor” and “environmental factor.” These variable hypotheses were accepted, implying that there is a statistically significant correlation between each of these factors and the adoption of artificial intelligence in Bahrain’s manufacturing organizations.

5 Conclusion, Recommendations, and Future Research

5.1 Conclusion

The research has begun with the explanation of the concept of AI and its ability to interface a new situation and adopt a strategy to create something new in intelligence way based on the behavior of humans to solve complex and simple problems.

Furthermore, several case studies have been discussed and scenarios of adopting of artificial intelligence technology in organizations in several sectors have been discovered, then in the manufacturing sector in particular. It was found that artificial intelligence used in manufacturing organizations are for the purpose of solving problems, analyzing the data, product design, predictive maintenance, and controlling inventories. Which can assist the organizations to have better optimize, monitor, and control their system and physical operations. In addition, AI helps the top management and concerned leaders to have better decision making; hence it will increase the efficiency and the productivity of the organization.

It was noticed through the research that the percentage of artificial intelligence adopter in manufacturing organizations in Bahrain is low (31.8%). Moreover, the most AI application used are visual diagnostics face or image recognition application (27.7%), predictive maintenance. (26.4%), and automated data analyst (24.8).

Lastly, as mentioned in chapter "Internet of Things for Healthcare: Evaluate User's Acceptance and Sustainability During Pandemics", the theoretical model is consist of three main barriers that can affect the adoption of artificial intelligence in manufacturing organizations, and after analyzing the survey results, it was noticed that the "technological factor" is not a barrier to adopt artificial intelligence, and it can overcome it easily. On the other hand, the "environmental factor" has the most influence on decision-makers to adopt the artificial intelligence as the beta is 0.754.

5.2 Recommendations

5.2.1 In Organizational Context

It is worth saying that adopting artificial intelligence in any sector will definitely return with a significant benefit in the long-term future, and the production cost will be cheaper, so the final products will cost less.

- Investing in artificial intelligence to be considered by allocating a percentage from the organization's capital or from the net profit to use it in artificial intelligence.
- To employ the right AI application, the top management has to identify their need and their problems that need for AI solutions and explore how these applications will occur the crucial change and benefit the organization in general. All this is achieved by building a clear strategy by the top management.
- The organization has to invest in building a good IT infrastructure eligible for AI usage in the future.
- Hiring an expert or employees with high qualifications in IT is required in each organization.

5.2.2 In Environmental Context

- It is recommended contribute private companies support the organizations to adopt AI. By offering a consultation guiding them for an ideal way to adopt AI based on their status of the organization.

- For those who require extra support, it is suggested that the private companies offer a customized program for each organization taking their hand from the zero levels, by understanding their process and examining the current status, and accordingly build a proposed plan in the know-how of implementing AI.

On the other hand, based on the finding of the research, government support has a prime role in encouraging the organizations in Bahrain to adopt artificial intelligence. Accordingly, the following are recommended:

- Bahraini government has to invest in the education of artificial technology in schools and universities to raise a new qualified generation in artificial intelligence (Badawi et al., 2019).
- Arrange awareness campaigns or seminars for top management of the organizations.
- Offer a free training courses and education to the technical workers that will assist in proper integration of artificial intelligence adoption within the organization (Hamdan et al., 2020).
- Offer funding packages support with subsidies for the AI machineries from Tamkeen for all organizations that have a full plan for adopting artificial intelligence.

5.3 Future Research Suggestion

The current study aimed to investigate the artificial intelligence adoption in manufacturing organizations in the Kingdom of Bahrain and identify the factors that considered a barrier to adopt artificial intelligence. Based on the study's findings and conclusions, the researcher might conclude that further research is required to address some of the gaps in this field of study, as below:

- To undertake future studies by investigating the barriers that were faced by the organization in other sectors in Bahrain
- Study of the impact of each artificial intelligence application on the organizations such as robotics, machine learning, etc.
- Figure out an efficient clear strategy can that organizations adopt to assist them in adopting artificial intelligence in a clear way without any doubt.

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The Impact of Teaching Artificial Intelligence Concepts and Tools in Improving Creative Thinking Skills Among Talented Students

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1 Introduction

The world today is moving toward preparing students with twenty-first-century skills that revolve around four important skills: creative, critical thinking skills, cooperation, and communication (4C skills). These skills are the concentration of keeping pace with the technical acceleration and the explosion of knowledge. Creative thinking comes among these four main skills and receives wide attention by educators. According to Crumpler (2021), creative thinking involves some actions like transforming a concept into fresh information to discover novel and improved items. The International Encyclopedia of the Social and Behavioral Sciences (2015) states that creative thinking is more likely when there is the right quantity of information available – more knowledge isn't necessarily better – and when the person is aware of how to use the information. It is also defined as the collection of abilities that allow a person to generate original ideas and evaluate them in a distinctive way. These abilities need continual practice to stay sharp and focused, as well as the use of different thinking strategies to improve the mentality necessary for the generation of novel and creative ideas (Tabieh et al., 2021).

Addressing the problem is the first step in the scientific activities that make up the creative thinking process, followed by gathering information about it. Then, the next steps are identifying different alternatives to the solution, testing alternatives to produce new knowledge by combining concepts and finally evaluating ideas and making decisions.

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One of the most important components and indicators of creative thinking is a person's skills of fluency, flexibility and originality. In light of this, creative thinking can be defined as a complex cognitive process aimed to improving ideas or producing new ideas. This study defines creative thinking as the ability to produce new solutions to problems, namely, how to think about the issue from different angles, using the right tools to evaluate them and make decisions, measured by the creative thinking skills test.

Since creative thinking has been considered the driving force behind all human progress (Saggar et al., 2017), the relationship between creativity and innovation is important. This means that curriculum developers must work to develop creativity by promoting curricula with fourth industrial revolution innovations such as the big data and artificial intelligence. This study focused on artificial intelligence, concepts and tools, to examine the impact of its teaching on the development of creative thinking skills, especially fluency, flexibility and originality.

John McCarthy coined the phrase "artificial intelligence" in 1956, and since then many theoretical concepts of artificial intelligence have emerged. Baker and Smith (2019) defined artificial intelligence as follows: Cognitive computing refers to machines that do tasks that are typically associated with human minds but that do not notably learn or solve problems. In order to emulate human intelligence, AI research and development have initially concentrated on the concepts of encoding human thought, and subsequently on "expert systems," which simulate expert procedural decision-making based on specific knowledge rules (Williamson & Eynon, 2020).

After 2010, artificial intelligence gradually returned to a new model that emerged, not as human intelligence, simulation software or expert systems, but as data processing systems that could learn and predict a particular classification. In addition, they can link huge amounts of big data and calculations including data analytics, machine learning, neural networks, and deep learning, and enhanced learning focuses not on creating (super-intelligence) but on developing machines that can learn from their own experience, adapting to improve its performance and creating a new decision-making algorithm (Williamson & Eynon, 2020).

According to this study, artificial intelligence (AI) refers to computerized systems that are capable of thinking like humans do, including learning, adapting, classifying, self-correcting, and using data for complex processing tasks that typically call for human intelligence, like visual perception. Zawacki-Richter et al. (2019) suggests that some important foundations have been laid to classify the field of artificial intelligence into three key types: basic artificial intelligence, with the aim of exploring computational techniques to simulate intelligent behavior, and applied artificial intelligence. This is interested in using current AI techniques to build products for use in the real world, and cognitive science, focusing on studying human or animal intelligence through different means.

The importance of the study lies in the fact that it provides a general framework for teaching basic artificial intelligence its concepts and tools at the core stage, which may benefit technology teachers, curriculum designers and developers.

The study links creative thinking skills to artificial intelligence in the fourth era of industry and education, fostering talented and programmatically superior programs.

2 Literature Review

2.1 Artificial Intelligence

The concept of artificial intelligence can be customized to systems that automatically perform tasks that are pre-trained and originally programmed to accomplish them. Also, these systems implement different algorithms in achieving their goals. We can define artificial intelligence (AI) as computing systems capable of engaging in human-like processes such as learning, adaptation, synthesis, self-correction and data use for complex processing tasks (Popenici & Kerr, 2017). Machine learning and deep learning have made it possible for artificial intelligence to learn on its own from large data sets (Aggarwal, 2018). Algorithms, machine learning and artificial neural networks are thus the three most crucial terms in artificial intelligence. The idea of algorithms initially came to an end in 1996, while the Google founders were still Stanford University students (Holmes et al., 2019). Recently, several trends have emerged in the search for artificial intelligence technologies and their applications on the one hand and AI concepts and related concepts on the other, such as studying the impact of artificial intelligence AI on teaching and learning. It is worth mentioning that higher education reveals the progress of AI capabilities to replace teachers with machines (Chassignol et al., 2018).

A study by Panigrahi and Joshi (2020) aimed to understand the extent to which AI is used in education and its expected benefits. He also provided examples of the use of artificial intelligence in education. This explores India as one of the developing countries, where education for all is seen as one of the sustainable development goals. Qian and Feng (2020) study stated that the great development of deep learning makes machine performance brain-like. The integration of artificial intelligence and education has become an inevitable trend for development. Hence the idea of the current study to study the impact of teaching AI concepts and tools in developing skills creative thinking for ninth graders as the first daughter in integrating AI into education. Seren and Ozcan (2021) aim to uncover methods that can contribute to increasing the efficiency of distance education and whether human education can be left to machines. Several studies discussed the type of attitudes that would be faced if such a system was used, and the results indicated that the use of AI-based education must be thoroughly considered by all parties involved and must be done so for the benefit of people.

Additionally, Bonami et al. (2020) aimed to provide definitions and discussions on artificial intelligence, big data from an academic point of view, or through what international organizations have published. The examination of education through the development of twenty-first-century skills and the influence of AI in the platform age is proposed in this study, subject to three systematic considerations: research, application, and assessment. As the same point, Popenici and Kerr (2017) explore the use of artificial intelligence in teaching and learning in higher education and also examine the educational implications of new technologies on the way students learn. In addition, we investigate how institutions teach and develop in their employment and how modern technological developments are explored. Apparently, the growing rate at which new technologies are incorporated into higher education in order to forecast how higher education would develop in a setting where artificial intelligence is ingrained in universities. The study identified some of the challenges facing higher education institutions and educated students in adopting these techniques to teach, learn, and support students and management.

In the same regard, Azid and Md-Ali (2020) conducted an experimental investigation utilizing mixed analysis to investigate the efficacy of the successful AI unit (SIIM) that employs thinking abilities. Additionally, University Utara Malaysia students' analytical, practical, and creative thinking skills were to be improved through the development of this interactive unit. The qualitative research methodology was utilized to attain this aim by posing an open question to a sample of professors in order to discuss the prospective effects of AI on higher education at Prince Sattam Bin Abdul Aziz University (Aldosari, 2020). The findings indicated a decline in knowledge of the methods used to use AI and the need to further spread knowledge about the potential applications of AI in education in Saudi Arabia.

In light of the results of previous studies, the current study relies on a training program designed by the researchers that aimed at spreading the culture of AI and integrating it into education. The program provides training in AI concepts such as machine learning, deep learning, features, patterns, data sets, and decision-making and on tools to apply these concepts: machine learning for kids, coinmates, and Google's teachable machine.

2.2 Creative Thinking Skills

With global variables, the world is moving toward preparing twenty-first-century students with the necessary knowledge and skills. Creative thinking and criticism are the most important features of a student's personality for the twenty-first century. These lead us as teachers to think about how to enhance teaching practices with thinking skills. In addition, when we understand that young learners are already active in the learning process before entering school, the use of creative and critical thinking skills as part of learning instructions becomes necessary (Netto-Shek, 2017). These thinking skills are at the heart of the education field, with many studies on how to develop these skills and how to improve students' attitude according to thinking skills. In the same regard, Wijayati et al. (2019) aim to improve the ability to think creatively, make thermodynamics devices, and make fuel oil from plastic waste. This study is a hands-on, classroom study that was carried out in three cycles, each of which had four stages: observation, process, re-observation, and reflection. Moreover, Netto-Shek (2017) argued for teaching thinking to young learners, especially in English lessons, to be educated in the twenty-first century. This paper explained how thinking skills should be contextual in authentic children's literature as a means of modeling thinking frameworks and good thinking. Furthermore, Putri et al. (2019) aimed to study improving the creative thinking skills of elementary school students in science through project-based learning (PBL). Use this quasi-experimental research with the design of an unequal control group. The study included (45) fifth graders at a public elementary school in Karawang, West Java.

In the light of these studies, this study seeks to combine the novelty of the field of artificial intelligence in its teaching among students of general education schools with the authenticity of thinking skills in terms of refinement and development. It aims to examine the impact of teaching the program on the concepts and tools of artificial intelligence on the development of creative thinking skills in line with studies that have studied several programs and strategies to develop these skills.

3 Study Objectives

- Detecting the impact of teaching artificial intelligence concepts and tools on creative thinking skills among talented students
- Identifying the significant differences between the talented students in the test of creative thinking skills

4 Study Importance

- It offers a broad framework for instruction. Artificial intelligence concepts and tools at the basic stage that benefit technology teachers, curriculum designers, and developers.
- The study presents a test to measure creative thinking skills that benefits interested and researchers in graduate studies.

5 Study Limitations

The research was carried out during the academic year (2020–2021), on a group of (25) ninth-grade talented students from three education directorates: West Gaza, East Gaza, and East Khan Younis.

6 Study Terms

- *Artificial intelligence concepts*: AI is related to concepts of intelligence agents, machine learning, deep learning, machine training, information, decision-making, and programming principles, which used to design the unit.
- *Creative thinking skills*: In this study, fluency, flexibility, and originality skills are intended for the student to be able to produce the largest number of ideas, adapting them to reality and the uniqueness of these ideas measured by creative thinking skills test.

7 Research Methodology

7.1 Research Aim

With the requirements of the twenty-first-century students with critical and creative thinking skills, it becomes a challenge in the field of education to prepare students with the knowledge and skills necessary to actively engage in their communities to keep pace with the new development in the fourth technical revolution and develop its concepts and tools in the hands of students to enable them to employ them effectively in solving their problems and those of their communities; in this context comes to link creative thinking skills as the most prominent skills of the twenty-first century with the most important innovations of the fourth technical revolution, namely, artificial intelligence. By examining the impact of teaching AI concepts and tools on the development of creative thinking skills among talented students, the problem was presented in the following major question:

What is the impact of teaching artificial intelligence concepts and tools on improving creative thinking skills among talented students?

It has the following sub-questions:

- Are there statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean score of the creative thinking skills of the experimental group students in the pre- and post-applications of the creative thinking test?
- Are there statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean scores of the creative thinking skills of the male and female students in the post-applications of the creative thinking test?

7.2 Study Hypotheses

- There were no statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean scores of the scientific of the experimental group students in the pre- and post-applications of the creative thinking test.

- There were no statistically significant variations at the level of ($\alpha \le 0.05$) between the mean scores of the creative thinking of the male and female students in applications of the creative thinking test.

7.3 Study Design

The research employed a descriptive and quasi-experimental methodology (the design of one group pre-post). The study's training program for teaching artificial intelligence concepts and tools was built using a descriptive approach, while the research experiment was designed according to the quasi-experimental approach for one experimental group of 25 ninth-grade talented students distributed among three education areas (West Gaza, East Gaza, and East Khan Younis). Students were selected intentionally based on their GPA and programming skills examined by the Programming Skills Test.

7.4 Data Collection

Reviewing literature and studies to assess creative thinking skills. The tested skills were determined by fluency, flexibility, and originality, the test was made of seven questions, and after the test was processed in its final form, it was adjusted and applied to the experimental group before the application of the program designed according to task-based learning (TBL) and applied remotely via Zoom and Google classroom and after the implementation of the program. The results were compared (pretest with post-test) to determine the impact of teaching the AI concepts and tools program on the development of creative thinking skills among students of the experimental group.

7.5 Validity and Reliability

To verify the validity of the test, the test was presented to a group of curriculum professors and methods of teaching science and technology to adjust the test and make the necessary adjustments. To confirm the internal consistency of the test, the researchers calculated the correlation factor between the paragraph grades and the overall degree of the test, and the results came as follows (0.851, 0.741, 601, 0.700, 0.829, 0.770, 0.455); all correlation transactions were statistically significant at the semantic levels (0.01, 0.05) and to verify reliability, the researchers calculated Cronbach's alpha coefficient, which was worth (0.786) as a result of the researchers' finding that the test was valid and reliable.

7.6 Analysis of Data

The data collected through the study tools was analyzed using the SPSS Statistical Package for the Social Sciences Version (23):

- The Kolmogorov-Smirnov test was examined to verify the natural distribution of the data, and the test showed that the population sampled was usually distributed.
- To evaluate whether the difference between the pre- and post-test was significant, a paired sample *t*-test was performed, and the value of η^2 was computed to determine the effect volume of teaching artificial intelligence concepts and tools. The independent sample *t*-test was conducted to determine if the difference between the female students' results and male students' results was significant.

8 Results and Discussion

8.1 Results

8.1.1 Results of Question 1

Are there statistically significant variations at the level of ($\alpha \le 0.05$) between the mean scores of the creative thinking skills of the experimental group students in the pre- and post-application of the creative thinking test? The hypothesis is as follows: There were no statistically significant variations at the level of ($\alpha \le 0.05$) between the mean scores of the scientific of the experimental group students in the pre- and post-applications of the creative thinking test.

In the creative thinking skills test, students pre- and post-test results varied significantly at level ($\alpha = 0.01$) as shown in Table 1. Pre experiment, the average student score was (30.04) after teaching the artificial intelligence unit using the (TBL) technique, average students score it increased to (57.40), to determine the effect size the value of η^2 was computed as shown in Table 2. The values of η^2 for all the

Table 1 Paired sample *t*-test between the pre- and post-test results

Scientific practices	d*f*	Test	Means	S. D	*t*-test	sig
Fluency	24	Pre	14.04	4.523	12.001	0.001
		Post	27.92	4.636		
Flexibility	24	Pre	9.76	2.204	10.067	0.001
		Post	16.52	2.874		
Authenticity	24	Pre	6.24	2.666	11.440	0.001
		Post	12.96	1.904		
Total degree	24	Pre	30.04	8.956	12.144	0.001
		Post	57.40	8.958		

Table 2 Effect size η^2 of teaching AI concepts and tools in improving creative thinking skills

Scientific practices	*t*-test value	t^2	d*f*	η^2
Fluency	12.001	144.024	24	0.85716
Flexibility	10.067	101.3445	24	0.80852
Authenticity	11.440	130.8736	24	0.84503
Total degree	12.144	147.4767	24	0.86003

Table 3 Independent sample t-test between males' and females' pretest results

Scientific practices	d*f*	Test	Means	SD	*t*-test	sig
Fluency	14	M	13.07	2.702	-1.220	0.235
	10	F	15.27	6.051		
Flexibility	14	M	9.57	1.604	-0.475	0.639
	10	F	10.00	2.864		
Authenticity	14	M	5.36	1.985	-1.978	0.060
	10	F	7.36	3.075		
Total degree	14	M	28.00	5.588	-1.303	0.205
	10	F	32.64	11.775		

creative thinking skills measured were all more than (0.14) with total effect size (0.85). This implies that teaching artificial intelligence concepts and tools has a significant impact among talented ninth-grade students' ability to think creatively.

8.1.2 Results of Question 2

Are there statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean scores of the creative thinking of the male and female students in the post-applications of the creative thinking test? The hypothesis is as follows: There were no statistically significant variations at the level of ($\alpha \leq 0.05$) between the mean scores of the creative thinking of the male and female students in the post-applications of the creative thinking test.

To examine this hypothesis, the experimental group is divided into males and females, and the pretest results were compared. This is to verify the equality of the two groups, as indicated in Table 3. There were no significant variations between the average scores of the male and female students in the pre-application of the creative thinking test. Also, there were no significant variations in the average scores of each skill between male and female students, to examine the impact of the program interaction with gender. The results of post-test were compared, as shown in Table 4 that there were no significant variations between the average grades of the two groups, which means that the program has an effective impact in improving creative thinking skills among male and female students with the same effect.

Table 4 Independent sample t-test between males' and females' post-test results

Scientific Practices	*df*	Test	Means	S. D	*t*-test	sig
Fluency	14	M	27.64	5.372	−0.331	0.744
	10	F	28.27	3.717		
Flexibility	14	M	16.21	3.191	−0.592	0.560
	10	F	16.91	2.508		
Authenticity	14	M	12.71	2.431	−0.721	0.478
	10	F	13.27	0.905		
Total degree	14	M	56.57	10.545	−0.514	0.612
	10	F	58.45	6.773		

8.2 Discussion

This study discussed the impacts of educating artificial intelligence concepts and tools among talented ninth graders' ability to think creatively. The study findings indicated that teaching an artificial intelligence concepts and tools unit has a favorable effect on boosting the average score of gifted students' capacity for creative thought. The findings of the study that creative thinking abilities can be enhanced are consistent with research. Wijayati et al. (2019) demonstrated that students' typical modes of thought are increasing significantly in terms of both fluency and elaboration, and Putri et al. (2019) study findings that demonstrated that students in the experimental group had better creative thinking abilities than those in the control group. It may be concluded that project-based learning (PBL) can successfully boost creative thinking skill of primary school pupils in science class. The Connecting, Organizing, Reflecting and Extending (CORE) learning paradigm is helpful in fostering students' capacity for creative thought. In addition to Saregar et al. (2021) study which showed that the (Connecting, Organizing, Reflecting, and Extending) CORE learning model, is effective in enhancing students' creative thinking skills with Effect Size (0.48), which is in the medium category. Meanwhile, a study by Aytaç and Kula (2020) found that (SCA) is a significant variable that has a good impact on pupils' capacity for creative thought (CTS). The project brief has a positive impact on creative thinking abilities, according to Habibi et al.'s (2020) study. When compared to the lecture strategy, the fluency indicator has the largest average effect, which is (15.7), as well as the average of (9.89) and the lowest on the originality indicator. According to Tabieh et al. (2021), the experimental group students' learning of fluency, one of the three creative thinking skills was impacted by the narrative technique. While the research of Rumahlatu et al. (2021) demonstrated that the resource-based learning design thinking (RBLDT) learning model has an impact on creative thinking abilities, idea acquiring, and digital literacy of students in the class (XI) senior high school on the topic of animal tissue ($p < 0.05$). The (RBLDT) learning model syntax can enhance students' conceptual learning, critical thinking, and digital literacy more effectively than RBL or DT used alone.

According to this study, the improvement of creative thinking skills may be attributed to the nature of content in the first place, which is considered attractive content belonging to the world of digital students and falls within the areas of their curiosity and interest. Additionally, the design of instruction with learning based on tasks puts students in a constant state of thought and frees up space for them to express and share their ideas with their peers. Researchers found no significant differences in students' learning abilities or curiosity towards acquiring and employing new knowledge in the digital world. While their abilities vary in technology, the passion for artificial intelligence in both teams is in similar proportions.

9 Conclusion

Artificial intelligence is one of the most important sciences that resulted from the Fourth Industrial Revolution. This study aimed to verify the impacts of teaching artificial intelligence its concepts and tools on their thinking skills and creativity in particular. Results showed the positive impact of teaching artificial intelligence concepts and tools on the creative thinking skills of the targeted students. Study tool's pre- and post-applications favor post-applications. Results also showed that there are no gender-based disparities in how the program affects pupils' ability to think creatively. Considering the findings, the study is considered an important study in introducing the concepts of artificial intelligence and its tools among students and examining their impact in improving some variables due to the novelty of artificial intelligence on the one hand and the specificity of the target group on the other hand.

10 Recommendations

1. Integration of artificial intelligence concepts and tools in school curricula for all stages
2. Training teachers on teaching artificial intelligence concepts and tools
3. Designing content with spiral width for the concepts of artificial intelligence and teaching it using active methods

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Part II
Digitalization Towards Improved Sustainable Business, and Society

Digital Risk in International Business Management and Allied Areas in India, the UAE, and Austria

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1 Introduction

The emergence of a new digital research frontier has occurred at the same time that international business (IB) has undergone significant transformation (Hennart, 2019). Companies operating on a global scale that are connected digitally have access to a wide variety of new opportunities, including the ability to obtain global resources, reach customers located in other countries, and improve global operations. However, top executives in companies must remember not to minimize the dangers that come along with these opportunities. Multinational corporations prioritize risk management. The IB disregarded the dangers that could be posed by digitization and instead concentrated on the dangers that could arise from politics, finances, and transactions (Rugman, 2009). IB researchers have to ask themselves a lot of questions because there is a need for additional research into digital threats.

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1.1 Research Objectives

The digitalization of industry is the fourth major industrial revolution. Connectivity to the digital realm may differ between nations, sectors, and companies as a result of international geopolitics, public health crises, and sluggish economic growth around the world. Multinational corporations (MNCs) both enable and benefit from increased connectivity, which transforms international business. Because digital connections can be used across national boundaries at a lower cost than traditional internet protocol (IB) connections, they are only available in certain countries. The new era of international business is dominated by digital global connectivity, which also serves to address growing levels of uncertainty. The process of digitization is fraught with numerous dangers, and despite its importance to business on a global scale, it has received little attention, either theoretical or empirical.

Risk management assumes that physical goods, services, investments, and capital flowed through tangible barriers. Intangible barriers to instant flow of ideas, data, and knowledge are decreasing. Figure 1 shows the actions MNCs must take individually and collectively to avoid digital risks. These actions include developing, deploying, and harnessing digital intelligence for local adaptation, transnational resilience, and global orchestration of digitally enabled cross-border activities. This paper discusses international business and related digital risks.

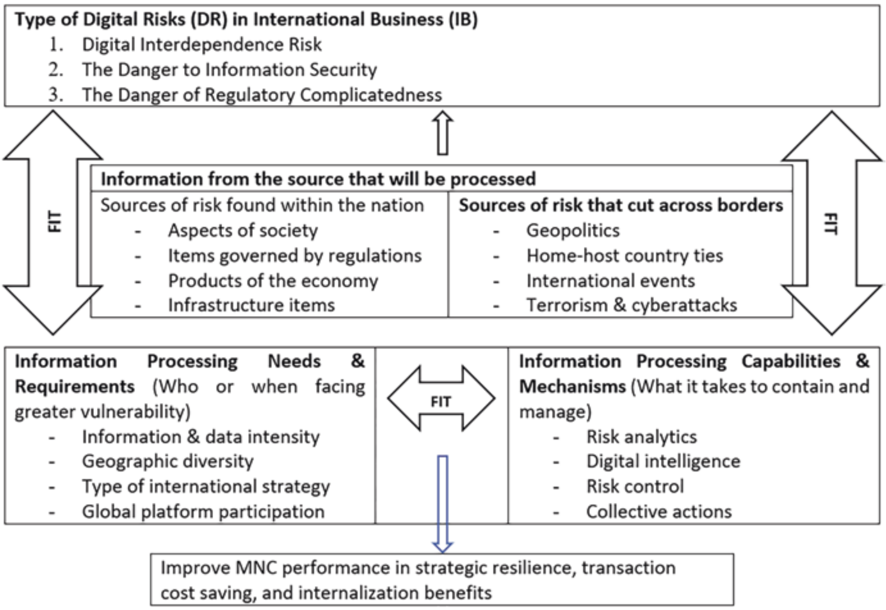

Fig. 1 A framework for the processing of information regarding IB digital risks. A comprehensive outline of the dangers posed by digitization (Information obtained from Yadong Luo in 2022)

1. *Identify* the key determinants to predict digital risks based on their feature importance.
2. *Design* artificial intelligence quantitative and qualitative models to address the risk features.
3. *Suggest* strategies for MNCs to effectively handle the business risks as a value-added proposition.

This study has five sections, including the introduction. Section 2 reviews the literature on digital risks, including types, sources, interdependencies, and information-processing needs and capabilities. Section 3 describes the framework, methodology, and data. Section 4 analyzes digital risk factors. Section 5 discusses limitations and future research (along with acknowledgment, contributions by authors, and conflict of interest, with source of funding for the research).

2 Literature Review

In this research, we apply Luo's framework to business firms in economic blocks like BRCS (Brazil, Russia, China, and South Africa), GCC (Gulf Cooperation Council), EU (European Union), and QUAD (Australia, Japan, and the United States) in general and India, the UAE, and Austria in particular to predict business risks that have been scantly researched by researchers.[1] Figure 1 presents Luo's model for the management of digital risks in multinational corporations (multinational companies). The theory of information processing, which states that information-processing systems deal with work-related uncertainty, serves as the theoretical foundation for the framework.

The framework emphasizes the most important points. First, the complexity of operational tasks and the requirements for information processing are both increased by digital threats. Second, the level of digital risk that is posed by multinational corporations varies according to the nature of their businesses and the requirements of their information systems. Those who have access to a significant amount of information and data, a geographically diverse user base, and participate on global platforms are at risk. Third, multinational corporations (MNCs) have the ability to manage these requirements by enhancing their information-processing capabilities. Some examples of these capabilities include risk analytics, digital intelligence, risk control, and collective actions. The management of digital risk necessitates an alignment between the requirements and capabilities of information processing and the nature of digital risk. This fit has an effect on efficiency and cost because multinational corporations are sensitive to the disruptions that digital technology causes. The field of information-processing theory places a greater emphasis on the

[1] For an excellent explanation of various digital risks, its sources, and how to manage them, please see Luo (2022).

information-processing mechanisms and capabilities of organizational design than does the field of transaction cost economics.

2.1 Digital Interdependence Risk

This results in unanticipated communication breakdowns, contagions, and interruptions between a focal multinational corporation (MNC) and its worldwide business partners, vendors, suppliers, distributors, customers, and corporate members. The global financial crisis of 2008 demonstrated how rapidly contagion can spread via links between capital markets. Businesses become more dependent on digital connections and platforms as a result of digitization, which also enables multinational corporations to better respond to unforeseen disruptions and difficulties (e.g., COVID-19 pandemic). The new era of IB is characterized by digital global connectivity, which is both a defining trait of this era and an essential catalyst for addressing new challenges and unknowns. How companies handle digital risk avoidance for their global operations varies greatly from one another.

2.2 Global Information and Cybersecurity Risk

Financial loss or other harm from a multinational corporation's fragile information and communications systems can lead to cyberattacks or data breaches. Customers worldwide are hesitant to use digital outlets that do not protect their personal information. They want the highest level of security, availability, reliability, and performance (Nambisan et al., 2017; UNCTAD, 2015). As corporate data crosses borders, security concerns grow (EIU, 2014). Internal and external security breaches are a new category of IB risk that manifest economically and socially (World Bank, 2016). Indirect damage from security breaches includes data loss, customer trust, and company reputation. Companies must guard against tangible and intangible threats. Cyberterrorism and cyberespionage threaten national security, and cyberattacks pose a new international business risk for multinational corporations (MNCs).

Theft of intellectual property, data breaches, and market manipulation are just some of the types of cybercrime that add up to a yearly cost of $400 billion to the world economy. In the future, more businesses will be impacted by cyberattacks, and those businesses that lack the necessary technology and security measures will be especially susceptible to these attacks. Firewalls are the industry standard for securing devices and zones, but risk management in the digital age calls for an approach that utilizes managed services and can protect IT ecosystems over time. The focus of cybersecurity moves from individual devices to services.

2.3 Digital Regulatory Complexity Risk

More emphasis is being placed on customers, digital taxes, the protection of sensitive information, and national security. The scope of these regulations necessitates the preparation of digital risk mitigation strategies. Adopting strategies for customer master data management is one of the ways that banks and other financial institutions can enhance their digital capabilities in preparation for Europe's General Data Protection Regulation. Many different national governments are currently debating whether or not they should place restrictions on the transmission and storage of data across international borders. There are those who advocate for governments to mandate that businesses process and store data on locally hosted servers. This law is interpreted differently in a variety of nations including Indonesia, Nigeria, Russia, Vietnam, and others as a result of differences in the digitalization-related regulations, rules, and standards that are in place in those nations. Disruptions at the international level are caused by the multiplicity, variance, and incompatibility of these factors. Laws in many countries are comparable to one another (Manyika et al., 2016).

2.4 Within-Country (Target Country) Sources

These include restrictions on digital connectivity and commerce as well as discrimination against foreign companies. These laws protect consumers from being defrauded digitally and online. Inadequate protection of digital intellectual property rights (such as AI) and a lack of transparency in economic and regulatory policies pertaining to digital connectivity are also contributing factors. The health of a target country's key sectors (e.g., electronics, the internet, and information and communication technology) will have an effect on the global connectivity of a foreign company. There is a correlation between physical conditions and digital risks. Broadband (fiber optics, 4G or 5G), international Internet bandwidth, internet data routes, mobile telecommunications, communications satellite, network infrastructure, data centers, cloud, big data, and the internet of things are examples of investments that have been made by both the public and private sectors (UNCTAD, 2015; World Bank, 2016).

2.5 Cross-Country Sources

The sources that span multiple countries become geopolitical. The United States is currently engaged in a trade dispute with a number of other countries, most notably China. As a result of this dispute, many governments have increased their scrutiny of foreign company takeovers, with a particular emphasis on the implications of information and communications technology (ICT) and other digital developments for national security and technological advantage. Digitization and information and communication technology standards are beginning to diverge among economies. Worsening ties between the home country and the host country make the situation more complicated. The deterioration of MNCs' relationships with their home countries can be detrimental to their businesses (or regions). The advent of the digital age has made multinational corporations (MNCs) more susceptible to international threats such as cyberattacks and acts of terrorism. Businesses are put in jeopardy as a result of the ease with which cybercriminals can carry out attacks overseas in secret or through proxies brought about by digital technologies (Kshetri, 2005).

According to the information-processing theory, cross-unit operations or responsibilities are difficult and fraught with uncertainty due to the complexity of the task, the interdependence of the subunits, and the dynamic nature of the task environment. These three factors all contribute to the overall complexity and unpredictability of the company. More processing power is required when dealing with complexity and ambiguity. The amount of MNC information and data intensity both contribute to an increase in the complexity of a digital task. There is a possibility that task interdependence will increase when a multinational corporation (MNC) participates more actively in global platforms or adopts a more globalized strategy. Environmental dynamism can be increased by a company's expansion of their global supply chain or their presence in foreign markets (Kano et al., 2020). Key determinants of information-processing demands for digitally connected activities, as well as firm-specific exposure and digital risk vulnerabilities, include the intensity of information and data, geographic diversity, the type of international strategy, and participation in global platform activities.

2.6 Information and Data Intensity

Some multinational corporations are more dependent than others on the flow of information both within and outside the company. Global executives develop a digital architecture to facilitate internal communication and data sharing, collaboration with global suppliers and customers, virtualization of global teams, and connection to global suppliers and customers. An ERP system, an HCM system, a CRM system, a data management platform, cloud computing, and a social marketing platform are all included in this architecture. Increased digital connectivity may alleviate some of the challenges associated with distance, space, and time in governance, but it may also drive up the costs of organizing and monitoring (Monaghan et al., 2020).

According to the theory of information processing, organizations that are susceptible to risk require additional information processing (Egelhoff, 1991). Companies with a lot of information have to worry about both cybersecurity and regulatory risks. Technology and politics have become the new battlefield. Several countries, particularly those that are already considered to be technological leaders, compete for information and communication technology standards and technologies in order to increase their economic and market power (Sacks, 2020). Because of regulatory and ICT tensions, many multinational corporations are unable to participate in activities associated with global value chains. ICT is rapidly transitioning into a foundational infrastructure for the digital age (UNCTAD, 2015). The global supply chain and production network of a company rely heavily on digital infrastructure, which includes things like automated processes, algorithms supported by artificial intelligence, and cloud computing, among other things.

2.7 Geographic Diversity

An MNC's internationalization (from supply chain expansion to market expansion) and global diversification across regions and countries are both aspects of what is meant by the term "geographic diversity." Diversification is a hallmark of global corporations. Multinational companies that diversify their operations put themselves at risk of being attacked digitally for several reasons. Diverse multinational companies need to cover more geographic ground, which will expose them to digital threats (both physical and institutional) in a greater number of countries. Second, the interdependence of a multinational corporation (MNC) with foreign resources, regulators, competitors, partners, vendors, platforms, and other ecosystem players is increased by diversity (Dellestrand & Kappen, 2012). This results in increased interdependence, information security, and regulatory risks in various countries. More diversity results in an increase in the number of information-processing nodes both within and between countries, as well as an increase in the number of digital risks resulting from interactions between organizations (Stallkamp & Schotter, 2021).

The increasing complexity of the global operations of multinational corporations is directly correlated to the diversification of their workforces. In order to better manage digital risks, many executives are increasing the amount of money they invest in their company's digital architecture (e.g., ERP, HCM, CRM, global talent bank, data management platform, cloud computing, and data analytics). This could result in failures of the internet and intranets, the leaking of sensitive information, and inadequate digital infrastructure in multiple countries. For the purpose of risk assessment, the MNC needs to process data from both the domestic and international levels. When it comes to the management of digital risks, multinational corporations (MNCs) will have to comply with more stringent information-processing requirements as their geographic diversity increases.

2.8 International Strategy

Leaders of multinational corporations (MNCs) often employ multi-domestic, global, hybrid, or transnational strategies when competing on a global scale (Bartlett & Ghoshal, 1989). A multi-domestic strategy, also known as a local adaptation orientation, is characterized by high levels of local adaptation and responsiveness in the respective countries in which MNC subunits compete. This strategy places an emphasis on competition within each country and segments foreign markets based on national boundaries. Decisions on both a strategic and operational level are made by foreign subunits in order to adapt products and services to specific local markets. Because of this strategy, the multinational corporation will be put in jeopardy in the country on multiple fronts, including the economic, social, and regulatory fronts. Additionally, the requirement for intra-MNC digitization interdependence and interconnection is lessened when a multi-domestic strategy is implemented (Bartlett & Ghoshal, 1989).

The globalization of markets presupposes the standardization of products across all of those markets. The command center operates under the presumption that overseas subunits are dependent upon one another and prioritizes integrating them (Prahalad & Doz, 1987). This approach takes advantage of both global scale and innovations developed locally. This strategy is put into action by the integrated ERP solution known as "SAP Business One," which is designed for use by multinational corporations, their overseas subsidiaries, and their suppliers. A core solution for the application that is both flexible and scalable is beneficial to growth and innovation. This architecture satisfies the global legal and linguistic requirements through the utilization of a single code base. Because each function related to the company is combined into a single package, it is very simple to install, configure, and operate. The use of open application programming interfaces (APIs) or certified standard integration packages makes system integration simple. This architecture is helpful under a global strategy, or higher global integration orientation, because multinational corporations (MNCs) face more cross-country risk forces, such as trade ties between their home country and the host country and geopolitics that affect digital globalization.

Positioned between multi-domestic and global strategies is that of transnational hybrid strategy (Prahalad & Doz, 1987). This hybrid strategy requires a shared vision, individual commitment, and an integrated organizational network that is still flexible in order to achieve global efficiency and local responsiveness (Baaij & Slangen, 2013). Leaders of MNCs who adopt this strategy intend to stimulate communication within the company, with the goals of preventing conflicts over integration and localization and increasing the flexibility and discretion of foreign subunits. In order to keep their local responsiveness while also transferring their specialized skills to other members of the network, hybrid businesses must collaborate. Because of these two mandates, information-processing requirements are becoming more and more stringent, and the design of the digitization system must be flexible enough to account for variations and unforeseen circumstances.

Foreign subunits need to be sufficiently differentiated so that they can respond appropriately to the various demands, markets, and policy environments they will encounter (Sturgeon, 2020).

2.9 Global Ecosystem

Because of digitization, businesses in many countries and industries are being forced to consider the products and services they offer as components of a larger whole. It is simple to transfer digital assets across organizational boundaries and national borders, as well as to modify and recombine them for use in a different market (Nambisan et al., 2017). The digital platform and ecosystem strategy of a multinational corporation is driven by data. When a platform is used on a global scale, data may travel across national boundaries. This presumption is being called into question as governments in almost every region of the world impose restrictions on how, when, or how much data can be transferred between countries in business transactions (World Bank, 2016). This evidence demonstrates both the benefits and the risks of global platforms.

3 Conceptual Framework, Methodology, and Data

3.1 Conceptual Framework

The psychological stance that companies take toward domestic and international markets for digital goods and services is one component of what is known as digital business risks (DBR). During times of widespread macroeconomic unpredictability, like financial crises and pandemics like COVID-19, businesses have a propensity to speculate, be optimistic, or be pessimistic about a particular digital trade. DBR explains why this happens.

$$\left(Y_{1ijt}\ Y_{2ijt}\right) = f\left(X_{ijt}, Z_{ijt}\right) + \varepsilon_{ijt} \tag{1}$$

The conceptual framework of the research is shown in Eq. 1 and Fig. 2. It is anticipated that the DBR output (Y_{itj}) will fall for India, Austria, and the UAE in particular, as well as for QUAD, BRCS, GCC, and EU in general. This output measure for the DBR is included in the framework. Inputs (X_{ijt}) are indicators of firms' trade diversity, trading partner reputation in terms of logistics and infrastructure to support trade in India, Austria, the UAE, QUAD, BRCS, GCC, and the EU. In addition, inputs (X_{ijt}) are indicators of infrastructure to support trade in India, Austria, and the UAE. The political and financial crises, pandemic events, and macroeconomic variables depicted in Fig. 2 are all behavioral factors that are related

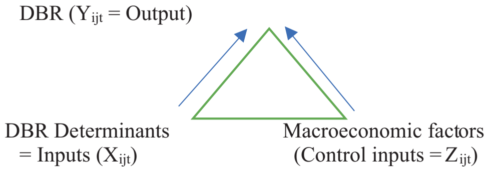

Fig. 2 Conceptual framework input-output relation of digital business risk (DBR) with DBR determinants and macroeconomic factors (Source: Authors' own creation)

to Sustainable Development Goal 8 (growth and economic development) and Sustainable Development Goal 9 (information and communication technologies). The research makes use of artificial intelligence (AI) to model DBR and capture behavioral factors rather than hypotheses.

3.2 Rationale for Focusing on Regional Economic Blocks Like BRICS, GCC, EU, and QUAD (AJUS)

3.2.1 BRICS

Brazil, Russia, India, China, and South Africa account for 41% of the world's population, 24% of global GDP, and 16% of global trade. BRICS drive economic growth. BRICS countries have different pharmaceutical trades, international participation, and other interests. The BRICS' rise as a unique organization with increasing transnational health and trade cooperation strains global governance systems and procedures. Academics, legislators, and consultants seek leadership and inspiration from national governments and regional blocks. BRICS nations may fill the leadership void left by retreating countries. More research is needed to determine if the BRICS can fill this gap. A constitutional definition of authority has contributed to Brazil's federal-state cooperation. Uncoordinated efforts to pool resources in Russia have led to inefficiency. BRICS countries provide diplomatic and technical support for global health programs

3.2.2 Gulf Cooperation Council (GCC)[2]

Dynamic, active, and diverse are the GCC and BRICS economies. The GCC and BRICS countries are attracting foreign investment as they enter the global economy and grow faster than the industrialized world (Bhuyan et al., 2016). According to the World Federation of Exchanges, the GCC and BRICS have a $12,809 trillion market

[2] Gulf Cooperation Council (GCC) comprises of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE).

cap. It is 1200 trillion dollars more than Europe, the Middle East, and Africa combined. The GCC and BRICS are important sources of demand and supply. In 2018, the UAE was 11.5% citizens and 88.5% expats. Fifty-nine percent of non-UAE citizens are South Asian. BRICS and GCC markets are affected by macroeconomic conditions (Mensi et al., 2014).

GCC and BRICS economies are internal. Many GCC and BRICS economies and financial systems are externally driven. The GCC and BRICS, which share gold and oil, benefit when the QUAD (the United States, Australia, and Japan) and other developed countries do well. Both China and India consume a lot of oil. Russia, a leading producer of crude oil and natural gas with ties to industrialized economies, is an energy powerhouse. Worsening economic conditions in developed economies would reduce capital flows from advanced to GCC and BRICS economies and exports to developed markets rich in oil, the GCC. The BRICS nations are able to make some modifications to the rich GCC block's model and then use it as their own. Collaboration in information technology may be led by BRICS. The information technology (IT) exports of India are projected to skyrocket in 2022. This year, it is anticipated that Indian exports will grow by 4.7%. Predictions pertaining only to India:

- It is possible that outbound shipments will exceed $400 billion.
- According to projections made by the WTO, India's exports will increase by 4.7% in 2022.
- The value of software exported could reach 148 billion dollars. This is more than the oil sales of GCC.
- In the coming weeks and months, India's software companies will experience significant growth.

Because the BRICS have the largest engineering population in the world, it is possible that software exports will skyrocket in 2022–2023 and beyond. Exports of software are a part of growth driven by exports, but their momentum is picking up

3.2.3 Australia, Japan, and the United States (AJUS-QUAD Partners)[3]

AJUS-QUAD is a trilateral technology accelerator between Australia, Japan, and the United States. It speeds up the development and use of key technologies. It is a deal between governments, research organizations, and private companies, including non-defense tech companies. The AJUS alliance is a foundational contribution to a

[3]A growing momentum toward monolateral cooperation in the Indo-Pacific to "meet the challenges of the twenty-first century" was fueled by the formation of AJUS in September 2021, which was an "enhanced trilateral security partnership" between Australia, Japan, and the United States. The agreement promotes the exchange of information and technologies; integrates security and defense research, technology, industrial bases, and supply chains; and enhances the combined capabilities and interoperability of the three countries. The grouping could improve security in the Indo-Pacific region despite the fact that it is limited to the three Anglo partners (Jagannath, 2022).

free, open, and inclusive Indo-Pacific. QUAD discusses COVID-19, vaccines, technological innovation, supply chain resilience, and climate change.

3.2.4 European Union

Within its borders, the European Union (EU) seeks to promote peace, its values, and the well-being of its citizens; offer freedom, security, and justice without internal borders; regulate asylum and immigration; prevent and combat crime; establish an internal market; and accomplish sustainable development based on balanced economic growth, price stability, and a highly competitive market economy that supports emoji. The global objectives of the European Union are to uphold and promote its values and interests, contribute to peace and security and sustainable development, and promote solidarity and mutual respect among peoples, free and fair trade, poverty eradication, and human rights, as stated on the website of the European Union (https://european-union.europa.eu/priorities-and-actions/eu-priorities-en).

3.3 Methodology

3.3.1 Traditional OLS and Ridge Regression

Because of multicollinearity, the design matrix is almost entirely singular, which means that X and $X'X$ do not have full rank. It is not possible to obtain the OLS estimate. As a result, one must pay attention to the multicollinearity of the data. The traditional approaches involve either gathering more data or reducing the number of variables. Increasing the amount of data collected can be prohibitively expensive or impractical. When trying to reduce multicollinearity in a model, dropping variables from the model could cause specification bias, which would make the solution worse than the original problem. Our objective is to derive the maximum amount of information from the data at our disposal, and this objective is what has inspired researchers to devise novel statistical methods, such as ridge regression (Vinod, 1978), in order to address the issue of multicollinearity. Ridge regression with Y_1 and Y_2 joint distributions was the method that we used in this study.

3.3.2 Artificial Neural Network (ANN)

Artificial neural networks (ANN) were developed by researchers in the fields of psychology, neuroscience, and engineering to approximate the way information is processed. ANN assists multinational corporations in responding to news, learning, processing information, and making decisions. ANN operates under the assumption of bounded rationality, which holds that market participants adjust their prior subjective beliefs based on their previous errors. The ANN makes the assumption that economic decision-makers react to external shocks in an asymmetrical and nonlinear fashion. The ANN provides an intuitive approximation of the decision-making process in economics and business. For two reasons that are interrelated, the emerging market logistics, information and communication technology, and other sectors are fertile ground for ANN. One reason is that the data are frequently noisy because of the shallowness of the market or the rapidity with which news spreads, which means that asymmetries and nonlinearities cannot be assumed to be eliminated. Second, participants in the market frequently learn about recent policy news, changes in the law, and other changes in the market through trial and error. An artificial neural network (ANN) uses a combination of learning and searching to arrive at its estimates of synaptic weights, also known as parameter coefficients (McNellis, 2005): (a) the perceptron, (b) the feed-forward neural network, (c) the multilayer perceptron, (d) the convolutional neural network, (e) the radial basis functional neural network, (f) the recurrent neural network, and (g) the LSTM – long short-term memory. In our research, we derived synaptic weights by using a multilayer perceptron artificial neural network (ANN). A comparison of (d) and (h) is not within the purview of the present investigation.

3.3.3 Random Forest Tree (RFT) Model

The ensemble machine learning (ML) technique known as random forest is trained using a large number of decision trees. Because decision trees are relatively straightforward, it is possible that a single tree won't be enough to construct a machine learning model. In order to make decisions, random forest combines the characteristics of many different decision trees. Therefore, it is a "forest" of trees; consequently, it is called "random forest." This method makes use of "randomly created decision trees," as the name of the method suggests. RFT utilizes bootstrap trees in order to make predictions and classifications (sometimes referred to as bagging). Multiple decision trees are aggregated into one larger tree in place of using just one. One of the drawbacks of using a decision tree is overfitting. It is possible to alleviate some of this difficulty by employing RFT regression rather than decision tree regression. In comparison to more conventional regression models, RFT is both quicker and more reliable.

RFT creates sample data sets for each model by selecting rows and features at random from the entire data set. Bootstrap. The random forest regression method is comparable to any other machine learning approach.

3.4 Empirical Model

The output, input, and control factors are detailed in Table 1. The framework is empirically analyzed using Eq. 2 covering OLS, ridge regression, RFT, and ANN specifications.

Table 1 Details of output (Y_{ijt}) and inputs (X_{ijt} and Z_{ijt})

	World Bank WDI factor description	Fig. 1 Relation	Factor implication
Y_1	The index of the net barter terms of trade (2000 = 100)	2.1	The higher the ICT coverage, the higher the barter index
Y_2	Individuals using the internet (% of population)	2.1	Imply higher penetration facilitating trade
X_1	Business extent of disclosure index (0 = less disclosure to 10 = more disclosure)	2.1	Higher ICT coverage facilitates greater disclosure
X_2	(Expressed as a percentage of the net difference Between exports and imports of commercial services) computer, communications, and other services	2.8	Positive metrics imply competitive advantage in exporting country and negative metrics imply competitive disadvantage in importing country
X_3	Broadband subscriptions that are fixed (per 100 people)	2.2	Imply higher ICT penetration
X_4	GDP per capita growth (annual %)	2.4	Higher per capital income implies capacity to access ICT tools
X_5	ICT goods net of exports-imports (% net goods total exports-total imports)	2.8	Positive ICT good metrics imply competitive adv. In exporting country and negative metrics imply competitive disadvantage in importing country
X_6	ICT service exports as a percentage of total service exports (base year)	2.8	Imply ICT services competitive advantage in exporting country
X_7	ICT investment with private sector participation (in current US dollars)	2.9	The higher the PP in ICT, the higher the competitive advantage in both the exporting and importing countries
X_8	The overall logistics performance index ranges from 1 (low) to 5 (high)	2.6	Imply supply chain higher performance due to ICT coverage
X_9	Index of the performance of logistics: infrastructure quality relating to commerce and transportation on a scale of 1 (low) to 5 (high)	2.6	Imply supply chain higher performance due to ICT coverage
X_{10}	Manufacturing sector net of exports-imports	2.8	Positive manufacturing sector metrics imply competitive adv. in exporting country and negative metrics imply competitive disadvantage in importing country
X_{11}	Merchandise by the reporting economy that is net of exports and imports, expressed as a percentage net of total exports and imports of merchandise	2.7	Positive metrics imply external trade diversity in these economies reducing business risks due to ICT coverage
X_{12}	Merchandise after deducting exports and imports to economies in the Arab World (expressed as a percentage after deducting total exports and imports of merchandise)	2.7	Positive metrics imply external trade diversity in Arab World reducing business risks due to ICT coverage

(continued)

Table 1 (continued)

	World Bank WDI factor description	Fig. 1 Relation	Factor implication
X_{13}	Merchandise after deducting exports and imports to economies with high incomes (percentage after deducting total exports and imports of merchandise)	2.7	Positive metrics imply external trade diversity in HIC reducing business risks due to ICT coverage
X_{14}	Merchandise net of exports-imports to LMIC (% net of total merchandise exports-imports)	2.7	Positive metrics imply external trade diversity in LMIC reducing business risks due to ICT coverage
X_{15}	Merchandise net of exports-imports to LMIC in EU and Central Asia (% net of total merchandise exports-imports)	2.7	Positive metrics imply external trade diversity in LMIC in EU and Central Asia reducing business risks due to ICT coverage
X_{16}	Merchandise net of exports-imports to LMIC in Latin America and the Caribbean (% net of total merchandise exports-imports)	2.7	Positive metrics imply external trade diversity in LMIC in Latin America and Caribbean reducing business risks due to ICT coverage
X_{17}	Merchandise net of exports-imports to MENA (% net of total merchandise exports-imports)	2.7	Positive metrics imply external trade diversity in LMIC in MENA reducing business risks due to ICT coverage
X_{18}	Merchandise net of exports-imports to South Asia (% net of total merchandise exports-imports)	2.7	Positive metrics imply external trade diversity in LMIC in South Asia reducing business risks due to ICT coverage
X_{19}	Merchandise net of exports-imports to sub-Saharan Africa (% net of total merchandise exports-imports)	2.7	Positive metrics imply external trade diversity in LMIC in sub-Saharan Africa reducing business risks due to ICT coverage
X_{20}	Merchandise net of exports-imports to LMIC outside region (% net of total merchandise exports-imports)	2.7	Positive metrics imply external trade diversity in LMIC outside region reducing business risks due to ICT coverage
X_{21}	Merchandise net of exports-imports to LMIC within region (% net of total merchandise exports-imports)	2.7	Positive metrics imply external trade diversity in LMIC within region reducing business risks due to ICT coverage
Z_1	Natural logarithm of GDP (constant 2015 US$)	2.1	Imply size of the country (control variable)
Z_2	Pandemic events (PE)	2.1	Like swine flu, malaria, smallpox, SARs, and recently the COVID
Z_3	Economic and financial crises (EC)	2.1	2008–2009 economic and financial crises

3.4.1 Empirical Model

$$Y_{jjt} = \alpha_{ijt} + \beta_{ijt} \sum X_{ijt} + \pi_{ijt} \sum Z_{ijt} + \varepsilon_{ijt} \tag{2}$$

where:

Y_{ijt} = Two outputs of DBR (Y_1 and Y_2) for three individual countries (India, the UAE, and Austria) and the four blocks *j* (QUAD, GCC, BRCS, EU) and *t* = 2000–2020.

X_{ijt} = Set of DBR indicator inputs (drawn from world development indicators (WDI) database of the World Bank) for countries in the blocks *j* and *t* = 2000–2020.

Z_{ijt} = Set of macro-factors such as GDP (2015 constant US$) representing the size of the country, pandemic, and economic crises events in the four blocks *j* and *t* = 2000–2020. The control inputs have a greater impact on DBR in the economies under study.

J = 14 economies grouped into seven groups comprising of three specific countries where one represents India, two represent Austria, three represent the UAE, and four regional blocks represented by QUAD (three developed countries excluding India), BRCS (four countries excluding India, i.e., Brazil, Russia, China, and South Africa), GCC block (excluding the UAE – five developing oil-rich economies: Bahrain, Kuwait, Oman, Qatar, and Saudi Arabia), and the European Union (excluding Austria) and *t* = time from 2020–2020.

ε_{ijt} is the error term for the *i*th country, *j*th block for time *t* = 2000–2020.

Third column in Table 1 aligns the output, input, and control factors to risk dimensions depicted in Fig. 1, which are explained in Sect. 2 under 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, and 2.9. The significance and influence of sector-specific studies in enhancing both domestic and international trade performance of business corporations cannot be overstated. This is the uniqueness of this research.

4 Model Results

Figure 3 shows that the root mean square error (RMSE) is highest in OLS model compared to ridge regression, RFT, and ANN models for predicting BDR.

So we focus our discussion of results on the RFT and ANN models for predicting accuracy of BDR. Figure 4 displays the feature importance of RFT in decreasing order in our data set.

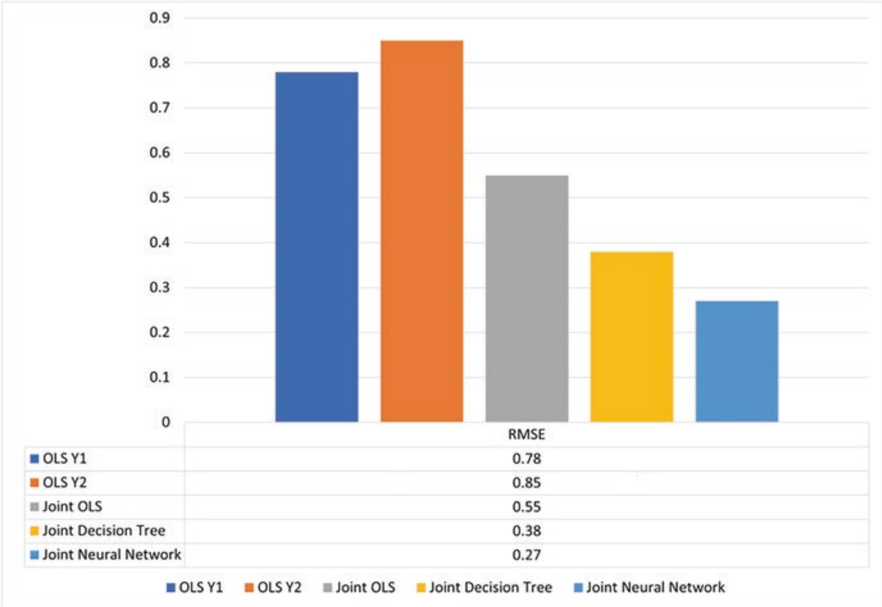

Fig. 3 Comparison of OLS, ridge regression, RFT, and ANN models

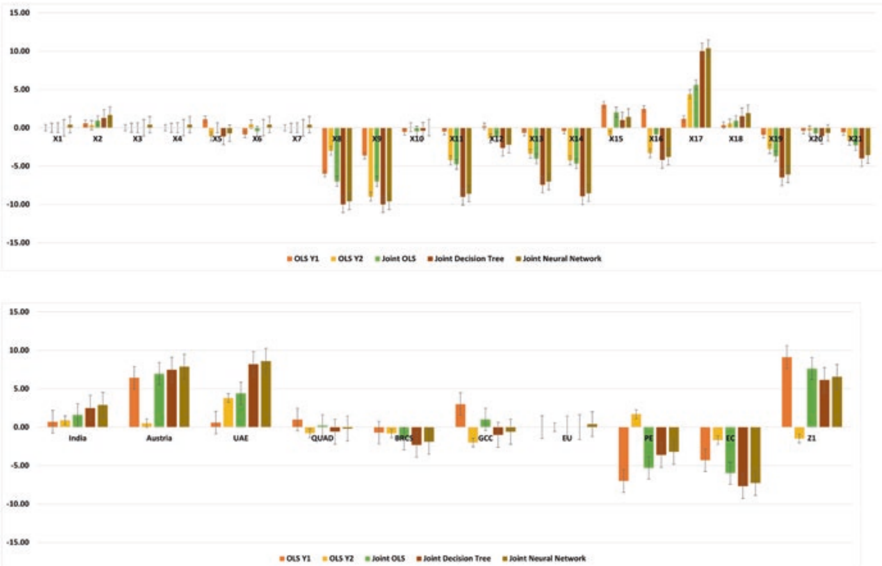

Fig. 4 Feature importance on BDR

4.1 SHapley Additive exPlanations (SHAP)

SHAP is most likely in the lead for ML explainability. This method involves the reversed engineering of the outcome of a prediction algorithm. Researchers make use of SHAP values in order to comprehend the choices made by a complex model (gradient boosting, neural network, etc.). SHAP is a concept in game theory. Take into consideration a predictive model, a "game," and "players" in the game. SHAP determines the degree to which each feature contributes to prediction. One observation is equal to one "game." The SHAP focuses on the possibility of local interpretation. The SHAP value plot depicts predictor-target relationships that are both positive and negative (in our case, ICT governance framework Y1 and Y2). These train data dots are used in this graph. Displays: Importance of feature: Variables are ordered descending.

- Horizontal placement shows whether a value affects a higher or lower forecast.
- Color indicates whether a variable is high (red) or low (blue) (in blue).

4.2 Discussion of RFT and ANN Model Results

Figure 4 displays the summary results of all models factor-wise. The following factors have positive impact on BDR in decreasing order of importance:

The X_{17} factor represents the disparity between MENA's exports and imports (as a percentage of the total amount of merchandise exported and imported). The trade surplus in low- and middle-income countries in the Middle East and North Africa (MENA), which increased ICT coverage, increased business risks. This corroborates the findings presented in Sect. 2.1, which state that the diversity of MNCs contributes to an increase in digital risks for a variety of reasons. The finding lends credence to this assertion. Diverse multinational companies need to cover more geographic ground, which will expose them to digital threats (both physical and institutional) in a greater number of countries. More geographic ground must be covered in order to cover more ground. Second, increased diversity heightens a multinational corporation's reliance on external ecosystem players such as foreign resources, regulators, competitors, partners, vendors, and platforms (Dellestrand & Kappen, 2012). This results in an increase in the risks associated with global interdependence, information security, and regulatory oversight. More diversity results in more information-processing nodes both within countries and between them, as well as an increase in the number of digital risks resulting from exchanges between organizations (Stallkamp & Schotter, 2021).

X_{18} factor, merchandise net of exports-imports to *South Asia* (% net of total merchandise exports-imports). The implication is the same as for the factor X_{17} factor for MENA trade surplus resulting in trade diversity.

X_2, along with the factors of computer, communication, and service (net commercial exports-imports). Because of the same factors as X_{17} and X_{18}, DBR increased as a result of a competitive advantage in India, the UAE, and Austria. This finding is in line with Luo's observation, which states that the volume of information and data, geographic diversity, the type of international strategy, and participation in global platforms all contribute to the specific exposure and digital risk vulnerabilities of a company.

X_{15} factor, merchandise net of exports-imports to LMIC in *EU and Central Asia* (% net of total merchandise exports-imports) was next important feature in predicting DBR. Surplus trade diversity in LMIC in *EU and Central Asia* increased DBR risks due for the same reasons as adduced for X_{17} and X_{18}.

UAE dummy had positive impact on DBR. This implies that ICT competitive advantage in the UAE increased DBR. The reasons are similar to those discussed under factor X_{17} above.

Austria dummy had positive impact on DBR. This implies that ICT competitive advantage in Austria increased DBR. The reasons are similar to those discussed under factor X_{17} above.

Z_1 factor, natural logarithm of GDP (constant 2015 US$) was next important feature in predicting DBR. This implies that the size of the country (control variable) was also important in predicting DBR. The higher the size of the country translates to developed economy and also developed ICT. The reasons are similar to those discussed under factor X_{17} above.

India dummy had positive impact on DBR. This implies that ICT competitive advantage in India increased DBR. The reasons are similar to those discussed under factor X_{17} above.

A net merchandise trade surplus was achieved as a result of exporting to MENA, South Asia, the EU, and Central Asia. This led to an increase in the digital business risk in India, the UAE, and Austria due to the depth and breadth of their ICT sectors. These findings imply that, in accordance with Sturgeon (2020), the leaders of MNCs in these economies adopt a hybrid strategy in order to achieve two goals: stimulating intra-firm communication in order to avoid integration and localization conflicts and increasing flexibility and discretion to foreign subunits. In order to maintain a local presence while also transferring specialized skills within the network, hybrid companies are required to do so. Because of these two mandates, information-processing requirements must be met, and the design of the digitization system must be flexible enough to account for variations and unforeseen circumstances. It is necessary for foreign subunits to have a sufficient amount of differentiation in order to meet the varied requirements of various markets and policy environments

The following factors have negative impact on BDR in decreasing order of importance:

X_9 factor, logistics performance index: Quality of trade and transport-related infrastructure (1 = low to 5 = high) was high in India, the UAE, and Austria. This implies supply chain higher performance in these three countries due to higher ICT coverage. These resulted in reduced DBR in these countries.

X_8 factor, logistics performance index: Overall (1 = low to 5 = high) was high in India, the UAE, and Austria. This implies supply chain higher performance in these three countries due to higher ICT coverage. These resulted in reduced DBR in these countries similar to quality of trade and transport-related infrastructure.

X_{14} factor, merchandise net of exports-imports to *LMIC* (% net of total merchandise exports-imports). Positive metrics in external trade diversity in LMIC thus reduce business risks due to ICT coverage. This result is contrary to results discussed under X_{17} and X_{18}.

X_{11} factor, merchandise net of exports-imports by the reporting economy, residual (% net of total merchandise exports-imports) was next important feature in predicting reduced DBR. Positive metrics imply external trade diversity in these economies reducing business risks due to ICT coverage.

X_{13} factor, merchandise net of exports-imports to *high-income economies* (% net of total merchandise exports-imports) was next important feature in predicting DBR. Positive metrics imply external trade diversity in HIC reducing business risks due to ICT coverage.

X_{19} factor, merchandise net of exports-imports to *MENA* (% net of total merchandise exports-imports) was next important feature in predicting DBR. Positive metrics imply external trade diversity in LMIC in MENA reducing business risks due to ICT coverage.

X_{21} factor, merchandise net of exports-imports to *LMIC within region* (% net of total merchandise exports-imports) was next important feature in predicting DBR. Positive metrics imply external trade diversity in LMIC within region reducing business risks due to ICT coverage.

X_{16} factor, merchandise net of exports-imports to *LMIC in Latin America and the Caribbean* (% net of total merchandise exports-imports) was next important feature in predicting DBR. Positive metrics imply external trade diversity in LMIC in Latin America and Caribbean reducing business risks due to ICT coverage.

X_{20} factor, merchandise net of exports-imports to *LMIC outside region* (% net of total merchandise exports-imports) was next important feature in predicting DBR. Positive metrics imply external trade diversity in LMIC outside region reducing business risks due to ICT coverage.

X_5 factor, ICT goods net of exports-imports (% net goods total exports-total imports) was next important feature in predicting DBR. Positive ICT good metrics imply competitive advantage that reduces DBR.

EC (2008–2009 economic and financial crisis) factor was next important feature negatively impacting predicting DBR. One plausible reason is that contagion of global financial crisis resulted in reduced in ICT infrastructure, reduced trade across borders, and hence increased DBR as detailed under Sect. 2.9 Global Diversity.

PE (pandemic events) that are control factors was next important feature in predicting DBR. This implies that pandemic events like swine flu, malaria, smallpox, SARs, and recently the COVID impacted the DBR negatively for the same reason as detailed for EC factor above.

BRICS dummy was next important feature negatively impacting in predicting DBR. One plausible reason is that ICT is well developed in BRICS and hence these economies have competitive advantage in ICT and thus experience lower DBR.

GCC dummy was next important feature negatively impacting in predicting DBR. One plausible reason is that ICT is well developed in GCC similar to BRICS and hence these economies have competitive advantage in ICT and thus experience lower DBR.

QUAD dummy was the next important feature negatively impacting in predicting DBR. One plausible reason is that ICT is well developed in QUAD similar to BRICS and GCC and hence these economies have competitive advantage in ICT and thus experience lower DBR.

In conclusion, a hybrid strategy tends to bring about a reduction in DBR when it is adopted by trading countries. This is the case because of a higher logistics quality index, a higher logistics performance index, and the diversity of its external trade with low- and middle-income countries as well as high-income economies. To be successful in these countries, the digital platform and ecosystem strategy of an MNC need to place a significant emphasis on data. When a platform has a global reach, it is reasonable to assume that data can be transferred between countries; however, this assumption is coming under increasing scrutiny as governments in almost every region of the world impose restrictions on how, when, or to what extent companies can transfer data between countries (World Bank, 2016). Global platforms and ecosystems bring with them both opportunities and dangers, as was demonstrated earlier.

5 Conclusion

Digital connections are country-specific because they can be used across national boundaries for less money than traditional IB connections. Digital global connectivity dominates the new era of international business and addresses rising uncertainties. Digitization carries myriad risks, a pivotal issue for global operations that has received little theoretical or empirical attention. In this background, this paper specifically addresses the three questions on digital risks in international business and related areas: (1) Identify the key determinants to predict digital risks based on their feature importance, (2) design artificial intelligence quantitative and qualitative models to address the risk features, and (3) suggest strategies for MNCs to effectively handle the business risks as a value-added proposition.

A comprehensive output-input framework was developed to address the research questions. The digital business risk (DBR) for India, Austria, and the UAE in particular and QUAD, BRCS, GCC, and EU economic blocks in general is the DBR output (Y_{itj}) to be predicted to mitigate. This is a key DBR output measure in the framework. The inputs (X_{ijt}) are indicators of firms' trade diversity, trading partner's reputation in terms of logistics and infrastructure to support trade, in India, Austria, and the UAE besides other economic blocks like QUAD, BRCS, GCC, and the

EU. The conceptual framework in Fig. 2 encompasses many behavioral factors related to sustainable development goal SDG-8 (growth and economic development) and SDG-9 (ICT) captured by political and financial crises besides pandemic events and macroeconomic variables in general. Thus, instead of focusing on hypotheses, the study captures the importance of the behavioral factors in DBR modeling by applying AI tools.

In conclusion, a net merchandise trade surplus caused by exporting to economies in the Middle East and North Africa (MENA), South Asia, the European Union (EU), and Central Asia resulted in an increased digital business risk in the exporting countries of India, the United Arab Emirates (UAE), and Austria. These three countries had a competitive advantage in terms of the depth and breadth of their information and communications technology (ICT). There is a tendency for DBR to be lowered by circumstances such as a higher logistics quality index, a higher logistics performance index, external trade diversity to LMIC, MENA, and high-income economies, as well as economic crisis and pandemic events. To lessen the impact of DBR, multinational corporations (MNCs) might work out some sort of hybrid strategy with their trading partners. Data serves as the primary motivator for a multinational corporation's digital platform and ecosystem strategy when operating in these countries. It is reasonable to assume that data can be transferred across national borders when using a platform that has a global reach, such as the internet. On the other hand, the fact that governments in almost every region of the world impose restrictions on how, when, or to what extent companies can transfer data across their border's casts doubt on the veracity of this assumption. The evidence presented here demonstrates both the benefits and the dangers that are associated with utilizing global platforms and ecosystems.

The area under study requires interventions in policy and regulation to bolster digital intellectual property rights (e.g., AI), as well as transparency in the process of enforcing economic and regulatory policies regarding digital connectivity. The economic conditions of a target country, such as the health of key sectors (e.g., electronics, the internet, and information and communication technology), will affect the global connectivity of a foreign company. The nation's digital risks can be affected by the physical conditions. Investments in areas such as broadband supply (fiber optics, 4G or 5G coverage), international internet bandwidth, internet data routes, mobile telecommunications, communications satellite, network infrastructure, data centers, cloud, big data, and the internet of things made by both the public sector and the private sector (IoT).

According to Sturgeon (2020), the leaders of multinational corporations in the three economies adopt a hybrid strategy in order to stimulate intra-firm communication and increase the flexibility and discretion of their foreign subunits. In order to maintain their local responsiveness while also transferring their unique skills, hybrid companies need to network. Because of these two mandates, information-processing requirements are being solidified, and the design of the digitization is being forced to accommodate variations and contingencies. It is essential for foreign subunits to have a sufficient level of differentiation in order to successfully navigate the varied demands, markets, and policy environments they will encounter.

5.1 *Directions for Future Research*

The study is limited with focus on three individual countries India, Austria, and the UAE with aggregate secondary WDI data in four regional blocks EU, BRICS, GCC, and the QUAD. Future studies may expand the database to specific countries in each block to broaden the research agenda for in-depth research on digital risk in international business and allied areas.

Authors' Contribution All four authors have equally contributed in developing this conceptual paper using their respective domain knowledge.

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An Online Market in Your Pocket: How Does an Augmented Reality Application Influence Consumer Purchase Decision

Haneen Mohammad Shoaib and Muhammad Saleem

1 Introduction

Online and digital channels are widely developing and empowering consumers to interact with retail stores worldwide (Almunawar & Anshari, 2014; Kotler et al., 2019). Smartphones are equipped with sophisticated interactive capabilities that enable consumers to have exciting, new, and unforgettable emotional and rational purchasing experiences with a brand (Meegahapola & Perera, 2017). In particular, augmented reality apps are among the most advanced and exciting technologies, with the dynamic capability to transform consumers' online shopping experience (Saleem et al., 2021b; Kamarudin et al., 2022). According to Poushneh and Vasquez-Parraga (2017), augmented reality apps are integrated with virtual reality, representing a fundamental innovative media format and allowing consumers to experience virtual objects, i.e., images or video. Therefore, in 2021 the augmented reality application in the consumer market was predicted to grow by 31%, mainly expected to place a robust future in the retail sector (Wang et al., 2013). For example, Adidas, Ikea, and Timberland offer augmented reality apps to consumers so they can experience virtual objects (Kim and Sullivan, 2019; Wadel et al., 2020).

Therefore, prior studies have stressed investigating the crucial role of augmented reality apps on consumers' attitudes and purchase intentions in a different context (Schwartz, 2011; Krishen et al., 2021; Saleem et al., 2021b). Thus, Saleem et al.

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(2021b) confirmed that the augmented reality mobile application significantly impacts consumers' buying intention. Further, they identified that augmented reality technology influences the online shopping environment and enhances consumers' involvement with the brands virtually. In this regard, Almunawar and Anshari (2014) suggested that the utilization of augmented reality in the retail sector is increasing mainly in developed countries. Thus, due to the lack of technological innovation and use, the retail sector in developing countries is still not mature enough to develop augmented reality apps (Saleem et al., 2021b). In addition, Alam et al. (2021) highlighted that the implication of augmented reality in the retail sector is still lacking theoretical evidence. Also, little scholarly work investigated the influence of augmented reality apps on the consumers' attitudes and purchase decisions toward a brand (Kim & Sullivan, 2019). According to Watson et al. (2018), "this model enables researchers to empirically identify causal links between physical, experiential retail elements, consumers' affective responses, and purchase intentions and behaviors" (p. 434). However, the aim of the current chapter was primarily focused on unfolding the use of augmented reality mobile apps in the retail sector and its impact on consumers' hedonic, utilitarian, hedonic, satisfaction, and purchase intentions.

2 Hedonic Value

Augmented reality apps enhance and modify user interaction with the physical objects by providing a virtual exhibition, such as videos and images (3D, 4D, 5D). The virtual experience of the physical objects encounters the users' intention to use and ensures the ultimate involvement with the brand (Alam et al., 2021). Poushneh and Vasquez-Parraga (2017) pointed out that the use of augmented reality apps in the retail sector is constantly increasing. Consequently, it also empowers the consumers to gain maximum information about virtual products on their smart devices. Thus, the use of augmented reality mobile applications is getting more familiar and motivating users to interact; as a result, it can enhance consumers' hedonic values (Qin et al., 2021). More recently, Saleem et al. (2021b) emphasized that augmented reality apps empower the consumers to get maximum information about virtual products in a real environment.

Therefore, it is also important for the retailer to design and develop a modern augmented reality app as it can deliver maximum information about a virtual product to the consumers (Krishen et al., 2021; Alam et al., 2021). Empirically, several studies identified that users who experienced superior levels of augmented reality apps could enhance their level of enjoyment (Kang et al., 2014). Likewise, users who experienced a high level of computer-generated 3D or 4D images reveal higher playfulness levels. Qin et al. (2021) concluded that the interaction of users with augmented reality apps could gain their hedonic value by offering exact information and low-risk factor induced by information about a particular product (Baker et al., 2020).

3 Utilitarian Values

According to Kang (2014), the utilitarian values of a user are determined by their actual thoughts, knowledge structure, and memories. In the virtual world, utilitarian values play an essential role by ensuring consumers' interaction based on their past experiences with the products they experienced on augmented reality apps (Riar et al., 2021; Gatter et al., 2022). Impressive virtual reality features of augmented reality apps attract consumers' attention to a virtual store of a brand (Krishen et al., 2021; Saleem et al., 2021b). The dynamic capability of augmented reality apps evokes users' responses and thus acknowledges their rational behavior (Whang et al., 2021). Schwartz (2011) and Lixăndroiu et al. (2021) identified that technological innovation is changing the online shopping attributes of consumers. Hence the traditional shopping habits are not affecting their intention to buy. The unique indicators of the augmented reality applications ensure consumers' engagement and intention to buy in a virtual environment. Considering the modern shopping trends, the retail stores, i.e., Ikea, Timberland, Ray-Ban, Nike, and others, are utilizing augmented reality apps (Kim & Sullivan, 2019; Wadel et al., 2020). In the present study, the utilitarian value was adapted to which consumers evaluate the augmented reality apps to acquire essential information for making purchase decisions (Pantano et al., 2017). For instance, augmented reality apps support users to visualize a physical environment with a virtual generated environment, maximizing the consumers' online shopping experiences by facilitating them to interact with virtual products (Kang, 2014). In addition, Qin et al. (2021) discussed that augmented reality applications likely generate positive feelings from consumers by offering complete information about a product.

4 Satisfaction Level

Prior studies addressed the effect of augmented reality mobile applications on consumers' satisfaction (Poushneh & Vasquez-Parraga, 2017; McLean & Wilson, 2019). Thus, Do et al. (2020) identified that the more users feel positive toward augmented reality apps, the more satisfied they will be. Due to the role of technology in online shopping, retailers are learning to adopt a modern and advanced system that could make consumers more satisfied when they use it to perform online shopping (Schwartz, 2011; Lixăndroiu et al., 2021). More likely, due to the novelty of augmented reality applications, retailers in developing countries are still unaware of how to develop augmented reality applications and interact with the consumers through a virtual environment (Poushneh & Vasquez-Parraga, 2017; Boardman et al., 2020). Therefore, McLean and Wilson (2019) confirmed that the consumers' satisfaction expands technology usage, buying, revisits, and recommendations of the brands in their social circle. In the context of augmented reality applications, consumers' satisfaction has been exhibited to have a substantial and positive impact on purchase intention (Qin et al., 2021; Haile and Kang, 2020).

5 Purchase Intention

Prior studies highlighted that the consumers' purchase intention is affected by several indicators, i.e., hedonic (Li et al., 2017), utilitarian (Kang, 2014), and satisfaction (Poushneh and Vasquez-Parraga, 2017). Therefore, Saleem et al. (2021b) found that augmented reality applications are constantly used in the retail sector. In this regard, it is also essential for the retail sector to identify the key indicators of the augmented reality apps, such as utilitarian and hedonic values, that can ensure the consumers' positive attitude and intention toward the virtual products. However, as discussed earlier in this study, augmented reality apps are assumed to obtain consumers' hedonic, utilitarian, and satisfaction levels, affecting the consumers' purchase decisions in retail sectors in Saudi Arabia. Additionally, the findings of Watson et al. (2018) provided strong empirical support for the influence of augmented reality apps on consumers' purchase intention.

6 Discussion

The current chapter described the influence of augmented reality apps on consumers' hedonic values, utilitarian values, satisfaction, and purchase intention during online shopping. The implementation and regular usage of augmented reality apps are still in their early stages, mainly in developing countries (Saleem et al., 2021a), but the retail sectors in most developed countries, i.e., the United States, the United Kingdom, Germany, and other countries, are featuring progressive developments with augmented reality apps. According to Poushneh (2018), modern technology in the retail sector supports them in enhancing their business operations by facilitating the consumers by providing comprehensive information about the virtual products on their mobile applications. More likely, the current study contributes to the contemporary augmented reality apps literature by describing how consumers assess immersive user interactive technologies' allied properties and features. The findings also enhance empirical affirmation of the rising augmented reality area by investigating how virtuality and interactivity ultimately shape consumers' rational and emotional intentions. Although the respondent population was random consumers who attempted to shop online, most consumers diligently use smartphones and integrate them into their regular shopping practices, so they are familiar with new smartphone applications and technologies (Schwartz, 2011; Lixăndroiu et al., 2021). Thus, specific contributions are presented as follows:

First, user control of the augmented reality apps meaningfully contributes to product success in a wide range. When consumers were able to control the presentation, computer-generated imagery objects, content, or the environment offered by the augmented reality app, they tend to perceive it as encompassing both hedonic and utilitarian values (Watson et al., 2018; Kang, 2014; Sung et al., 2021; Qin et al., 2021).

Second, consumers' interactivity with the augmented reality apps meaningfully influences consumer perceptions of utilitarian, hedonic, and satisfaction. Perceived experience of consumers enhanced control of the augmented reality app, which can integrate the apps more intensely into their online shopping experience. Consumers can experience the virtual products in a physical store visit in a natural setting. Hence, augmented reality apps change the consumers' shopping experience by altering how they sense and interact with products virtually. However, implementing augmented reality apps for several famous brands, i.e., Ikea, Nike, Ray-Ban, and Timberland, allows consumers to experience their virtual products in a real-time environment (Rese et al., 2017; Kim & Sullivan, 2019). It also delivers maximum information about a product to the consumers in which it acknowledges the interaction of consumers with the brands through augmented reality apps. As a result, brands can obtain their business goals and sustain their competitive advantages in domestic and international markets. Earlier studies by Pantano et al. (2017) and Lixăndroiu et al. (2021) highlighted that augmented reality apps during online shopping ease the consumers' journey to find and experience their required brands. Wang et al. (2013) suggested that the augmented reality apps empower the consumers to interact with the retailers while experiencing 3D, 4D, and 5D images of the virtual products that support them in accomplishing their shopping goals. Furthermore, consumers' level of satisfaction would be higher because of the uniqueness of delivering product information via augmented reality apps.

However, the retailer's adoption of augmented reality apps can also affect consumers' utilitarian and hedonic values. Therefore, retailers need to understand consumers' rational and emotional capabilities and develop the content of products on augmented reality apps accordingly, as the consumers can feel more satisfied, which turns into purchase intention. Prior studies found a positive impact of augmented reality apps on consumers' hedonic values, utilitarian values (Kang, 2014), satisfaction, and purchase intention (Qin et al., 2021). Consequently, Kowalczuk et al. (2021) suggested that the retailers should focus more on modern shopping techniques, which significantly affect and develop consumers' strong intention to purchase.

7 Conclusion

This study highlighted the consumers' purchase intention to adopt augmented reality apps for online shopping. Augmented reality apps' virtual presentation of the products positively impacts consumers' utilitarian values, hedonic values, satisfaction, and purchase intention. However, due to the COVID-19 pandemic restrictions, consumers face a tough time visiting retail stores physically for shopping purposes.

Nevertheless, online shopping trends are still a cultural challenge for consumers in developing countries.

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Healthcare Technology and Innovation Management Methods: Theoretical Interpretation

Michael Fascia, Ellie Koseda, and Bryan McIntosh

1 Introduction

Discussions are within a predicate interpretive framework (Di Bella, 2016; Kon et al., 2016; Stones, 2017); this indicates value, from the perspective of the patient (client). As a result, technology and innovation can be valued. Locate systemic management and probability; assume elemental obligations; these actions become the appropriate actions of the client instead of just being a mandatory response from a manager. Adopting this perspective grants a business context to the core interpretation of a healthcare management setting and decision-making (ElMelegy et al., 2016; Pegram et al., 2014; Seran & Izvercian, 2014).

Moreover, to allow definitive axiomatization (Kurucz, 2008), we recognize the logic of epistemic actions (Kurucz, 2010) as a core aspect of interpretation (Kurucz & Marcelino, 2012). From a healthcare manager's point of view, it allows recognition and understanding of elements of technology and innovation. This becomes key in the region of cooperative problem-solving (Kajzer Mitchell & Walinga, 2017) and latterly (Wright-St Clair & Newcombe, 2014) linked to decision-making.

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2 Positioning

Technology and innovation management share a symbiotic relationship (Trong Tuan, 2017; Wanberg et al., 2017), the relationship between the source and the recipient and the broader environment in which technology and innovation management occurs (Fascia, 2019; Zhao et al., 2017), whereby all contributing factors in assessing success of a decision.

This interpretation satisfies the necessary axioms, both by contradiction and revision, to define success or failure.

As a result, this formalized position allows us to highlight principles that are apparent in current theoretical or conditional interpretations of technology or innovation management around or surrounding mechanisms. This facilitates the association of these ideas to practical and recognizable business environments. For instance, healthcare leadership is discussed in greater detail by Hargett et al. (2017). Healthcare leadership in this context is concerned with the leadership of healthcare organizations and their members. This includes establishing goals and strategies, developing and implementing policies and supervising the staff's work.

As such, effective leadership in healthcare is crucial to ensuring organizations can provide high-quality care and meet the needs of their communities (Haddad, 2012). As a result, healthcare leaders have a responsibility to manage a variety of activities including financial and operational management, personnel, quality improvement and outreach in the community. They may also have a role in promoting the organization to stakeholders like patients, staff and policymakers.

Constructive truth is frequently employed to resolve issues, understand situations or improve them. It can involve presenting information in a straightforward and concise manner and providing context or perspective that helps others comprehend a reality. Conversely, truths that are neither constructive nor destructive may be ineffective or even harmful because they lack context or perspective, they are too severe or critical, or they are presented without consideration. Non-verbal truths that are ineffective can lead to misunderstandings or conflicts and may not be beneficial in resolving issues or improving situations.

3 Analysis

This interpretation is straightforward: The central location of the foundational realist concept is significant and perhaps crucial to the identification or interpretation of knowledge usage in an organization. Additionally, this concept is important if predicated by the desire to achieve or measure competitive advantage. Clearly, the doctrine of foundational realism affirms that there is a singular reality that is separate from language, thought and perceptions. This foundation or basis of all of our experience and knowledge may not perfectly represent this reality, but they are still connected to it and rooted in it. Investigation of technology and innovation demonstrates that, similar to fundamental realism, emergent themes are opposed to various forms of scepticism, which believe that our experiences and knowledge are not necessarily connected to an independent reality, and various forms of relativism, which believe that the nature of reality is dependent on our perceptions, thoughts or language. Despite the apparent simplicity of this position, its generalizability is limited on the surface. Contemporary theory is vastly different and has significant flaws.

This is evident in the management literature, which has little in common that can be attributed to a subsequent theoretical position. It is still difficult, therefore, without the use of a logical structure, to determine which interpretations of knowledge are supportive of or interruptive of emerging ideas, or simply a by-product of the interaction of all of the participants in the technology transfer process.

Given the preceding text, it is perhaps understandable why many of the leading authors have focused on understanding and ultimately improving this approach to explaining technology and innovation management in a business context, as this appears to be a key factor in explaining useful properties (Miller & French, 2016; Carroll & Richardson, 2016). In doing so, however, this perspective will ultimately attempt to examine various arguments from one point of view, primarily a Western focus. A logical context does not exist when deriving reality. Thus, the explanatory practice of specific knowledge schemes can be discussed in detail, as there does not appear to be any single explanation that can be interpreted as normal knowledge, even in the contemporary field of thought surrounding critical realism (Holmes et al., 2017; Naylor & Foulkes, 2018; Yanchar, 2018).

As such, when considering a useful component of technology and innovation management in an organization, it would seem logical to consider how a recognized position of knowledge is identifiable within an organization's general interpretation of formalized knowledge in business management theory and how this knowledge is interpreted as "useful" in this context. That is, the knowledge must have value if we consider the observer's actual perception of the reality and motivation associated with the knowledge transfer scenario. This would lead to a formal structure for the agent's beliefs and the ordering of epistemic propositions becoming a beneficial or significant position.

4 Technological Implementation and Ethical Interpretations

Technological implementation in healthcare settings (particularly health and social care services) could potentially help to reduce increasing gaps between supply and demand for resources (Dastbaz et al., 2018). New technologies provide many potential advantages for organizations, including improved efficiency, quality of care, health outcomes and provisions of new services (Dastbaz et al., 2018; Franziska Kaiser et al., 2021). However, despite reported benefits, technology implementation remains challenging with a lack of acceptance and uptake. Barriers to enhancing transformative practices counter any benefits derived from new innovations or stall progression over the long term. Health and social care systems worldwide are facing increasing pressures, driven by limited resources, an aging population and the prevalence of long-term conditions (Dastbaz et al., 2018; Azimi et al., 2017; Ng et al., 2021).

Current practice suggests a need for technology to overcome key problem areas with service efficiency linked to extended waiting times, accident and emergency admissions, general practitioner appointments and referral to treat/discharge patients (Franziska Kaiser et al., 2021; Ng et al., 2021). The nexus of sustainability and the information communications of technologies are changing the way people live, learn and conduct business (Franziska Kaiser et al., 2021). Therefore, one cannot ignore emerging and ubiquitous technologies embedded in the daily lives of people, which may rightfully be considered as enabling solutions for future sustainable development in healthcare (Kabaniha et al., 2020; Dastbaz et al., 2018; Kaliraj & Thirupathi, 2022).

Management within a business context considers pre-conceived and evolving ideas to accommodate the application of evolving technologies (Dastbaz et al., 2018). Conversely, managers in healthcare settings interpret various ethical perspectives in the form of risk aversion, thus prioritizing outdated approaches over competitive advantage (Fenn & Egan, 2012). Moreover, adopting certain measures continues to remain problematic for the purpose of strategy and enhancing operations. Revisiting foundational and doxastic positions enables healthcare managers to view technological enhancement, management and knowledge as a singular construct, thus reinforcing the notion of multitude definition, although not defined by a (singular epistemic principle). Significance is applied to tripartite theory of "Knowledge, Belief, Truth and Jurisdiction" (epistemic principle) being inferred as the norm within transfer mechanisms.

As previously outlined, it fundamentally allows for the identification of alternative perspectives to technology and innovation management. Barriers to technology implementation are not confined to the realm of operations; such definitions pertaining to ethical considerations and universal acceptance could be considered contributing factors (Saarni, 2008).

There is evidently a need to better understand the factors that contribute to the translation of development of sound technology to successful implementation and ongoing use outside a business context (Kabaniha et al., 2020; Franziska Kaiser et al., 2021). Singular thought processing applies episodes of thinking in addition to epistemic possibilities, or relevant constraints continue to influence managerial decision-making with respect to ethical decision-making.

The epistemic principle is a norm for within transfer mechanisms that allows for the identification of alternative perspectives in technology and innovation management (Fascia, 2019a, b; Nathan, 2015). It is a way of understanding how knowledge is acquired, structured and used in different contexts and how this can inform decision-making and problem-solving. This principle is important for understanding how different perspectives can influence the development and implementation of technology by helping organizations become more adaptable and responsive to changing conditions (Kaliraj & Thirupathi, 2022).

Singular thought processing is the tendency to rely on only one perspective or approach when making decisions, instead of considering multiple options or alternative approaches (Crane, 2011). This can be problematic when considering ethical considerations, as it may lead to decisions that are not in accordance with established ethical principles or that do not take into account the potential effects on different parties.

Counter arguments to singular thought processing reside within ethical decision-making, as it may lead to decisions that are not in line with established ethical principles (Tannahill & Douglas, 2014). Healthcare managers have the tendency to scrutinize the epistemic possibilities and relevant constraints for a more informed and ethical decision-making (Grote & Berens, 2020). These further challenge ideas to incorporate decision-making processes made by machine learning with respect to paternalism, moral responsibility and fairness, in essence further limiting the deployment of technologies (Grote & Berens, 2020; Tsamados et al., 2022). Epistemic possibilities and relevant constraints are factors that can influence decision-making and can help managers to identify and consider multiple perspectives and potential outcomes. By considering these possibilities and constraints, managers can make more informed and ethical decisions that are better aligned with organizational goals and values.

5 Conclusion

A predicate for adaptive interpretation was employed that valued technology and innovation from the perspective of the patient, this definition the success or failure by contradiction and revision. This emphasizes the significance of technology and innovation management in healthcare, specifically the difficulties in accurately assessing it. This discussion has described perspectives around current and historical practices of technology and innovation linked to contemporary management philosophy. Focused aspects of theory and positioning were incorporated into the realm of a business context to investigate the concept of technology and innovation management in healthcare, specifically its challenges in establishing and measuring formalized valuable contribution. In the analysis, a dedicated and collective effort was devoted to a doxastic stance and epistemic principle that concerns the utilization of knowledge in a business setting.

Key findings from the literature suggest that the use of technology and innovation management is crucial for business success and competitive advantage, but it remains problematic to evaluate it in a healthcare setting. Moreover, the analysis reflects on the significance of technology and innovation management in a business context and suggests a different perspective that does not conform to prevailing knowledge theory. Propositions are put forward around "technology and innovation management" that can help healthcare organizations stay economical by improving efficiency, productivity and patient satisfaction.

Through the reconciliation of the fundamental and doxastic positions, the significance of technology, management and knowledge can be viewed as a singular concept. Suppositions necessitate this combined approach when assessing the value of knowledge in this context. However, this is characterized by the multitude of definitions surrounding the use of "value" as opposed to a singular epistemological principle of something that is valuable. Additionally, it must be assumed that any significance or relevance to the sender or receiver is derived from the tripartite theory of knowledge: belief, truth and justification (the epistemic principle). This principle also serves as a norm in the mechanism that transfers knowledge, and it provides justification for the premise of the interaction between an epistemic knowledge principle, derived from the knowledge transfer practitioner's perspective supported by a doxastic assumption.

While technology and innovation management are important to business success and a competitive advantage, it is difficult to quantify in healthcare organizations. Importantly, from the perspective of mainstream business management and the foundations of practice (success and strategy), this flexibility in interpretation becomes beneficial to business and organization.

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The Relationship Between Food E-Advertising and Children's Obesity in Bahrain: Role of Rules

Aalaa Ameer Affooni and Allam Hamdan

1 Introduction

Obesity rates in the Kingdom of Bahrain have skyrocketed in recent years, making it one of the country's most significant threats to public health. National estimates for overweight and obesity in Bahrain have reported that among Bahraini children, one out of every three boys is overweight (36%) and about the same percentage for girls (34%). Figures from the 2019 school screening program show that obesity and overweight may be as high as 45.5% in girls and 40.4% in boys aged 10–12 years. Obesity's increasing prevalence is especially concerning as the major risk factor for chronic illnesses, and various types of cancer can eventually lead to mortality.

On top of that, a statement by the Centers for Disease Control and Prevention (CDC) asserted that obesity affects children's behavior, making them lean toward more sedentary activities and affecting their sleep routine and medication use (CDC, 2021). Overweight or obese adults appear to be more likely to become overweight or obese, increasing their risk of at least 12 distinct forms of cancer (Government, 2020). Based on the high percentage of obesity in Bahraini children, it is crucial to investigate further the impact of food E-advertisement on children in Bahrain and the existing rules and regulations that help monitor these advertising activities, along with suggesting new rules and limitations that must be implemented to diminish, and hopefully eliminate, the link between E-advertising and obesity.

It is important to identify the relationship between food E-advertising and children's obesity as the number of children struggling with obesity in the Kingdom of

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Bahrain is increasing. After further research, it was clear that even though the number of children suffering from obesity has increased in the past few years in Bahrain, there is not much research on the reasons behind this increase. Also, with children's screen time increasing and advertisements targeting children popping up all over social media platforms and gaming apps, it is important to assess how relevant this is to children's obesity.

2 Literature Review

People's increasing desire to communicate and technological advancement has led to social media's evolution. Cambridge dictionary defines social media as websites and programs on the internet accessed by people using computers or mobile phones to communicate and share information. Some forms of social media are blogs, podcasts, and applications like Instagram, Snapchat, and Facebook (Cambridge, n.d.). Social media platforms created an interaction opportunity with the target audience and increased sales and brand familiarity. Advertising is a method used for raising awareness among customers regarding a product's applications and benefits, making products accessible for users seeking them; this fulfills the advertiser's goal and boosts their profits. In brief, advertising serves three goals: improving businesses and increasing company sales, providing quality service to consumers, and ensuring the economic and social well-being of society (Mwakasege, 2015).

Obesity is a complicated condition caused by genetics, emotional and intellectual qualities, and the environment. A variety of personal, behavioral, and lifestyle habits influence weight. Obesity, which builds gradually with time, is usually the result of unhealthy dietary and lifestyle decisions, many of which are acquired in childhood (Harvard, 2009).

Obesity has reached epidemic proportions in GCC countries. The region's and, more specifically, Bahrain's increased numbers of overweight and obesity are among the most extreme reported globally. Regarding the Eastern Mediterranean region, the World Health Organization has classified Bahrain, Egypt, Jordan, Saudi Arabia, Kuwait, and the UAE as the countries with the highest obesity rate (WHO, Obesity, 2020). The 2018 Bahrain National Health Survey found that one among three Bahraini adults over the age of 18 is overweight and 42.8% are obese. These two categories were pooled, and for all people surveyed, it was found that one-third of which were non-Bahraini nationalities, and Bahraini nationals had greater levels of overweight and obesity, rating 76% versus non-Bahraini citizens rating 65.5%. Over the last 40 years, obesity rates have increased in Bahrain among girls and boys aged 5–19 years. According to statistics, one in three boys (36%) is overweight, which in comparison with the rates in 1975 it is almost double, and approximately the same percentage of girls are overweight (Sabt et al., 2019).

2.1 Food E-Advertisement and Its Relation to Obesity

According to American Psychological Association (APA), children nowadays use various forms of media and spend up to 44.5 h per week in front of computers, TV, and gaming panels instead of doing any other activity in their daily lives besides sleeping. Arguably, as mentioned earlier, the rise of advertising of non-nutritious food has been associated with higher rates of childhood obesity (APA, 2010). Usually, children under the age of 6 cannot differentiate between programs and advertisements, and notably, they do not grasp the manipulative intent of the advertisements. Therefore advertising targeting children under 8 years old is considered exploitation. Product preference influences children's purchase demands, influencing parents' buying decisions (APA, 2010). Only a limited number of advertisers provide reminders to differentiate content from pure advertising (APA, 2010).

2.2 Rules and Regulations

As part of integrated marketing communications (IMC), food and beverage producers, supermarket merchants, and quick-service restaurants employ a variety of tactics and channels to advertise their products and brands (Kraak et al., 2019). Marketing on social media has risen in recent years to become among the most popular marketing platforms in various industrial sectors, including the food sector (Kraak et al., 2019). Increased usage of social media advertising has made reaching a larger audience, including children and teenagers, much easier (WHO, 2018; Kemp, 2020). Researchers who study food brand websites revealed that child-targeting websites frequently use entertaining, dynamic, and compelling methods to advertise unhealthy products. The British Heart Foundation (BHF) investigated more than 100 websites for food and drink goods commonly purchased or sought by children, such as treats and cereals, which makes 80% of goods that have not been permitted to be marketed to children on television based on UK broadcast constraints that were advertised online using animations, cartoons, competitions, brand characters, games, links, and available for download materials (e.g., mobile phone ringtones).

2.3 Advertising Regulations of Major Social Media Platforms

A large proportion of social media platforms' revenue is typically generated from advertising (Zenith, 2020). Social media advertising is mainly self-regulatory, with businesses marketing themselves on social media platforms held responsible for material validity and compliance with city codes and regulations (ACCC, 2020). Despite the strong international recommendations for action to limit children's exposure to unhealthy food advertising, almost none of the major and most commonly used social media platforms have implemented a full prohibition on unhealthy food advertising. Even though YouTube Kids, a platform that is designed specifically for children under the age of 13, has an advertising rule in which it prohibits marketing food products on its platform, there is proof that children using this platform may be subjected to unhealthy food products through sponsored content and promotional material on the platform (Greenberg, 2015). Sacks and Looi (2020) conducted a study and identified that almost all platforms restricted and, in some cases, banned the advertising of tobacco goods and alcohol. Still, regarding safeguarding children, social media platforms lack comprehensive policies to limit the marketing of unhealthy foods on their platforms.

3 Research Methodology

A quantitative method was used to conduct and assess the research to obtain the objectives of the present study. The primary data for this study was obtained from the Bahraini community to assess the impact of food E-advertising on children's obesity and the effect of rules and regulations in mitigating this impact. A distributed online survey was used to collect data (questionnaire). The sampling number is calculated by considering several factors, such as the volume of the questioned population, the error margin, and the confidence level. As a result, the sample size calculated for this study is 398 samples. Furthermore, the frequency and percentage that determine the questionnaire's key demographics are provided in Table 1.

4 Data Analysis

The survey included statements to test the two factors influencing children's obesity. This section will explore the independent variables of food E-advertising and rules and regulations, as well as the dependent variable represented by children's obesity.

5 Children's Obesity

According to Table 2, most participants believe that children's obesity is primarily caused by a lack of physical activity and poor eating habits, with 67.3% strongly agreeing and 27.9% agreeing with statement S1, accounting for 95.2% of all respondents. This could imply that most participants are unaware of the impact of advertisements and other factors on children's obesity or that they simply consider it a part of the unhealthy eating habits and lack of activity caused by long hours spent online.

Table 1 Participants' responses to demographic questions

Question	Answer choices	Freq.	%
Gender	Male	58	14.6
	Female	340	85.4
	Total	*398*	*100*
Age	Less than 25 years	26	6.5
	25–35 years	163	41
	36–45 years	123	30.9
	Above 45 years	86	21.6
	Total	*398*	*100*
Marital status	Single	71	17.8
	Married	310	77.9
	Divorced	10	2.5
	Widow	7	1.8
	Total	*398*	*100*
Level of education	Secondary or below	34	8.5
	Diploma	46	11.6
	BSc	248	62.3
	Masters	63	15.8
	PhD	7	1.8
	Total	*398*	*100*
Number of children under 14 years	1-Dec	149	37.4
	2-Jan	157	39.4
	5-Mar	82	20.6
	More than 5	10	2.5
	Total	*398*	*100*

Table 2 Children's obesity

Statements	% Degree of agreement					Mean	SD	General %
	SD	D	N	A	SA			
Children's obesity is caused by a lack of activity and unhealthy eating habits.	0.3	0.8	3.8	27.9	67.3	4.613	0.624	92.30
Genetics is the only driver of obesity or thinness in children as they are born this way.	10.6	42.7	27.4	16.8	2.5	2.58	0.972	51.60
Childhood obesity affects the risk of developing some diseases such as cancer and heart disease in the future.	0.5	1	14.3	48.2	35.9	4.181	0.746	83.60
Most obese children lack self-control.	1	11.1	22.4	48.2	17.3	3.698	0.917	74
I don't have a constant control on what my child eats during the day.	4.5	28.1	31.7	28.6	7	3.055	1.015	61.10
Obese children will not lose weight as part of their natural growth alone without diet and exercise.	0	0.5	0.8	27.1	71.6	4.698	0.506	94
Children's obesity is a public health issue that society needs to help solve.	1.3	12.3	17.3	48.7	20.4	3.746	0.959	74.90
Children's right to health must be protected at all costs.	0.3	1.3	2	32.4	64.1	4.588	0.624	91.80

The respondents also showed that they disagree with the statement that genetics is the only factor behind obesity in children with 53.3% strongly disagreeing and disagreeing collectively 27.4 neutral answers, and 19.3 strongly agreeing and agreeing collectively, with a mean of 2.580 and a standard deviation of 0.972, which is barely <1 in statement S2, indicates that there are conflicts in the participants' answers. S4 was about children's lack of self-control, in which 65.5% strongly agreed and agreed with the statement, 12.1% strongly disagreed and disagreed, and 22.9% were neutral; this led to a $\mu = 3.698$ and a standard deviation of 0.917. On the other hand, S5, which stated that parents do not have a constant control on what their child eats during the day, resulted in a 35.6% collective strong agreement and agreement, 31.7% neutral answers, and 32.6% collectively disagreeing and strongly disagreeing. Moving to S6, majority of participants agreed (27.1%) and strongly agreed (71.6%) that obese children will not lose weight as part of their natural growth alone without diet and exercise where the mean was 4.698 and standard deviation was 0.506. When asked about children's obesity being a public health issue that society needs to help solve in S7, 69.1% of participants strongly agreed and agreed with the statement, 13.6% strongly disagreed and disagreed with the statement, and 17.3% were neutral resulting in a mean of 3.746 and standard deviation of 0.959. The vast majority of participants showed their agreement and strong agreement with the statement S8 with a percentage of 96.5%; this led to a mean of 4.588 and standard deviation of 0.624.

5.1 Food E-Advertising

The results of Table 3 will be used to describe the E-advertising aspect.

Looking at the result in statement S1 that measures participants' concern about the E-advertising of unhealthy food products at times when children are on the internet/social media platforms, it was clear that most participants agreed and strongly agreed with the statement with a collective 82.2% agreement, while only 0.8% strongly disagreed and 4.8% disagreed and 12.3% were neutral. As shown in Table 3, in statement S2 the responses resulted in $\mu = 4.407$ and standard deviation = 0.745; results showed that 53.5% of the participants strongly agreed that use of popular personalities or characters in food E-advertisements targeting children increases the influence of unhealthy food promotions and 36.2% agreed with the statement to, only 2.3% collectively disagreed and strongly disagreed which is a very small percentage. Moreover, the results were similar for statement S3 where 52.5% strongly agreed that food E-advertising that promotes free toys or gifts with products attracts children to unhealthy food, 38.7 agreed, and only 3% strongly disagreed and disagreed collectively resulting in a mean of 4.397 and standard deviation of 0.773. Another statement that majority of participants agreed on was that food E-advertising does not provide accurate information about nutritional quality of the product being advertised, 53.8% strongly agreed with the statement, 37.7% agreed, 6.5% were neutral, 1.5% disagreed, and 0.5% strongly disagreed. The mean and standard deviation values were 4.427 and 0.726 confirming the agreement of the participants. The statement S5 regarding

Table 3 Food E-advertising

Statements	% Degree of agreement					Mean	SD	General %
	SD	D	N	A	SA			
I am concerned about the E-advertising of unhealthy food products at times when children are on the internet/social media platforms.	0.8	4.8	12.3	37.2	45	4.209	0.889	84.20
The use of popular personalities or characters in food E-advertisements targeting children increases the influence of unhealthy food promotions.	0.3	2	8	36.2	53.5	4.407	0.745	88.10
Food E-advertising that promotes free toys or gifts with products attracts children to unhealthy food.	1	2	5.8	38.7	52.5	4.397	0.773	87.90
Food E-advertising does not provide accurate information about nutritional quality of the product being advertised.	0.5	1.5	6.5	37.7	53.8	4.427	0.726	88.50
I monitor what my child watches on the internet and social media platforms.	0.8	4.5	30.4	39.9	24.4	3.827	0.877	76.50
I observe the effect of E-advertising of unhealthy foods on my child's choice of foods.	0.5	9.3	25.4	41.2	23.6	3.781	0.928	75.60
Food E-advertising affects children's obesity.	0.5	3.8	11.8	48	35.9	4.151	0.808	83

monitoring what children watches on the internet and social media platforms resulted in a mean of 3.827 and a standard deviation of 0.877, and participants collectively agreed and strongly agreed with the statement with a percentage of 64.3; on the other hand 30.4% were neutral, 4.5% disagreed, and 0.8% strongly disagreed. The findings of S6 resulted in 64.8% of the participants collectively agreeing and strongly agreeing, 25.4% were neutral, 9.3% disagreeing and 0.5% strongly disagreeing, and the results of the mean and standard deviation were 3.781 and 0.928, respectively. Meanwhile, statement S7 also resulted in the majority of participants agreeing and strongly agreeing with the statement where 35.9% strongly agreed and 48% agreed. The disagreement percentage of S7 was very low, where 3.8% disagreed and 0.5% strongly disagreed, and the mean value was 4.151 and the standard deviation was 0.808. The results of the last two statements clearly indicate that there is an issue with food E-advertisements that targets children and that many parents have noticed the impact that these advertisements have on their children's food choices.

5.2 Rules and Regulation

Table 4 will measure the role of rules and regulations in protecting children from unhealthy food E-advertisements to reduce and hopefully eliminate children's obesity.

Table 4 Rules and regulations

Statements	% Degree of agreement					Mean	SD	General %
	SD	D	N	A	SA			
There are laws in the Kingdom of Bahrain regulating food E-advertisements directed at children.	7.8	20.1	57.5	11.3	3.3	2.822	0.852	56.40
If any, the current regulations of food E-advertising in the Kingdom of Bahrain are not effective in protecting children from targeted advertisements.	0.5	2.8	36.7	42.2	17.8	3.741	0.797	74.80
If any, rules that are implemented by social media platforms are not enough to protect children from E-advertisements of unhealthy food products.	0.5	1.8	9.8	41.7	46.2	4.314	0.761	86.30
The government should introduce stronger restrictions on food E-advertising.	2.3	8.5	19.3	30.9	38.9	3.957	1.063	79.10
Unhealthy food E-advertisements should be totally banned.	0.3	1	24.4	47.7	26.6	3.995	0.758	79.90
Major social media platforms should voluntarily restrict the exposure of children to E-advertisements of unhealthy foods.	0.5	2.3	10.3	43	44	4.276	0.777	85.50

As shown in Table 4, participants responded to the statement S1 that indicates that there are laws in the Kingdom of Bahrain regulating food E-advertisements directed at children with 7.8% strongly disagreeing, 20.1% disagreeing, 11.3% agreeing, and 3.3% strongly agreeing, and there were also 57.5% neutral responses that resulted in a mean of 2.822 and standard deviation of 0.852. S2 was related to how effective are Kingdom of Bahrain's regulations where the results indicated a cumulative agreement and strong agreement equaling 60%, a cumulative disagreement and strong disagreement equaling 3.3%, and a neutral value of 36.7%; as mentioned before the percentage of neutral responses indicates that participants are unaware of the existence of rules and regulations implemented by the Kingdom of Bahrain let alone their effectiveness. The mean and standard deviation values were respectively, 3.741 and 0.797. On the other hand, S3 stated that rules that implemented by social media platforms are not enough to protect children from E-advertisements of unhealthy food products, the responses were mostly in agreement with the statement where 41.7% of participants agreed and 46.2% of participants strongly agreed, and there were some disagreement (1.8%) and strong disagreement (0.5%), but they were minimal in comparison to the agreement, and the responses resulted in a $\mu = 4.314$ and standard deviation = 0.761. The findings of S4 resulted in 69.8% of the participants collectively agreeing and strongly agreeing, 19.3% participants were neutral, 8.5% disagreeing and 02.3% strongly disagreeing, and the results of the mean and standard deviation were 3.957 and 1.063, respectively. Unhealthy food E-advertisements should be totally banned; this statement was to measure the participants' view of the negative effect that unhealthy food E-advertisements have on children; a total of 74.3% agreed and strongly agreed with the statement, while 24.4% were neutral and 1.3% disagreed and strongly disagreed. The responses resulted in a μ = 3.995 and standard deviation = 0.758. The findings of S6 resulted in 87% of the participants collectively agreeing and strongly agreeing, 10.3% of participants were neutral, 2.3% disagreeing and 0.5% strongly disagreeing, and the results of the mean and standard deviation were 4.276 and 0.777, respectively.

5.3 Path Analysis

Table 5 represents the *T*-test results of participants' perspectives on the factors influencing children's obesity in terms of whether the participants are males or females; all the variables revealed no significant difference because the *T*-test results were higher than (0.05 sig.).

Table 6 represents the ANOVA test results of participant's perspective about the variables affecting children's obesity based on the participant's age.

Table 5 Participants' perspectives based on their gender

Variable	Factor of gender	Mean	*T*-test	*p*-value
Children's obesity	Male	3.808	-1.959	0.051
	Female	3.910		
Food E-advertising	Male	4.168	-0.580	0.954
	Female	4.172		
Rules and regulations	Male	3.756	-1.542	0.124
	Female	3.867		

Table 6 Participants' perspectives based on their age

Variable	Factor of age	*F*-test	*p*-value
Children's obesity	Less than 25 years	2.633	0.05
	25–35 years		
	36–45 years		
	Above 45 years		
Food E-advertising	Less than 25 years	5.359	0.001
	25–35 years		
	36–45 years		
	Above 45 years		
Rules and regulations	Less than 25 years	4.552	0.004
	25–35 years		
	36–45 years		
	Above 45 years		

When comparing the significance level to alpha = 5%, it is apparent that there was a significant difference between the groups in participants' responses regarding food E-advertising variable statements (sig. = 0.001) and rules and regulations statements (sig. = 0.004) where both significant values were under 5%. The variance in responses was mostly between participants who were less than 25 years and the other groups.

5.4 *Testing the First Hypothesis*

The first hypothesis stated that food E-advertising is a contributing factor to obesity in children. The results of the regression were shown in Table 7.

The data outcome reveals that the hypothesis is accepted as the sig. (0.000) < 0.05. The data also shows that R is 32%, which means that food E-advertising is a contributing factor to children's obesity, and the effect percentage of food E-advertising is shown to be 10.3%. Remarkably, the findings of the study accurately reflect the arguments mentioned in the literature review where it was stated that food E-advertising influences children's eating habits and therefore influences children's obesity.

5.5 *Testing the Second Hypothesis*

The second hypothesis stated that rules and regulations related to monitoring food E-advertisement in Bahrain can help mitigate children's obesity. The results of the regression were shown in Table 7. The data outcome reveals that the hypothesis is accepted as the sig. (0.000) < 0.0; the data also shows that R is 38.5%, which means that rules and regulations have a positive impact (14.8%) in mitigating the effect of food E-advertising on children's obesity. The reasons why rules and regulations are important in preventing the effect of food E-advertising on children's obesity were also emphasized in the literature review.

Table 7 Regression results

Hypothesis	R	R^2	F-test	Sig. (F. test)	T-test	Sig.
Food E-advertising is a contributing factor to obesity in children.	0.320	0.103	45.309	0.000	6.731	0.000
Rules and regulations related to monitoring food E-advertisement in Bahrain can help mitigate children's obesity.	0.385	0.148	68.825	0.000	8.296	0.000

6 Conclusion, Recommendations, and Future Research

The study's main goal was to investigate the relationship between food E-advertising and children's obesity in Bahrain, as well as the impact of rules and regulations on this relationship. The study adopted a quantitative technique, which included distributing a survey to Bahraini citizens as the study's target population, which resulted in 398 responses. The testing of hypotheses acknowledged the significant impact of food E-advertising on childhood obesity, as well as the significant role that rules and regulations can play in preventing it. To summarize, this study found that food E-advertising has an impact on children's obesity in the Kingdom of Bahrain and that implementing rules and regulations to control food E-advertising will mitigate this impact. Children's obesity rates in the Kingdom of Bahrain are rising. Thus, the lack of published data and evaluation on the relationship between food E-advertising and childhood obesity in the Kingdom of Bahrain was the study's main limitation. It was also difficult to find any rules or regulations particularly related to food E-advertising targeting children, as most regulatory actions were related to children-targeted advertisements on television or in printed ads.

Children should be encouraged to participate in the digital world so that they can exercise their rights to information and participation. However, the participation of children in the digital world should not be conditional to exposing them to advertisements for unhealthy foods. Furthermore, given the tragic increase in childhood obesity in Bahrain, we have an obligation to protect children's rights to a healthy life and, as a result, establish statutory regulations for the digital marketing of unhealthy foods to children. Concerned governmental entities, in my opinion, should work together to improve existing rules and regulations controlling advertising in general, as well as construct new rules and regulations and establish a new law governing children's food advertising.

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The Obvious Foreseen Effects of Machines Replacing Humans in Society

George Sammour and Laila Malas

1 Introduction

Creativity, imagination, and innovation are key methods humans use to make their lives easier and achieve success. To increase productivity and profits, companies have sought to involve employees in manual craftsmanship like sewing and have encouraged the use of counsel and scientific knowledge to strengthen their capabilities. Additionally, gaining the ability to persuade others of one's viewpoint has been seen as integral to success.

So, the Ideas about human existence were explored until the industrial revolution of 1790 to 1840, when automation began to enter the scene. This caused great concern to workers whose jobs were now in jeopardy. In 1837, Charles Babbage developed the analytical engine, the first device considered to be a computer. Soon after, robots started to emerge, with the term coined by Karl Kapek in 1939. The first physical robot was created a year later, named ELEKTRO. It was showcased in an international exhibition, marking a milestone for the history of automation. Figure 1 shows the advancement of artificial intelligence (AI).

With this ever-increasing focus on automation, this notion is the ultimate innovation of humanity, which we will discuss in this paper, the artificial intelligence (AI) that was transformed during the Second World War. In 1950, Alan Turing devised a technique to quantify the intelligence of the device that was based on the device's capacity to think and comprehend, thus the artificial intelligence that involves composing a learning program and algorithms that allow the machine to function, and this is called machine learning, so that if it applies to any device like cars, it becomes

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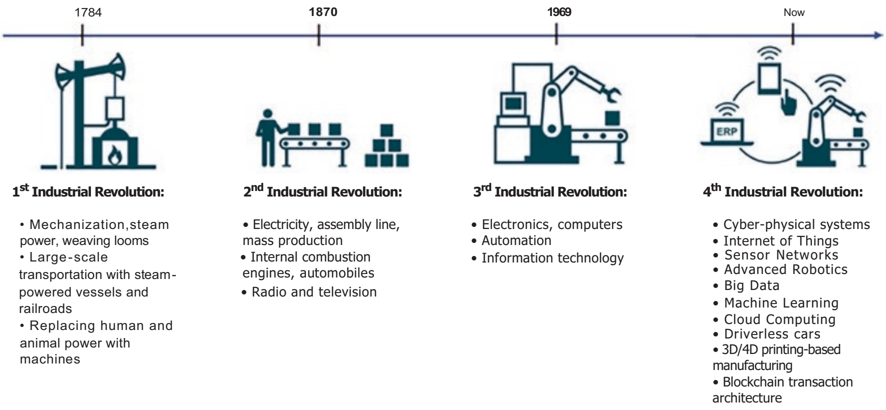


Fig. 1 The temporal development of the automation process from the first industrial revolution until now

intelligent in its functioning without a driver (A history of automation: The rise of robots and AI, 2019).

Nowadays, it is essential that people pay attention to potential issues that may arise and affect humanity and that we must take the time to seriously consider how to best prepare for any potential difficulties that could arise, as these could have a profound impact on our lives and our ability to generate an income.

The emergence of modern machines and technologies such as AI and robots has caused a disruption in the workplace. They have been successful in generating profits and increasing productivity in a short time; however, these machines lack the capability to understand and work with the intelligence of emotions and feelings, as in the case of a patient who needs 50% affection for treatment. To keep the human element alive in the work environment, people have come up with solutions that guarantee the human right to strive for development and creativity.

The importance of this investigation is to accomplish a harmony between man and machine without disregarding the human factor. Rather, we make utilization of machines advantageous for organizations and decision-makers as an approach through which it helps decision-makers to help their work in a specialized manner utilizing artificial intelligence and without dispensing with the human factor so that organizations and businesses can accomplish what profits them, arrive at a reasonable conclusion, and acquire benefits all this in this paper.

The research paper will be structured as follows mentioning all the related works that talk about machines replacing humans and what they did not mention in order to discover the gap; next the solution will be explained by evaluating real-life methodology that shows how machines and humans are used in business wise; after that the solution will be proposed to ensure in previous section that the methodology must be balanced between machines and humans using hybrid intelligence to finally reach to the conclusion and recommendation.

2 Literature Review

In this section, the paper will explore various published works related to machine substitution of human labor, analyzing the perspectives, beliefs, and opinions of the authors. Also, we will identify any gaps in the existing literature and present our own ideas to provide a holistic understanding of the topic and its potential solutions.

Bruuna and Duka (2018) in their research "Artificial Intelligence, Jobs and the Future of Work: Racing with Machines" focused on the reality that artificial intelligence is advancing in our everyday lives and how, if left unchecked, it will eventually replace human labor and lead to a disaster. Therefore, they set out to lessen the potential of technological unemployment in their research. To help those who become unemployed, the government should implement taxes on corporations that use robots in place of human labor. These taxes should be distributed among the affected employees. Initially, they utilized the situation analysis method to categorize scenarios whether they are repetitive or non-repetitive or cognitive or manual, based on cognitive level and repetition level. Additionally, they utilized the unconditional universal basic income method to impose taxes on companies that use robots in place of human workers, in certain proportions. This change eventually resulted in a standardized shift in the current economic model and diminished some of the most adverse effects linked with technological unemployment (Bruuna & Duka, 2018).

Dahlin (2019) in his research "Are robots stealing our jobs?" emphasizes that automation, including robots and artificial intelligence, is spread unevenly across the labor market, particularly in middle-skill jobs. As such, his goal in his research was to examine the degree of the effect of robotics and automation on employment through the perspective of displacement and enhancing in the United States between 2010 and 2015 using the linear regression method between industrial robots and the loss of jobs and gains. Therefore, results showed that the rise in robot industrialism is connected with the rise in high skill and some occupations in medium skills. These results suggest that we are entering a new era in which robots are more technologically advanced and able to collaborate more effectively with human employees (Dahlin, 2019).

Fossen and Sorgner (2019) in their research "Mapping the Future of Occupations: Transformative and Destructive Effects of New Digital Technologies on Jobs" this article explore the effects of modern technological digitization on professions that can be destructive or transformative. To begin, the researchers categorized professions into four groups: rising stars, collapsing, machine terrain, and human terrain, each of which differed according to the effect of digitization. Two measures were used to analyze these professions: a destruction measurement and a transformation measurement. The destruction measurement is based on expert judgment and O*Net Database data gathered by the US Department of State. The transformation measurement is based on data provided by the Electronic Frontier Foundation and O*Net occupation data, which measures the progress of artificial intelligence for each profession. This data will help to determine which occupations will have a demand and what the rate of employment is (Fossen & Sorgner, 2019).

One could conclude the outcome of the four mentioned thoughts by the authors notice that we are entering into an age full of dilemmas facing humanity. The very clear fact that man invented machines control by computers for those machines to replace their inventors.

If one look at the core of the problem, he would notice that his thoughts and conclusions mixed with his inventions are all in vicious circle as man will start inventing computers and machines to replace him reaching to a point for those machines to think by themselves to replace the inventor. When one look into such a problem it will lead him to a machine controlling the new invention of new superior machines that will reach a point to be clever enough to surpass the inventor. But what would be very clearly noticeable during this journey of inventions that no matter where machine could reach, they will lack the sense of humanitarian characteristics and emotions. This issue by itself will put the major constraint on the dream of any inventor to have the perfect machine resampling humans as created by God.

It is believed that a considerable percentage of the evolving workforce will be replaced by machines and robots controlled by computers (StringField & Stone III, 2017). Those kinds of replaceable tasks and jobs are the kind of high-speed production units that are purely repetitive and that do not need high levels of intelligence. Contrary of this kind of labor sector there is tow bands of lower production and less of intelligence needs that will be always available for human labors to occupy at a much lower cost than inventing machines to replace this kind of lower band of the workforce.

This will leave us with the upper band of the labor force that represents the human productive mind and intelligence of high-caliper personnel such as doctors, lawyers, and scientists characterized by the human touch of emotions and affections that could never be accommodated to machines and computers. So whatever people talk about machines and computers replacing humans, it should have constraints not to bypass certain limits.

3 Methodology

After studying the relationships between these publications and knowing the gap that they did not touch upon. In this section, the paper will tackle the problem of replacing humans with machines using an experimental real-life example that shows that humans have their own capabilities and that machines have specific capabilities in order to complement each other that cannot be replaced. Since human beings have the ability to intuit, make decisions and arbitration, and understand the parties, machines cannot perform these operations because they are only able to extract information and carry out some tasks according to certain algorithms and rules that would help humans to make the decision, and therefore we have to balance between humans and machines to cancel the idea of substitution, and this example works to reinforce the concept of balancing between humans and machines using brainstorming method.

Suppose that ACME Company seeks to solve the marketing strategy problem that confronts them. Therefore, managers resort to a brainstorming session to solve this problem and reach a result that humans extracted, but before the session is held, each person must obtain, analyze data as a proof of concept, and guide to take the appropriate decision toward this problem so that here comes the role of machines that work to explore and extract data in a way that makes it easier for humans to make decisions without errors or repetitions, so the research will explain here the role of the machine by extracting and analyzing dataset extracted from Kaggel website using the knowledge discovery method (KDD), which goes through several stages (Guerra-Hernández et al., 2008); see Fig. 2.

1. Determine the aim of the application and the previous knowledge by establishing the goal of the KDD process; here in this example the goal is to analyze Fitbit Fitness Tracker Data to get insights on how consumers use the app and figure out the patterns so as to give a top level of recommendation for marketing strategy.
2. Data selection: this aims to create a target dataset from the original data and choose a subset of the variable data samples that must be discovered.
3. Preprocessing is an important step in data cleaning and preparation for analysis. It involves detecting and eliminating inconsistencies and outliers, filling in missing values, and applying statistical techniques to determine mean, median, variance, and standard deviation. Machine learning is also used to handle missing values.
4. Transformation is an integral part of the knowledge discovery process that works to reduce and drop data by selecting examples and important features. It can also be used to decrease the number of variables being studied or to change the data format.
5. Data mining: by extracting interesting patterns by choosing:

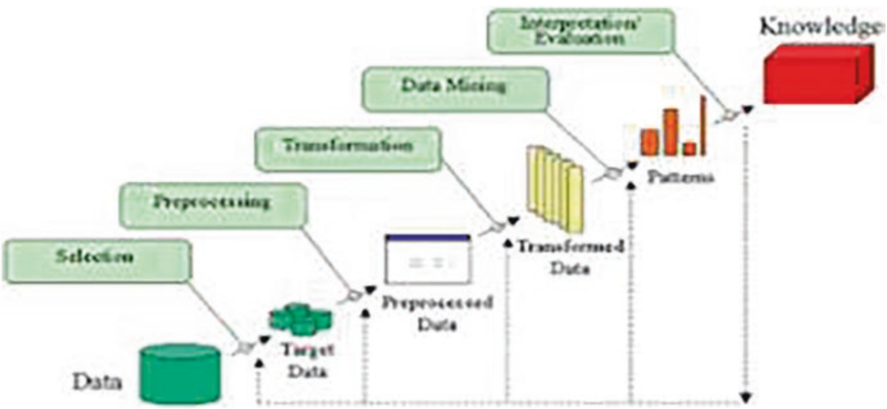


Fig. 2 The knowledge discovery process for data analysis

(a) Specific task or method to extract data such as summarization, classification, aggregation, clustering, regression, etc.
(b) Algorithms and techniques for researching patterns in reduced data such as K-means, CART data mining algorithm, k-nearest neighbors, statistical analysis, etc.
(c) Relevant representation of output outcomes

6. Interpret and evaluate mined patterns and review some steps.

3.1 Data Description

The First Step will target dataset from Kaggle website: Fitbit Fitness Tracker Data that consist of 18 CSV files this data all combined and collected from surveys generated from March 12, 2016, to May 12, 2016 (FitBit Fitness Tracker Data, 2016).

In terms of personal data, 30 Fitbit users consented to submit their personal data; all these datasets consist of five main aspects: physical activity recorded in minutes, heart rate, sleep monitoring, daily activity, and steps.

Of course, each dataset has several limitations. One of them is that these datasets collected from 2016 about daily activity, fitness, sleep, and stress, etc. All these patterns may be changed after certain period of time based on the user behavior so it must be on real-time manner and relevant, also the personal data of the 30 Fitbit users is not representative of the entire female population, in addition to that since this data collected from survey unable to ascertain the integrity or the accuracy of the data.

In order to select the best dataset to work with, we have to measure the quality of data using evaluation criteria that show the effectiveness of this dataset by ROCCC metric that stands for reliable, original, comprehensive, current, and cited the following table describe this data source using this matric that is shown in Table 1.

Here in this example the paper target one dataset called daily activity merged, this dataset consist of 940 samples and 15 attributes, all these attributes are numerical attributes and they are ID which is id for each user that must be unique as primary key, activity date, total steps, total distance, tracker distance, logged activity distance, very active distance, moderate active distance, light active distance, sedentary active distance, very active minutes, fairly active minutes, fairly active minutes, lightly active minutes, sedentary minutes, and calories.

Table 1 The evaluation criteria that this methodology relies on

Reliable	Original	Comprehensive	Current	Cited
Low	*Low*	*Medium*	*Low*	*Low*
Only has 30 respondents	There is a third-party provider for this data source	Since these parameters match Bellabeat product parameters	Because these dataset from 2016 and is not relevant	These data collected from third party

3.2 Data Preprocessing

In order to preprocess the data, this paper uses Python programming language in google Colab as a tool to process, analyze, and visualize the data so the following steps are taken into consideration for this data:

Step 1 Import the basic libraries that we need to use for this dataset NumPy for numerical operations, pandas for data structure and data analysis, matplotlib for data visualization, and date time for date data types. Figure 3 shows the code to import libraries.

Step 2 Show the first ten rows from the data in order to make sure that the data are now currently available and we can modify it as shown in Fig. 4.

Step 3 Check the missing values for each attribute as shown in Fig. 5.

```
[ ] # import packages and alieas
    import numpy as np #data arrays
    import pandas as pd #data structure and analysis
    import matplotlib as plt #data visualization
    import datetime as dt #date time
```

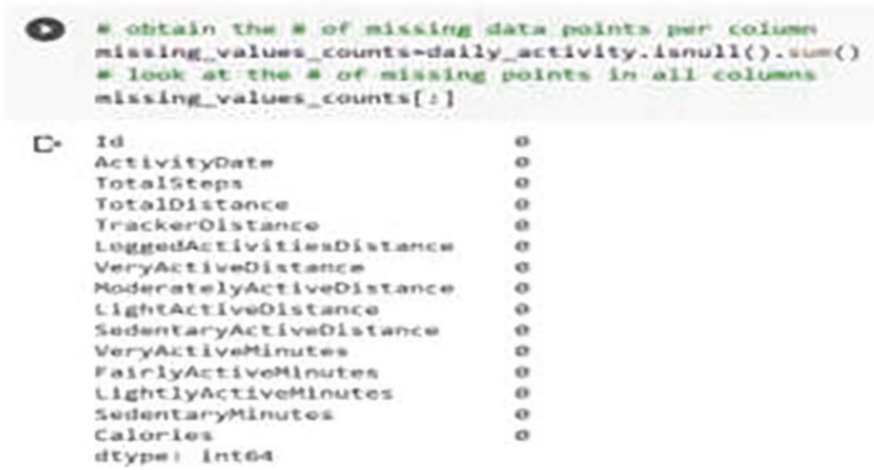
```
[ ] #read CSV function to read the required CSV file
    daily_activity=pd.read_csv("dailyActivity_merged.csv")
```

Fig. 3 The basic libraries to import the data that can be used for analysis

```
[ ] #Data Cleaning and Manipulation
    # preview first 10 rows with all columns
    daily_activity.head(10)
```

	Id	ActivityDate	TotalSteps	TotalDistance	TrackerDistance	LoggedActivitiesDistance	VeryActiveDistance	ModeratelyActiveDistance	LightActiveDistance	SedentaryActiveDist
0	1503960366	04/12/2016	13162	8.50	8.50	0.0	1.88	0.55	6.06	
1	1503960366	4/13/2016	10735	6.97	6.97	0.0	1.57	0.69	4.71	
2	1503960366	4/14/2016	10460	6.74	6.74	0.0	2.44	0.40	3.91	
3	1503960366	4/15/2016	9762	6.28	6.28	0.0	2.14	1.26	2.83	
4	1503960366	4/16/2016	12669	8.16	8.16	0.0	2.71	0.41	5.04	
5	1503960366	4/17/2016	9705	6.48	6.48	0.0	3.19	0.78	2.51	
6	1503960366	4/18/2016	13019	8.59	8.59	0.0	3.25	0.64	4.71	
7	1503960366	4/19/2016	15506	9.88	9.88	0.0	3.53	1.32	5.03	
8	1503960366	4/20/2016	10544	6.68	6.68	0.0	1.96	0.48	4.24	
9	1503960366	4/21/2016	9819	6.34	6.34	0.0	1.34	0.35	4.65	

Fig. 4 Sample from the data first ten rows



```
# obtain the # of missing data points per column
missing_values_counts=daily_activity.isnull().sum()
# look at the # of missing points in all columns
missing_values_counts[:]

Id                            0
ActivityDate                  0
TotalSteps                    0
TotalDistance                 0
TrackerDistance               0
LoggedActivitiesDistance      0
VeryActiveDistance            0
ModeratelyActiveDistance      0
LightActiveDistance           0
SedentaryActiveDistance       0
VeryActiveMinutes             0
FairlyActiveMinutes           0
LightlyActiveMinutes          0
SedentaryMinutes              0
Calories                      0
dtype: int64
```

Fig. 5 How to check if there is missing value or not

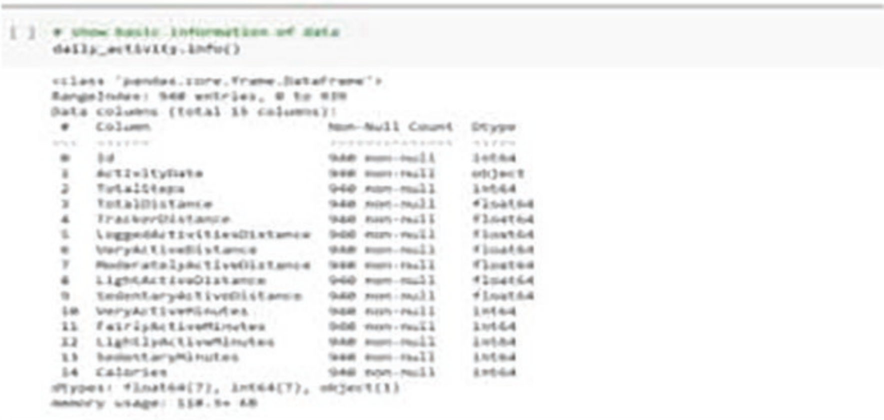


Fig. 6 Data type for each attribute

Step 4 Discover the data types for each attribute as displayed in Fig. 6

Step 5 Determine the distinct values of IDs as presented in Fig. 7

From here, the results noticed that there are no null or missing values, this dataset consists of 15 attributes and 940 samples but the activity date misclassified must be date data type, and also there is 33 unique IDs instead of 30 that are consented for sharing their personal data as a fitness tracker user. All these will be solved in the transformation step.

```
[ ]  # count Distinct value of "ID"
     unique_id = len(pd.unique(daily_activity["Id"]))
     print("# of unique ID:"+str(unique_id))

     # of unique ID:33
```

Fig. 7 The uniqueness IDs

3.3 Data Transformation

Here changing data type and structure of features will be applied; the below steps solve the above limitations:

Step 1 Transform the activity date data type into the following format yyy-mm-dd as exposed in Fig. 8.

Step 2 Create list of rearranged columns as displayed in Fig. 9.

Step 3 Create new column called day of week in order to represent each date with their day as shown in Fig. 10.

Step 4 Rename columns as presented in Fig. 11.

Step 5 Create new column called total min that calculate the minutes of very active, fairly, lightly, and sedentary minutes as presented in Fig. 12.

Steps 6 Create total hours columns that convert the total min into hours by rounding them as exposed in Fig. 13.

3.4 Data Modeling

Here in this example the paper tends to analyze the data by interpreting some descriptive analytics using some statistics in order to explain exactly the results clearly (mean, median STD, quartiles, min, max) as displayed in Fig. 14.

The results indicate the following:

1. Generally, people logged 7637 steps or 5.4 km, which is not enough. As suggested by the CDC, a grown-up female needs to target a minimum of 10,000 steps or 8 km every day to gain from overall health, fat reduction, and fitness enhancement. Source: Medical News Today article.
2. The majority of users are sedentary, logging an average of 991 min or 20 h, which accounts for 81% of the total average minutes.

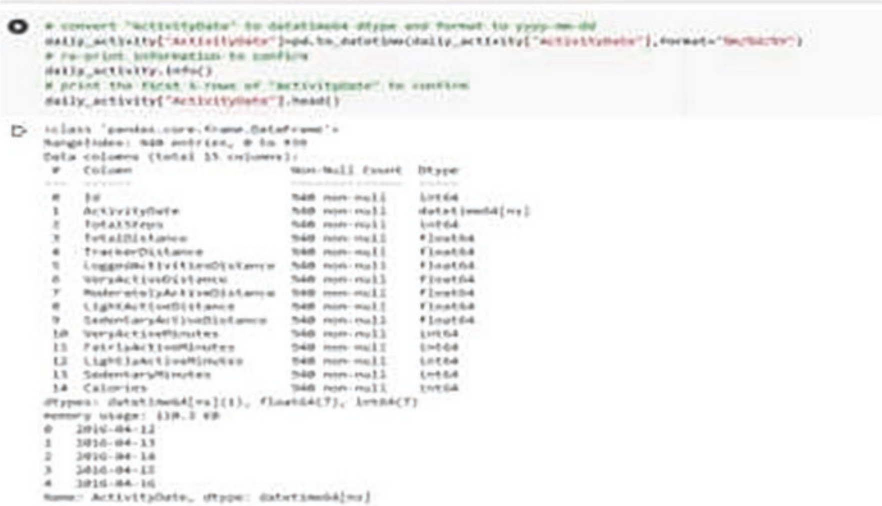


Fig. 8 Change the format of date data type attribute

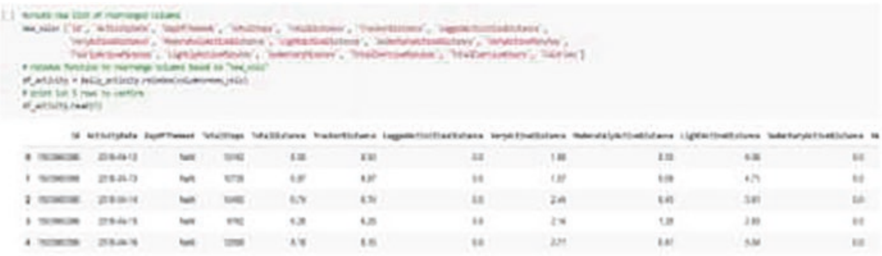
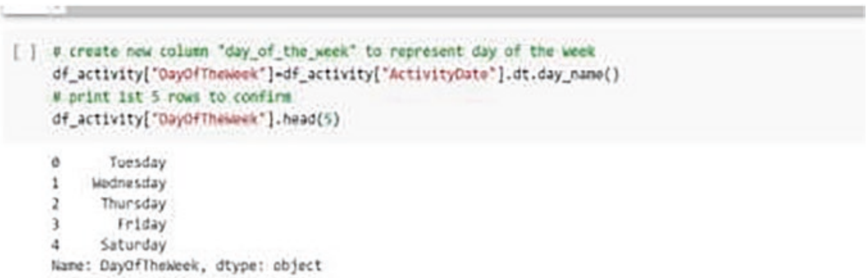


Fig. 9 Apply feature selection and arrangement



```
# create new column "day_of_the_week" to represent day of the week
df_activity["DayOfTheWeek"]=df_activity["ActivityDate"].dt.day_name()
# print 1st 5 rows to confirm
df_activity["DayOfTheWeek"].head(5)

0      Tuesday
1    Wednesday
2     Thursday
3       Friday
4     Saturday
Name: DayOfTheWeek, dtype: object
```

Fig. 10 Create new feature in this dataset

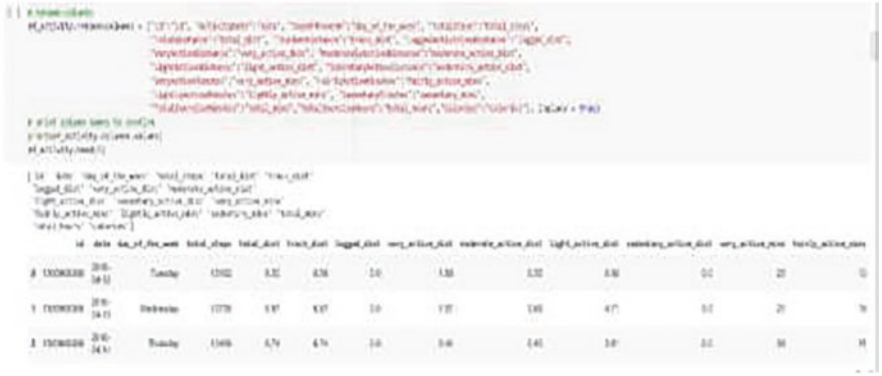


Fig. 11 Change attribute names

```
# create new column "total_mins" containing sum of total minutes.
df_activity["total_mins"] = df_activity["very_active_mins"] + df_activity["fairly_active_mins"] + df_activity["lightly_active_mins"] + df_activity["sedentary_mins"]
df_activity["total_mins"].head(5)
```

```
0    1094
1    1033
2    1440
3     998
4    1040
Name: total_mins, dtype: int64
```

Fig. 12 Create calculated field to find the total minutes

```
# create new column "total_hours" by converting to hour and round float to two decimal places
df_activity['total_hours'] = round(df_activity['total_mins'] / 60)

# print 1st 5 rows to confirm
df_activity['total_hours'].head(5)
```

```
0    18.0
1    17.0
2    24.0
3    17.0
4    17.0
Name: total_hours, dtype: float64
```

Fig. 13 Apply another feature creation that calculates total hours

```
[ ] # pull general statistics
    df_activity.describe()
```

	id	total_steps	total_dist	track_dist	logged_dist	very_active_dist	moderate_active_dist	light_active_dist	sedentary_active_dist	very_active_mins	fairly_active_mins	lightly_active_m
count	9.400000e+02	940.000000	940.000000	940.000000	940.000000	940.000000	940.000000	940.000000	940.000000	940.000000	940.000000	940.000
mean	4.855407e+09	7637.910638	5.489702	5.475351	0.108171	1.502681	0.567543	3.340819	0.001606	21.164894	13.564894	192.812
std	2.424805e+09	5087.150742	3.924606	3.907276	0.619897	2.658941	0.883580	2.040655	0.007346	32.844803	19.987404	109.174
min	1.503960e+09	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000
25%	2.320127e+09	3789.750000	2.620000	2.620000	0.000000	0.000000	0.000000	1.945000	0.000000	0.000000	0.000000	127.000
50%	4.445115e+09	7405.500000	5.245000	5.245000	0.000000	0.210000	0.240000	3.365000	0.000000	4.000000	6.000000	199.000
75%	6.962181e+09	10727.000000	7.712500	7.710000	0.000000	2.052500	0.800000	4.782500	0.000000	32.000000	19.000000	264.000
max	8.877689e+09	36019.000000	28.030001	28.030001	4.942142	21.920000	6.480000	10.710000	0.110000	210.000000	143.000000	518.000

Fig. 14 Statistical analysis for the data

3. Taking into account that the average calories burned is 2303 calories, which is equivalent to 0.6 pound, it is difficult to explain in more detail, as the number of calories burned depends on various aspects such as age, weight, daily activities, exercise, hormones, and daily calorie intake. Source: Health Line article.

3.5 Result and Discussion

After all operations are completed, the results are visualized by dashboard as a guide or tool that helps members make decisions, such as the example shown below in Fig. 15.

Each graph indicates as a key performance indicator that reflects the whole dashboard.

The First Graph Indicates that user tracks their activity using app during mid-week from Tuesday until Friday and the rest of the days the frequency dropped down; see Fig. 16.

The Second Graph Here the graph noticed that there is a positive correlation between steps taken and calories burned and when users >0 to 15,000 steps taken with calories burn rate cooling down from 15,000 steps onward as displayed in Fig. 17.

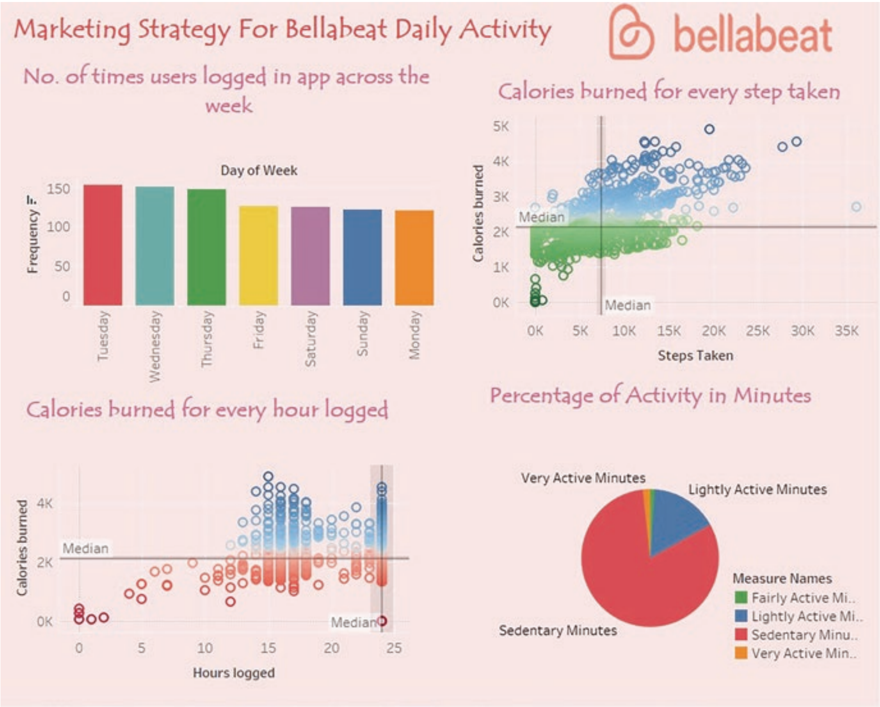


Fig. 15 The dashboard result for the data analysis

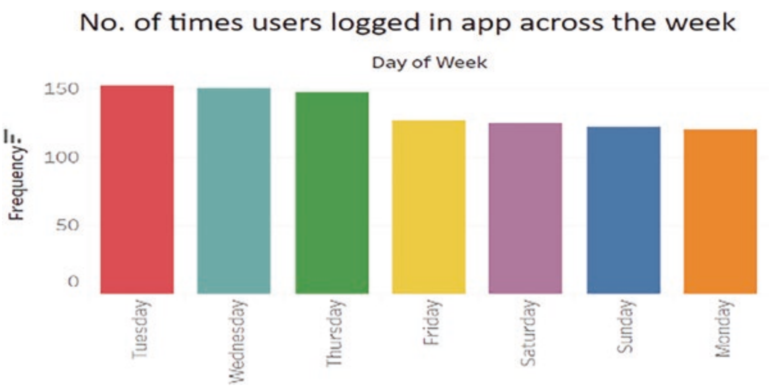


Fig. 16 Number of users logged by day of week

The Third Graph This graph shows weak correlation where increase in hours logged does not translate more calories being burned; also there is fewer outliers as exposed in Fig. 18.

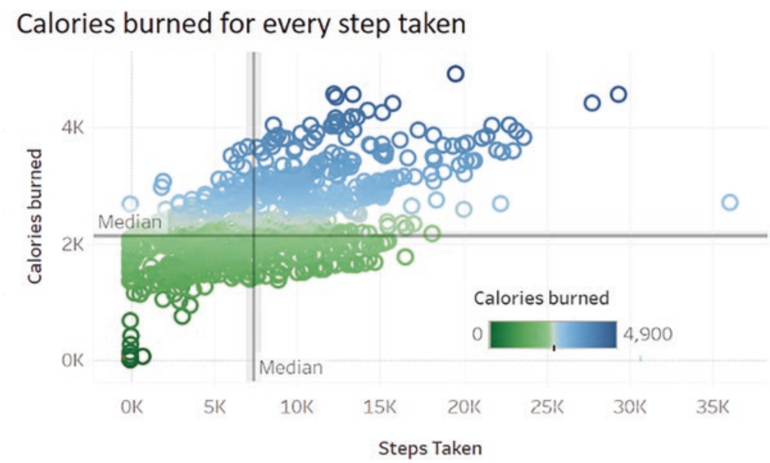


Fig. 17 Correlation between steps taken and calories burned

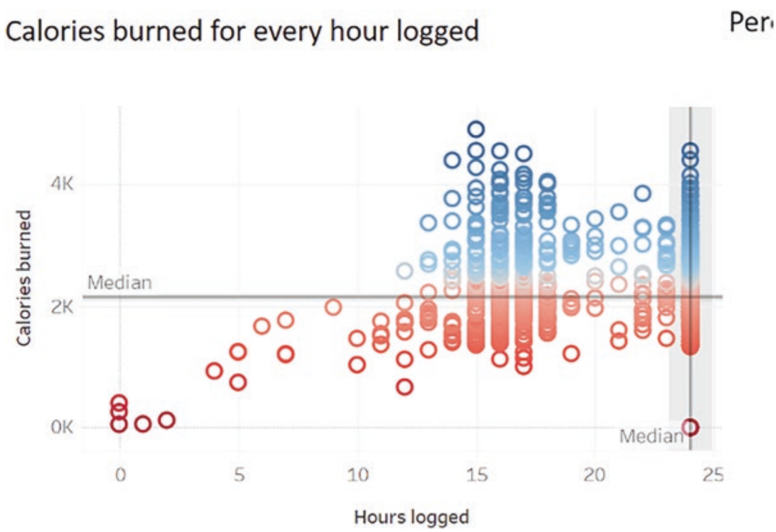


Fig. 18 Correlation between hours logged and calories burned

The Fourth Graph Sedentary minutes takes the biggest slice at 81.3% (Fig. 19). After that, the brainstorming session begins to discuss the data appearing from each person and to develop appropriate solutions to reach appropriate marketing strategies; see Fig. 20. For example, some people may develop a proposal to improve customer loyalty through targeted advertising campaigns or define promotional strategies to enhance their profitability, and here the strengths and weaknesses of each option are discussed by using mind map, which help them to put the main ideas for the problem.

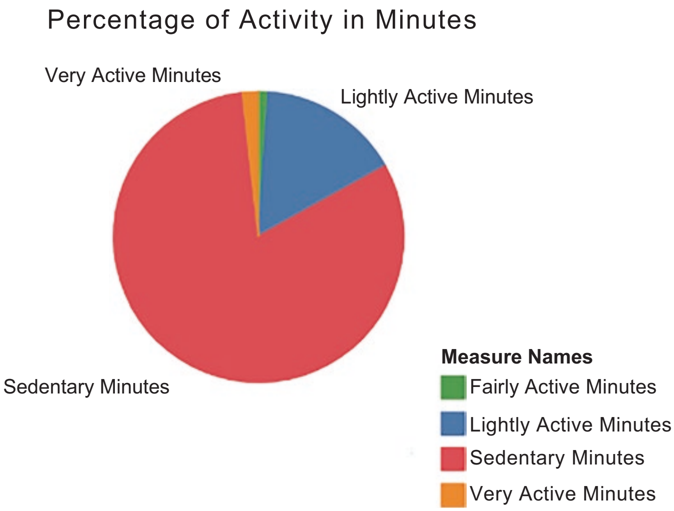


Fig. 19 Percentage of activity in minutes

Fig. 20 Mind map for marketing strategy

After the brainstorming process is over, a collective agreement is reached by consensus on an appropriate solution based on the extracted data and based on the recommendations of the members. This example is not only limited to the field of business in marketing, sales, production, and human resource, but also, we can set this example for engineers, doctors, and lawyers who face a problem and want to address it through brainstorming.

This methodology concludes high level of recommendation of marketing strategy that is being discussed in a brainstorming session and concludes that the majority of users (81.3%) are utilizing the Fitbit app to record sedentary activities and not for monitoring their health habits.

Also, people tend to monitor their activities more on weekdays than on weekends – likely due to the fact that they spend more time outdoors during the weekdays. Both companies manufacture products that concentrate on providing women with data regarding their health, habits, and physical fitness and motivate them to be cognizant of their current lifestyle and make healthy choices. These frequent tendencies related to health and fitness could be applied to Bellabeat customers with great effect. In addition to that, on weekends, Bellabeat app can also prompt notification to encourage users to exercise.

From here the following question is asked, "Who made the decision?"; the answer is humans who have decision-making, arbitration, and persuasion skills that machines helped them solve by extracting data free of errors and repetitions, and this led to a balance between humans and machines and this balance is called "hybrid intelligence," which will be highlighted in the next section.

4 Hybrid Intelligence as a Best Solution

In the past, the overall goal of artificial intelligence was to demonstrate the capabilities that naturally come to a person like logical progress, and artificial intelligence systems are far from ideal. When machines operate without human assistance, mistakes can be committed or fail completely. For example, when artificial intelligence works on driving a car, the percentage of errors and failures at this stage may increase and may adversely affect the user and can lead to bad results such as loss of lives, so the idea of hybrid intelligence emerged. Which works to establish and emphasis the idea of partnership between humans and systems of artificial intelligence and balance between them without becoming the only controlling machine that has been replaced by humans so that hybrid intelligence can produce mathematical tasks in front of humans to overcome the disadvantages of artificial intelligence systems alone (Kamar, 2016).

Hybrid intelligence is essential to maximizing the potential of both human and artificial intelligence. Machine learning algorithms can uncover complex and accurate patterns in large datasets that surpass the capabilities of the human brain. On the other hand, the brain can effectively handle noisy, uncertain information and changing circumstances. To take advantage of the strengths of both, humans and machines must come together to form a hybrid intelligence. Research has found that 67% of people believe that artificial intelligence will help humans and machines work together to increase their overall strength (Deric, 2019).

One of the prime examples of this technique is a crowdsourcing application, in which human intelligence is readily accessible to both developers and users. Meanwhile, artificial intelligence systems can provide assistance when the user is unavailable or unable to do so (Fig. 21).

With the advancement of artificial intelligence and machine learning, humans can use their creativity and decision-making skills to take on the tasks that machines are unable to accomplish. Humans are the ones who created and developed the

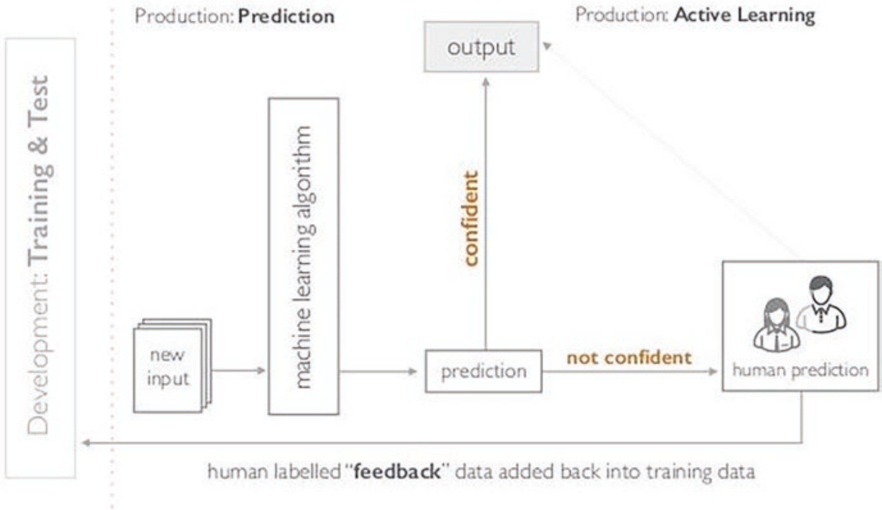


Fig. 21 The hybrid intelligence architecture

machines, so it is impossible to eliminate human jobs. This means that job security is maintained and the idea of automation being a substitute for humans is cancelled.

5 Conclusion and Recommendation

To conclude what covered in this paper that shed light on the development of automation since the first industrial revolution until now and how artificial intelligence has become part of our lives that still constitute a major obstacle in all aspects of life even in the field of jobs that worked to replace humans with machines where more than one researcher focused on this problem, but from a different angle, which was mostly focused on previous and limited data in the field of economics.

Nonetheless, in this research paper, the primary focus became on abolishing the concept of substitution and stressing the idea of equilibrium between humans and machines. We learned from the instance that engaged the problem of marketing strategy that humans were the ones who made the decision based on data that was mined and derived from a machine to aid the human being to make the suitable decision that accomplished equilibrium through hybrid intelligence, which concentrated on combining human and artificial intelligence with its varied algorithms, which made the future of jobs a beginning point by making human beings have a role in this hybrid intelligence by transforming the nature of work, unifying the assets of human intelligence and addressing new predicaments.

Therefore, the paper recommends at the end to keep humans in the loop with artificial intelligence because only humans have the ability to invent, create, and solve problems and communicate with individuals in an understandable way.

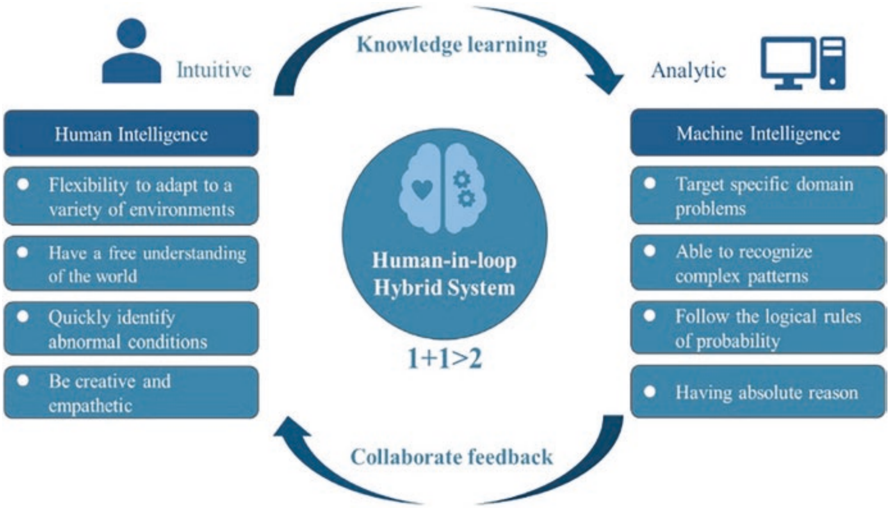


Fig. 22 Show hybrid intelligence with human loop

Without human beings, we would not have reached artificial intelligence, which has made it easier for us to do things in all areas of Interest. Figure 22 shows how to keep the human within the loop.

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Digitizing Business Education and Quality of Education: A Survey

Ali Ateya Ali Alromaihi, Allam Hamdan, and Amir Dhia

1 Introduction

Via a digital learning setting, specific channels are provided to the users to facilitate the interaction between students and their instructors independently and collaboratively. In a collaborative learning setting, technological tools are integrated to facilitate the process. Learning Management System (LMS), Google Classroom, and Google Hangouts are examples of those tools (Janahi et al., 2023). HEIs shifted toward other learning methods such as video conferencing courses. In this type of learning, instructors can upload their learning sessions, quizzes, and activities (Klašnja et al., 2011). The use of video conferencing allows for valuable guidelines on varying levels of knowledge and cognitive skills among learners and connections with various learning styles (Hsu, 2017). The course instructors evaluate their student's work either by individual work assigned to them or through group tasks in the form of a project or a case study (Janahi et al., 2023).

Therefore, business education plays a significant role in supplying the demand of the local labor market with skilled employees who will become future leaders (Sun & Lee, 2020). In return, this will bolster the national economy due to the reliance on national labor instead of expatriates. According to Bahrain Vision 2030, the Kingdom seeks to improve the skills of Bahrainis so that they become the first

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choice for the labor market. Therefore, in order for Bahrain's Vision 2030 to become a reality, the country has taken a number of initiatives to improve its educational system. This includes providing high-quality standards in education to satisfy future needs. Over the past few years, many lives have been disrupted due to the outbreak of COVID-19. At the initial phase of the virus, the World Health Organization (WHO) office in China declared the newly spread COVID-19 virus as an epidemic on December 31, 2019. However, the situation continued to evolve until WHO declared on March 11, 2020 the novel COVID-19 virus as a pandemic as it spread on a global scale (Alhalwachi et al., 2022).

For so long, the quality of education indicators has been a focus for several researchers (Al Dhaen, 2021; Agrawal & Mittal, 2018). During the pandemic, large numbers of students joined business tertiary education programs. As a result, many of them graduated or are expected to do so soon. Subsequently, those students will be returning to their workplaces and are expected to reflect on the skills they acquired throughout their studies. This can only be assured if the delivery in education is of quality. Therefore, a question arises whether the quality and learning outcomes of the courses were at the same levels as at pre-pandemic levels. The reason behind this is that the COVID-19 pandemic forced HEIs to change their learning mode from traditional to digital learning via technology integration. Consequently, the role of international accreditation bodies is to monitor the quality of education after the shift to digital education, maintain quality pre-pandemic standards, and provide full support to HEIs to overcome challenges while ensuring quality in digital learning (Janahi et al., 2023).

This research paper aims to study the impact of digitizing business education on the quality of business education. Further, the study analyzes the moderating effect of international accreditation bodies in ensuring the delivery of quality in digital business education. Firstly, the study contributes toward covering the scarcity of studies that deal with the quality of digitizing business education, especially in times of global pandemic. Secondly, the study provides faculty in HEIs with important information that can be employed to develop future business education in a digital setting. At the same time, the results of this study are essential for HEIs in Bahrain, both public and private, to update their business programs to keep pace with changes in the labor market in general and with developments that may occur at any time. It is considered one of the trending topics in the global arena as it affects a vast number of students around the globe. Finally, the researchers believe that distance learning will continue after COVID-19; therefore, considerable research needs to be done in this area.

2 Literature Review

According to Lim et al. (2022), HEIs faced many challenges to achieve sustainable development, especially during the COVID-19 pandemic. Their research explores different levels of attitudes toward the digitalization of education in HEIs. The authors divided the attitude experienced into three correlated attitude levels. In the first level, teaching attitudes and educational attitudes exist. The second level comprises digital platform attitudes, technology attitudes, use of technology attitude, and resource attitude. Finally, the third level incorporates network, service, and development attitudes. Their study suggests that HEI should continuously improve their digital education by innovation, development of their technology, resource allocation, and designing better digital platforms or creating better environments.

Further, sustainable technical support plays a significant role in enhancing the quality of digital learning. That is because there is a need to have in place the proper infrastructure of gadgets, networks, and technical teams consisting of experts to provide technical support at any time required (Nawaz & Kundi, 2010). In addition to the aforementioned variables that have an impact on the quality of digital education, the gender of students plays an important role in the quality, satisfaction, and motivation with respect to digital learning (Cuadrado-García et al., 2010). Finally, the study revealed that the level of quality of digital learning varied between the levels of courses. This is also supported by the study of Peixoto et al. (2012), which stresses that, based on the level of the course, there is a difference between study habits, satisfaction, and learning strategies (Alromaihi & Hamdan, 2022).

According to Gómez et al. (2016) and Kurucay and Inan (2017), faculty and student satisfaction, as well as learning effectiveness, access, and institutional cost-efficiency, all contribute to learning quality. In a previous study conducted by Rienties and Toetenel in 2016, it was concluded that there is no significant difference between traditional learning and digital learning if the digital class was well designed. However, other studies found that students and instructors were more satisfied with traditional learning (Fishman et al., 2013). Measurement of student satisfaction in digital learning, according to other studies, is an important part of successfully fostering educational processes for institutions, instructors, and students (Latip et al., 2020; Cheon et al., 2020). The faculty, interactions, and the technology are the three main factors that influence student and instructor's satisfaction with digital learning (Bolliger, 2004; Kurucay & Inan, 2017) as well as the students, their instructors, and the institution (Bolliger & Wasilik, 2009). There is a relationship between student and faculty satisfaction. Since student satisfaction is influenced by interaction and technology, this requires extra effort from the instructors to engage the attendees of the digital class. The course instructors, even more, must possess proper techno-pedagogical abilities (Hamdan & Hamdan, 2020).

The concept of quality in higher educational institutions seems to be vague as researchers have defined it based on different points of view. Based on Mishra and Jha (2019), the term quality is defined as "a focus on meeting a predefined set of standards, specification, and requirements, or focusing on exceeding the highest standards in pursuit of excellence and exclusivity." Several other researchers defined it as "focusing on accountability to the public or providing a transformative learning experience to benefit students and employers" (Blitz, 2020; Thomas et al., 2017). Quality is viewed as a tool for achieving success in all sectors, specifically in education. In higher education, academic excellence has long been a core value. Accreditation is used to improve and develop educational quality in the academic environment (Hamdan et al., 2020). Currently there are numerous accreditation bodies all around the world. The Association of Advance Collegiate Schools in Business (AACSB), the European Foundation for Management Development (EFMD), and the Association for MBAs (AMBA) are business school accreditation bodies, to name a few. The purpose of assessing any business school or management program is to promote ongoing quality improvement in education by assuming general presumptions about the standards and quality of those institutions (Cura & Alani, 2018).

Accreditation agencies such as AACSB, AMBA, and the EQUIS grant HEIs accreditations based on their quality of education and research conducted. The intention of accreditation is to ensure and maintain high standards of education (Sen, 2021). The authors express that the current accreditation and quality metrics are not suited for digital classes, but rather suited for traditional classes. Following the digitization of HEI classes, the authors suggest that the existing quality metrics should be redesigned. Accreditation bodies need to take into consideration new factors related to physical resources, infrastructure, and administration support. That would also include robust network connectivity, digital infrastructure, online databases and resources, and resource portability between different systems (Alshurafat et al., 2021). Parameters for quality may take into account faculty who are adequately trained to handle support systems and conduct digital classes.

Since COVID-19, faculty around the globe have witnessed unethical behavior and moral issues from students. For instance, it has become challenging to administer digital exams and quizzes without the student engaging in unfair practices. To limit students from cheating, the authors suggest using customized proctoring software, design exams that include a certain percentage of multiple-choice questions, and create question banks. Furthermore, to ensure utmost fairness in exams, questions assessing conceptual clarity and creativity may be made mandatory.

3 The Method and Survey

The quantitative method employed targeted academic staff in the colleges of business in both public and private HEIs in Bahrain. The number of business academic staff identified by liaising with HEC according to their statistics was 441. The total responses received from the faculty of the colleges of business in public and private HEIs in the country were 232 samples as presented in Table 1.

4 Descriptive Analysis

In respect of quality of education, three factors that are independent variables (IVs) having an impact on the dependent variables (DVs) were identified from existing literature. Also identified was the moderating variable (MV) based on the role of international accreditation bodies. Table 2 identifies the impact on each factor. In

Table 1 Participant's responses to demographic questions

Question	Answer choices	Frequency	Percent
Gender	Male	141	60.80
	Female	91	39.20
	Total	232	100
Age	26–35 years	61	26.30
	36–45 years	68	29.30
	46–55 years	56	24.10
	More than 55 years	47	20.30
	Total	232	100
Nationality	Bahraini	122	52.60
	Non-Bahraini	110	47.40
	Total	232	100
Educational background	Bachelor's degree	7	3.00
	Master's degree	57	24.60
	Doctorate degree	168	72.40
	Total	232	100
Academic rank	Professor	31	13.40
	Associate Professor	42	18.10
	Assistant Professor	94	40.50
	Lecturer	52	22.40
	Teaching and Research Assistant	13	5.60
	Total	232	100
Experience	Less than 1 year	4	1.70
	1–5 years	34	14.70
	6–10 years	50	21.60
	11–15 years	48	20.70
	More than 15 years	96	41.40
	Total	232	100
Type of institution	Public	78	33.60
	Private	154	66.40
	Total	232	100

this part, three sub-factors are examined, namely, LMS, assessment of students, and interaction with students. Subsequently, both the MV and DV will be examined.

5 Learning Management Systems Analysis

According to the results of the first indicator (Table 2), Learning Management Systems, participants tended to agree and strongly agree that "the quality of digitizing business education depends on the IT infrastructure of the institute" (mean $\mu = 4.582$ and std. deviation $<$ 1). The participants who strongly agreed were

Table 2 The impact LMS on the quality of education

Statement	Frequency					Mean	SD	%
	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)			
The quality of digitizing business education depends on the IT infrastructure of the institute	65.5	28.0	6.0	0.0	4.0	4.58	0.65	91.6
Your institute changed the curricula (course content) due to the consequences of the pandemic	34.9	25.9	19.1	10.9	8.7	3.68	1.29	73.7
Your institution provides supports to students to address any difficulty faced (technical, academic, etc.) in a timely manner	61.2	29.3	7.3	1.3	0.9	4.49	0.76	89.7
Course instructors at your institute had experience with digital learning prior to COVID-19 pandemic	36.2	26.7	21.6	13.4	2.2	3.82	1.13	63.7
Digital learning tools are fast, reliable, and easy to use	33.2	51.3	12.1	2.2	1.3	4.13	0.80	82.6
Learning Management Systems provide a unique experience to students	50.4	36.6	10.8	1.3	0.9	4.35	0.79	86.9
Learning Management Systems maintain the confidentiality of personal information	45.3	33.2	16.8	3.9	0.9	4.18	0.91	83.6

65.5%, those who agreed 28%, those neutral 6%, those disagreed 0%, and those who strongly disagreed 4%. The overall mean was 4.582 and the standard deviation showed a lower percentage than 1 (precisely at 0.6461). The overall percentage of this indicator is 91.6%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The second question relates to whether "your institute changed the curricula (course content) due to the consequences of the pandemic" (mean $\mu = 3.683$ and std. deviation > 1). The majority either strongly agreed (34.9%) or agreed (25.9%). Slightly behind were participants who were neutral (19.1%), followed by those who disagreed (10.9%) and strongly disagreed (8.7%). The mean $\mu = 3.683$ and standard deviation $= 1.2913 > 1$. The overall percentage of this indicator is 73.7% and therefore represents a positive result since it is more than 60% (Balogh et al., 2001).

The third question asked if “your institution provides support to students to address any difficulty faced (technical, academic, etc.) in a timely manner” (mean $\mu = 4.487$ and std. deviation < 1). The majority either strongly agreed (61.2%) or agreed (29.3%). Participants who were neutral were 7.3%, while those who disagreed were 1.3%, and those who strongly disagreed were 0.9%. The mean $\mu = 4.487$ and standard deviation = 0.7615 < 1. The overall percentage of this indicator is 89.7% and therefore constitutes a positive result since it is more than 60% (Balogh et al., 2001).

The fourth question examined if the “course instructors at your institute had experience with digital learning prior to COVID-19 pandemic” (mean $\mu = 3.815$ and std. deviation > 1). The results of this item indicated that the majority either strongly agreed (36.2%) or agreed (26.7%). Participants who chose to be neutral were 21.6%, those who disagreed 13.4%, and strongly disagreed 2.2%. The mean $\mu = 3.815$ and standard deviation = 1.1301 > 1. The overall percentage of this indicator is 63.7%; therefore once again it is a positive result since it is more than 60% (Balogh et al., 2001).

The results of the fifth question, namely, “digital learning tools are fast, reliable and easy to use” (mean $\mu = 4.129$ and std. deviation < 1), indicated that the majority either strongly agreed (33.2%) or agreed (51.3%). Some 12.1% of the participants chose to be neutral, 13.4% disagreed, and 2.2% strongly disagreed. The mean $\mu = 4.129$ and standard deviation = 0.8008 < 1. The overall percentage of this indicator is 82.6%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The sixth question reflected on if the “Learning Management Systems provide a unique experience to students” (mean $\mu = 4.345$ and std. deviation < 1). The results indicated that the majority either strongly agreed (50.4%) or agreed (36.6%). Participants who were neutral represented 10.8%, those who disagreed were 1.3%, and those who strongly disagreed were 0.9%. The mean $\mu = 4.435$ and standard deviation = 0.7907 < 1. The overall percentage of this indicator is 86.9%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

Finally, the seventh question addressed the extent to which “Learning Management Systems maintain the confidentiality of personal information” (mean $\mu = 4.181$ and std. deviation < 1). Most participants either strongly agreed (45.3%) or agreed (33.2%). Participants who were neutral represented 16.8%, while those who disagreed were 3.9% and those who strongly disagreed were 0.9%. The mean $\mu = 4.181$ and standard deviation = 0.9079 < 1. The overall percentage of this indicator is 83.6%; therefore, it leads to a positive result since it is more than 60% (Balogh et al., 2001).

Table 3 The impact of the assessment of students on the quality of education

Statement	Frequency					Mean	SD	%
	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)			
Your institution developed new assessment measures, especially for exams	58.2	32.8	5.6	1.7	1.7	4.44	0.82	88.8
COVID-19 has disrupted the trust in quality assurance and learning outcomes of the degree	16.4	37.5	23.7	11.6	10.8	3.37	1.20	67.4
Instructors experience difficulty in assessing student's degree of attention	30.2	44.8	14.2	9.9	0.9	3.94	0.96	78.7
Malpractices such as plagiarism and cheating has increased in digital learning	47.0	27.6	13.8	7.8	3.9	4.06	1.13	81.2
The academic performance of students during the pandemic is higher than their performance before	40.9	24.6	16.4	9.5	8.6	3.80	1.30	75.9

6 Assessment of Students Factor Analysis

Assessment of students was the second factor examined (Table 3). The results showed that the majority of participants agreed with the statement "your institution developed new assessment measures, especially for exams" (mean $\mu = 4.440$ and std. deviation < 1). The majority either strongly agreed (58.2%) or agreed (32.8%). Participants who were neutral represented 5.6%, those who disagreed were 1.7%, and those who strongly disagreed were 1.7%. The overall mean was 4.440 and the standard deviation showed a lower percentage than 1 (precisely 0.8196). The overall percentage of this indicator is 88.8%, therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The second question inquired on whether "COVID-19 has disrupted the trust in quality assurance and learning outcomes of the degree" (mean $\mu = 3.371$ and std. deviation > 1). Some 16.4% strongly agreed, 37.5% agreed, 23.7% were neutral, 11.6% disagreed, and 10.8% strongly disagreed. The mean $\mu = 3.371$ and standard deviation $= 1.2027 > 1$. The overall percentage of this indicator is 67.4%, therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The third question asked if the "instructors experience difficulty in assessing student's degree of attention" (mean $\mu = 3.935$ and std. deviation < 1). The majority either strongly agreed (30.2%) or agreed (44.8%). Participants who were neutral represented 14.2%, those who disagreed were 9.9%, and those who strongly disagreed were 0.9%. The mean $\mu = 3.935$ and standard deviation = 0.9581 < 1. The overall percentage of this indicator is 78.7%, therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The fourth question questions whether "malpractices such as plagiarism and cheating has increased in digital learning" (mean $\mu = 4.066$ and std. deviation > 1). The majority either strongly agreed (47%) or agreed (27.6%). Participants who chose to be neutral were 13.8%, those who disagreed 7.8%, and strongly disagreed 3.9%. The mean $\mu = 4.066$ and standard deviation = 1.1265 > 1. The overall percentage of this indicator is 81.2%, therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

Last, the fifth question questioned if "the academic performance of students during the pandemic is higher than their performance before" (mean $\mu = 3.797$ and std. deviation > 1). The majority either strongly agreed (40.9%) or agreed (24.6%). Participants who were neutral represented 16.4%, those who disagreed were 9.5%, and those who strongly disagreed were 8.6%. The mean $\mu = 3.797$ and standard deviation = 1.3018 > 1. The overall percentage of this indicator is 75.9%, therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The statistical findings of the assessment of students' variables indicate that the quality of business education is impacted by the method of assessment. The participants' responses indicated that most of their HEIs developed new assessment measures, particularly for exams. Although many HEIs had LMS in place prior to the pandemic, there was no assessment mechanism to evaluate students digitally. Participants also indicated that they agree with the fact that the pandemic has disrupted the trust in quality assurance and learning outcomes of the degree achieved via digital learning. This may be due to the fact that course instructors experienced difficulties in assessing the student's degree of attention along with the increase of malpractice actions during digital learning. To conclude, most participants in the questionnaire emphasized that digital learning has enhanced the academic performance of students when compared to their performance before the pandemic.

7 Interaction with Students Factor Analysis

According to the results of the last indicator of this section (Table 4), "Interaction with students," participants tended to agree and strongly agree that "digital learning provides greater involvement and attention of students during the lesson based on the questions addressed in the chat" (mean $\mu = 3.625$ and std. deviation > 1). Those who strongly agreed were 22.4%, and those who agreed were 38.8%. Participants who were neutral were 22%, those who disagreed were 12.5%, and those who strongly disagreed were 4.3%. The overall mean was 3.625 and the standard deviation showed a greater percentage than 1 (precisely at 1.0938). The overall percentage of this indicator is 72.5%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

Table 4 The impact of the interaction with students on the quality of education

Statement	Frequency					Mean	SD	%
	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)			
Digital learning provides greater involvement and attention of students during the lesson based on the questions addressed in the chat	22.4	38.8	22.0	12.5	4.3	3.63	1.09	72.5
Digital learning provides more availability of contacts outside class hours for clarification via email and WhatsApp	52.6	32.3	11.2	3.4	0.4	4.33	0.84	86.6
Digital learning provides a greater "sense of team" and collaboration between students and their instructors, aimed at better preparations for exams	21.6	43.5	18.1	12.9	3.9	3.66	1.07	73.2
Absence of direct face-to-face interaction has a negative impact on the learning experience	50.0	28.0	13.8	5.6	2.6	4.17	1.03	83.4
Despite heightened disengagement level due to the loss of social interaction, students learned new skills such as time management and responsibility through digital learning	23.7	46.1	19.0	9.5	1.7	3.81	0.96	76.1
The course instructor applies different tools and strategies to promote active participation in the virtual classroom	48.7	38.4	9.5	2.6	0.9	4.32	0.82	86.3
Interaction in the digital classrooms depends on the personality of the course instructor and his students	47.8	37.1	9.9	3.4	1.7	4.26	0.90	85.2
The digital learning environment offers the possibility to interact with students and with specialists from different parts of the world	55.2	31.9	10.8	0.9	1.3	4.39	0.81	87.8

The second question wondered if "digital learning provides more availability of contacts outside class hours for clarification via email and WhatsApp" (mean $\mu = 4.332$ and std. deviation < 1). The majority either strongly agreed (52.6%) or agreed (32.2%). Participants who were neutral were 11.2%, those who disagreed were 3.4%, while those who strongly disagreed were the minority (0.4%). The mean $\mu = 4.332$ and standard deviation $= 0.8412 < 1$. The overall percentage of this indicator is 86.6%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The third question inquired whether "digital learning provides a greater 'sense of team' and collaboration between students and their instructors, aimed at better preparations for exams" (mean $\mu = 3.659$ and std. deviation > 1). The majority either strongly agreed (21.6%) or agreed (43.5%). Participants who chose to be neutral were 18.1%, followed by those who disagreed (12.9%) and those who strongly disagreed (3.9%). The mean $\mu = 3.659$ and standard deviation $= 1.0733 > 1$. The overall percentage of this indicator is 73.2%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The fourth question intended to see if "absence of direct face-to-face interaction has a negative impact on the learning experience" (mean $\mu = 4.172$ and std. deviation > 1). The majority either strongly agreed (50%) or agreed (28%). Participants who chose to be neutral were 13.8%, followed by those who disagreed (5.6%) and those who strongly disagreed (2.6%). The mean $\mu = 4.172$ and standard deviation $= 1.0343 > 1$. The overall percentage of this indicator is 83.4%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The fifth question intended to examine if "despite heightened disengagement level due to the loss of social interaction, students learned new skills such as time management and responsibility through digital learning" (mean $\mu = 3.806$ and std. deviation < 1). The majority either strongly agreed (23.7%) or agreed (46.1%), while 19% of the participants chose to be neutral. On the other hand, the participants who disagreed were 9.5%, and those who strongly disagreed were 1.7%. The mean $\mu = 3.806$ and standard deviation $= 0.9631 < 1$. The overall percentage of this indicator is 76.1%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The sixth question assesses if "the course instructor applies different tools and strategies to promote active participation in the virtual classroom" (mean $\mu = 4.315$ and std. deviation < 1). The majority either strongly agreed (48.7%) or agreed (38.4%). Participants who were neutral were 9.5%, those who disagreed were 2.6%, and those who strongly disagreed were 0.9%. The mean $\mu = 4.315$ and standard deviation $= 0.8166 < 1$. The overall percentage of this indicator is 86.3%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The seventh question relates to if the "interaction in the digital classrooms depends on the personality of the course instructor and his students" (mean $\mu = 4.259$ and std. deviation < 1). The majority either strongly agreed (47.8%) or agreed (37.1%). Participants who were neutral were 9.9%, those who disagreed were 3.4%, and those who strongly disagreed were 1.7%. The mean $\mu = 4.259$ and standard deviation = 0.8985 < 1. The overall percentage of this indicator is 65.2%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

Finally, the eighth question reflects on if "the digital learning environment offers the possibility to interact with students and with specialists from different parts of the world" (mean μ = 4.388 and std. deviation < 1). The majority either strongly agreed (55.2%) or agreed (31.9%). Participants who were neutral were 10.8%, whereby those who disagreed were 0.9%, and those who strongly disagreed were 1.3%. The mean μ = 4.388 and standard deviation = 0.8141 < 1. The overall percentage of this indicator is 87.8%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The statistical findings of the last variable in this section indicate that quality of business education relies on the interaction between the course instructor and students. Most of the responses indicated that digital learning had a positive impact on the quality of education and that it facilitated the interaction between instructors and their students. It was noted that based on the questions addressed in the chat, there was greater involvement of students and attention. The availability of more contact hours rendered course instructors more accessible and approachable so that they can accordingly assist students resolve any issues or provide further clarifications. Most respondents also agreed that digital learning better prepared students for exams as it provided a greater sense of teamwork and collaboration.

Although almost half of the participants indicated that they strongly agree with the statement that the lack of face-to-face interaction has a negative impact on the learning experience, most of them indicated that digital learning helped students to learn new skills such as time management and a greater sense of responsibility. Additionally, the respondents agreed to the statement that digital learning allows for interaction with students and experts globally to share knowledge. To remedy any shortcomings of digital learning and especially those related to the personality of the course instructor or students, the course instructor agreed that different tools and strategies must be applied to promote active participation in the digital classroom.

8 International Accreditation Bodies Factor Analysis

As in Table 5, with respect to the moderating variable "The role of international accreditation bodies," the participants tend to agree and strongly agree that "gaining an international accreditation has a positive impact on the institution and the society" (mean μ = 4.578 and std. deviation ˂ 1). Those who strongly agreed were 68.5%, and those who agreed were 23.7%. Participants who were neutral represented 6%, those who disagreed were 0.4%, and those who strongly disagreed were 1.3%. The overall mean was 4.578 and the standard deviation showed a lower percentage than 1 (precisely at 0.7403). The overall percentage of this indicator is 91.6%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The second question relates to if "applying international accreditation standards improves faculty professional development" (mean μ = 4.491 and std. deviation < 1).

Table 5 The role of international accreditation bodies

Statement	Frequency					Mean	SD	%
	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)			
Gaining an international accreditation has a positive impact on the institution and the society	68.5	23.7	6.0	0.4	130.0	4.58	0.74	91.6
Applying international accreditation standards improves faculty professional development	61.2	30.2	6.0	1.7	0.9	4.49	0.76	89.8
The management of my institution has an active role to achieve international accreditation of business programs	63.8	28.4	4.3	2.6	0.9	4.52	0.77	90.3
International accreditation assists in formulating a strategy to harmonize digital business education and the quality of education	53.9	34.5	8.2	2.6	0.9	4.38	0.81	87.6
International accreditation standards help in the implementation of quality in business education	58.6	33.6	5.6	0.9	1.3	4.47	0.76	89.5
International accreditation helps in embedding technology in business education	54.7	32.8	9.9	0.9	1.7	4.38	0.83	87.6

The majority either strongly agreed (61.2%) or agreed (30.2%). Participants who were neutral were 6%, those who disagreed were 1.7%, and those who strongly disagreed were 0.9%. The mean $\mu = 4.491$ and standard deviation = 0.7616 < 1. The overall percentage of this indicator is 89.8%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The third question inquired if "the management of my institution has an active role to achieve international accreditation of business programs" (mean $\mu = 4.517$ and std. deviation < 1). The majority either strongly agreed (63.8%) or agreed (28.4%). Participants who were neutral were only 4.3%, followed by those who disagreed 2.6% and those who strongly disagreed 0.9%. The mean $\mu = 4.517$ and standard deviation = 0.7727 < 1. The overall percentage of this indicator is 90.3%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The fourth question assessed if "course instructors at your institute had experience with digital learning prior to COVID-19 pandemic" (mean $\mu = 4.379$ and std. deviation < 1). The majority either strongly agreed (53.9%) or agreed (34.5%).

Participants who chose to be neutral were 8.2%, those who disagreed were 2.6%, and those strongly disagreed were 0.9%. The mean $\mu = 4.379$ and standard deviation = 0.8128 < 1. The overall percentage of this indicator is 87.6%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The fifth question intended to draw an understanding if "international accreditation standards help in the implementation of quality in business education" (mean $\mu = 4.4474$ and std. deviation < 1). The majority either strongly agreed (58.6%) or agreed (33.6%), while 5.6% of the participants chose to be neutral. Participants who disagreed were 0.9%, and those who strongly disagreed were 1.3%. The mean $\mu = 4.474$ and standard deviation = 0.7555 < 1. The overall percentage of this indicator is 89.5%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The sixth question examined to what point "international accreditation helps in embedding technology in business education" (mean $\mu = 4.379$ and std. deviation < 1). The majority either strongly agreed (54.7%) or agreed (32.8%). Participants who were neutral represented 9.9%, those who disagreed were 0.9%, and those who strongly disagreed were 1.7%. The mean $\mu = 4.379$ and standard deviation = 0.8339 < 1. The overall percentage of this indicator is 87.6%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

Overall, it could be concluded that the respondents acknowledged the importance of international accreditation bodies and appreciated their role in maintaining the quality of education. Participants also acknowledged the pivotal role of the international accreditation bodies in improving the faculty professional development, harmonizing digital business education and the quality of education, and embedding technology in business education. The responses indicate that the faculties of the college of business in Bahrain possess great knowledge of the international accreditation process and its impact on the relationship between digitizing business education and the quality of education. However, around half of the participants previously indicated in their responses that they have not either gained international accreditation or that their HEIs are in the process of gaining it.

9 Quality of Education Factor Analysis

With respect to the dependent variable "Quality of education" (Table 6), the participants tend to agree and strongly agree that "the institution faculty maintains consistent discipline which is conductive to learning" (mean $\mu = 4.328$ and std. deviation ˂ 1). Those who strongly agreed were 48.7%, and those who agreed were 38.4%. On the other hand, those who were neutral were 10.3%, those who disagreed were 2.2%, and those who strongly disagreed were 0.4%. The overall mean was 4.328 and the standard deviation showed a lower percentage than 1 (precisely at 0.7816). The overall percentage of this indicator is 86.6%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

Table 6 Participants' Perspectives on the quality of education

Statement	Frequency					Mean	SD	%
	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)			
The institution faculty maintains consistent discipline that is conductive to learning	48.7	38.4	10.3	2.2	0.4	4.33	0.78	86.6
The course instructor provides sufficient and appropriate information regarding the students' academic progress	51.3	40.1	6.9	1.3	0.4	4.41	0.71	88.1
The institution faculty employs various instructional methods and strategies to meet the students' needs	53.9	36.6	8.2	0.9	0.4	4.43	0.72	88.5
Educational support is a key factor in the student's educational success and to ensure quality of education	65.1	30.6	3.9	0.4	0.0	4.60	0.59	92.1
The institute provides support of professional development for pedagogy (pedagogical tools, instructors behaviors and attitudes)	46.6	34.9	15.5	1.3	1.7	4.23	0.88	84.7
My institute offers adequate access to up-to-date computers and technologies	47.8	33.2	11.6	3.4	3.9	4.18	1.03	83.5
My institute ensures quality in structuring its programs designs (by benchmarking and providing up-to-date programs)	49.1	37.1	10.8	0.4	2.6	4.30	0.87	85.9
Maintaining quality of business education ensures the achievement of knowledge, skills, and experience required for the labor market	56.5	35.3	6.9	0.9	0.4	4.47	0.70	89.3

The second question examined if "the course instructor provides sufficient and appropriate information regarding the students' academic progress" (mean $\mu = 4.405$ and std. deviation < 1). The majority either strongly agreed (51.3%) or agreed

(40.1%). Participants who were neutral represented 6.9%, those who disagreed were 1.3%, and those who strongly disagreed were 0.4%. The mean $\mu = 4.405$ and standard deviation = 0.7145 < 1. The overall percentage of this indicator is 88.1%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The third question raised the point if "the Institution faculty employs various instructional methods and strategies to meet the students' needs" (mean $\mu = 4.427$ and std. deviation < 1). The majority either strongly agreed (53.9%) or agreed (36.6%). Participants who were neutral formed 8.2%, followed by those who disagreed 0.9% and those who strongly disagreed 0.4%. The mean $\mu = 4.427$ and standard deviation = 0.7170 < 1. The overall percentage of this indicator is 88.5%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The fourth question pertains to whether "educational support is a key factor in the student's educational success and to ensure quality of education" (mean $\mu = 4.603$ and std. deviation < 1). The majority either strongly agreed (65.1%) or agreed (30.6%). Participants who chose to be neutral were 3.9%, those who disagreed were 0.4%, and those who strongly disagreed were 0%. The mean $\mu = 4.603$ and standard deviation = 0.5867 < 1. The overall percentage of this indicator is 92.1%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The fifth question reviewed if "the institute provides support of professional development for pedagogy (pedagogical tools, instructors behaviors and attitudes)" (mean $\mu = 4.233$ and std. deviation < 1). The majority either strongly agreed (46.6%) or agreed (34.9%), while 15.5% were neutral. Participants who disagreed were 1.3%, and 1.7% strongly disagreed. The mean $\mu = 4.233$ and standard deviation = 0.0.8813 < 1. The overall percentage of this indicator is 84.7%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The sixth question intended to assess whether "my institute offers adequate access to up-to-date computers and technologies" (mean $\mu = 4.177$ and std. deviation > 1). The majority either strongly agreed (47.6%) or agreed (33.2%). Participants who were neutral were 11.6%, those who disagreed were 3.4%, and those who strongly disagreed were 3.9%. The mean $\mu = 4.177$ and standard deviation = 1.0272 > 1. The overall percentage of this indicator is 83.5%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

The seventh question wondered if "my institute ensures quality in structuring its programs designs (by benchmarking and providing up-to-date programs)" (mean $\mu = 4.177$ and std. deviation < 1). The majority either strongly agreed (49.1%) or agreed (37.1%). Participants who were neutral totaled 10.8%, those who disagreed were 0.4%, and those who strongly disagreed were 2.6%. The mean $\mu = 4.181$ and standard deviation = 0.8741 < 1. The overall percentage of this indicator is 85.9%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

Finally, the last question addressed the understanding that "maintaining quality of business education ensures the achievement of knowledge, skills and experience required for the labor market" (mean $\mu = 4.466$ and std. deviation < 1). Most participants either strongly agreed (56.5%) or agreed (35.3%). Participants who were neutral represented 6.9%, those who disagreed were 0.9%, and those who strongly disagreed were 0.4%. The mean μ = 4.466 and standard deviation = 0.7016 < 1. The overall percentage of this indicator is 89.3%; therefore, it is a positive result since it is more than 60% (Balogh et al., 2001).

It is obvious from most respondents that their HEIs take several measures to maintain the quality of education. These measures include following a consistent discipline by course instructors that enhances the educational process, providing information to students about their academic progress, offering support for professional development, and the adoption of various strategies to meet the student's needs. The results of the respondents are in line with their responses for the first independent variable "Learning Management Systems," as respondents affirmed that their HEIs offer adequate access to up-to-date computers and technologies that will result in better quality assurance and enhanced learning outcomes. Most of the responses strongly agreed and agreed to the statement that their HEIs ensure quality in structuring their programs design. This is accomplished by providing relevant, up-to-date programs and by benchmarking their programs with international HEIs. To end, participants assured that quality assurance of business education ensures the achievement of knowledge, skills and experience that is required for the labor market.

10 Conclusion

Indicators of the quality of education have been a focus for many researchers for a long period of time (Al Dhaen, 2021; Agrawal & Mittal, 2018). Due to the novel pandemic, HEIs were forced to shift from traditional to digital education, rendering digital education vital for the continuation of the educational process. Many students have joined HEI to continue either undergraduate or postgraduate programs. As a result, a large number of students have graduated or are expected to do so soon. Subsequently, those students will be returning to their places of employment and are expected to reflect on the skills they gained during their college years and studies.

The reflection of skills acquired during college cannot be assured unless the quality of education is assured. Therefore, a question arises whether the quality and learning outcomes of the courses were at the same levels as pre-pandemic. The underlying reason for questioning the quality of education was that the pandemic forced HEIs to adopt digital education via technology integration within a short period of time making the shift sudden for HEIs. Therefore, the role of international accreditation bodies is vital as it is being tasked with monitoring the quality of education after the shift to digital education, maintaining its quality pre-pandemic, and providing full support to HEIs to overcome challenges accompanied with ensuring quality in digital learning.

The quantitative finding of this research emphasizes the significance of the factors that impact the quality of business education. After performing simple regression analysis to the IVs, the findings indicated that LMS was the most important factor that influenced the quality of education among the other two IVs followed by the interaction with students and then assessment of students. To also measure the impact of the MV, "the role of international accreditation bodies" was incorporated in the formula. The findings showed that the MV enhances the results of the simple regression analysis performed. The findings also highlighted the challenges accompanied with achieving the accredited status by HEIs from international accreditation bodies. Furthermore, it demonstrated the perception of the faculty with respect to digitizing business education and the role of international accreditation bodies.

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Digital Sustainability for Business Education: Literature Review

Esra AlDhaen

1 Introduction

During global crisis higher education institutions (HEIs) faced a tremendous challenge to survive in terms of delivery, recruitment of new students and intellectual operations. Most HEIs globally reacted to the crisis by using digital tools in order to continue performing. In some cases, the utilization of digital tools was a learning curve for the faculty members specifically while delivering online courses and described as Do it Yourself (DIY) method (Abad-Segura et al., 2020). Several HEIs did not utilize digitalization prior to the COVID-19 pandemic which is a step prior to digital transformation, and hence with the COVID-19 pandemic a radical change took place to all HEIs in terms of academic delivery and administrative operations (El Hilali et al., 2020). Innovative models towards digital transformation in HEI context were proposed by researchers, for instance Rof et al. (2020) emphasized that digital transformation is beyond digitalization of specific aspects such as academic operations, and digital transformation should be considered at an institutionalized level covering digitalization of processes in academic and non-academic, connectivity, data-informed decisions, and digital innovation. There have been several assumptions by HEIs towards resisting digital transformation, for instance Kopp et al. (2019) stated that HEIs assume that digitalization is costly and exceeds their budget without any return in terms of change. On the other hand various studies were conducted to investigate the effectiveness of digitalization in terms of virtual learning and assessment (Deev et al., 2021) alongside several academic standards which were established to support HEI adaptation for virtual delivery and

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sustainability (UNESCO, 2021). Although HEIs have taken initiatives towards digitalization, the initiatives are focused on academic delivery and covering the overall operations of HEIs. In this context, a research study by Guandalini (2022) argued sustainability could be achieved through digital transformation by setting a clear strategy covering different aspects such as policy, procedures, process and owners to be digitalized and used for reporting and decision making. The definition of digital transformation is not yet well-defined and consistent in HEIs as there is a clear overlap between the terminology used "digitalization" and "digital transformation". For instance Gartner (2021) defined digitalization as the use of digital tools and techniques towards activating some processes that could lead to digital business. In similar context Hanelt et al. (2020) defined digital transformation as an organizational transformation that covers a clear strategy for implementation which could lead to innovation. In this context, Guandalini (2022) argued that there is a clear relationship between sustainability and digitalization. However, Del Río Castro et al. (2021) argued that the definition of sustainability has lost its identity with various views, whereas Caputo et al. (2021) stated that sustainability definition is hard to define as it includes multidisciplinary and other behavioural and influencing socio-economic organizations. This paper argues that business schools and HEIs must consider digital sustainability in order to contribute to the United Nations Sustainable Development Goals (UNSDGs) specifically for business education as it produces graduates that are serving the economic growth directly.

2 Business Education Overview

According to Charroin et al. (2022) business schools worldwide need to change in order to sustain and create a positive impact to the world. Business schools must reconsider its vision and focus on different methods of teaching and delivery, and emphasis on interdisciplinary academic delivery and research and frugal innovation was highlighted. In similar context, Bryant et al. (2022) stated that business schools are facing unprecedented challenges specifically from external stakeholders as the market demand is dynamically changing; therefore, business schools must consider a serious transformation in order to produce top-notch graduates to serve the society. International accreditation standards are used as a driver towards the change. Dudley and Cairney (2021) stated that although business schools were able to perform during the pandemic, it is time that business educations rethink of its vision and strategy to address global challenges and societal needs. Business schools were described as a hub for change and innovation, and therefore, business schools must consider digitalization for sustainability from multiple aspects related to the three core functions: teaching, research and societal engagement. Association to Advance Collegiate Schools of Business (AACSB) revised the Accreditation Standards in 2020 with inclusion of various dimensions including the use of ICT and digitalization as part of teaching and learning. With consideration of sustainability as often considered as part of academic curricular in HEIs, several research papers investigated the need of integrating specific competencies as part of academic curricular to support producing graduates serving the society—competencies related to research and business ethical standards. For instance, Peterlin et al. (2018) highlighted the need to develop a strategic process that is aligned with the business schools' vision towards integrating specific competencies to support sustainability. Research papers investigated integrating sustainably through specific competence within the academic curricular; however, most of research papers are restricted to academic delivery and linkage of UNSDGs to curricular and does not cover financial risk or HEI effectiveness sustainability (Abad-Segura et al., 2020).

The following section will describe the research methodology and data analysis, followed by a systematic literature review related to the digital use of ICT in business education and integrating sustainability in business education, which leads to the originality of this paper introducing digital sustainability strategies for business education. This paper aims to provide strategies for implementing digital sustainability for business education which is beyond integrating ICT in curricular, and the discussion and conclusion will provide an insight on how to set a strategy to implement digital sustainability through mission-driven approach and holistic engagement. The findings of this paper will also provide future recommendations that could be practically applied by leaders of business schools and policy makers as well as scholars.

3 Research Methodology and Data Analysis

This paper is developed based on the systematic literature review analysis to build a research case to be investigated by other scholars. This research is conducted by structuring the literature review in the area digital sustainability for business education with creating synthesis that could be used as a written case for authors to review and utilize towards future investigation. According to Patten and Newhart (2017) that creating research synthesis based on a structural literature review is a core basis for research investigation. Therefore, this research used specific keywords in line with Saunders and Lewis (2017) method as part of the systematic review including digital transformation, digitalization, digital sustainability, sustainability, sustainable development, business education, and impact. The keywords enabled to create an overview on the status in relation to digital transformation in business education and propose a new framework "digital sustainability" that could be considered by business schools specifically those seeking international accreditation. The literature review was carefully analysed to propose an overview of the digital use in business education and defines the difference between terminologies including digital transformation and digitalization, followed by the status of integrating sustainability in business education. The proposed framework proposes developing a holistic framework that is derived by mission-driven strategies and decision-making processes. The systematic reviews defined major factors that could be contributing to digital sustainability framework. This research provided a definition of each factor that could be utilized while future investigating the framework.

4 Digital Use of ICT in Business Education

Business education has attracted several researchers, and several research papers share the experience of using digitalization in different aspects. According to Krishnamurthy (2020) the future of the business schools is to create an impact to the society and hence there is a need to transform the university by using ICT and artificial intelligence to multiple operational aspects as well as student support issues in order to lead to the transformation of business schools.

The use of ICT in business education was recommended by multiple researchers for instance Umoru and Okereke (2016) highlighted that business schools must invest in the use of digital teaching and learning to ensure that the graduates are equipped with innovative competencies. Furthermore, the use of e-learning in business education was investigated by Sandybayev (2020) and concluded that e-learning creates a positive impact in terms of education; however, leaders of business schools must set a clear strategy to apply e-learning and motivate the faculty to ensure that regular faculty development sessions are planned.

In addition, several research studies have been calling for the rethinking of the academic curricular of business education. According to Cahapay (2020) there is a serious need to rethink the academic curricular of business education post-COVID-19 covering a set of competencies including the use of ICT. The revision needs to consider innovative teaching methods and tools.

Business education had a rapid change after the COVID-19 pandemic, and several research papers called for developing clear quality assurance standards for virtual learning to maintain quality business education (Gidado & Daramola, 2022). In similar context, Al Dhaen et al. (2022) highlighted the need that leaders of business schools must utilize the practice of COVID-19 and establish clear policies and procedures to sustain quality education. Although several successful practices of virtual learning were investigated, the case of low-income countries such as Nigeria faced a tremendous challenge in the use of ICT or digital education as it lacks several built-in infrastructures at the school level as well as lack of financial support for the students and faculty (Nwabufo & Nuhu, 2022). Therefore, calls for measuring the effectiveness of digital use in business education were questioned although it is a requirement.

It is evident that business schools require using ICT and digitalization for business education; to support producing graduates with innovative skills, business schools seeking international accreditation such as AACSB must rethink its mission in consultation with relevant stakeholders and consider automation of operations leading to the actual impact (Cortes, 2022). According to Qian (2019) business schools seeking international accreditation need to develop a mechanism at strategic level to ensure that the mission is implemented, and the use of digitalization could support measuring the extent of implementation and impact (Table 1).

Table 1 Summary of research papers related to digital use in business education

Authors	Year	Journal	Main key findings
Krishnamurthy	2020	*Journal of Business Research*	There is a need for digital transformation for business schools
Sandybayev	2020	*International Journal of Research in Tourism and Hospitality (IJRTH)*	Integration of e-learning in business education and digitalization leads to innovation
Cahapay	2020	*Aquademia*	The use of digital tools as teaching methods for business education allows creativity and sustainability
Gidado and Daramola	2022	*International Journal of Education (KIJE)*	The use of ICT and digital tools is important for business education to build the competence; however quality assurance standards are required

5 Integration of Sustainability in Business Education

According to Edwards et al. (2020) business education curricular should be reconsidered with an integration of sustainability-related competence and defined ethics, engagement and creativity. In this regard, Edwards et al. (2020) stated that curriculum should be designed at three stages to achieve sustainable outcome starting with multidisciplinary, interdisciplinary and multidisciplinary moving towards transdisciplinary. In similar context, Junn and Moon (2021) investigated the integration of sustainability related to business education in Korea, and the study concluded that business schools must ensure that sustainability-related courses should be integrated at different levels across the learning, starting with introductory (theoretical courses) at the first and second year of learning and more in-depth courses (practical and outcome based) at the third and fourth year.

Researchers have been calling for sustainability prior to COVID-19; however, business schools have actively engaged in sustainability after the COVID-19 pandemic and various United Nations campaigns. For instance, Barber et al. (2014) stated that one of the methods to include sustainability as part of business education curricular is to engage internal and external stakeholders in different projects serving the society and highlighted that business school leaders should pave the way with industries and be proactive in establishing multidisciplinary projects to serve the society and economic growth. AACSB considers internal and external stakeholders' engagement as part of the accreditation process; in 2020 AACSB revised its standards to include a new standard related to engagement and societal impact. International accreditation such as AACSB could be a driver to integration of sustainability in business education (AlDhaen et al., 2022); however, as identified by Barber et al. (2014), external stakeholders such as employers must be satisfied with the future graduates as they must be equipped with different skills beyond business such as ICT, digital use of specific software and research ethics.

In terms of business disciplines accounting and finance attracted researchers in terms of integrating sustainability. For instance Mburayi and Wall (2018) stated that accounting and finance differ from management-related academic curricular, and therefore, there are specific skills and competence required in order to ensure that the graduates are produced with sustainable outcomes. These include the use of specific digital software that generate sustainable reporting and auditing such as Bloomberg. Furthermore, Craig et al. (2021) investigated the co-relation of STEM (science, technology, engineering and mathematics) learning in order to procedure graduate with sustainable outcomes. The findings of the study revealed that STEM competencies have a positive impact on sustainable outcomes as it covers multidisciplinary skills.

Researchers argued that aligning the curricular to sustainability through integration of specific competencies and skills including ICT and digital software is vital; however, there is a need to have a clear quality assurance standard in order to ensure it is appropriately delivered and not superficially aligned (Junn & Moon, 2021). In this regard, business schools seeking accreditation must ensure that it is aligned to its mission to accelerate innovation and impact.

In similar context, Painter-Morland et al. (2016) argued that integrating sustainability is beyond curricula integration and proposed a model of 'Systemic Institutional Integration" that covers multiple dimensions beyond curricular such as leadership, institutional capacity and infrastructure and internal and external engagement. Considering the status of business schools and the challenge to amplify societal impact, the argument of Painter-Morland et al. (2016) pertaining to institutional capacity and infrastructure is vital; business schools must invest in various ICT and digital platforms to foster engagement at both internal level between students and faculty and external level with relevant stakeholders. Furthermore, Bosevska and Kriewaldt (2020) stated that sustainable education should be mission-driven; therefore, it is beyond curricular changes and it requires to be institutionalized across the business schools and linked to different operations.

6 Digital Sustainability Strategies for Business Education

According to Bradley (2007) digital sustainability requires an overall life cycle to manage the technology and create an impact. Similarly, Krishnamurthy (2020) stated that the future of business schools is to transform digitally to sustain effective operations. The argument of Abad-Segura et al. (2020) is that higher education sustainable management should be supported by digital transformation. In this context, Budihardjo et al. (2021) stated higher education including business schools should have clear strategies for sustainable management; factors contributing to sustainable management were identified by Budihardjo et al. (2021) covering teaching and learning, research, outreach, campus operations and administration. A study investigated strategies to promote sustainability in higher education; the study concluded that strategies at higher education should be institutionalized and governed by policies and procedures that quality assures consist of the implementation of the strategies (Berchin et al., 2017). In this context, Benavides et al. (2020) argued leaders of higher education including business schools should rethink their strategies and organizational structure and consider mission-driven approach as part of holistic transformation.

A study in higher education institutions in Turkey identified that digital sustainability should be derived by a clear strategic plan driven by a set of objectives that are aligned with the mission statement of the university (Hakan, 2020). The study also concluded that external engagement with stakeholders is required in order to revisit the strategy. Business schools aiming to attract international accreditation such as AACSB are accountable to reflect their operations in line with the mission statement and reflect clear impact measures. Therefore, leaders of business schools must reconsider and restructure their strategies towards digital sustainability covering different factors that could be vital to create an impact to the society.

7 Digital Sustainability in Strategic Decision Making in Business Education

According to Schiuma et al. (2022) the use of digitalization allows knowledge visualization and supports effectively strategic decision making. It is argued that data visualization allows presenting meaningful data leading to inspirational and sustainable decision making. In similar context, Stone et al. (2020) argued that the use of artificial intelligence leads to effective strategic decisions in business sector and supports sustainable decisions during uncertainty. Furthermore; Nauhaus et al. (2021) stated that there is a need to reconsider strategic decision making in sync with digital age and highlighted that during COVID-19 organizations had to take strategic decisions to cope with the uncertainty. It is argued by Elbanna and Child (2007) that uncertain decisions could be effective due to other contextual factors that allow performing rational strategic decisions. However, strategic decisions formed during uncertainty may be effective to cope with the situation for short term but not sustainable enough as it is not based on enough knowledge and data presentation (Schiuma et al., 2022).

There have been calls to investigate augmentation concept in strategic decision making leading to sustainable decisions (Raisch & Krakowski, 2021). Argumentation concept is calling for interaction between human and machines; this could be integrated through major organizational transformation including revisiting the structure, authorities, defined processes for retrieving and exchange of knowledge (Nauhaus et al., 2021). There have been calls for developing new models to investigate the use of digitalization in strategic decision making covering various contextual factors (Nauhaus et al., 2021).

Business schools seeking international accreditation such as AACSB are evaluated on mission-driven approach which requires strategic decision making. In line with the above-mentioned literature, the use of digitalization towards strategic decision making is expected to lead to sustainable decisions. Business schools must be the pioneer in establishing digital sustainability models considering a number of factors leading to impact measures. The following section provides a synopsis of identified factors that could be investigated as part of the digital sustainability model of business education.

8 Factors for Digital Sustainability for Business Education

Based on systematic literature review, several factors were identified that contribute to digital sustainability in higher education and hence business schools. This paper proposes a development model investigating the following factors as drivers for digital sustainability.

Identified factors	Definitions	Supporting authors
Teaching and learning	Integration of digitalization as part of teaching and learning, virtual learning and integrating of sustainable development topics	Budihardjo et al. (2021), Dybach (2019)
Research	The use of digitalization for research, interdisciplinary topics related to sustainable development, global research trends, research impact and innovation	Budihardjo et al. (2021), Abad-Segura et al. (2020), Guandalini (2022)
Outreach	Engaging in different projects with external stakeholders, project serving the society, societal impact	Budihardjo et al. (2021), Hakan (2020)
Administration	Considering campus management, infrastructure efficiency, competitive advantage and digital innovation used for academic and non-academic operations	Budihardjo et al. (2021)
Campus operations	Considering organization sustainability in terms of business operations, green campus, smart technology, institutionalized digitalization, staff satisfaction and engagement	Budihardjo et al. (2021)
Quality assurance	Governance of policies and procedures that quality assures the integration of digitalization for sustainable management	Dybach (2019), Berchin et al. (2017)
Human resources	Faculty, support staff and leaders of higher education institutions are the drivers for digital transformation and digital sustainability	Benavides et al. (2020), Abad-Segura et al. (2020)
Impact measures	The use of digital measures that assess impact at holistic manner covering economy and society	Lejeune et al. (2019), Soltanifar et al. (2021)

9 Challenges of Digital Sustainability in Business Education

Although digitalization and digital transformation have attracted business schools and higher education sectors during COVID-19, various challenges are still occurring that require attention by leaders of higher education. According to García-Peñalvo (2021) faculty resistance towards the digital transformation is a key factor to reduce the maturity of digital transformation and hence digital sustainability. In similar context, Brunetti et al. (2020) identified cultural issue as a major challenge that needs to be carefully considered. Business schools must consider a dynamic organizational culture that enables dynamic transformation. For instance, Kraus et al. (2022) stated that organization undergoing digital transformation deals with dynamic changes and therefore one of the major challenges is to maintain the quality of the delivered services and the brand name. Sustainable quality education is one of the key aspirations for business schools seeking international accreditation; therefore, business schools aiming for digital transformation and sustainability must develop rigorous policies and procedures that assure equivalent quality is maintained. In addition, García-Peñalvo (2021) stated that maintaining ethical standards and policies is one of the major challenges that could be faced by HEIs including business schools while considering digitalization and hence digital sustainability may be challenging as it requires very rigorous procedures to maintain ethical standards at both academic and non-academic operations. A serious issue was raised by Weiß et al. (2019): digital transformation should ensure engagement and interaction. This matter becomes more acute in business schools as the graduates must be equipped with an extensive level of engagement and communication skills.

This study argues that digital sustainability framework is required to ensure that there is a digital transformation and sustainability to support business education. However, as stated by García-Peñalvo (2021) HEIs are not yet fully matured in terms of digital sustainability. Therefore, measuring the extent of effectiveness of such framework is a challenge itself. The following section will provide an insight on the way forward for business education, including practical recommendations that could be carried out by scholars and policy makers.

10 Conclusion and Practical Application

Despite various research conducted in relation to digital transformation, digital sustainability and digitalization is business education. In support to García-Peñalvo (2021) it is visible that there is a need to ensure a maturity in terms of transformation in the education sector including business education. The need for digital sustainability becomes more acute in business schools as it requires to be implemented with a consideration of mission-driven approach (Junn & Moon, 2021). Business schools are considered the drivers for societal impact and hence they are competing in attaining international accreditation that is considered as a mechanism towards digital transformation and digital sustainability (Dudley & Cairney, 2021). This paper proposes to develop a digital sustainability framework that could be applied in business schools to serve business education considering factors that are related to academic and non-academic activities; the proposed framework includes factors related to teaching and learning, research, outreach, administration, campus operations, quality assurance, human resources and impact measures. This paper conducted a systematic literature review analysis to narrow the more relevant factors that could be investigated to support digital sustainability in higher education and business schools. However, along with the factors identified there are other contextual factors that may be identified such as regulatory requirements, cultural issues and leadership.

Leaders of business schools need to establish a clear foundation to implement digital sustainability framework; from a practical application angle there is a need to develop a clear mission-driven approach supported by a set of policies, procedures and ownership with defined responsibilities and authorities (Guandalini, 2022).

Policy makers including regulators need to define clear standards to support higher education sector to implement digital sustainability framework that covers ethical standards to maintain the security of data including student records (Nabbosa & Kaar 2020).

Business schools seeking international accreditation could utilize the outcome of the digital sustainability framework to generate reports leading to decision making to support business sustainability. For instance, reporting is frequently required to support risk assessment; therefore, digital sustainability reporting will allow mitigating action and strategic level decision making.

11 Limitation and Future Recommendations

This paper is limited to a systematic review analysis and findings; therefore, it provides a proposed framework with defined factors that are based on literature review analysis and cannot be confirmed as it is not yet investigated. Due to lack of maturity of digital transformation in the education sector, digital sustainability in business schools may require rigorous actions to expedite the integration of digitalization considering institutionalized operations.

This paper identified factors that could be considered as part of digital sustainability; however, other moderating factors may be considered such as regulatory standards, accreditation requirements and cultural issues.

Future investigation could be conducted by applying digital sustainability framework in business schools as a full cycle of implementation and investigate the extent of usefulness in terms of measuring the overall impact.

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The Feedback System Based on Computer-Supported Collaborative Learning (CSCL) on the Case of Covid-19

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1 Introduction

CSCL computer e-learning provided technical means and tools that played a major role in the development of teaching and learning methods and the opportunity to improve learning methods that would provide a suitable environment for learners. e Learning seeks to hold the student responsible for the educational process by developing their ability to learn and explore. However, there is a need to adopt the student-centered approach by changing the role of the student to be a sender and not only recipient of the knowledge (Allaymoun, 2020, 2014).

CSCL is an interactive system of collaborative education that provides learners with information technologies and depends on an integrated digital environment that displays courses through electronic networks and provides technical tools for teaching, guidance, and organizing tests. As well, it provides a collaborative learning environment, creating virtual groups that are very similar to traditional educational groups and providing these groups with tools to help exchange information and review educational materials via multimedia (Miyake, 2007). CSCL focuses on learning to transfer knowledge and manage educational groups, become a supervisory teacher, and intervene when needed (Stahl & Hakkarainen, 2020). CSCL and its tools seek to develop the conceptual and learning skills of students and

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encourage them to explore and manage dialogues to achieve greater self-reliance in the knowledge exchange (Wise & Schwarz, 2017; Allaymoun & Trausan-Matu, 2016a).

CSCL chat is the most important tool used to exchange knowledge between students. The students are the focus of the educational process. Therefore, CSCL chat allows students to express their opinions and ideas (Allaymoun & Trausan-Matu, 2016b; Stahl et al., 2006). Nevertheless, there are some obstacles to face in their communication, including the difficulty of conducting self-assessment by students to recognize their level of understanding and the absence of the serious attraction of students' attention to ensure their interaction to the discussions of their colleagues. Therefore, this paper seeks to find a solution to overcome such obstacles by developing the model of a feedback system, which enables students to be updated about their understanding of particular topics. They receive feedback, and based on it, they enhance their performance to reach successful educational methods. Hence, each student seeks to be a successful educator, as well as all listeners pay more attention to educational dialogues. The reason behind is that the listening students are subjected to random inquiries that keep them alert to answer and interact with their peers. Moreover, such an approach holds the student to act as a responsible educator to exchange knowledge with others.

The instant feedback results during the chat help determine the level of understanding of the educator and the level of achievement of learners. It seeks to develop and review performance and then develop plans to improve such performance. The system creates a reference point at every discussion, links it to the results of the feedback, and provides it to teachers through which it assesses the performance of groups and intervenes when necessary to improve educational groups' performance.

This study is organized as follows: the current section is the introduction. The second section is the literature review. Section 3 contains the materials and methods. Section 4 is the results and discussion. Finally the last section is the conclusion.

2 Literature Review

CSCL is one of the most promising innovations to improve teaching and learning with the help of modern ICT tools. Likewise, it is considered as one of the most important areas of computer-supported education, which aims to improve the learning process, as well as employing group work so that learners can discuss their ideas and express their views, allowing a process of exchange of ideas and information. It is also interested in multiple and different perspectives on the subject of learning (Trausan-Matu et al., 2014).

In general, CSCL contributes to activating student-centered learning; student is the focus of the learning process, by providing them with the opportunity to use multiple learning methods, training them in communication skills, and working in educational groups (Allaymoun, 2018).

In addition to developing methods of participation and exchange of ideas, it helps students search for information and explore many new and difficult fields with the help of educational groups (Cress et al., 2015). On the other hand, it improves and develops student skills in using supportive technical tools effectively, such as evaluation, communication, and analysis (Ludvigsen et al., 2016).

CSCL environment contains many different technical applications that aim to facilitate the collaborative and distributive teaching and learning, such as multimedia, experimental simulation, and educational application programs, all of which are involved in supporting cooperation between students (Stahl, 2017).

One of the most important tools of CSCL environment is the chat option, which works to create virtual synchronous groups that resemble traditional classrooms, which allow students to exist virtually simultaneously and in different places and provide a flexible environment that allows for the conduct of educational dialogues with ease and effectiveness (Allaymoun & Trausan-Matu, 2015). In addition, the chat effectively helps develop the individual skills of students in exchanging views and providing a collaborative learning environment, which guarantees independence in the discussion of academic subjects (Allaymoun, 2020). On the other hand, the cooperative in educational dialogues is to involve all students in a concerted effort to discuss a study topic or solve a problem together.

Most educational institutions use chat as an effective tool among the e-learning tools they provide to their students (Zoom, MS Teams, and Moodle Chat), for ease of achieving an educational cooperative for its students. Online peer feedback is one of the most promising educational strategies for improving student-learning outcomes. For example, researchers have shown that peer feedback can improve students' educational levels (Jacques et al., 2021; Jacques et al., 2020; Huisman et al., 2018; Noroozi & Hatami, 2018).

Feedback is considered as one of the most important methods used in the education process, as it depends on the speed and ease of student learning. It has a vital role in motivating students to learn and contributes to modifying behavior, as well as the development of their positive attributes (Noroozi & Mulder, 2017; Noroozi et al., 2016).

On the other hand, the student's knowledge of his performance level motivates him to achieve the best by correcting the mistakes that he makes; feedback is not an advice; it is information about what is being done to reach the desired goal of the educational process, and accordingly, feedback is a basic process to improve learning for the students (Valero Haro et al., 2018).

Scientific research has focused on studying the impact of peer feedback used in e-learning, including research, which studies the effect of feedback in raising the quality of education, in addition to improving educational methods for students' users EduTech, and this research proved the superiority of students academically through receiving feedback (Latifi et al., 2019; Kanetaki et al., 2022).

A digital learning module also supported the peer feedback process to engage students in an intensified learning process and write about a controversial topic. The use of peer feedback support guided the student's in appropriate ways to analyze learning partners' arguments about the topic, express agreements/disagreements, and, when possible, integrate various points of view in their reflection report. Exchanging diverse and multiple conflicting opinions, analyzing one another arguments, and expressing agreements/disagreements supported with scientific facts, arguments, logical evidence, and examples were then reflected in the attitudinal change of students towards the controversial topic of the GMOs from pre-test to post-test (Noroozi et al., 2019).

There is a lot of research that has created feedback tools that support e-learning, for instance, Synergy. Synergy comprises tools to support learning activities during dialogic feedback. These tools incorporate scripting and learning analytics support to guide learners. Using Synergy as an example, we discuss its importance (Er et al., 2019).

Feedback on student performance in explaining their topics in a chat, not assessing students about the knowledge obtained. In general, the proposed feedback in this research is based on a scenario that the student discusses specific information during the CSCL chat, so he would like to know the opinions of his colleagues about the way he explained and discussed the topic and get their views, and in addition to that, he would like to know the level of his performance if it is good or not. Accordingly, the feedback aims to assess the performance of the students themselves to obtain results that help in modifying their way of explaining topics and improving performance and ensuring that students are attentive and attracted to the explanation during the conversation (Allaymoun & Shorman, 2022).

The feedback system added to the CSCL chat avoids being critical, judging, or evaluating, but rather seeks to improve, develop, and review students' educational performance in order to increase student satisfaction with their performance and to build confidence in their educational roles effectively, to reach cooperative learning groups.

On the other hand, the feedback system helps to introduce the student to his position in the educational dialogues. Developing the cooperative spirit and attention in educational groups, through students knowing in advance that they are exposed to questions during the dialogue, as well as the evaluation mechanism from the students themselves, increases the student's focus in the chat. Each participant seeks to communicate knowledge to all participants clearly and finally create a reference point for each feedback—for the teacher to evaluate the performance of the educational groups later. Feedback is information related to performance and reflects the extent of cooperation and students' understanding of the educational content presented during a chat (Allaymoun & Shorman, 2022; Al-Shoqran & Shorman, 2021).

The following are three questions that this research seeks to discuss:

- What is the effect of students' feedback on their performance in educational discussions?
- What are the effects of feedback from students with increased attention and focus on cooperative education?
- What are the indirect effects of teachers and e-learning?

3 Materials and Methods

A study was conducted at GUI, and the number of participants was 20 (sampling + population) students, first-year students in HR, who study human resources (BUSS 131), and the students were divided randomly into 5 groups; each group contains four students, and the topics that the students will discuss in advance are software, hardware, network, and computer. In general, the implementation of the study took about 5 h and was distributed as follows:

- 10 min to distribute students to groups
- 60 min for each student to study and prepare the topic that has been identified
- 10 min of explanations of the feedback system's mechanism for all groups (ask a question, analyze results, and determine tasks)
- 30 min of chat time per group
- 10 min to analyze the results by the teacher, evaluate, and give feedback, 10 min in some groups that need points of disagreement that the teacher re-explains

The study consists of several phases:

The first phase: Randomly distribute students to educational groups, each group containing four students, and then each student selects a subject to explain it.

The second phase: Clarify the mechanism and elements of the work of the feedback system in the chat, how to know the results, and what options will be decided, such as whether to continue if it is a satisfactory result or replay if it is an unsatisfactory result, or request for a system point to give a signal to the teacher in order to re-explain or clarify the point of disagreement.

The third phase: After completing a chat, the teacher gets a report showing the results, through which the teacher can evaluate the educational groups, in addition to clarifying and re-explaining the points of disagreement that the student could not explain.

The chat tool on the Moodle website (https://moodle.gulfuniversity.org) allows simultaneous text-based conversations in real time and allows saving chat sessions and allows everyone to view the dialogue records for all groups; the screen shows the names of the students within the group and the timing of the dialogues. The feedback system button during the conversation consists of one question (Did you understand what I explained?). The answers include multiple options (strongly understood, understood, I do not understand, point system) and be in the form of the chat screen; in the end, the chat tool shows results in the form of statistical tables, as well as results for a chat group, for the results of all dialogues.

This Moodle is an educational platform offered by Gulf University for e-learning, which contains a chat tool, and the chat tool has been modified to suit our research by adding a feedback system. The new addition is a button that appears in a chat, through which the student clicks on it if he wants to ask for feedback from his colleagues regarding the part that he explained during the chat. A screen appears that contains a question (Did you understand what I explained?), and a message appears

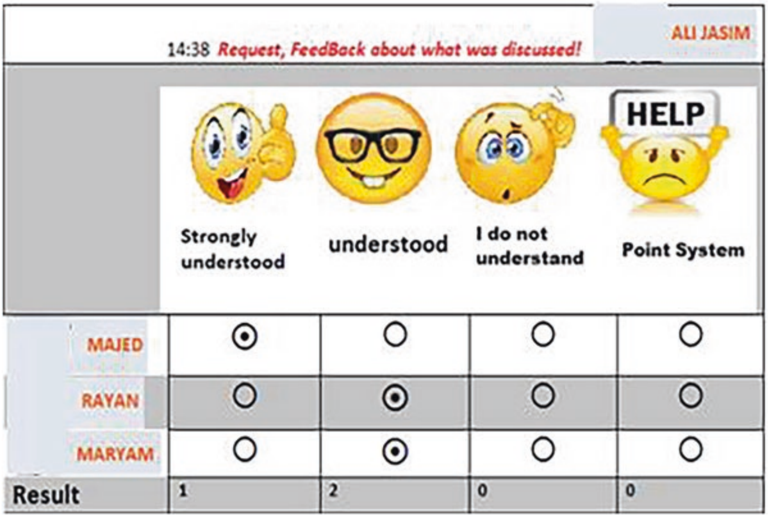

Fig. 1 Feedback question screen

in front of students, and the answer is in the form of emoji (strongly understood, understood, I do not understand, point system) (Sun et al., 2019). Emoji is a more enjoyable feedback (studies indicate that emoji increases students' awareness of the emotional state and it is used to distinguish simple cognitive notes attractively and is more interactive than the option of the check box) (Using and Perceiving Emoji in Design Peer Feedback) (Noroozi et al., 2019; Er et al., 2019). In addition, the answer time is limited to 5 s, which is enough time for students to answer a question. Then, it shows the feedback results in front of the student to decide whether to continue the chat or repeat what was explained in a better way (Fig. 1).

As it is noted a simple question reflects the extent to which students understand the explanation of their colleague and determines whether the educational method of knowledge delivery is successful. A series of meetings were held with experts in educational sciences to determine a question and answer in order to fit the objectives of the research. In conclusion, each student seeks to be active and effective to prove its ability to deliver knowledge. Moreover, students bear the responsibility for their understanding of the topics at hand, and the teacher's role is supervisory and he/she only intervenes when needed. This is what the CSCL environment seeks in creating effective educational groups in which the student is the main focus of knowledge transfer (Allaymoun, 2020; Shorman, 2019).

Reports in the form of statistical tables and graphics make it easy for teachers to track student dialogues, as well as self-assessment of student performance in educational groups. On the other hand, the point system is any points that the student could not explain or be understood by the rest of the students, which need direct intervention by the teacher to re-explain it. Through these results, the teacher can infer and evaluate students' behavior within the chat.

4 Results and Discussion

1. What are the effects of students' feedback on their performance in educational discussions?

   Through studying the level of students' focus and attention in the dialogue sessions, students are exposed to questions during their dialogue, reflecting on their performance and providing the best possible way to explain and deliver knowledge to their colleagues. Hence, the data is analyzed, and the student's behavior is monitored within the chat groups that use the feedback system. Feedback is a reference point for measuring students' self-performance. It has become a qualitative addition to learning conversations to stimulate students' educational behavior within groups so that an increase in cooperative and interactive behavior has been observed.

   Figure 2 shows the steps of the student's request to provide feedback on his performance inside the chat. By obtaining the results that reflect the students' performance, every student tries to transfer knowledge to his colleagues in an appropriate manner. The reason for this is that the student is exposed to evaluating his performance, in addition to knowing the opinions of his colleagues on his performance. The feedback system allows us to obtain answers with three options; the first option is that the result is positive, which indicates that all students understood the method of explanation and the knowledge delivered. The second option is for when the result is negative, meaning that most of the students did not understand the point that the student requested feedback, so here it is an option for a student to try to communicate knowledge in another way and in a better way. The last option is a point system, meaning that the student tries to convey knowledge more than once, but most students cannot understand it; hence, the teacher is asked later to intervene and re-explain it.
2. What are the effects of feedback from students with increased attention and focus on cooperative education?

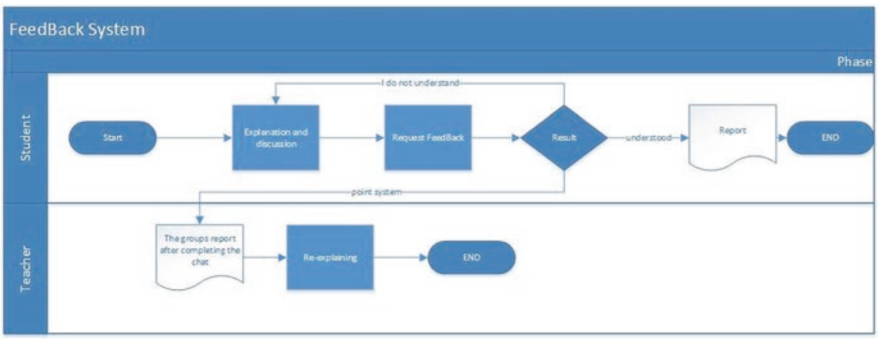

Fig. 2 The steps of the student's request to provide feedback

Accordingly, each student becomes responsible for delivering knowledge that suits his abilities, so he is responsible for his performance. Also, the recipient students are responsible for understanding the topic being discussed. It has been observed that students have increased attention in chat groups because they are more likely to evaluate their performance within the group. As a result, the feedback system in the CSCL chat achieved the goal of raising students' level of attention within groups.

On the other hand, the feedback results help students feel included in the dialogues, increase their sense of satisfaction with themselves, and motivate them to persevere and develop their performance. The main goal of instant feedback is to constantly check students' understanding while maintaining their attention and participation in the chat.

3. What are the indirect effects of teachers and e-learning?
   The feedback system provides results that can be analyzed and knowledgeable of students' behavior within CSCL chat groups and provides these results to the teachers to evaluate the performance of groups, review students' behavior during their conversations, as well as intervene in the event of point system, to re-explain or develop plans to improve students' performance. We will try to discuss the results in two cases, firstly by reviewing the results for students within the group and secondly by reviewing the results for all groups.

Table 1 and Fig. 3 show the results of group 3, which shows some data on student dialogues, such as how many feedback requests, their results, how much re-explanation, and points of the system. The teacher can evaluate the behavior of the students, provide feedback, and redirect students regarding the improvement of teaching methods.

The table indicates that the third student was the student with highest results, and this indicated that his method and method of delivering knowledge were excellent, unlike Student 1 who showed low results and how much he re-explained. Hence, the

Table 1 The results of group 3

	Chat		Result					
Group 3	Chat no.	Feedback no.	Strongly understood (4)	Understood (3)	I do not understand (2)	Point system (1)	Feedback no./chat no.	Rating
Hussain (participant 1)	52	12	1	1	3	7	0.23	20
Bader (participant 2)	66	32	6	19	2	5	0.48	90
Mohamed (participant 3)	87	48	22	17	8	1	0.55	156
Suhair (participant 4)	72	37	10	20	6	1	0.51	113
Total	277	129	39	57	19	14		
Result/feedback no.			0.30	0.44	0.15	0.11		
Feedback no./chat no.	0.47							

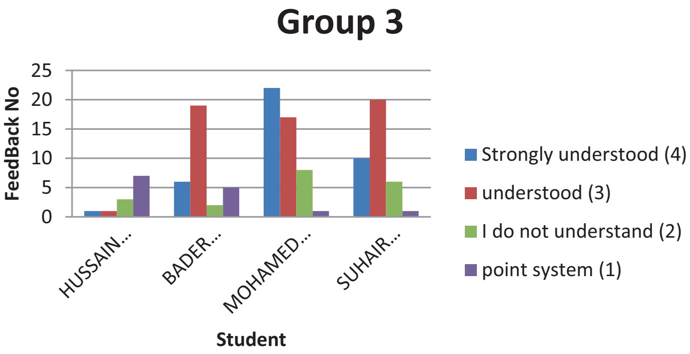

Fig. 3 The results of group 3

Table 2 The results of all groups

	Chat		Result				
	Chat no.	Feedback no.	Strongly understood (4)	Understood (3)	I do not understand (2)	Point system (1)	Feedback no./chat no.
Group 1	240	137	20	80	25	12	0.57
Group 2	189	32	4	19	2	7	0.17
Group 3	277	129	39	57	19	14	0.47
Group 4	120	71	0	11	20	40	0.59
Group 5	221	118	18	58	23	19	0.53
Total	1047	487	81	225	89	92	
Feedback no./chat no.	0.47						
Result/feedback no.			0.17	0.46	0.18	0.19	

teacher can focus on that student, and re-explain what he explained because it shows his inability to communicate knowledge to his colleagues. There are several possibilities that Student 1 did not understand the topic or did not have an educational method to present his ideas. As well the table also inferred points of the system and their location in a chat, which makes it easier for the teacher to follow the students' conversations and to know the places of lack of understanding and maybe the defect of the way of delivery of knowledge or lack of absorption of the recipients. Accordingly, the teacher after obtaining a report re-explains the points of the system, for example, there are six points of contention, and the teacher later re-explains it.

Table 2 and Fig. 4 show all groups' results after the chat is over, such as how much feedback, answers, and points of the system. Also, through the table, the teacher can evaluate the performance of the groups. For example, in group no. 1, most of the students got high results for feedback and fewer points of the system, and through this result, it is inferred that this group is more effective and cooperative

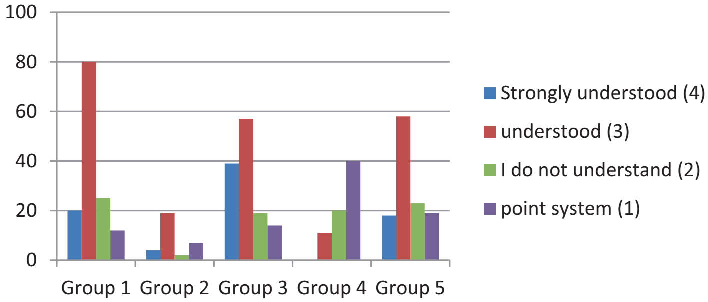

Fig. 4 The results of all groups

in the delivery of knowledge—unlike group 4, which as observed from the results, a request for re-explanation and points of the system is more than the rest of the groups. This indicates that the group is not homogeneous and that there is a weakness the teacher must intervene to improve their performance. As for groups of 4 and 2, their results are close, and that this is the normal rate for educational groups, and the results are average, and points of the system are acceptable.

On the other hand, the teacher can evaluate all educational groups easily and effectively, by analyzing the results of the feedback system, which helps to motivate students to cooperate and express their opinions on the topics for discussion, in addition to enhancing their confidence in managing the educational dialogues with high skill and enhancing their self-confidence to manage educational dialogues with high skill. As well, the teacher re-manages the educational groups to reach effective and cooperative groups.

It is important to have a clear mechanism for the development of chat to serve e-learning; the results of the analysis of the chat of educational groups at the end of the sessions provide feedback to the teacher.

5 Conclusions

This paper reviews a new method to develop and evaluate conversations effectively, which may change the course of e-learning in the CSCL environment and make the e-learning more enjoyable and cooperative, as it helps guide learners towards optimal methods of communicating and receiving information. CSCL chat is the most important and most popular tools used to transfer and exchange knowledge between students. The student is the main focus of the educational process. Among the features of the CSCL is allowing conversation among students to express their opinions and ideas. However, the problems faced in the chat include the difficulty of students knowing their performance and the lack of a mechanism capable of ensuring that students interact and pay attention to their colleagues' conversations. Therefore, this paper seeks to solve these problems by creating an immediate feedback mechanism that allows students to inquire about their performance in explaining their topics immediately, and obtaining results through which they infer their performance, and then try to modify and develop their performance, in order to reach successful educational groups. Hence, each student seeks to be a successful recruiter for educational topics, as well as that all recipients increase their attention and focus in the educational groups. This is because they are exposed to questions during the chat, which the student seeks to vacate his responsibility for the delivery of information. The student is responsible for his understanding of the topics presented. The feedback system is done by asking the students about their understanding of the topic that was discussed. Results in instant feedback during chat help determine students' level of performance and understanding, in addition to seeking to develop and review performance and then develop plans to improve and develop teaching methods. The system aims to develop cooperative education in educational groups and to reach an effective learning environment.

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A Reinforcer to Become a Foodpreneur Through Cloud Kitchen: Sustainable Technology-Driven Business Model During Pandemic

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1 Introduction

The phrase "foodpreneur" refers to a creative entrepreneur who has made food creation their passion, despite the fact that it may seem new. "Foodpreneur is the combination of 'food' and 'entrepreneur' to create an entirely new career title" (Attri & Bairagi, 2020). Foodpreneurs are hardworking individuals who create their own business opportunities in the service sector, especially in the food segment. Any type of business that involves food can fall into this broad, innovative category (Lukman, 2020).

Cloud kitchen concept is delivery-only café/restaurant and more dining area people can sit and eat which accepts only order and delivers the food through food aggregators, various websites or through mobile apps like Zomato, Swiggy and so on. A commercial kitchen area known as a "ghost kitchen" or "virtual kitchen" offers food enterprises the amenities and services required to create menu items for delivery and takeout. Contrary to conventional brick-and-mortar establishments, cloud kitchens enable the production and delivery of food products with low overhead. There was nothing special about the infrastructure, waitstaff, tables or furniture (McCrimmon, 1995). Customers can place online orders through restaurant

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apps or online food aggregator apps, hence the name "cloud kitchen". These kitchens are sometimes referred to as virtual kitchens, ghost kitchens and gloomy kitchens. Numerous traditional restaurants have converted to cloud kitchens due to necessity. Meal delivery was already redefining the restaurant experience before COVID-19, enabling customers/foodies to have restaurant-calibre food in their homes and enabling eateries to expand their clientele outside their physical locations. Cloud kitchens were a part of this movement, although they were still somewhat experimental (Coronavirus Careers, 2020). The data survey says that the number of people who started ordering food online increased by 150 per cent during 2019 and 2020. USP (Unique Selling Point) says that the food delivery market may increase more than 10 times in the next 10 years, i.e. from 35 billion dollars per year to 365 billion dollars ("Global Cloud Kitchens Market Report, Share, Size, Analysis 2021–2027", 2021). The online food delivery market is predicted to generate US$0.77 trillion in revenue by 2022. By 2027, it is anticipated that revenue will increase by 13.68% p.a., with a market size of US$1.45 trillion. Cloud kitchen, also known as "virtual brand," "cyber kitchen" and "dark kitchen," was a major trend both during and after COVID-19 (Oracle, 2020). The following are the reasons for the new technology-driven cloud kitchen business model, which is a technology-driven model: fewer human resources in the form of employees, low-cost investment, easy expansion and so on. These are the reinforces that encourage foodpreneurs to adopt the cloud kitchen business model, which is a technology-driven model (Table 1).

Table 1 Types of cloud kitchen

Type	Specification	Floor area requirement (approx.)
Independent cloud kitchen	It is a traditional and independent model. It is a restaurant without any actual physical space. This model is basically a single brand model that cooks its meals in a kitchen in accordance with the online orders that it receives. In terms of taking orders and delivering prepared meals, the company concept is self-sufficient	500–600 sq. ft
Multi-brand cloud kitchen	This type of cloud kitchen is based on a careful scrutiny of local food consumption patterns. A communal commercial kitchen is used to cook and package the meals for several companies. It is an effective and strategic model that makes money and saves money	1500–2000 sq. ft
Hybrid cloud kitchen	It is the combination of cloud kitchen and a takeaway restaurant. Delivery can either be done independently or through food delivery apps and websites, etc. In this approach, a single brand operates out of a single kitchen, but there are also numerous walk-in locations that provide takeout and delivery options	2000+ sq.ft
Delivery app-owned cloud kitchens	In this business model, a delivery app company leases or buys a convenient kitchen area and assigns it to various up-and-coming food brands. These apps are used to place orders, and they also control the delivery fleet. The food businesses leverage the app's audience to attract more consumers, while the app leverages the talent to provide its users more choices	n.a.

2 Theoretical Foundation

As a result of the COVID-19 virus's and pandemic situations likely long-term prevalence, digitally shifted platforms like cloud kitchens and delivery aggregators will overcome all previous formats. In the ensuing 10 years, these styles would gain dominance in the Indian food service industry. In India, the COVID-19 pandemic would significantly change how food is consumed today and in the future due to its long-term persistence (John, 2021).

The purpose of the study was to see whether cloud kitchens would be preferred during the pandemic over restaurants (Fernandes, 2021). The tremendous global rise in food delivery and the quick development of technology have given cloud kitchens even more momentum. Additionally, the importance of sanitation and safety as well as evolving sales tactics can reinforce the viability of cloud kitchens as a whole. Cloud kitchens also provide streamlined menus. The fundamental justification for the increased demand for cloud kitchens is the availability of simple, nutritious ingredients devoid of complexity (Warrier & Venkteshwar, 2020). Due to their minimal operating costs, cloud kitchens are generally more affordable than restaurants.

The major differences between cloud kitchen and traditional kitchen are customer behaviour and response to cloud kitchens, and the during and post COVID-19 has had on consumer contact with food delivery, with a focus on cloud kitchens, are all discussed here. The analysis of this market is crucial for its future development because it helps to pinpoint the major problems and consumer behaviours that are unique to cloud kitchens in terms of expectations and how they prioritise factors connected to food delivery (Sufi & Ahmed, 2021). The research's conclusion was that cloud kitchens offer maximum productivity and satisfy consumer demands for sanitation, superior food quality, and quick delivery without compromising because they have less inventory and physical management issues than traditional kitchens do (Chhabra & Rana, 2021).

2.1 Porter's Five Forces Analysis of Cloud Kitchen

Any business model's industry attractiveness is gauged using Porter's five forces, which also provide insight into what motivates profitability and skill. Any industry with a high level of competition will have lower profit potential for businesses operating there (White, 2017). These forces are known as Porter's five forces since Harvard University professor Michael Porter explained them. The main goal of this analysis is to show that, in addition to your immediate competitors, you also face off against a wider range of competitors, including those listed below, in the battle for profitability.

Rivalry Among Existing Competitors (Low) It is how fiercely the existing businesses in the sector compete with one another. If there are many rivals of comparable size and strength and if industry growth is moderate, which is not the situation in this industry, then the competition is fierce.

- Limited competition
- Rapid growth
- High flexibility to exit

Threat of New Entrants (High) It measures the threat to the industry's current participants from the introduction of new competitors who bring in a product identical to the current market participant. Entrepreneurs wishing to launch their businesses in the food and beverage industry are drawn to cloud kitchen because of its inexpensive start-up and ongoing running costs. Cloud kitchen facilitates simple customer contact via online food delivery apps (Venkteshwar & Warrier, n.d.).

- Low investment and reduced operating cost
- High ROI
- Limited barriers to entry and expand
- Customer loyalty
- Easy access to distribution channel

Threat of Substitutes (Moderate) It identifies the threat that the availability of additional goods that meet a comparable need outside the cloud kitchen sector poses to the current industry players. Service food is important in cloud kitchen because satisfied customers are more likely to place repeat orders and less likely to switch to a different brand or replace the flavour.

- Advantage of unique taste
- Promotion and branding through apps
- Customers' willingness to substitute
- Less switching cost

Bargaining Power of Suppliers (Low) The suppliers in the cloud kitchen sector are the raw material providers for building up the fundamental kitchen as well as the supermarkets for daily food supplies (Mehta & Kalara, 2005). Since there are several of these suppliers, the current business can change to any new supermarket if it is more affordable. Due to the abundance of suppliers of food and the low cost of the raw materials needed for kitchens, business switching costs are minimal. Cloud kitchens are primarily reliant on these food aggregators for business since they only fill takeout orders placed through online food platforms.

- Large no. of buyers
- Low price
- Easy availability of information
- Convenient for customers
- Price-insensitive buyers

Bargaining Power of Buyers (Low) Because consumers in the cloud kitchen sector care about cost, quality and taste, they have significant bargaining power. There are many customers; however, the average order size is little. Instead of being price

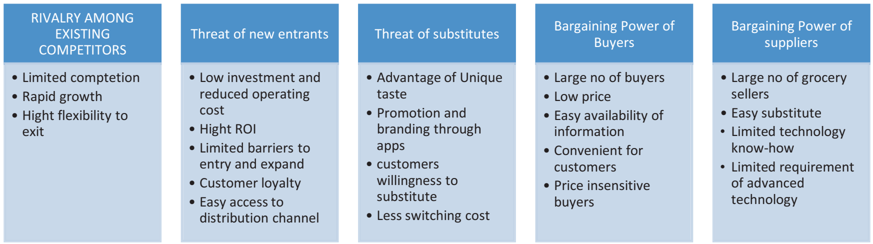

Fig. 1 Porter's five forces analysis of cloud kitchen

sensitive, consumers are attentive to taste and quality. Discounts, however, draw customers; therefore, cloud kitchens' collaboration with online food delivery applications helps with client retention (Fig. 1).

- Large no. of grocery sellers
- Easy substitute
- Limited technology know-how
- Limited requirement of advanced technology

2.2 Cloud Kitchen Technology Solution: Intention to Become a Foodpreneur

Reduced Capital Investment, Operating Cost and Customer Acquisition Cost (CAC) The expense of starting a business is the biggest barrier for entrepreneurs trying to break into the food industry (Beniwal & Mathur, 2021). It is far less with cloud kitchens because they do not require expensive rent for prime locations, any front-of-house staff (such as valets, waiters, front desk personnel, etc.) or any seating area. Highest savings on infrastructure purchases (Mehnaz et al., n.d.). Further, restaurants incur greater operating costs because they must hire better waitstaff and improve their decorations to draw customers. On the other hand, a cloud kitchen doesn't have to worry about any of this because their sole priority is the quality of the cuisine. The price associated with acquiring a new customer. Instead of needing to sell themselves, cloud kitchen businesses get simple and quick exposure through their delivery partners (The Restaurant Times, n.d.). Despite the fact that they must pay for their presence on the delivery platforms, altogether, it is less expensive than what a restaurant would spend on conventional setting.

H1: Reduced cost of the cloud kitchen model impacts the foodpreneur intention.

Pandemic Situations Following the recent COVID-19 pandemic, it was observed that people reduced their nonessential outdoor activities and preferred deliveries over dining in for safety reasons. This presented a great opportunity for both new and existing players in the cloud kitchen industry. People experienced severe financial hardships throughout these pandemics and were suffering to get employees during these times (Kulshreshtha & Sharma, 2022); one answer to these issues is the cloud kitchen.

H2: Pandemic situation has an impact on foodpreneur intention to start their businesses under cloud kitchen.

Technology The fact that technology and cloud kitchens go hand in hand makes it simple for them to obtain user data, which allows them to easily adjust their operations and staffing plans as well as their user interface and profits in accordance with consumer behaviour (Attri & Bairagi, 2020). Customers are choosing home delivery choices more frequently due to time constraints. Restaurants are now shifting to cloud kitchen operations as the quantity of delivery requests rises (Gosai & Palsapure, n.d.).

H3: Technology-enabled cloud kitchen model impacts the foodpreneur intention.

Self-Efficacy The conviction that one can effectively carry out an activity is known as self-efficacy, and it has been said that "Efficacy beliefs influence how people feel, think, motivate themselves, and conduct" (Bandura, 1993, p.118; Zhang & Huang, 2021). Self-efficacy beliefs are a significant predictor of performance because they have a significant impact on people's behaviour through their task selection as well as the motivation and effort they put into completing those tasks (Chen et al., 1998). It is usual to practise when discussing self-efficacy to distinguish between generalised self-efficacy and other types of the task- or domain-specific self-efficacy (Asimakopoulos et al., 2019).

H4: Self-efficacy has an impact on foodpreneur intention.

Flexibility The proprietor of a cloud kitchen may be adaptable and easily adjust the menu in response to a change in consumer demand, although it is more difficult for traditional restaurants to follow every trend in taste. Since cloud kitchens are not physically confined, changes to the menu or even the hours of operation can be made to meet corporate requirements without substantially affecting consumer satisfaction ("Cloud Kitchens and New Technologies in the New Normal," n.d.).

H5: Flexibility in cloud kitchen model impacts the foodpreneur intention.

Creativity/Innovativeness The ability to think creatively is now necessary for good business judgment. If you lack creativity, the company could fall into a condition of stagnation very rapidly. A foodpreneur inventiveness has a big impact on their ability to be an entrepreneur and leads to it. Food industry is long-lasting, and customers prefer creativity in the food items too. Foodpreneurs' ability to think creatively and innovatively is enhanced (Rout et al., 2022). To be a successful entrepreneur in the modern world, it is necessary to be innovative and empowered to take new initiatives.

H6: Flexibility in cloud kitchen model impacts the foodpreneur intention.

3 Research Model and Methodology

This study was carried out using both qualitative and quantitative methods. The initial phase of the study was exploratory in nature, and desk work was done to gather and review the literature with respect to foodpreneur and cloud kitchen. At the second stage of the study, a survey method is used to conduct a descriptive study. After moving past a review of the literature, the researcher (Deepak et al., 2022) concentrates on methodology, developing goals with the statement of the problem and choosing the best research design for the study. There were 200 respondents included in the study from various parts of India. The survey was conducted using social media and Google Forms. Questionnaires were circulated among the respondents to get their responses regarding their intention towards foodpreneur through technology-driven cloud kitchen. Primary data was gathered through a questionnaire that was sent via social media, Google Forms, e-mails and WhatsApp. The opinions of few respondents were recorded in the physical interview.

3.1 Research Framework

Based on the literature review, the following framework was developed to find out the intention towards being a technology-driven cloud kitchen-based foodpreneur (Fig. 2).

4 Analysis and Interpretation of Results

The data were collected via a structured questionnaire which was developed and circulated via social media across India. The questionnaire has two parts: the first part is related to the respondent's demographic information and the second part is

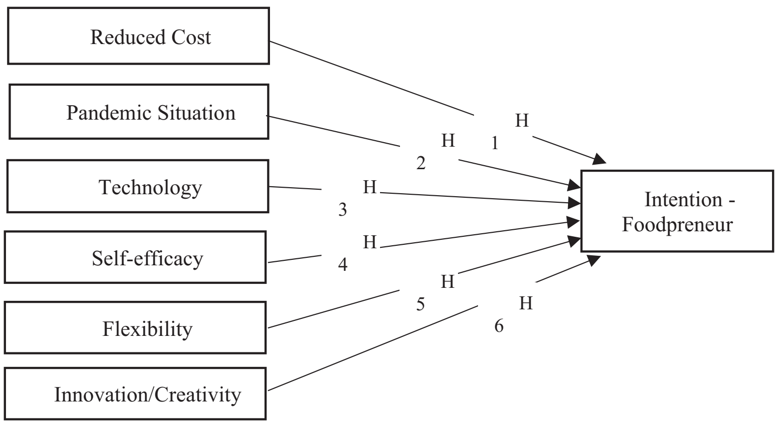

Fig. 2 Foodpreneur intention: proposed research frame

having questions to measure the intention to become foodpreneurs based on cloud kitchen business model. The maximum respondents are male (62%), and 37% fall under the age group of 25 to 35. Majority of the respondents are degree holders. Most of the respondents (35%) are not having any family business, while 20% are doing their own family business.

4.1 Measurement of the Model

To test the reliability of the questions, the items were measured using Cronbach's alpha to find out their internal consistency. The results shown in the following table present the Cronbach's alpha of each construct. It is inferred that all the items are above the recommended value 0.7, which shows that the subscales of all the variables are highly reliable (Table 2).

The KMO (Kaiser-Meyer-Olkin) test was conducted to measure the adequacy of the sampling for all the factors. The results of the test supplied the adequate factor loadings which are shown in the above table.

4.2 Hypotheses Test Results

The suggested measurement model was tested using the data collected through questionnaires from the respondents. Structural equation modelling (SEM) was used to measure and prove the hypotheses framed using AMOS. The first step in SEM is to measure the model fit comparing the various model fit indices. The result shows the fitness of the final structural equation model developed to assess the impact of chosen independent variables on the dependent variable. The result shows that all the indicators of model fit attain the threshold limit. Hence, the developed model is considered fit. The first fit is the minimal fit, i.e. chi-square. For the model, the chi-square data is 256.21 with 134 degrees of freedom is 1.91 which shows an adequate fit. The GFI (goodness of fit index) achieved is 0.929, while the AGFI (adjusted goodness of fit index) is 0.909, above the required 0.90. The CFI and NFI (normed fit index) values computed are more than 0.90, indicating that the model fits perfectly with the data. It was discovered that RMSEA is 0.054, which is lower than 0.08, and that it confirms the model fit. SEM was employed to examine the proposed model. The following figure and table show the results of the hypotheses and their relationship clearly (Table 3).

The regression estimates and their significance for the entire path are calculated. Each estimate represents the amount of change in its dependent variable for each one-unit change in the variable predicting it. The relative contribution of each predictor variable to each dependent variable is given by the standardised estimates in the above table. The results of the model show all the independent variables have an impact on the dependent variable (Fig. 3).

Table 2 Survey item and factor loading

Constructs	Code	Measurement items	Loading	Cronbach's alpha
Reduced cost	RCI	This model reduces the capital cost	0.81	0.89
	ROC	It involves less operating cost than the restaurant's setup	0.84	
	RCA	Customer acquisition cost is less in this model	0.79	
	REC	This model requires less employee cost than the actual restaurant model	0.85	
Pandemic situation	PR	This model is suitable for pandemic restrictions	0.89	0.73
	PER	As it required less employees, it is suitable for pandemic situations	0.76	
	PSC	This model is suitable when there is a curfew	0.87	
Technology	TTS	This model saves time in finding information	0.76	0.81
	TUF	This model is user-friendly	0.72	
	TCA	Customers prefer this technology-driven model to get their food	0.82	
Self-efficacy	SE1	I am self-motivated to start this kind of business	0.86	0.84
	SE2	I am confident that I can shine in this business model	0.88	
Flexibility	FAT	I can change the model any time	0.74	0.85
	FCM	It is a very flexible model to change menu according to the customer need	0.89	
	FCP	This model does not have long process to change their menu when compared to corporate diner	0.81	
Innovation	INN	This model is an innovative one	0.77	0.79
	CRE	I can introduce creativity in the menu	0.81	
Foodpreneur intention	FI	I intend to become a foodpreneur	0.88	0.82
	FIC	I want to start my career as a cloud kitchen-based foodpreneur	0.78	

Table 3 Regression weights of the estimated model

DV	INF	INDV	Estimate	S.E.	C.R.	P	Result
Foodpreneur intention	←	Reduced cost	0.87	0.079	4.871	**	Accepted
Foodpreneur intention	←	Pandemic situation	0.64	0.058	2.327	*	Accepted
Foodpreneur intention	←	Technology	0.45	0.087	2.452	**	Accepted
Foodpreneur intention	←	Self-efficacy	0.38	0.060	2.721	*	Accepted
Foodpreneur intention	←	Innovation/creativity	0.51	0.104	3.113	*	Accepted
Foodpreneur intention	←	Flexibility	0.42	0.072	2.141	*	Accepted

*$p < 0.05$, **$p < 0.01$

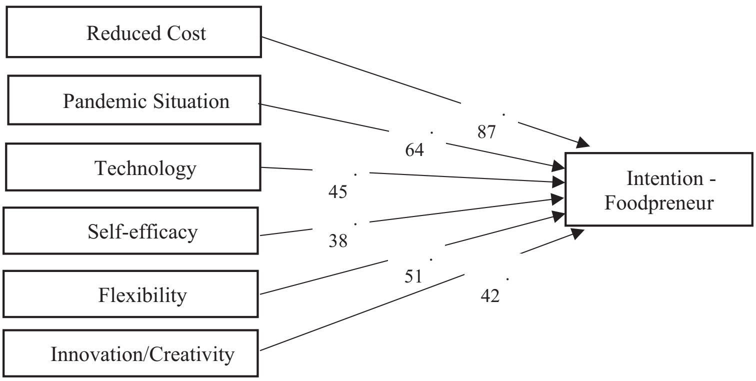

Fig. 3 Structural equation model of foodpreneur intention

4.2.1 Reduced Cost and Foodpreneur Intention

Reduced investment cost, operating cost and employee cost have a significant and positive impact on foodpreneur intention (estimator value = 87% – 0.087) as the p value is less than 0.05 ($p = 0.002$) with CR of 4.87. Cost-effectiveness is the major factor which attracts foodpreneur intention towards this technology-driven model. This result was similar to the research (Deepak et al., 2022) conducted in Hyderabad and in India (Sarangdhar, 2021).

4.2.2 Pandemic and Foodpreneur Intention

Pandemic situation created a significant impact on foodpreneurs to start their businesses using cloud kitchen as the p value is less than 0.05 ($p = 0.02$) with the estimator value of 0.64, SE of 0.58 and CR of 2.327. Cloud kitchen model is apt during pandemic situations to manage both finance and human resource shortage which is similar to the study conducted by Choudhary (2019a), Li et al. (2020) and Fernandes (2021).

4.2.3 Technology and Foodpreneur Intention

The ever-changing technology and its usability have a significant impact on foodpreneurs to start their businesses using cloud kitchen as the p value is less than 0.05 ($p = 0.010$), with the estimator value of 0.451, SE of 0.087 and CR of 2.452. New technologies are on the rise because individuals prefer to do business online rather than in person. Cloud kitchen is the one solution for saving time, and it is proved by the research conducted by (Assistant Professor, School of Hotel and Catering Management, Vels Institute of Science Technology and Advanced Studies (VISTAS), Moyeenudin et al. 2020).

4.2.4 Self-Efficacy and Foodpreneur Intention

Self-motivation and self-confidence have a significant impact on foodpreneurs to start their businesses using cloud kitchen as the p value of 0.012 is less than 0.05, with the estimator value of 0.38 (SE is 0.060) and CR of 2.721. The finding of the result says that self-efficacy is one of the driving forces for people to intend to become foodpreneurs, and this result is similar to the research conducted by Romero-Galisteo et al. (2022).

4.2.5 Innovation and Foodpreneur Intention

Innovation and creativity in the model have significantly influenced the respondents to intend to become foodpreneurs as the p value is less than 0.05 ($p = 0.016$) with the estimator value of 0.51 (SE is 0.104) and CR of 3.113. It is enabling the innovation and creativity among the foodpreneurs which triggers their intention towards this technology-enabled business model (Chhabra & Rana, 2021; Etty Susilowati et al., 2021).

4.2.6 Flexibility and Foodpreneur Intention

Flexibility in the model has significantly influenced the respondents to intend to become foodpreneurs as the p value is less than 0.05 ($p = 0.016$) with the estimator value of 0.42 (SE is 0.072) and CR of 2.141.

5 Conclusion

The successful business model must incorporate innovation and creativity, and only those who do so to stay current with the ever-changing business model will survive a crisis. The emerging technology-enabled food aggregators and cloud kitchen worked on business strategies to adapt to changing consumer preferences during the pandemic curfew and lockdown. The key driving forces behind practical, less expensive and home-based transportation solutions to deliver food to our doorsteps are the growing population, shifting dietary habits, longer dwell durations and longer trip times. In the digital age, Indians must use commonplace food delivery services like Swiggy, Zomato, Foodpanda, Uber Eats and Dominos. To take advantage of the numerous opportunities offered by cloud kitchens, canteens are turning away from traditional kitchens. The concept of a cloud kitchen encourages more control over supply and demand, which aids in accelerating production. The growing preference among consumers for high-quality food over the fatty fare that is typically provided by low-cost food establishments is another factor that increases the popularity of cloud kitchens. The fundamental change from being a housewife for a living has helped women stand on their own two feet and gain self-assurance and self-sufficiency not only by learning about digitalisation and the new trend in the market but also by creating a new type of business model that allows them to grow their business in a small space with less capital and more profits while taking care of both their family and themselves.

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The Implementation of Blockchain Technology in the Development of Socioeconomic Environment: A Conceptual Framework

Nabil Ahmed Mareai Senan and Imran Ahmad Khan

1 Introduction

The reality of the twenty-first century reveals a long list of problems and social and economic situations, some of which have only recently appeared, that require attention. The construction of systemic solutions that make possible adequate responses represents a real challenge for our society, which in some cases is still not sufficiently prepared. The aging of society, the depopulation of the rural world and its consequent concentration in urban environments, the financial exclusion also in these environments, climate change, migrations and the realities that arise with them, and the structural increase in unemployment are just samples of the evidence of which societies are progressively becoming aware and demanding solutions from governments.

Another demographic phenomenon that, although it has occurred throughout history, takes on special relevance in the current context due to its impact on the composition of the demographic profile is that of migratory flows. Migrants constitute a subset of the population that will require specific services to enable them to achieve the objective for which they have left their countries of origin. In this new situation, one of the most relevant aspects of the migrant collective is made up of the

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management of the so-called remittances, concretized in the sending of economic resources to the part of the family that remains in the country of origin, and with which a percentage of the economic resources obtained in the new destination is shared.

In this same area, the financial one, and direct and transversal relation with migrations or depopulation in the rural world, there is an additional problem. This is none other than the financial exclusion that has occurred in India, mainly due to the merger process, for subsequent bankarization, of a large part of the savings banks, and the resulting resizing of the sector. This has implied a process of closure of numerous bank branches considered to be less profitable, although mainly located in small municipalities, where traditional banks had not been present. The direct impact on the welfare of society has been more than evident. Thus, the difficult access to financial services in rural areas or disadvantaged urban spaces has been producing very negative economic effects, directly affecting minority groups living in these areas and suffering situations of social exclusion.

Frey and Osborne (2017) conducted a rigorous analysis of the professions likely to disappear due to the computerization of the economy, concluding that, in the US labor market, there is a risk of 47% of jobs disappearing in the next 15 to 20 years. Similarly, the final report of the 2016 World Economic Forum in Davos predicts the disappearance of 7.1 million jobs in the 15 most industrialized countries in the world, and the creation of 2.1 million new jobs by 2020, mostly related to new digital skills and abilities. The conclusion of all of these is clear: the current economic model will be unable to provide enough jobs to allow large segments of the population to obtain sufficient resources to cover their basic subsistence needs.

One of the solutions that technology itself has offered in the field of financing social entities, and therefore related projects or undertakings, has been the use of crowdfunding, which allows the collection of financial resources from small donations from a large number of donors. However, this type of financing requires the use of platforms offering crowdfunding services that require a percentage of donations for their maintenance, as well as online payment services offered by financial institutions, giving the paradox that, sometimes, the collection of resources by social entities generates a flow of commissions whose beneficiaries may be part of the problem being addressed.

All of the above is leading to a crisis of confidence that calls into question the current social, political, and economic systems, which are witnessing the emergence and expansion of social groups of different kinds that are suspicious of the functioning and results derived from the market economy. For this part of the citizenry, globalization is seen as a threat and a challenge that demands greater control and stricter regulation from governments in all industrial sectors (Roth, 2009).

Following the distrust generated in the financial system after the collapse of Lehman Brothers in 2008, the technological guru Satoshi Nakamoto presents a tool that will allow online peer-to-peer payments to be sent from one party to another without the intervention of any financial institution (Nakamoto, 2008) This system is none other than Bitcoin, the first cryptocurrency that, using different already existing techniques such as software that supports P2P applications and cryptography among others, can create an environment of trust in which transfers of value occur between peers without the need for the involvement of a third party, which is usually a financial institution. The technology on which Bitcoin has been built, and which is being used to develop new applications in very diverse fields of life, is known as blockchain technology, more commonly referred to as the blockchain.

Bitcoin has been the first digital asset that has no intrinsic value, is backed by a third party, and at the same time does not require a centralized issuing entity (Buterin, 2013). It has also been the first proposal to emerge under the shelter of blockchain technology.

Subsequently, given the potential applications offered by Bitcoin, not only as a financial tool but software, developers were also faced with a dilemma, having to decide between building these applications on Bitcoin itself and doing so from a new blockchain. That is why at the end of 2013, a Bitcoin enthusiast software developer named Vitalik Buterin launches a white paper in which he presents the idea of Ethereum, a blockchain with a general purpose that adds the possibility of code fragment execution (Antonopoulos & Wood, 2018). The so-called world computer is thus built, a virtual machine that runs on multiple computers connected to the Ethereum blockchain and provides it with the ability to execute computer code in the form of small programs that are called smart contracts. This code contains the conditions that must be met for the execution of a transfer, whether economic or data.

Blockchain technology is categorized by Iansiti and Lakhani (2017) as a fundamental technology that has the potential to create new foundations for our economic and social system. It thus endows the concept of the crypto economy with new content. The set of characteristics on which this technology is based means that, as underlined by the European Economic and Social Committee (2019), blockchain technology has a suitable fit for the social economy, stating that "some characteristics of these technologies make blockchain a digital infrastructure that could be used to advantage by Social Economy organizations to improve the fulfillment of their purposes, increasing their capacity to generate positive social impact and promote social innovation."

On this basis, the objective of this paper is to analyze how blockchain technology is being used de facto for the creation of decentralized applications (DApps) that support projects with a relevant social and environmental impact, assessing its potential for social economy entities, through case studies. To this end, and beyond a broad presentation of blockchain technology in its conception and operation, a synthesis of its main features is necessary to facilitate the understanding of what this technology brings to each of the cases to be analyzed, and which form the core of this analysis. A section dedicated to the methodology followed precedes the results of the work, which concludes with a section containing its main contributions.

2 The Blockchain Technology: Structure and Operation

As already indicated, one of the main consequences of the international economic crisis that followed the collapse in September 2008 of the Lehman Brothers bank has been the emergence of a crisis of confidence on the part of the public both in the banks and in the global stability of the financial system, as well as in the institutions and their underlying values (Roth, 2009).

At the same time, and within the aforementioned framework of weak international trust, a group of computer developers grouped under the pseudonym of Satoshi Nakamoto presented a paper published in the Cryptography Mailing List, an electronic peer-to-peer value transfer system that did not require intermediate agents to endow it with trust, as this was implicit in the system itself (Nakamoto, 2008). This system was based on the assignment of value to a digital asset, which could subsequently be used to transfer its implicit value between peers irreversibly, being recorded in a decentralized and immutable database, thanks to the use of various computer control technologies. Bitcoin, which is the name given to this digital asset, burst onto the technological-financial scene as the first cryptocurrency with no intrinsic value and without any institution to back it up (Buterin, 2013).

This entire system was based on the technology known as the blockchain. Blockchain consists of a decentralized database in which all securities or data transactions occurring between the parties participating in the system are recorded. Each transaction is verified and recorded in this database after the consensus of the majority of the participants in the system. Transfers are grouped into blocks for verification, blocks that are placed on a chain. That is, each block is linked to both the preceding and subsequent block, hence the name of the technology blockchain.

A concept of particular importance in this environment is that of the digital token, which is conceived as the digital representation of any value, created by a specific entity and which can be used in various ways thanks to the large amount of information it can contain. Thus, it can be used for the representation of a cryptocurrency, to grant a right, or to represent a physical good (Rohr & Wright, 2017).

The operating steps of a blockchain that has "n" nodes, understanding by node each of the computers that are part of the network, can be schematized as follows:

1. Two nodes in the network decide to perform an exchange of value or data through the blockchain system to which they are connected. For its effective realization, they disseminate the data of the same to the rest of the nodes that are connected.
2. The connected nodes receive this transaction and include it, together with others that have been received and are pending, in a block. This block is then transmitted to the rest of the network.
3. The nodes evaluate the transactions included in the block, and once validated, the connected nodes use consensus mechanisms based on a set of agreed rules. When consensus is reached, which requires the agreement of more than 51% of the connected nodes, the transactions included in the block are verified.
4. Once the block has been validated, a one-way cryptographic function is applied to it, returning a value (called a hash) that can be used to detect any subsequent

alteration of the block's contents. Each block contains a link to the hash of the previous block, thus creating an unalterable blockchain thanks to the properties of the hash function(x).

In this way, a system is obtained that provides security, anonymity, and integrity in the data it uses and independently, i.e., without the need for third parties to control and certify them. This eliminates, in a parallel way, the concentration of analytical and decision-making power.

The management of digital assets, which are key pieces of the blockchain's operation, is done through the use of digital wallets, usually referred to as wallets, by the users. These wallets are pieces of software that allow blockchain users to monitor transfers and store and manage digital assets related to the blockchain. They can also be continuously connected to the Internet (hot wallets) or remain offline, in isolation from the blockchain (cold wallet) storing assets on paper, a piece of hardware, or an external USB storage drive (Antonopoulos & Wood, 2018).

In 2013, the computer developer Vitalik Buterin proposed to the Bitcoin development community the introduction of modifications to the Bitcoin scripting system that would provide the ability to execute complex computer programs, thus appears the Ethereum platform which, using blockchain technology, creates a decentralized open-source space with the ability to execute code fragments with which smart contracts are implemented. These smart contracts consist of code fragments built following the conditions set out in a contract between parties and which are automatically executed when these conditions are met.

The Ethereum blockchain supports two types of transactions, those that transfer value through the use of a cryptocurrency and additionally others that perform data transfers. The latter are those used for the execution of smart contracts, which are performed in the virtual machine that Ethereum (EVM) builds with the connected nodes (Antonopoulos & Wood, 2018). EVM is a sort of global computer containing millions of fragments of executable objects, each of which has its permanent data store.

An additional element contributing to the potential use of blockchain technology is decentralized applications (DApps). DApps are the basis of Web3, a decentralized application environment that endows it with resilience, transparency, and resistance to censorship. These are applications that run on the Internet in a decentralized way, without the presence of a central agent (middlemen) that oversees their operation or manages information related to users.

Another important concept, which emerges with the application of the tools that blockchain technology provides, is decentralized autonomous organization (DAO). A DAO is an organization that, under a set of predetermined rules, runs a business or social activity (both online and offline) in a completely autonomous way in an open-source environment that is decentralized (distributed among stakeholders' computers), transparent, secure, and auditable. It is a group of smart contracts and/or autonomous agents linked together and endowed with initial capital.

On this basis, numerous cryptocurrencies have been built mainly to obtain the financial resources necessary for the implementation of business projects, mainly based on the development of applications in the Internet environment, and to be used as the means of payment used in them. The blockchain thus introduces tools and procedures that change the way people organize their economic activities and social environments, allowing the development of new governance schemes based on more democratic and participatory decision-making.

Each of these proposals is based on the drafting of a document that includes the technical characteristics and business model proposed for each project. For this purpose, the expression white paper is used, which is usually the initial basis for raising the resources that make the development of the proposal possible, usually through an initial coin offering (ICO). This is a cryptocurrency issue that goes on sale to raise funding for the implementation of projects based on blockchain technology.

3 Research Methodology

The recent irruption of blockchain technology on the technological scene has opened the door to the emergence of new applications capable of providing a trusted environment to processes that until now have depended on third-party actors that endorsed and generated, in one way or another, the aforementioned reliable space for action. Despite the rapid dynamics of development of this technology, it is still short history makes it necessary to use an exploratory approach of a qualitative and quantitative nature simultaneously as a methodological approach to research.

On this basis, this work has focused on the case study of different proposals for the use of blockchain technology, from a socio-technological perspective, through which to assess the possibilities that the use of this technology opens to the social and solidarity economy sector in the generation and development of projects with positive social and environmental impact.

Yin (2018), Dźwigoł and Dźwigoł-Barosz (2018), and Rashid et al. (2019) support the use of this methodology by allowing the analysis of the phenomenon under study through different sources of evidence, quantitative and/or qualitative simultaneously. The construction of a theory is thus made possible through the analysis of a theoretical sample made up of one or more cases, rather than through the extraction of a representative sample, which is necessary for a quantitative study (Dźwigoł & Dźwigoł-Barosz, 2018). In this sense, Yin (2018) considers the case study as a valuable research tool, as it is the way used to assess and record behaviors of the actors present in the phenomenon under study, as opposed to quantitative methods focused on verbal information obtained through questionnaire surveys.

Thus, the empirical work of this study starts with a process of identification, observation, and interaction of the set of initiatives that use blockchain technology in social and environmental sectors with potential positive impact. After that, a small number of initiatives, or cases, are selected for further exploration and analysis with rigor and depth. The cases have been selected for their representativeness, both in terms of pioneering, and their quantitative significance, or for their qualitative potential in the context of action in which they have arisen and developed.

The variables used for the selection of the cases under analysis were based on three main factors:

1. The scope of action deployed to address the problems they address, giving priority to those that do not develop in a specific geographic area, but deploy their actions globally. Although the cases studied are not the only ones that meet this requirement, their dynamics have already been studied in other works by the authors of this article, which is why the starting point of knowledge is higher.
2. The existence of pre-eminent performance spaces with the presence of developers of decentralized applications using blockchain technology.
3. Their innovative or pioneering nature in the use of blockchain technology in their field of activity and outside traditional financial applications. This becomes of utmost importance to assess in what way they contribute a vision that questions the dominant socioeconomic system within which they have appeared, thus fulfilling one of the main functions of the social economy, as is its political vector of pioneering in the generation of nonexistent social initiatives.

In procedural terms, the information-gathering work has been carried out in three stages. The first stage involved the review and analysis of the white papers that each of the selected initiatives or cases presented on their web pages. A second stage was dedicated to the interaction with these tools through their use as active technological users. Finally, a series of contacts were made with those responsible for the target cases, through open conversations via e-mail, Twitter, instant messaging, and videoconferences.

The cases selected for study and analysis were the following. In the field of energy, the proposal presented by the Pylon Network platform was chosen because it is a tool for use by consumers and user cooperatives working in the production and commercialization of renewable energies. At the same time, it acts as an enabler for the development of collective self-consumption initiatives, one of the keys to the construction of a new energy model that is presented as an alternative, under market conditions in line with the competition and against the oligopoly of large energy companies that dominate the market in India in this second decade of the twenty-first century.

Secondly, the Arcadia platform, aimed at providing financial services to refugees, won first place in the Startup Days Bern 2019 Pitching Battle. This award gave visibility to its proposal and it was one of the eight startups selected to participate in the Fintech Solutions for Refugees Summit. Although there are other proposals in this field that could have been selected for analysis, the Arcadia platform has been chosen for its accessibility and willingness to share information.

Additionally, Binance Charity has been selected as a crowdfunding platform proposed by binance.com, one of the main cryptocurrency exchanges that proposes and creates the Blockchain Charity Foundation with the aim of improving transparency in philanthropic donations, expanding the use of cryptocurrencies, and accelerating sustainable global development. Its choice is motivated by its pioneering nature in this area of activity.

Finally, the evolution and operation of two of the three proposals that have been working since 2018 in the field of universal basic income (UBI) generation, UBU, and Mannabase have been analyzed. Through their study, it has been possible to capture and analyze the changes that have occurred in their mission from a "constructive perspective" typical of the multistage and cyclical nature that occurs in innovation processes and more specifically in social innovation. Processes built on evidence of trial and error introduce different perspectives to achieve the final objective that does not vary.

In this context, all the information provided by the GoodDollar initiative (also known as the GoodDollar experiment), which began its implementation at the end of the same year to assess the feasibility of using blockchain technology to reduce economic inequality in twenty-first-century society, was collected and analyzed. The method of collecting information was based on periodic tests and questionnaires addressed to people who voluntarily made their mobile devices available to the project by installing a Beta version (or test version of the programmed material), as well as their commitment to interact periodically, thus ensuring their traffic and the verification of its operation.

4 Empirical Analysis: Case Studies

4.1 Democratization of Energy Production

In the energy sector, the case of the Pylon Network has been selected and analyzed. This project is defined in its white paper as "an energy-neutral database, using Open-Source blockchain technology, specially designed to meet the needs of the energy sector. It is a blockchain code that is fast, scalable, and with minimal energy requirements, designed to play the role of digital communication infrastructure for greater participation of distributed assets in energy markets, as well as the provision of digital energy services in the future of our energy systems."

The Pylon Network is thus presented as a decentralized platform, in which the different stakeholders of the energy sector (i.e., consumers, traders, distributors, energy producers) can "dump" information on their trading history and will also be able to access it on an open-source basis, with greater security and transparency. At all times the project is conceived as an improvement solution oriented to the end customer, to enable a more transparent, open, and competitive energy market for the end user.

The ultimate objective of this project is to enable companies offering energy services to analyze them and, based on the results obtained, to build a set of services that will enable them to use energy more efficiently. The aim is to generate efficient energy use, which will determine a saving in economic costs for the energy consumed.

For this purpose, the Pylon Network provides users with an app that allows them to access their energy data and share it with energy service providers. This tool is part of the wide range of instruments through which an alternative ecosystem is being built, formed by consumer and user cooperatives with proposals, all grouped under the second-degree cooperative, which works for a new energy model in India.

The blockchain algorithm used in the Pylon Network, Pylon Coin CORE, has been specifically designed for the energy sector and aims to meet the needs of scalability, security, and privacy, as well as sustainability based on minimum energy costs.

The technical characteristics of Pylon Coin Core are accessible through the Github platform, being relevant to highlight the critical aspects that have been taken into account in the design of this algorithm, such as the carbon footprint involved in its operation and the scalability of the system. The coherence with the aforementioned critical aspects underpins a proposal with a cooperative and noncompetitive vision in the block mining process, which is decisive in achieving a much lower energy consumption per transaction than those existing in other consensus protocols.

While the tool is accessible to any operator in the energy sector, regardless of its legal form, the Pylon Network aspires to the democratization of information and the consequent construction of a cooperative ecosystem that allows a real decentralization of the sector. In fact, and coherence with this, a pilot test was carried out in March 2018 within the cooperative. For this purpose, smart metering devices were installed that made it possible to acquire consumption data in real time, to trace the origin of the energy consumed, and thus to be able to pay for energy exchanges between users participating in this decentralized network.

4.2 Crowdfunding

In the late 1990s of the last century, the tools of information and communication technologies were introduced in various types of crowdfunding proposals. This funding modality, commonly known as crowdfunding, consolidates small contributions, about the overall amount pursued, from multiple donors to cover the economic-financial needs of certain projects proposed by specific individuals or entities.

Among them, an endless number of projects aimed at social action have been generated, which sometimes face a double problem: technical and ideological. On the technical side, the use of platforms that provide crowdfunding services implies the payment to them of a percentage of the funds raised for their maintenance, which usually ranges between 4% and 8% of the total amount raised, and on the other hand, the use of payment gateways that introduce an additional cost to the amount donated by the people participating in the project. In most cases, this type of financing requires a factor of trust in the entity or its managers, to which resources are contributed, since this type of operation does not make it feasible to track the final destination of the funds applied.

From an ideological perspective, and taking into account these collateral payments that arise from the mere fact of participating in a traditional crowdfunding campaign, sometimes there is the paradox that the bank fees paid go to the coffers of financial institutions that play a role in this scheme of operation that also determines the problem to be addressed. For example, think of projects that try to help people who are victims of war conflicts, and that with the creation and management of a crowdfunding campaign for this purpose, generate a flow of commissions to financial institutions that are possibly using these same funds to finance companies producing the weapons that are used in this same conflict.

However, the emergence of blockchain technology and its use in crowdfunding schemes for social action projects solves most of these problems. The use of cryptocurrencies can minimize the amount of possible payments to third parties and adds a trust factor regarding the final destination of the donation since it enables the traceability of the donation. This trust factor is provided by the very nature of blockchain technology, which enables a traceability system that allows knowing in which expenditure each of the units of value that have been donated has been applied.

The possibility of dividing each cryptocurrency unit into values that occupy decimal positions very far from the unit, as shown by the Bitcoin (BTC) and a Satoshi or minimum unit of measurement of value that is equivalent to 10–9 BTC, giving them a negligible value if they are observed in isolation, opens the door to the emergence of nano-donations. However, if this type of donation is observed in a massive environment, with a sufficient critical mass of contributors, it adds value to the concept of crowdfunding and the construction of large collectives around specific projects.

An example of the use of blockchain technology for these applications is the Binance Charity platform offered by the Binance Charity Foundation (BCF). This platform presents different projects with positive social impact that have passed due diligence carried out by the foundation's technical team, which guarantees the appropriateness of the project to be financed on it, always seeking to optimize the social impact of each monetary unit used. The donor or entity has the possibility of choosing among the set of projects presented, and to which of them he/she wants to make his/her donation. If the donation is not directed to any specific project, it is managed through the Binance Charity Wallet, which unilaterally distributes the funds received.

The operating costs involved in the donations received through this platform are assumed by Binance (www.binance.com), a proposed financial ecosystem around blockchain technology, thus maximizing the percentage of donations that reach the final beneficiaries.

Donations can be made through the use of different cryptocurrencies, which allows the implementation of mechanisms to track donations by anyone, as the Binance blockchain is a public blockchain.

BCF is just one example of the potential that blockchain brings to the field of donations. Other examples that can be taken into account in this context are BitGive, BitHope, Helderbit, and GiveTrack. There are also proposals for the creation of digital currencies for social purposes to support specific programs, such as Clean Water Coin, PinkCoin, or AidCoin.

4.2.1 Financial Inclusion

In 2018, the number of refugees fleeing war conflicts in their countries of origin, including due to situations of climate change that made it enormously difficult to access a dignified life, reached 70.8 million forcibly displaced persons, twice as many as 20 years ago (UNHCR, 2020). The dimension of this reality has placed it in the focus of attention of global civil society constituting a problem of political and humanitarian urgency.

Among these problems is the inability to access banking and financial services, either due to the lack of proof of identity and/or roots in the destination country or due to the host country's policies. According to the World Bank's Identification for Development (ID4D) initiative, around one billion people around the world lack official proof of identification, making it difficult for them to access multiple services, including banking services. This situation undermines the potential integration of refugees, their access to work and finance, and undoubtedly their ability to pursue entrepreneurship as an economic outlet (UNHCR, 2020).

Faced with this situation, the Arcadia Blockchain for Refugees Association has built the Arcadia platform through which resources are offered to nongovernmental organizations (NGOs) working in the field of refugees, to provide cash transfer services to this group that lives in a situation of financial exclusion. This group is quantitatively very significant, as evidenced by a recent study conducted by Arcadia according to which, as an example, 80% of Myanmar refugees had no access to financial services. This exclusion arises mainly due to the refusal of financial institutions to open bank accounts. Blockchain technology offers these people the possibility of having an account where they can receive and manage their money, under the supervision of the NGO that offers these services through the Arcadia platform.

According to the Ethereum community's website (https://ethereum.org/), this is "the world's largest and most active blockchain community. It includes core protocol developers, crypto-economic researchers, cypherpunks, mining organizations, ETH holders, application developers, ordinary users, anarchists, Fortune 500 companies…." The size of this community makes it possible to guarantee that, if the NGO through which you are managing your account with Arcadia should stop offering the service for any reason, it will continue to be available to users without the need for intervention from the former.

This blockchain has a cryptocurrency, the Ether (ETH), which is the element that will be used to transfer, to the users of this system, the value with which to make payments. Likewise, the choice of Ethereum guarantees the existence of a large community among developers and users that constitutes a mainstream ecosystem that has been operating since 2015.

The objective of this entity is to enable the inclusion of these groups in the local economy of the place where they establish their residence, either temporarily or permanently, under equal conditions. To this end, Arcadia has created tools that are easy to understand and use, even for people unfamiliar with cryptocurrencies and their operations, to simplify the entire process of receiving funds from refugees, who are currently its main target users, and their use in their real economic transactions.

This operation begins with the registration of the person who is going to use this form of payment on the Arcadia platform. All that is required is an email account and a postal address to which the Arcadia application management entity will send a physical card containing the public key of the ETH wallet, which is issued at the same time, and the private key of the same account in another complementary card. The aforementioned public key is valid for accessing the platform and performing all the necessary operations, such as checking the balance of the wallet through which the user receives the funds, obtaining those funds, and even sharing them with other people who may need them. The private key is necessary to perform transactions and pay for products and services and is used together with a passphrase that protects it from misuse in case of loss.

Likewise, and for the approach of charging for products and services, ETH is used as a unit of value. For this purpose, Arcadia provides a platform that makes it understandable to merchants, without technical knowledge about blockchain, the use of ETH as a means of payment. To this end, they simply need to register their business in this application, associating an ETH wallet in which to receive payments, and indicate the fiat currency, which can be in euros, dollars, or other currencies, in which the prices to be used in transactions are marked.

This operating scheme, as is to be expected since it is based on a technology that is still at an incipient stage of development, has certain drawbacks that must be taken into consideration when it is used.

Cryptocurrencies in general, except those known as stablecoins that have been designed to maintain a stable value against fiat currencies, such as the DAI or the USDT, present a certain component of volatility that introduces a certain factor of uncertainty in this scheme. To minimize these effects, Arcadia proposes to the different users to convert ETH to fiat currency in a reasonably short time and thus obtain an exchange rate close to that existing at the time of the transaction. Arcadia's future action plan contemplates obtaining the necessary license to directly exchange cryptocurrencies to fiat currencies, to subsequently launch its token, designed with the stablecoin vision, referenced to various fiat currencies. All this is possible thanks to the possibilities that the Ethereum blockchain offers for the creation of proprietary tokens in a standard format (ERC20), which enables them to be used in the construction of new applications using smart contracts.

4.2.2 Universal Basic Income

Universal basic income (UBI) consists of the periodic and unconditional transfer of income to all people in a society who find themselves in conditions of poverty and exclusion, and this is in terms of an established right. It is beyond the scope of this paper to analyze its relevance or the possibility of its implementation in the twenty-first century, as there is a large number of works on this subject to which the reader is referred. However, the concept of UBI has been considered in this study since blockchain technology enables a corpus of tools that will make it possible, together with the will of the members of society, to build alternative social and economic ecosystems where the concept of UBI is contemplated.

At the very core of these new ecosystems is the possibility of introducing alternative operating dynamics that give a different meaning to the concept of the value of tangible goods and to that of human relations. These dynamics are based on the establishment of automatic and decentralized systems for the creation and distribution of cryptocurrencies that guarantee equality among the different participants.

Such proposals can indeed be seen as an attempt to question the current status quo, however, and regardless of this, what is relevant is that within them are different proposals that are born under the shelter of cryptocurrencies created ad hoc, as well as a set of smart contracts based on which the rules for their distribution and use are defined.

In the blockchain technology space, there are different proposals revolving around the concept of the UBI and its implementation that use this technology as a way to solve people's income inequality and as a tool to fight extreme poverty.

One example, which has a relevant track record, is the UBU project (www.projectubu.com). This is an initiative developed by a DAO (decentralized autonomous organization) that distributes 100 UBU tokens daily, through a specific digital wallet for this value, among all the people who have registered as a citizen in the application created for this purpose. In parallel, the UBU project builds a network of vendors (merchants) that use this platform as a tool to promote their brands and products, establishing different pricing strategies such as the introduction of part of them in UBUs. As stated on its website "The UBU project is an ambitious effort to monetize the waste and inefficiencies present in all economic ecosystems, and redistribute that value to all participants in the UBU world."

A UBU is a free token that is distributed daily among all citizens registered on the platform, forming the central part of an autonomous and decentralized UBI ecosystem. This token can be used to make value transfers between citizens and make payments at participating merchants as an alternative to traditional means (cash, credit, and debit cards). One of the main features of this proposal is the process by which the balance of each citizen's wallet is reduced daily by 1% of its volume, which returns to the system to be distributed again among citizens following the usual scheme. This fact can be understood as part of an oxidation process that encourages the use of this token as an instrument of measurement and value transfer and penalizes its accumulation. This process arises from the concept created by Silvio Gesell (1862–1930) which refers to the expiration or loss of value of money with time to avoid its speculative accumulation.

The UBU project in its early stages was presented as a tool to fight extreme poverty based on the creation of a new ecosystem of citizens and suppliers. The same was provided with a set of actors with tools that make it possible to extract value from dying assets (products not accepted by the traditional market either by the proximity of its expiration, its design out of current trends, being items already used, etc.), and inject them back into the ecosystem itself creating a network of equitable distribution of wealth. Currently, the project's operating fundamentals maintain the automatic and decentralized distribution of UBUs with an objective focused on establishing relationships with commercial brands that introduce their use in their marketing strategies.

Another example of the use of blockchain technology in this field is presented under the name Mannabase. This proposal carries out the distribution of a UBI among all the people registered on its platform and whose identity has been verified. A specific cryptocurrency created for this purpose, manna, is used for this purpose. This cryptocurrency is the basis of value distribution proposed by the People's Currency Foundation as part of a set of tools built using blockchain technology, which under the common denominator of Hedge for Humanity (www.hedgeforhumanity.org) covers the spaces of generation (humanity fund) and distribution (manna) of wealth, as well as the identification of the people receiving the transfers (www.brightid.org) as unique human beings.

Similar to what happened with the UBU project proposal, a strategic and sustainability reflection has been carried out around the whole project itself. These reflections have had a lot to do with the scalability of the project and its sustainability based on the costs that the use of the technology itself implies. In this last sense, the inherent cost of maintaining the servers that host the hot wallets used for the distribution of assets, and the lack of profitability for Mannabase block miners in an exclusive blockchain, forcing migration to another more robust and scalable blockchain, should be identified. The project remains a pilot project that has been financed with funds provided by its founders and through the dedication of volunteers and supporters. From a future perspective, this group of actors is focused on the search for more funding that will allow the project to be scaled up to a level where it can have a significant impact on people's lives.

Finally, a third example that deserves consideration along the same lines is the GoodDollar. This proposal is presented as a research program focused on reducing inequality based on the appropriate use of blockchain technology. To this end, thanks to the participation of volunteers as users of the service, a distribution test of its cryptocurrency is carried out. As detailed on its website, its mission is "…to build a new open-source global cryptocurrency, called GoodDollar, that serves to distribute money using the principles of the UBI."

This is a nonprofit project that, like the projects considered previously in this section, aims to promote the creation of an alternative ecosystem aimed at reducing inequality among people from an economic perspective.

The research areas of the GoodDollar project are aimed at finding solutions to the challenges that condition the operation of a UBI on a global scale. These areas are:

1. Social identity, guaranteeing the unique identity of the user in the blockchain technology paradigm
2. Social interest, implementing a system in which the participation and commitment of the community are capable of creating added value
3. Social governance, seeking a governance model that allows communities, regardless of their size, to self-manage their economy

5 Conclusions

Blockchain technology is still at a very early stage of development and requires improvements in the areas of standardization of developments, security, and regulation. There is a significant disparity between the different blockchains in cyberspace, so standardization will facilitate the interaction between different blockchains, making these interactions and the development of applications created on the same blockchain more efficient. Likewise, the lack of a legal framework around it creates a situation of legal uncertainty, similar to what happened in the early stages of the development of crowdfunding platforms, which is a conditioning factor for its development. The creation of this regulatory framework will be decisive for the more agile deployment of this technology in an atmosphere of security, generating confidence for the different interest groups that arise around each of the proposals that appear.

Glimpsing the future of blockchain technology is complicated beyond the conviction, evidenced throughout this work, of its implementation in many of the exchange processes, both of value through the different fungible tokens that currently exist and the continuous appearance of new tokens over time, and of physical assets through the use of non-fungible tokens. However, the number of applications of this technology outside the purely financial sphere is increasing, and, thanks to its characteristics, it offers distributed, transparent, and secure solutions to a wide variety of economic, social, and environmental problems.

The vision behind this technology bets on a perspective of values that go beyond the concentration of economic power that occurs in the dominant capitalist system, opening the door to the construction of a new paradigm that references the value of things, behaviors, and the exchange itself built on different bases than the traditional ones, and with transaction instruments that do not necessarily have to have a direct reference to those existing today.

While the advantages of new technologies usually favor consumers who have a personal situation of wealth and connection, blockchain technology can be directed towards the creation of opportunities for the weakest and/or most marginalized part of the citizenry. In this sense, the elements that form part of the framework of the cryptographic community that creates these new opportunities will play a relevant role. Thus, there are more and more initiatives for the use of this technology in areas of social impact sponsored by relevant actors in this sphere, such as UNICEF. Similarly, these impact applications can pave the way for the achievement of the Sustainable Development Goals (SDGs) of the 2030 Agenda, by placing decentralized tools in the hands of civil society that enable it to meet the demands for action that this entails.

Blockchain technology is at an early stage, but is developing rapidly, and is being used in a wide range of fields. The speed of growth of this transformative tool will depend on how the deficit of developers and programmers with sufficient knowledge of it in the market is solved, on the regulatory framework that is established around it, and, of course, on the vision that entrepreneurs have of social and environmental problems and their willingness to face them since blockchain is just the tool.

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The Impact of Smart Technologies on SME Sustainability: The Mediation Effect of Sustainability Strategy – Literature Review

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1 Introduction

In the last few decades, enterprises have had great potential through the utilization of smart technologies to sustain their competitiveness. Smart technologies are defined as information, material and social-political technologies with advanced and intelligent features (Mizintseva, 2020). Such technologies include big data, the Internet of Things, cloud computing, and artificial intelligence, and contributed to digital economy trends (Kusiak, 2017).

However, small and medium-sized enterprise (SMEs) experienced challenges to their survival during uncertainty among larger enterprises, although customers and suppliers may increase their expectations through effective technology (Zutshi et al., 2021). The literature finds that organizations have to adopt sustainability strategies in their management practices, to help to obtain successful business performance in profitability, while ensuring environmental stability and social sustainability (Saunila et al., 2019).

Therefore, the study contributes by examining the problem of the failure of SMEs to sustain the business, as strategic and financial planning are considered a major key to business success. Smart technologies can help SMEs to gain sustainable and growth performance achievements along with effective strategic practices. Many authors have found that the sustainable performance of SMEs is determined

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by three sub-factors: profitability, social sustainability, and environmental sustainability (Kumar et al., 2020).

The literature review has covered the theoretical framework, and scholars have contributed to the adoption, of smart technologies in the sustainable performance of SMEs.

"Environmental, social sustainability and profitability" performance factors, which indicated the quantitative statistical analysis of the study.

The framework is determined by two theories, as follows.

1.1 Institutional Theory

Institutional theory is defined as the ability to inspect business or society borders, whereby SMEs are shaping their business strategies upon borders, in order to sustain their businesses and lead to growth (Shibin et al., 2020). Sustainable processes are not voluntary activities, whereas a firm's performance is affected by various challenges, such as governmental regulations and global pressures. Such theory focuses on internal or external factors of a firm centralized in sustainably innovative ways (Caldera et al., 2019).

The implications of institutional theory have many creative ways in the context of institutional limitations, such as developing business strategies in a proactive way, a firm strengthening its development, and participation activities within communities and authorities. A sustainability term in institutional theory belongs to the three factors that act as a driving force on behalf of a firm's actions, forceful pressures, imitative pressures, and normative pressures. The factors were aimed at enhancing a firm's initiatives for a sustainably objective, environmental, and social growth performance by which SMEs achieve and create a value (Nimfa et al., 2021).

The theory view of gaining innovative capabilities with SME sustainability growth by pursuing the factors of a firm's culture, social environment, cultural values, economic schemes and market value, sustainable business models, and obtaining efficient opportunities (Hadjimanolis, 2019).

In addition, the behavioral action demonstrated by enterprises behind institutional theory are to fulfill stakeholders' needs and society stability. Moreover, the theory forwards factors pressure to sustainability directions by enterprises, although its framework facilities offer an innovative approach through cooperation with a large group of stockholders to increase the sustainable factor growth of SMEs (Ratten & Usmanij, 2020; Ahmad et al., 2020).

It was concluded that the sustainability concept of SMEs is theoretically supportive by using the institutional theory, which reshapes business practices, creates sustainable business models, besides addressing environmental, social, and economic factors. The theory meets the needs of stockholders and increases profitability on objective ways towards business growth in the marketplace.

1.2 Diffusion of Innovation Theory

The diffusion of innovation (DOI) theory illustrates the innovation and technological orientation concept transferred over decades for different purposes. The DOI is defined as the process of adopting and introducing a new innovative approach. One of the theory's frameworks is the strategic management field; another framework used the theory in the adoption of technologies and spreading innovation with a wide range, which contributes to the business effectiveness of SMEs (Stuart, 2000).

The term diffusion is defined as "the process while innovation function communicated internally between social systems members through selective channels over time". Innovation is defined as a practice and an idea that are specific to a large scope of components that have been adopted. Therefore, the main elements of the DOI concept are innovation, time, channels of communication, and social structure. The adoption of technology is involved in DOI theory; one of the major drivers of SME sustainability and optimization objectives is adopting new technology innovation (Anderson & Eshima, 2013). It has led to significantly better income ratios, creative business processes, and growing employment factors toward economic growth (Jia et al., 2020).

The capabilities of innovation extend the enterprise competitiveness by the adoption of technologies and reengineering of strategic businesses operations; it promotes sustainable opportunities for SMEs in the context of businesses stakeholders, suppliers, customers, and governmental organizations (Miola & Schiltz, 2019). According to Sustainable Development Goals (SDGs) 2030, the DOI involves the establishment of dynamic capabilities in order to improve innovation culture to enhance SME growth, and it is contributing significantly to global economic stability (Francke & Alexander, 2019; Nimfa et al., 2021).

It is concluded that adopting smart technologies in the SME sector considers a theoretical lens used to establish the diffusion of innovation theory. It is the innovative way of improving the strategic business model, extending innovation to business processes toward technology orientation, and growing economic and social systems. Institutional and DOI theories carry through the concept of the study, and smart technologies examine DOI theory. Moreover, institutional theory performed by SME sustainable performance factors, which are profitability, and environmental and social performance.

2 Literature Review

In recent decades, SMEs considered engines that drive the development of the economic era. SMEs support businesses account for 99% in developing countries, a result of economic development through job creations, tax provision, and participating in gross domestic product (GDP).

Well-managed SMEs with a healthy image are an important source of global economic stability. They contribute to social justice activities and increase tax revenues. As studied by the International Finance Corporation, there is an imperative relationship between the country income level and the large group of SMEs per 1000 people. SMEs in Arab countries drive the three main forces to strengthen performance. First, an imperative vehicle of stabilizing the economy by the terms of employment and alleviation of poverty power, and contributing a big share of the labor force. Second, they are one of the key components in sustaining the national economy and export power. Third, they significantly extend the economy to be adaptable to global fluctuations and crises (Elasrag, 2011).

In Arab countries, SMEs are the emergence of the private sector, which led to total growth of the national economy. However, it is important to address the challenges in the growth of the role of SMEs toward maintaining the growth of developing countries (Vrgović & Jošanov-Vrgović, 2018).

2.1 Smart Technologies

The development of new technologies is considered a revolution, because of their ability to induce a wide range of changes in activities. Smart technologies have influenced business models and disrupted traditional business practices. Moreover, the implications of smart technologies need to be utilized by firms, to enhance their business practices and achieve their business goals.

Smart technology is defined as an artifact intended to offer consumers considerable control and its ability to interact. In other words, the technology beyond the normal sending and receiving, or consumer searching for information (Liu et al., 2020).

Liu et al. (2020) also provide a definition that considers smart technologies to have the attributes of self-monitoring, analysis, and reporting. The implications are that smart technologies interact with the user and guide their behaviors.

Fiorentino et al. (2020) identifies three types of smart technologies that include smart devices, smart connected devices, and Internet of Things (IoT) devices. In addition, smart devices have basic automation and are programmed through an intuitive user interface. Smart connected devices are remotely connected or monitored by Bluetooth, Wi-Fi, or other technologies. Although IoT devices are defined as software products that generate more value than smart or connected devices, the implications are that smart technologies are scalable, upgradable, automated, and future ready.

Many studies have sought to define the concept of smart technologies by evaluating their attributes. Roy et al. (2018) find that smart technologies are programmable and addressable because they can accept new reconfigurations and answer messages individually. The implications are that smart technologies interact with users, or are modified for new functions.

Another study identifies smart technologies as possessing communicability and memorability, which helps in message communication, recording, and archived information, which is created, sensed, or communicated. The features are impressive, as it shows the potential of smart technologies to enhance business processes and understand the changes in the business environment (Cedeño et al., 2018).

Lee and Trimi (2018) have conducted a study to demonstrate the characteristics of smart technologies. The findings conclude that interactivity, editing and distribution, and openness options have specific characteristics. Interactivity refers to technologies that communicate with users and understand their needs. The editing option refers to updating content, items, and data, whereas openness allows digital technologies to be accessible and modifiable. The distribution option allows technologies to bypass geographical or time-related constraints.

The researchers identify the characteristics of digital technologies and evaluate their efficiency in business applications. Moreover, these technologies are utilized to enhance the quality of life and provide objectives for all the stakeholders of an organization. Smart technologies can assist organizations in gaining higher revenues, enhancing customer experience, and boosting employee satisfaction, as it restructures their organizational environments to improve productivity and output (Lee & Trimi, 2018; Fiorentino et al., 2020; Cedeño et al., 2018).

As a contribution, smart technologies represent the next level in the evolution of technology. Organizational growth and integration have led to disruptions in traditional business models. Moreover, there is considerable potential for smart technologies to be applied in various sectors. Such an approach will be beneficial, as it will help to solve many problems faced by human society and economic challenges (Lee & Trimi, 2018).

2.2 Smart Manufacturing in Industry 4.0

Kahle et al. (2020) explain that, in order to achieve the capacity to build smart products that represent a high level of technical and economic feasibility, SMEs need to build collaborative systems. The ability and competence to build such products are rarely found in one company. Hence, the best approach for SMEs is to collaborate with each other to create smart products using smart technology. It is expected that such collaboration enables them to overcome the financial constraints to the acquisition of smart technology.

A study by Rauch et al. (2019), suggests that SMEs in developing countries, which benefit from Industry 4.0 technologies, might promote smart manufacturing. It ensures that supply and manufacturing match accurately with demand by using IoT technologies that integrate manufacturers' internal processes with those of suppliers and customers.

In addition, Rauch et al. (2019) suggest that the results of such integration might be immense. However, it requires close collaboration between the different stakeholders. Furthermore, they explain that sizable barriers exist to the adoption of smart manufacturing technology such as 3D printing that could help SMEs to manage their production costs, to be more efficient, while contributing less toward environmental pollution.

2.2.1 Big Data

Iqbal et al. (2018) argue that SMEs can benefit greatly by adopting big data systems and methods. They explain that SMEs can achieve sustainability with big data usage in many ways. For example, big data promote the openness and transparency of information, which can help managers to make quicker and more effective decisions. They can store data in electronic form, which increases the speed during access. Customer-related data could be used to generate reports and decision-making tools for more accurate predictions about customer behavior.

Iqbal et al. (2018) also claim that SMEs can use big data to make their logistics, supply chain, and customer service operations more efficient. The interesting thing about big data is that it allows firms to benefit at all stages of their development, as it is extremely beneficial for SMEs and other firms at an early stage of their development. Through joining the big data revolution, SMEs can not only identify trends in customer behavior and develop products accordingly, they can also spot environmental threats and risks that might pose a risk to their growth and survival in the industry. For this reason, it argued that big data is a critical element of the smart technology strategy of SMEs.

Liu et al. (2020) also touch upon the role of big data, in that it is helping SMEs to achieve sustainability. They criticize SMEs for being late to big data, mainly because of the common perception that big data are utilized for more by large organizations than by SMEs. However, Coleman et al. (2016) argue that since SMEs are an important part of the economy, they should lead the big data movement to address complex issues relating to stakeholder management, quality management and even influencing national economic policies. That has contributed SMEs addressing the issues that affect their productivity, using data-based policies and strategies.

It concluded that big data analytics provide opportunities for the sustainable performance of SMEs. It is achieved when SMEs understand their need to analyze critical data and apply them to their strategic goals. Moreover, data analytics have to develop in a robust and sophisticated way, so that SMEs achieve their sustainability goals.

2.2.2 Cloud Computing

Asiaei and Rahim (2019) find that cloud computing offers many benefits to SMEs, whether they adopt this technology at an early stage or migrate to it later in their development. The biggest benefit comes in the form of cost savings as SMEs do not need to spend as much on hardware, such as servers that represent a lot of unused capacity, and wasted funds while the firm is still in a growing phase. By making accurate strategic decisions with regard to their IT investments, SMEs can not only achieve a flexible position concerning their IT resources and capacity, but it also reduces the carbon footprint of their IT operations. The support provided by cloud companies ensures that their systems are responsive to customers' requests permanently, and it maintains smooth coordination with supply chain partners.

Assante et al. (2016) have a view that finds that cloud computing offers various advantages to SMEs, mainly in the area of learning. Cloud computing allows data to be more accessible to teams working on different projects, regardless of their access to particular hardware or networks. This significantly increases their productivity, as they can continue to work flexibly from different locations. For the growth targets of SMEs, such flexibility is of paramount importance, especially when the organization is in the process of acquiring customers, studying the competition, or developing a new product.

According to Assante et al. (2016), when employees have greater and more open access to data, their capacity for learning increases dramatically and they make better decisions regarding the growth and sustainable performance of the SME. Neicu et al. (2020) suggest that one of the major benefits of cloud computing for small businesses is that they only pay for resources used, and can easily access additional resources on demand. Their response to IT-related issues is more flexible as they are not bound by technology or geography for their need to access data.

Despite previous advantages and the fact of cloud computing being conceptually close to the existing computer networks that firms use, there is limited awareness of the benefits that cloud computing offers to SMEs, especially with regard to their sustainable performance goals (Assante et al., 2016, Neicu et al. (2020).

It is concluded that cloud computing is a viable smart technology; it enhances the productivity and robustness of SME business performance. It can reduce resources and energy usage through an effective approach. However, SMEs need to select the best cloud computing platforms that are reliable and flexible solutions to meet their specific needs.

2.2.3 Internet of Things

The impact of IoT adoption in the context of SMEs has various results and improvements in a number of areas of SME operations reported. For example, SMEs suggest that processing speed be optimized when automation is introduced into the supply chains. At the same time, innovation is enhanced and the SME is able to produce products of higher value than previously (Vitkauskaitė et al., 2019).

The study suggests the potential of IoT to create profitability for SMEs; it also has an indirect positive effect on the overall sustainability of SMEs, as it develops efficient relations with suppliers and customers that lead to efficient supply chains and minimization of waste, as well as achieving environmental sustainability (Vitkauskaitė et al., 2019).

Voda et al. (2021) have suggested that SMEs have different resource and market profiles than large firms, which makes it challenging to transfer sustainability strategies of large firms to the SME environment. However, although the IoT requires initial financial investment to make and integrate the technology into the enterprise, which may not be possible for all SMEs, especially those in developing countries, government funding can support and alleviate this concern to a considerable extent and assist SMEs to derive the sustainability benefits and business growth by the adoption of smart technologies.

When it comes to the IoT, there are many benefits to SMEs aiming for sustainability. At the same time, there are some challenges, as noted by Nylander et al. (2017). By focusing on a single case study, Nylander et al. (2017) argue that the IoT creates opportunities to improve relations with customers, which contributes toward steady sales and sustainability of operations.

As mentioned in several other studies, access to funds is considered a major challenge for SMEs planning to implement an IoT system across their organization. The best solution to this challenge is proposed by Nylander et al. (2017), that governments support SMEs with their funding requirements. As the government facilitates the funding and resourcing, the benefits of the IoT may be achieved relatively smoothly, resulting in greater organizational sustainability.

It is concluded that the IoT contributes to assisting SMEs to achieve sustainability by identifying the priority areas and using their core competencies to make change and growth. SMEs can integrate the technology into their decision-making processes and supply chain management systems to achieve systematic growth and development. Moreover, they need to develop a collaborative model in order to overcome any problems.

2.2.4 Artificial Intelligence and Machine Learning

Bauer et al. (2020) explain that machine learning (ML) and artificial intelligence (AI) have enabled large organizations to attain a reasonable degree of sustainability through adoption into their operations and customer-facing activities. Using chat-bots, for example, the need for dedicated human resources to manage customer queries and feedbacks is reduced, without any loss of customer satisfaction with the service.

According to Bauer et al. (2020), companies can incur substantial savings through these innovations; however, the challenge to SMEs is that they lack an adequate understanding of ML and AI to appreciate how these applications add value and contribute toward their sustainability. One of the ways of reducing the gap is by collaborating with partners that possess knowledge about AI and can implement their systems within these organizations. Through such measures, SMEs can begin the transition toward AI and derive benefits within a short time.

Hansen and Bøgh (2020) argue that SMEs in the manufacturing sector in particular have great potential to use AI to their sustainability goals. These organizations need to identify the enablers and barriers to change in their organizations, to implement such systems.

In fact, Hansen and Bøgh (2020) propose a model in which IoT and AI are used in a collaborative way of gathering manufacturing data and feeding it into an intelligent decision system that operates under an AI model. This creates a complete solution by which SMEs can simplify and systematize their data gathering and analysis processes. Every member of the team, from the operator to the team leader and manager, can access data at any point of this system for their respective decision-making needs.

According to a report published by the OECD (2019), AI has the potential to create an enabling external environment for SMEs that makes it easier for them to access customers and markets while navigating the complex competitive landscape. In addition, AI can help SMEs to construct such business models that enable them to achieve results in scale and productivity. This inevitably leads to the efficient use of resources and less of an impact on the environment.

Brynjolfsson et al. (2019) indicate that AI has been the most significant trend for SMEs since the introduction of computers into the workplace. They explain that by the inclusion of AI into the organization's systems, the ability to tap into the tacit knowledge of the organization becomes stronger, whereas previously the members of the organization had access to explicit knowledge in a comprehensive way. This has been made possible by the use of sensors, machine language, and other aspects of AI. Some of the most beneficial applications of AI to SMEs as well as large organizations include facial recognition systems, processing data in natural language, big data, and automation. Moreover, most of the previously determined applications are discussed in previous sections of the literature review.

However, as explained by Huang and Rust (2018), AI also enables SMEs to achieve a high degree of process automation, which helps products, as well as service-oriented SMEs, to achieve large-scale efficiencies in their systems. The systems become self-learning by developing the capacity to access real-time data in large volumes from multiple sources and using intelligent systems to make decisions responding to changes in the data.

The OECD (2019) report also states that AI plays an active role in sustainable development as it is a general-purpose technology that is applied across industries and market segments. A study also finds that AI can help SMEs to achieve financial transparency and identify ways of reducing costs by integrating sustainability strategies into the business environment. Automated audit processes will lead to an increased security level, as it will also reduce human error, manipulation, and time-consuming issues. Moreover, it will reduce the time spent on searching documents and file maintenance and will lead to the automated maintenance of digital files. Auditors can find any file or any data they require by using the AI data management systems (Hansen & Bøgh, 2020).

In addition, it was found that AI contributes to the use of human judgment by providing comprehensive and elaborate data, as it will reduce their time consumption and increase their performance. AI will help in recording individual financial transactions in the system. Also, AI will help organizations to analyze their historical financial figures and estimated future cash flows and cash requirements, which will result in business profitability (Hansen & Bøgh, 2020).

A conclusion to previous studies in the ML and AI literature review is that AI enhances the sustainability approaches to SMEs. It can develop a collaborative approach to overcoming the survival challenges of SMEs over time. Moreover, SMEs have to pay attention to their required strategies to achieve the strategic goals of sustainability and achieve success in the environment.

2.3 SME Sustainable Performance

The rapid industrialization, migration, and development of technologies have brought prosperity and quality of life for humans. These have improved economic development in many societies. Technology contributes to enhancing society and provides humans with comfort and satisfaction. In addition, it contributes to helping to facilitate communication and provide access to information.

In the world of corporations, technology has brought many opportunities to develop new models, leading to an increase in revenues and customer acquisition. However, technologies and rapid developments have resulted in steep prices, because of degradation and social issues (Bansal & Song, 2017).

Poverty, illiteracy, mismanagement, human rights violations, and others are considerable problems faced by the world. Consequently, the need to fulfil human development requirements and protect natural resources has given rise to the term sustainability. The term is defined as pursuing human development activities through an efficient approach and protecting natural resources (Lyon et al., 2018).

The rationale is that resources require protection for future generations. Business firms have undergone monitoring in terms of their practices, manufacturing, supply chain, and other activities that have an impact on society and the environment. Consequently, the concept of corporate sustainability assumes and is aimed at providing a business framework, to monitor and track profitable, environmental, and social value simultaneously. It was found that firms are engaged in corporate sustainability, as it needs to meet the expectations of multiple stakeholders, avoid government regulation, retain their customers, and perform in a highly competitive industry (Landrum, 2018).

The implications of the previous studies contribute to sustainability embedded in the organizational model. However, it could not use a standalone approach, as it also requires to be aligned with the overall business goals. Business firms are rapidly investing in policies and practices to promote SME sustainability.

Kiron et al. (2017) argue that business firms are using corporate sustainability, as its belief that sustainable development will not be the domain of policy makers and regulators. Corporations have been the drivers of economic development; meanwhile, they need to be proactive in balancing the goal with social equity and environmental protection. Firms have been partly responsible for unsustainable conditions (Kiron et al., 2017). In addition, corporations consider the resources to address such problems.

Saunila et al. (2019) find that the concept of the triple bottom-line has gained prominence in business entities. The concept considers sustainability to revolve around three dimensions, which are social, environmental, and profitable outcomes.

Environmental sustainability refers to actions that conserve the environment, reduce pollution, mitigate greenhouse gas emissions and apply practices that do not harm the surrounding environment (Saunila et al., 2019). Social sustainability refers to welfare and humanitarian programs that empower local communities and support charitable causes. Profitability refers to achieving revenues after deducting expenses, satisfying stakeholders, and generating new markets (Alarussi, 2018).

Furthermore, sustainability is considered to be a broad and dialectical concept that balances the need for economic growth with environmental protection and social equity, as it is a process of transformation that benefits resources and redirects investments in an efficient way (Fehrer & Wieland, 2021). Moreover, technological development and institutional changes are used to meet human needs and aspirations. Thereby, it includes economics, social justice, environmental science, and business management (Wu et al., 2018).

A brief analytical definition defines sustainability as being continuously redefined under the circumstances of transformations. It has been recognized that government and policymakers would not achieve sustainability. On the contrary, the industry has to play a significant role, by being proactive in balancing the need for economic development, social equity, and environmental protection. In addition, it is consider to be the cause of unsustainable conditions, as well as having the objective of overseeing resources to address the problems (Atwood, 2018).

Based on the corporate social responsibility concept, the social contract concept argues that society has multiple interest groups, organizations, individuals, and institutions, as there are explicit and implicit contracts among all the above groups. The agreements between the various groups demand trust and harmony. Corporations as organizations enter into contracts with other members of society and receive resources, goods, and societal approval to operate in exchange for good behavior. The above perspective can view SME sustainability as strategic firms emulating good behavior and showing that they are responsible for the multiple needs of society.

The implications that firms need to develop their strategies in such a way, it can also provide benefits for the entire society. Such an approach will help to achieve the strategic goals. Another useful concept is that social justice states that fairness and distributive justice create a just and balanced society, as the principles of justice and fairness are implemented in society, and societal good is distributed among the members of society. A fair society is defined as the needs of all the members being met and considered without distinction by groups or individuals with power and wealth. Moreover, this implies that the term sustainability helps to create fairness and equity, as a manager works toward appropriately distributing goods in society (Alda, 2019).

It has concluded that firms need to evaluate their core competencies and identify areas in which it can contribute toward social and environmental values. Such an approach will assist the firms to achieve their strategic goals and create a positive image.

2.3.1 Profitability

Profitability is defined as company earnings generated by revenues after all expenses incurred within a certain period have been deducted. Profitability is one of the important factors considered for business success, satisfaction of shareholders, investment influence, and corporate sustainability indicators (Alarussi, 2018).

Sooksan Kantabutraab (2020) finds that firms have to be economically sustainable, as they can achieve the principle of surplus equal distribution. The implications refer to practices that support the long-term profitable value of the organization without a negative impact on social, environmental, and cultural aspects of society and other stakeholders.

The implantation of innovation in business processes and innovative strategic practices allow increase the profitability target to be increased, which describes the term sustainability, and firms can differentiate themselves toward maximizing profits. Such business practices prove the possibility of making a profit while pursuing such innovative tactics, as they benefits the social and natural environment (Bekmezci, 2015).

Bekmezci (2015) also finds that the efficient use of resources is driven by preventing environmental pollution, although by producing products that are in high demand with consumers, in addition to improving developing countries and their social conditions, such innovative practices lead to an increase in companies' production regions and generate new markets for societies toward maximizing business profits.

Meuer et al. (2020) find that good corporate governance refers to economic practices, whereas the board of directors and management align the shareholders' interests with the community, value chains, and end-user customers. The implications are that accurate and transparent accounting methods are allowing investors to ensure full knowledge of the company's transactions, as they are able to vote on specific issues.

In contrast, profitable and economic sustainability create changes in phases, which help to attain the strategic goals of the firm in efficient ways. Profitable ways have the potential to find new, innovative products and processes, in order to promote economic growth without sacrificing the environment or social variables. The study finds that recycling resources are sustainable activities that help to reduce resource depletion and environmental pollution (da Cunha Bezerra et al., 2020).

Moreover, a wide range of green products are available for customers that are created with a minimal impact on the environment and society. The study also finds that green industries have begun the process of innovation and creativity, in order to identify new products aimed at helping firms to remain competitive and strong with regard to profitable businesses objectives (da Cunha Bezerra et al., 2020).

2.3.2 Environmental Sustainability

Environmental sustainably, or in other words, stabilizing the environment. The concept refers to companies striving to safeguard the environment. The study finds that environmental stability allows firms to reduce their carbon footprints, packaging waste, and overall impact on the environment. The implications are that environmental stability is beneficial for the firm in terms of financial indicators. The overall spending on materials used for packaging may decrease while the company is focusing on environmental sustainability (Testa et al., 2020).

Currently, environmental stability is considered a systematic approach pursued by companies. The study by Zhang et al. (2020) finds that companies will not engage in superficial actions, as it has to integrate it with the business model. Such a strategy assists the organization to achieve its key targets. The study also finds that firms have a negative impact on the environment, by causing air and water pollution, releasing greenhouse gas emissions, and affecting human health and well-being (Nunhes et al., 2020).

Consequently, environmental stability is considered vital in order to reduce legal risks and liabilities. Furthermore, companies have to create sustainable processes that protect the natural environment.

2.3.3 Social Sustainability

Social sustainability states that firms need to operate with the support and approval of employees, stakeholders, and local communities. The study by Kitsios et al. (2020) finds that approaches to managing and securing the social license are multiple. However, it can involve treating employees fairly, being a good neighbor and community member at the local and global levels. The study states that businesses focus on retention and engagement with their employees (Silvestre & Fonseca, 2020).

It provides responsive benefits such as superior maternity and paternity benefits, flexible working, and learning and development opportunities. In contrast, the community engagement strategies include fundraising, scholarships, sponsorship, and investments in local public projects (Silvestre & Fonseca, 2020). Another study finds that businesses on a global scale can be socially sustainable by identifying the way in which the supply chain is being filled (Aksoya et al., 2020).

For instance, firms may investigate child labor and unfair wages as it makes efforts to ensure that work in the environment is safe. Social sustainability plays a vital role in the firm's success, as it has developed and maintained its image, as well as ensuring its response to different types of challenges in an effective way.

2.4 SME Challenges and Benefits by Adopting Smart Technologies

Several strategies address supporting enterprise growth during critical times, such as innovation in providing products, new techniques in financial resources, supplier alliances with a different approach, and intelligent management information systems. Strategic management of critical times inspired SMEs with a new innovative culture by adding a valuable strategic tool to their business growth on a large scale (Bourletidis & Triantafyllopoulos, 2014).

Billing (2016) explains that at times size becomes a barrier to SMEs that seek to achieve sustainability, as they have limited funds to invest in such areas. Kumar et al. (2020) note that by using big data analytics, cloud computing, AI, and the IoT, SMEs can speed up operational tasks such as responding to queries from customers, increasing the life cycle of current products, promoting innovation, and 3D printing to minimize inventory requirements. All of these changes in the long run contribute toward the performance of SMEs by radically minimizing the resources required to manufacture products and meet customers' needs.

Smart technology offers SMEs numerous benefits for achieving sustainable performance in the long term through changes in their operational structure and control mechanisms. As a result, their staff can deliver more orders in a day within the time that they would spend receiving and accounting for cash payments using manual methods (Yang et al., 2017).

Another feature of SMEs is that smart technologies can help SMEs to manage payables and receivables automatically, without human involvement. Energy management is also an emerging area in which SMEs can be successful in sustainability. The best example is the smart factory or IoT, which can regulate energy consumption by aligning energy systems in such a way that human error, which would result in wasteful consumption of energy or causing machines to run at idle capacity, is reduced (Warren, 2017).

The Government of Bahrain has been considering a program of Economic Vision for 2030 within a proactive framework, with a future view of the equitable distribution of national development gains. Therefore, SMEs are aligned with the economic vision, which will assist Bahrain's economy to achieve various national goals (Al-Shakar, 2017).

Linan et al. (2020) find that developing technology innovation can orient global competitiveness strategies, which leads to sustainable growth for SMEs in the long run.

2.5 Sustainability Strategy

As the world makes the shift toward sustainability, enterprises are at the forefront of change and innovation. They are under pressure to achieve their economic value and generate profits while keeping in mind the social and environmental aspects.

Wijethilake (2017) finds that limited business firms have implemented previous goals mainly because data to support such a strategy are hard to come by. Such a problem may not be an obstacle from now on. In the Industry 4.0 revolution, with the assistance of digital technologies it has become possible to use concepts such as AI, robotics, and the IoT to support efficient operations that lead to an environmentally sustainable organization. Furthermore, managers may feel compelled to implement environmentally sustainable policies, in terms of evidence of environmental degradation, and the role of corporations as irrefutable. In addition, they can no longer claim, while there is no proof that factory emissions cause global warming and drag ecosystems at risk of irreversible damage organization.

Currently, managers have realized that traditional business models are not adequate to meet the needs of a future generation of consumers while maintaining the ecological balance. Digital technology offers immense support to environmental performance, as it assists companies to visualize the effects of its polluting activities in the natural environment. A complete understanding as regards sustainability can help businesses to justify their investments, and divert funds into more sustainable projects that gives a better return in the long run (Bansal & Song, 2017).

Hence, sustainable operations are in the strategic interest of businesses, while being beneficial for the environment. In addition, they ease the pressure of regulators and nongovernmental organizations constantly watching over their shoulders, to spot the polluting activities of businesses. By merging new software into the infrastructure and production systems, organizations can maintain functional productivity as well as environmental sustainability (Zimek & Baumgartner, 2017).

Likewise, in the fourth industrial revolution smart technologies have also enabled firms to achieve social sustainability, which is a highly desirable goal for organizations today. Lyon et al. (2018) concludes that social sustainability is a relatively new concept but one that is easy to understand. Social sustainability is aimed at developing products that are accessible and useful to all, as manufacturing itself reduces the tools needed, in addition to employment systems that benefit workers' health and wellbeing. Moreover, it has a positive impact on society by breaking down barriers to equal opportunities for different categories of people.

An example of the previous study can be found in the form of intelligent vehicle systems that improve the efficiency of supply chains in organizations, while relieving human workers of their need to place their safety at risk performing dangerous activities. Furthermore, the increasing efficiency of job design assists in the design of ergonomic tools and workstations, and enhancing safety systems, although alarm systems can ensure that workers operate in a much safer environment than before (Singh & Kim, 2018). The drive toward implementing smart technologies to attain sustainability goals has been studied extensively by scholars mainly from an economic or efficiency-based perspective. Landrum (2018) finds that climate change and the associated environmental concerns pose questions regarding the future shape of operations, especially for energy companies. An example of the previous study, using systems based on smart technologies, energy companies can save on resources that are used in cooling operations, which contributes to cost and environmental savings (Akeju, 2021).

In the approach to utilizing the potential of technological development, smart technologies can help firms to positively reduce their overall costs and increase the pace toward profitability objectives, while achieving their sustainability goals (Landrum, 2018). Energy firms benefit as well, and smart technologies offer many benefits to other industries. Regardless of the industry in which they are used, smart technologies can help organizations to dramatically decrease costs by reducing the time taken to produce products and minimizing waste in the production process (Kiron et al., 2017).

In particular, it helps to prolong the serviceable life of production machinery, as it is used to produce a larger output using the same amount of resources. Through smart technologies, firms can improve the efficiency of their systems, by enabling production equipment to self-organize output levels and detect errors, in addition to carrying out machine maintenance at fixed intervals, and schedule fleet systems according to high demand and availability (Ashrafia et al., 2018).

The acquisition of new materials, products, and equipment can be planned, using smart technology systems, by managing an integral part of the company's drive to reduce expenditure in a host of areas. In addition to this, the overall speed of operations, product quality, and output volume increases, while maintaining economic, profitable, and environmental sustainability concepts (Ashrafia et al., 2018).

It is concluded that the integration of smart technologies with SMEs platform dimensions of environmental, social, and profitable performance, leading to improvements in their business models. It creates flexible and deliverable values with faster solutions of business platforms, as it enables firms to achieve their strategic goals. Moreover, SME sustainability is a systematic process supported by smart technologies, and contributes to achieving the highest levels of efficiency and effectiveness; such approaches have led to economic growth of the Kingdom of Bahrain and to the development of the objectives of the Economic Vision of Bahrain 2030.

2.6 Innovative Benefits for SMEs Toward the Kingdom of Bahrain Economic Vision 2030

The Economic Vision of 2030 has been established since 2008, with the various purposes of implementing the vision of minimizing the high dependence of the Bahrain economy on gas and oil, promoting the manufacturing sectors, and assisting the Kingdom to face a decline in oil and gas production. Bahrain has made efforts to empower the industrial sectors such as manufacturing, and the Government has strived to support strategic practices as a key success to empowering SMEs, filling the gaps that appear in Bahrain labor force skills (Almuslamania & Daud, 2019).

The Government of Bahrain is considering a program of economic vision within a proactive framework, with a future view of an equitable distribution of national development gains, the development of changes in investment, and stimulation of the private sector, which includes SMEs and large enterprises (Khairy, 2017). In the same context, SMEs are aligned to the Bahrain economic vision; thus, such governmental strategic goals are important to build entrepreneurial economic development, which will assist Bahrain's economy to achieve various national and strategic goals, including the Economic Vision of 2030 (Al-Shakar, 2017).

Linan et al. (2020) find that developing technological innovation can orient global competitiveness strategies, which leads to sustainable competitiveness and growth for SMEs in the long run. Accordingly, countries are advised to design technology innovation tools oriented toward economic strategies in order to achieve sustainable global goals.

2.7 The Mediating Role of the Sustainability Strategy in the Relationship Between Smart Technologies and Sustainable Performance

Small and medium-sized enterprises (SMEs) contribute toward local and national economies by providing employment and tax revenues. They stimulate local economies and contribute to the GDP of countries. Furthermore, SMEs assist urban and rural growth by contributing toward economic strategic visions; this can be a useful strategy in reducing poverty and empowering local communities (Gherghina et al., 2020).

Therefore, they have low starting costs, to make it easier to start and develop an SME. Many SMEs perceive the term sustainability to be relevant for large companies. However, SMEs integrate sustainability into the core business strategy, to generate significant dividends in the form of lower costs, reduced risks, and new opportunities on the way to the target profitability. Sustainability goals are strong in SMEs, as they need to measure and manage the impact on the environment. Regulatory and legal frameworks have sought to monitor SMEs; accordingly, they reduce the negative impact on the environment (Bagheri et al., 2019).

Small and medium-sized enterprises ensure that they have resources that enable them to offer their products and services in the future. Sustainability initiatives can be beneficial for the growth and development of SMEs, as they improve their bottom line, as well as offsetting the initial costs by achieving cost savings, positive brand association, risk reductions, and the ability to meet investor and supplier demand for environmentally conscientious products and services (Bagheri et al., 2019; Tukamuhabwa et al., 2021).

Even though traditionally the role of smart technologies was observed to promote innovation and efficiencies in organizations, Burlea-Schiopoiu and Mihai (2019) argue that in the context of SMEs, this relationship moves one step further. They explain it by promoting innovation within their organizations; SMEs can help in the promotion of SDGs. Hence, innovation leads to promoting a culture of learning within SMEs, as it enables their workers to propose better and more efficient ways of working. In fact, adopting smart technologies can help SMEs to leap ahead of larger organizations instead of making incremental changes.

Small to medium-sized enterprises are often characterized by a constraint of financial resources. The use of smart learning technologies toward innovation can help them to maximize the value of available financial resources (Burlea-Schiopoiu & Mihai, 2019). A report published by the European Commission (n.d.) discusses six different initiatives to increase SMEs' access to smart technologies in order to achieve a sustainability strategy. These include initiatives specifically developed for industries as varied as fashion, automotive, logistics, tourism, food, and construction.

The initiative for the automotive industry, for example, suggests that SMEs in this sector can gain easier access to markets by significantly reducing their operational costs, by way of incorporating information and communication technologies into their systems. The observed benefits of the study include a 30% increase in the productivity of their staff, an 80% reduction in errors and operational costs, in addition to superior flexibility and faster actions in business activities. In the long run, these results contribute toward SDGs for SMEs in different sectors (Neirotti et al., 2018).

Wiesner et al. (2018) explain that environmental sustainability is a major challenge for SMEs, as they need to achieve it alongside their business objectives. In addition, Wiesner et al. (2018) argue that smart technologies help to bridge this gap and eliminate this false binary by aligning environmental sustainability with the overall financial wellbeing and sustainability strategy of the organization.

Previous findings have been used to investigate the role of smart technologies in organizations at an early stage of growth. In addition, the investments that are made at this stage will set the course for their future development; then it remains relatively difficult for organizations to transition to a different technology at a later stage.

2.8 Incremental Sustainability Versus Value Creation

A distinction needs to be drawn between the sustainable performance of SMEs, which is implemented as add-on model and embedded within organizational processes. According to Larrán Jorge et al. (2016), it needs to be understood that SMEs develop a holistic understanding of their processes and supply chains as its ability to incorporate smart technology at every step and activity of the value chain. Incorporating technology has a direct impact on the ability of SMEs to generate high levels of quality in their operations, which is a basic requirement for achieving a sustainability strategy.

It has been explained by Klein and Todesco (2021) that a sustainability strategy is largely technology driven, and in the age of the COVID-19 pandemic, with reduced headcounts, SMEs have to leverage the available technologies to the maximum possible extent. Another distinction that needs to be achieved is between innovations that lead to cost savings and reductions in environmental impact versus innovations that create value for customers.

According to Rao and Kumar (2019), SMEs have to focus more on the final stages of business initiations by the adoption of smart technologies, as these activities create a competitive advantage for SMEs, instead of showing savings on the balance sheet at a simple level. A major issue for SMEs is to pursue the same approach as large firms, as they intend to improve their technology infrastructure in an incremental manner. This approach deprives them of achieving the target progress, the cause of their small size and greater flexibility. Hence, the best approach is to invest their resources in acquiring smart technologies and building their value chain around them.

An interesting argument contributed by Tarí (2011), who explains by incorporating recent technologies as part of a total quality management (TQM) approach that it is possible for SMEs to meet their quality targets, which helps them to save costs while having a positive impact on the environment through the minimization of waste. His study also explains that the use of technology helps SMEs to bring their suppliers and vendors on board with the TQM program and to derive substantial benefits in terms of production efficiency and environmental conservation. As smart technologies are embedded in the process, a high degree of automation is achieved, which helps to simplify and streamline the entire process. Through these initiatives, it becomes possible for SMEs to compete with their larger counterparts on increasing sustainability.

2.9 Summary of Literature Review Gaps

The scholars contributing to the literature review focused on clarifying an effective assessment as regards the relationship between the adoption of smart technology and the sustainable performance of SMEs. Moreover, various studies shed light on the effective impact of SMEs' sustainability strategy as a mediating effect on the relationship between smart technology and SME s' sustainable performance; Industry 4.0 technologies were the key strategy in assisting the sustainability target of SMEs toward innovative and profitable business operations and productivity (Saunila et al., 2019; Silvestre & Fonseca, 2020).

However, the gap in the conducted literature review indicates the limitation of research in studying the effect of the adoption of smart technologies on the sustainability solution of SMEs and examining the mediating effect of a sustainability strategy. In the Kingdom of Bahrain, a lack of research, statistical reports, and data related to applicable technologies and managerial practices, although the scholars of governmental support in terms of supporting SME growth were limited to carrying out and depending on, and to conducting full information in order to get a deeper look at the strategic moves of SMEs.

2.10 Added Contributions by the Research

This paper generates a new strategic model for the SME sector by carrying out the conducted study, targeting a sustainability concept, social justice, saving the environment, and increasing profitability driven significantly by filling the gap of the adoption of technological innovation in the SME sector in the Kingdom of Bahrain.

Accordingly, this study contributes significantly to Bahrain's economic growth, by studying the proactive and innovative methods toward increasing the efficiency of SMEs, furthermore adding value to the national economy of Bahrain by investigating the role of SMEs and their strategic practices by implementing smart businesses toward developing business empowerment in Bahrain's Economic Vision 2030 and meeting SDGs regionally and globally.

In addition, the study contributed to the digital transformation trends in Industry 4.0, which from a personal perspective increases knowledge-based technological innovation, flexibility, and productivity in efficient ways, in addition to increasing optimal future opportunities for various business industries. Another valuable contribution is that the study shed light on the great potential of SMEs to adopt the concept of "sustainability," reshaping business operations, which will enhance national economic development while balancing nature and protecting the resources of future generations.

3 Conclusion

Owing to economic conditions, SMEs play a critical role in developing countries. The research was aimed at investigating the utilization of smart technologies such as big data, AI, and IoT devices in the sustainable performance of SMEs by studying profitability, environmental, and social sustainability performance factors, in addition to measuring the mediating effect of a sustainability strategy. Theoretically, the research concludes the significant impact of utilizing smart technologies on SMEs' performance factors, which includes environmental and social sustainability and profitability. Also, the research concludes that institutional and division of innovation theories supported the research significantly. Literature review gaps summarized the limitation of research in investigating the impact of smart technologies on SME sustainability. In Bahrain, there is a lack of research and statistical reports related to utilizing technology in SMEs. The scholars of governmental support in terms of supporting the growth of SMEs was limited to depending on gaining a deeper look at the strategic moves of SMEs, which rely on conducting empirical study and measuring the effect of smart technologies on the sustainability of SMEs in Bahrain.

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Development of a Cloud Business Process Architecture Using the Riva Method

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1 Introduction

A business process architecture (BPA) is a systematic overview of all main processes that manage the business in an organization (Dumas et al., 2013; Ould, 2005). Specifically, it is deployed as an organization high model that reflects the structuring of crucial business processes (BPs) and their connections (Gonzalez-Lopez & Bustos, 2019).

The development of a BPA is applied in different areas than the business of an organization. It is adopted to implement significant disciplines such as change management (Samhan et al., 2018). This could be explained due to the comprehensiveness, simplicity, and usefulness that BPA provides in presenting any business, especially if we are using essential business entities (EBEs) that identify this business. Thus, exploitation of BPA in presenting new technology such as cloud computing (CC) is suggested to reflect these features that BPA achieves in addition to other benefits such as interoperability and integration.

Cloud computing is a freshly established computing sector that has been utilized for information technology activities by a considerable number of enterprises throughout the globe (Jamsa, 2012). Cost savings, increased efficiency, increased agility, increased flexibility and scalability of services, and environmental sustainability are all advantages of moving to cloud computing (Odeh, 2020). Cloud computing grew in popularity as a result of its ability to transform the IT industry's physiognomies via the usage of virtualization (Odeh, 2019). Meanwhile, several fundamental worries about cloud computing, such as security and privacy breaches, stem from the virtualized environment. Accordingly, the functioning of cloud computing is similar to that of information technology (IT) outsourcing (Joshi & Shah,

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2019). However, the complexity of security makes quality control in cloud computing a challenging task (Halpert, 2011).

Cloud computing (CC) can be defined as a model through which users can access a shared combination of configurable software and hardware resources using the internet (Sultan, 2014). These resources are rapidly provided with minimum managerial effort (Siebel, 2019). It can be applications, servers, computer networks, data storage, or any other service. Companies with problems in adopting CC will be at risk due to market competition (Buyya et al., 2008). These problems include factors of high complexity from the review of the previous literature to determine the gap in this study. They include factors of high complexity, low compatibility, and less technological preparedness in cloud computing technology (Lynn et al., 2020).

Nevertheless, CC still requires development and progression in computer systems, software engineering, and performance engineering (Papadopoulos et al., 2019). It is also demanding as a modern technology to address caused-problems disasters in the Middle East and North Africa (MENA) (Al Kurdi, 2021). Cloud computing has emerged as one of the most influential IT paradigms of our time, addressing users' needs for dynamic, high-capacity computing in a variety of applications like business intelligence and data collected and stored while effectively creating business value for cloud service providers out of (at least initially) surplus computing resources (Hugos & Hulitzky, 2010). Therefore, like with all emergent technologies, the lifespan of the paradigm will be decided by how specific difficulties are addressed.

In this paper, we use Riva method with its elements of units of work (UOWs), 1st and 2nd cut process architecture diagrams to introduce cloud computing business process architecture (CCBPA). A CCBPA is developed to present the CC domain and describe its elements. It is also used to clarify CC capabilities to integrate and support other fields. Evaluation of the CCBPA is accomplished using several criteria which imply perceived ease of use (PEoU) and perceived usefulness (PU). These criteria were argued to predict initial technology adoption (Liu & Prybutok, 2021). They also present cognitive beliefs, in the theory of reasoned action, that affect attitudes, intentions of use, and eventual use of objects such as CC (Karahanna & Straub, 1999).

2 Cloud Computing Definition

However, it seems that there are several definitions of cloud computing (Lehrig et al., 2015). According to Sultan (2014) (a multinational management consulting firm), there are a considerable number of different definitions of cloud computing. In reality, there seems to be no clear definition or standard for cloud computing. Clusters of dispersed computers (often massive data centers and server farms) that deliver on-demand resources and services across networked media are a more widely used definition (usually the internet) (Armbrust et al., 2010). The word "cloud" was most likely inspired by drawings in IT textbooks that represented distant settings (such as the Internet) as cloud pictures to hide the complexity that lay behind them. Understanding the types of services provided by cloud computing, on the other hand, helps to clarify what this new approach is all about (Armbrust et al., 2009).

3 Cloud Computing's Main Features

Cloud computing is a recent and cutting-edge pattern of Information Technology (IT) service that provides software and hardware services on customer demand across the internet in a customer-operated mode and is unrestricted to device and location. It also has several features that support either integration or flexibility (Liu et al., 2011). Flexibility includes features of scalability, elasticity, pay-per-use, ubiquitous access, and low cost. On the other hand, CC supports the integration of IT resources. Resource pooling, data concentration, and a shared environment are critical features that increase an organization's ability to integrate its data and multiple applications (Lehrig et al., 2015).

3.1 Scalability

Cloud computing service companies provide solutions that are both elastic and scalable. Despite their similarities in appearance, scalability and elasticity in cloud computing are not identical. Elasticity is the capacity of a system to expand or shrink dynamically in response to varying workload needs, such as an increase in website traffic. A flexible system adapts in real time to match resources as closely as feasible with demand. A company with fluctuating and unplanned requirements may use the public cloud as a flexible option (Jansen & Grance, 2011). As stated before, a system's scalability relates to its capacity to expand workload while retaining current hardware resources. A scalable solution permits predictable, long-term expansion, while an elastic solution accommodates more urgent, unpredictable fluctuations in demand. In cloud computing, both elasticity and scalability are essential characteristics, but which one takes precedence relies in part on whether the organization's workloads are highly predictable or very changeable (Lehrig et al., 2015). Due to virtualization, it is now possible to design a scalable cloud infrastructure. In contrast to actual computers, which have relatively fixed resources and performance, virtual machines (VMs) are very flexible and can be scaled with relative ease (Odeh, 2019). As needed, they may be transferred to a new server or hosted simultaneously on many servers, and workloads and applications can be migrated to larger virtual machines. In addition, cloud providers already own the great majority of the infrastructure and software resources required for rapid growth, which a single firm could not pay. Due to virtualization, it is now feasible to develop a scalable cloud infrastructure. Unlike traditional computers, which have set resources and performance, virtual machines (VMs) are very versatile and may be rapidly scaled up or down. They may be relocated to a new server or hosted on many servers simultaneously, and applications and workloads can be migrated to bigger virtual machines as required. In addition, the great bulk of infrastructure and software resources necessary for fast development are already owned by third-party cloud providers, which a single business could not afford. The following are the important cloud scalability aspects that encourage large and small company adoption: With a few mouse clicks, IT managers may build new VMs that are immediately accessible and customized to the business's requirements. As a result, IT staff will save time (Masdari et al., 2016). Instead of investing hours or days to installing physical equipment, teams may devote their time to more crucial tasks. IT's agility enables it to respond fast to changing and expanding business requirements, including unanticipated spikes in demand. Even the smallest companies now have access to formerly prohibitively expensive high-powered resources. Companies are no longer constrained by outmoded technology; they can quickly upgrade their systems and expand their power and storage capacity. Due to the scalability of the cloud, organizations may be able to save money by eliminating the upfront expense of acquiring costly, soon obsolete equipment. By using cloud service providers, consumers only pay for the services they use, hence reducing waste. Cloud-based disaster recovery minimizes the need to build and operate alternative data centers, hence decreasing the expenses associated with disaster recovery (Jamsa, 2012).

3.2 Elasticity

The solutions provided by cloud computing service providers are both elastic and scalable. Despite seeming similar, scalability and elasticity in cloud computing are not the same. Elasticity is the ability of a system to dynamically expand or contract in response to fluctuating workload demands, such as an increase in web traffic. A flexible system dynamically changes in real time to match resources with demand as closely as possible. A business with changing and unanticipated demands might use the public cloud as a flexible solution (Jansen & Grance, 2011). As mentioned earlier, a system's scalability refers to its ability to increase workload while using existing hardware resources. A scalable solution allows for predictable, long-term growth, while an elastic solution handles more urgent, volatile changes in demand. In cloud computing, elasticity and scalability are both crucial qualities, but whether one takes priority over the other depends in part on whether the organization's workloads are highly predictable or very variable (Lehrig et al., 2015). It is now feasible to construct a scalable cloud architecture due to virtualization. Unlike physical computers, which have relatively fixed resources and performance, virtual machines (VMs) are very flexible and can be scaled up or down with reasonable ease (Odeh, 2019). As required, they may be relocated to a new server or hosted on many servers concurrently, and workloads and applications can be migrated to bigger virtual machines. Additionally, third-party cloud suppliers already own the vast bulk of the infrastructure and software resources necessary for fast development, which a single company could not afford. It is now possible to design a scalable cloud architecture due to virtualization. In contrast to conventional computers, which have fixed resources and performance, virtual machines (VMs) are very adaptable and may be scaled up or down fast. They may be moved to a new server or hosted on many servers concurrently, and programs and workloads can be shifted to larger virtual machines as necessary. In addition, third-party cloud providers already own the vast majority of the infrastructure and software resources required for rapid expansion, which a single organization could not pay. The following are the essential cloud scalability features that stimulate adoption by both big and small businesses: With a few clicks, IT administrators may create new VMs that are instantly available and tailored to the specific needs of a business. IT employees will save time as a consequence (Masdari et al., 2016). Instead of devoting hours or days to assembling physical equipment, teams may focus on more important activities. IT' s agility allows it to react rapidly to changing and growing corporate needs, including unplanned surges in demand. Even tiny businesses now have access to formerly prohibitively costly high-powered resources. Companies are no longer restricted by obsolete technology; they can easily update their systems and increase their power and storage capacity. Due to the scalability of the cloud, businesses may save money by avoiding the initial costs of purchasing expensive equipment that will quickly become outdated. By using cloud service providers, customers only pay for what they need and reduce waste. Cloud-based disaster recovery reduces the need to construct and run alternative data centers, hence reducing disaster recovery costs (Jamsa, 2012).

3.3 Pay-Per-Use Business Model

The pay-per-use model offers the advantage of not wasting resources since customers only pay for the services they use, as opposed to pre-purchasing a certain quantity of resources that may or may not be used (Odeh & Yousef, 2021). In traditional business architecture, users create data storage to handle the heaviest burden. In contrast, the pay-as-you-go model in the public cloud allows you to pay just for the data you store. Pay-per-use systems, such as Amazon EC2, enable clients to personalize their computing resources and pay only for what they use. The CPU, memory, storage, operating system, security, networking capacity, and access limitations, as well as any additional programs, are selected by the user. As mentioned earlier, cloud computing is a new paradigm for computer service delivery. As with any new service of this magnitude and complexity, there will be questions, ambiguities, and worries over the maturity of the technology. Control, vendor lock, performance, latency, security, privacy, and reliability are among the most urgent issues (Armbrust et al., 2009). However, security is one of the greatest issues for cloud computing, and it is one of the reasons why many firms are hesitant to use cloud solutions. Cloud computing requires a high level of security. Cyber-attackers' other kinds of black hats try to get access to your network for personal gain, and the annual cost of cyber-attacks is enormous (Al-Ramahi & Odeh, 2020). Firewalls, anti-virus and anti-malware software, physical security measures including guarded data centers, and sophisticated authentication and authorization processes are used to protect our data and networks. Notably, though, the security challenge has a cloud-based solution that is gaining popularity. Security is increasingly provided as a managed service by a third-party provider, which bolsters the relevance of cloud computing (Halpert, 2011).

There are multiple obvious reasons why cloud-based security outsourcing is an excellent solution. As with many other types of cloud-based services, security is a highly specialized field. As a result, having access to the greatest security professionals in the market via a third-party vendor will offer greater protection, more knowledge and experience, and the capacity to move to more modern security systems and equipment than these organizations could deliver on their own. The defining characteristic of a cloud platform is that it enforces an instance of common software components that developers may "bolt on" to their applications rather than having to build them from scratch. This advantage is dangerous in terms of security.

4 Cloud Computing Models

Cloud computing can be classified into two main categories: deployment models and service models (Seethamraju, 2015). The first classification focuses on the managerial approach that the service provider represents. In comparison, the service model focuses on the technical process provided to the customers. In cloud computing, the phrase "services" refers to employing reusable, fine-grained components throughout a vendor's network. This is often referred to as "as a service." Characteristics of offerings with as a service as a suffix include the following: low entry hurdles, making them accessible to small enterprises, extensive scalability, and multitenancy, which enables several users to share resources. Device independence allows users to utilize the systems on various devices (Rao et al., 2015).

Cloud computing is not just a futuristic notion with a lot of potential. It has already become a reality, with several commercial applications. Cloud computing seems driven by economics, simplification, and ease in the delivery of computer-related services (Armbrust et al., 2009). Many authors believe that technology offers significant potential for lowering IT costs for businesses and relieving them of the price and trouble of having to install and maintain software locally.

From the technical perspective, cloud computing presents several types of service models: application as a service (AaaS), platform as a service (PaaS), and infrastructure as a service (IaaS) (Jamsa, 2012). Applications are offered as a service across the internet at IaaS. Instead of installing and maintaining software, you just use the internet to access it, eliminating the need for complicated software and device maintenance. This cloud service provides full application capability, ranging from productivity (e.g., office-type) apps to programs like customer relationship management (CRM) or corporate resource management.

PaaS is a platform that gives web application developers access to development tools and hosting alternatives. Cloud computing is a new business model, distinct from those described by authors, who saw service as either a supplement to an existing physical product or a service relying on a provider using skills and knowledge (i.e., competencies) to provide clients with a solution (Tsui et al., 2011).

IaaS provides customers with the processing, storage, networking, and other computer resources they need to execute specific software (operating systems and applications) on their servers. The only disadvantage is that cloud providers are in charge of the infrastructure (Seethamraju, 2015).

Despite the several types of cloud service models, all of such classes are presented based on the same business model, which is pay-per-use. As mentioned before, the service provider will charge the cloud customers with the only actual uses. Such features may help customers save significantly in both the short- and mid-terms. However, the decision to adopt cloud technology in the long term requires a careful calculation and comparison between leasing and owning the information technology equipment. However, with the flexibility of cloud computing, none of those mentioned earlier providers can guarantee that their cloud goods will operate right out of the box. Google Apps, for example, is an example of an out-of-the-box messaging and collaboration cloud solution, even though it still requires some configuration (Arif et al., 2019). Using the cloud providers' APIs, some level of development (i.e., programming) will be necessary (application programming interfaces). These are the programming instructions cloud service providers produce and make available to anyone who wishes to use their goods. Many of the APIs are now proprietary. This topic will be discussed more when we look at some of cloud computing's limits and concerns.

The cloud deployment model consists of four main types. The first type is the public deployment model. In this type, the model provides an almost free cloud computing service with nearly zero cost. However, the public model is considered the less secure model level (Jamsa, 2012). In contrast, the second model, i.e., the private model is the most expensive cloud deployment type, which provides the highest security level. The community model is the third deployment model type, which focuses on the same type of customers who share the same interests, such as universities, tourism companies, and libraries. In this model, the cost will be shared in the community. The security level is usually fair compared with the cost of this type. The last deployment model type is the hybrid model, which is simply a combination of two or more models (Sultan, 2010).

Cloud computing is considered an umbrella, including several online services and models. It uses servers hosted on the internet to process and store data instead of using in-house resources based on a pay-per-use business model. The pay-per-use business model could be presented according to the following equation based on an assumption:

$$C1 : P_i ; A ; P \tag{1}$$

$$C1 : \forall P_i \in P ; A\left(P_i\right) \leq A\left(H\right) \tag{2}$$

Where P_i is the cost of the process, N represents the number of activities "a" in the process of P_i, and cost (a) denotes the cost of each activity $a \varepsilon A$. While device H with area $A(H)$ and pins $T(H)$ (number of programmable input/outputs (I/Os) per device).

$$C2 : \text{TCCost} = \sum_{i=1}^{k} \text{CCost}\left(P_m\right) = \sum_{m=1_{T_i \in P_m ; T_j \in \overline{P_m}}}^{k} \alpha_{i,j} \leq T\left(H\right) \tag{3}$$

Where TC Cost denotes total communication cost, CCost (P_m) denotes the communication cost of the partition P_m and the weight $\alpha_{i,j}$ of an edge, and $e_{i,j}$ defines the amount of data transferred from T_i to T_j.

5 Methodological Approach

In this study, the data was collected using the qualitative approach through semi-structured interviews with experts in the domain. The reason for selecting interviews as a data collection method is to collect high-quality data from experts instead of surveys with a random sample. Experts in this domain include IT managers, professors in cloud computing, and experts in Riva methods. On the other hand, primary data was collected from the literature review. For the data analysis process, the authors have adapted the Miles and Hebrman data analysis approach, which includes data reduction, data display, and conclusion drawing/validation and verification. In addition, several software tools are employed, such as Nvivo and Microsoft Visio (Huberman & Miles, 2002).

6 BPA and Riva Method

Malinova et al. (2013) present two tracks to process architectures (PAs) based on the outcome of an empirical study. The first one is the decomposition PAs which include the pipeline, the hierarchical, and the divisional PAs. The second one is the service-oriented PAs. PAs in this classification can be described as non-systematic since no clear steps or rules are followed by these organizations to design their PAs. Another classification by Dijkman et al. (2016) stems from the basis on which processes and their relations are identified. Accordingly, five types of modeling approaches are suggested: object-based, action-based, goal-based, function-based, and reference model-based.

The Riva method (Ould, 2005) is defined as one of the object-based BPA approaches that exist in this field. Ould proposes Riva as a simple, obvious, practical and systematic approach for developing PAs from the essential business entities (EBEs). He also affirms that Riva BPA is unaffected by an organization in the same business.

The development of a BPA using the Riva method includes several steps. The steps are followed in this paper to generate a UOWs diagram for the CC discipline. The steps of the Riva method are the following:

Step One: Agree on domain and business boundaries.
Step Two: Brainstorm the EBEs candidates (CEBEs) and filter them into EBEs.
Step Three: Determine the units of work (UOWs).
Step Four: Determine each dynamic relationship between UOWs and generate a UOWs diagram.
Step Five: Translate the diagram of UOWs into first cut PA diagram.
Step Six: Translate the first cut PA into the second process architecture.

6.1 Demonstration of Riva BPA on CC

In this section, we apply the four steps of the Riva method to generate the UOWs diagram of CCBPA.

A. *Step One*

According to Ould (2005), we define in this step what we are looking at. In our case, we are looking at the CC discipline which is the domain and boundary we are identifying.

B. *Step Two*

Brainstorming CEBEs of the CC domain and filtering into EBEs are the most critical steps in building a CCBPA. This is due to its importance in carrying on the remaining steps and discovering the probability of generating a BPA for a CC domain using the Riva method. CEBEs are suggested to be identified through Ould's suggested prompt questions, which facilitate listing these CEBEs. The questions are customized to be appropriate for BPA development of a domain rather than an organization business. Table 1 presents these questions and their corresponding CEBEs in the CC domain.

After identifying these CEBEs by using (Ould, 2005) suggested questions, we discussed them with experts in the domain and we concluded that all these CEBEs characterize cloud business and can be reported as EBEs.

C. *Step Three*

In this step, determining the units of work is the main task that is required. A unit of work is an EBE with a lifetime during which we look after. Excluding non-UOWs from the EBEs list does not depend on this definition alone. Further filters

Table 1 Extracting CC domain CEBEs/EBES corresponding to Ould prompt questions

Riva prompt questions	CEBEs of CC domain
What things do we produce? Or what things do we take care of?	Public cloud, private cloud, hybrid cloud, community cloud, management of cloud deployment models
What do we deliver? What line of products do we have? What services do we present? What lines of service do we have?	SaaS (software as a service), IaaS (infrastructure as a service), PaaS (platform as a service), pay-per-use, on-demand computing
What kind of things do we handle during the daytime?	Application, structure, server, storage, program unit, information, database, hardware component, software component, operating system, middleware, data, networking
Are there things that customers of our organization have, need, or do, which could be EBEs?	Vendor, customization
What issues can we simply not leave behind?	Service provider, internet connectivity, cloud standardization
Who are the customers of the organization?	End user, developer, expert, cloud user

should also be applied to EBEs to identify UOWs. These filters include (1) excluding EBEs that are not classified as UOWs, (2) excluding also EBEs that are not UOWs, even if they are for someone else, such as national standards, which can be a UOW for quality group and not for a hotel or other businesses, (3) excluding EBEs that are roles which contribute partly in processes, and (4) excluding any that is implicitly part of other EBE and does not have its own lifetime.

By applying these filters, we remove the following EBEs from the UOWs list:

- Vendor and Cloud Standardization are not EBEs with a lifetime we look after.
- Hardware Component, Software Component, Customization, Operating System, Middleware, Data, and Networking are only part of IaaS EBE and do not have their own lifetime.
- Application, Storage, Structure, Database, and Information are only part of SaaS EBE and do not have a separate lifetime.
- Program Unit is only part of PaaS EBE and does not have a separate lifetime.
- Internet Connectivity is part of Service Provider EBE.
- End User, Developer, and Expert are part of Cloud User EBE.

D. *Step Four*

After filtering EBEs into UOWs, we identify the dynamic relationships between them and draw the UOWs diagram. In the UOWs diagram, each dynamic relationship emerges when a UOW (such as X, for example) involves or generates another UOW (such as Z, for example) during the lifetime of X. The relationship is implemented using an arrow from the generating UOW (X) to the generated UOW (Z). Figure 1 shows the UOWs diagram of CCBPA after the identification of dynamic relationships between the UOWs.

The arrow between any two UOWs is nominated by “g” in addition to the relationship number. The relationship number is for discrimination and does not always

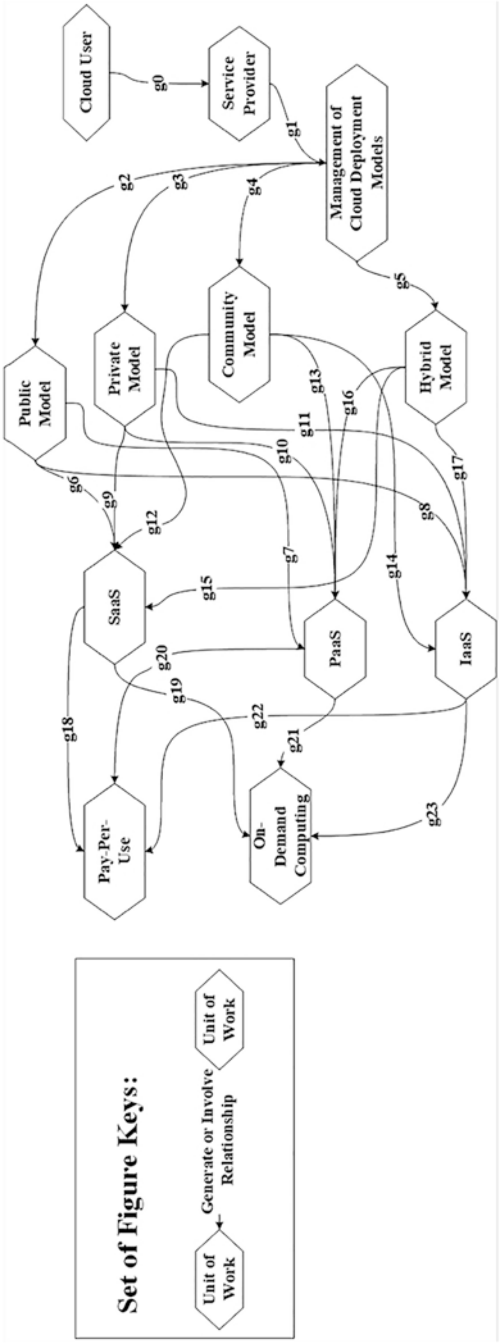

Fig. 1 Riva UOWs diagram of CCBPA

mean the sequence or the synchronization in generating these relations. For example, g6, g9, g12, and g15 are different relationships that indicate the generation of SaaS UOW. However, the number of each one does not reflect the sequence in their occurrence. Thus, a SaaS case or UOW could be generated asynchronously by one of the cloud models, whether it is a hybrid, public, community, or private cloud model.

E. *Step Five*

Riva's first cut process architecture is generated in this step. Each UOW is translated into a case process (CP), case management process (CMP), and case strategy process (CSP). CSP is not considered in this paper as it is still not well developed or clear as other Riva remaining elements, i.e. CP and CMP. A new CP means a new case instance we are handling. The CP and CMP are sequentially recognized by the word "Handle" and the phrase "Manage the flow of." Relationships between UOWs are also translated into "starts," "requests," and "delivers" relationships. By applying these rules to the UOWs diagram in step four, we can generate the first Riva cut process architecture of CCBPA (see Fig. 2).

F. *Step Six*

After the development of the first cut Riva BPA in Fig. 2, a series of heuristics are applied in this step, where they can be applied. Heuristics are a kind of reduction that is applied to Riva first cut architecture to reflect or simulate the actual practice that exists in the real business world. These heuristics include (1) merging CMP into the requesting CP when CMP is a task force, (2) replacing two CMPs by one when we cannot distinguish between these two CMPs, (3) delivering interactions or chains when there is no delivery between the requested CP and the requesting one, then delivery interaction is removed or short-circuited, i.e, the drawn arrow between the requested and requesting CPs is omitted, (4) merging CMP in the requesting CP when its root UOW is part of another UOW, (5) and emptying CMP when we have only one case instance of CP.

The heuristics that we have identified in CCBPA first cut architecture are as follows:

- Merging CMP into the requesting CP when CMP is a task force. The merged CMPs are as follows: *management of the flow of the public model, management of the flow of the private model, management of the flow of the community model, and management of the flow of the hybrid model*. These CMPs are merged in the requesting CP, which is *handling the management of cloud deployment models*.
- Emptying CMP when we have one instance of CP. In CCBPA, we have one instance of Service Provider, which is the company that offers cloud services. A one-case instance does not require a CMP to manage. Thus, we remove the *management of the flow of Service Providers* CMP.

The researchers identify no other heuristics. However, we have identified previous heuristics that require reconfiguring start (s) relationships by changing their source from CMP to CP. These new start relationships in Riva second cut process architecture of CCBPA are g0s, g2s, g3s, g4s, and g5s. Thus, the Riva second cut of CCBPA is generated by applying these heuristics and their required changes (see Fig. 3).

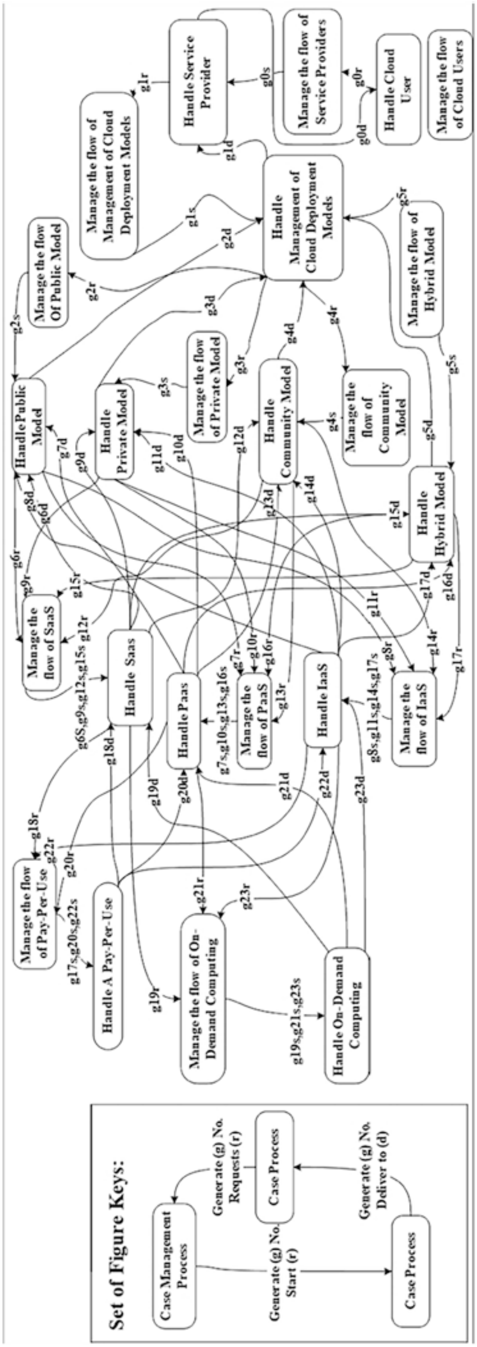

Fig. 2 Riva first cut diagram of CCBPA

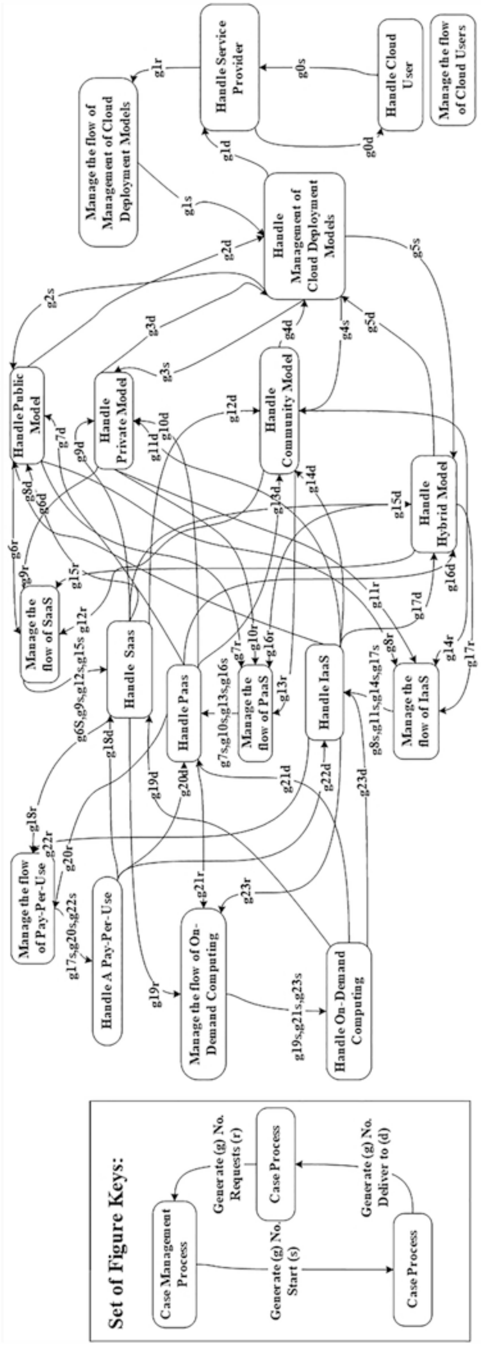

Fig. 3 Riva second cut diagram of CCBPA

6.2 Evaluation of CCBPA

An evaluation of CCBPA has been conducted after the generation of Riva-based CCBPA. The evaluation includes validation of CCBPA by checking the validity of its elements. It also involves checking the CCBPA support to understanding, presenting, and the ease of use of the CC domain; recognizing CC usefulness; deciding to adopt CC in business; and integrating CC with other related disciplines. EBEs, UOWs and their relationships, CMPs, CPs, first cut process architecture, and the adopted heuristics to the second cut process architecture are the essential elements that are hired to test validity. The evaluation has been performed with the collaboration of a few experts in the domain. Table 2 shows the results that indicate this evaluation through which the whole Riva-based CCBPA is evaluated.

Table 2 Evaluation of Riva-based CCBPA

Elements of Riva BPA	Elements of CCBPA	Validation check
EBEs	32 elements were identified as EBEs after a brainstorming conducted using Ould prompt suggested questions	Are these the right EBEs that characterize cloud computing? **Answer: checked and right**
UOWs	12 EBEs were classified as UOWs	Are these the right UOWs that have a lifetime during which we look after? **Answer: checked and right**
UOWs relationships	24 relationships were generated between UOWs	Are these the right generated relationships between UOWs? **Answer: checked and right**
CPs	12 CPs matching to UOWs belong to 1st and 2nd cut process architecture diagrams	Are these the right CPs that match to UOWs? **Answer: checked and right**
CMPs	12 CMPs matching to UOWs belong to the 1st cut and 7 out of 12 belong to the 2nd cut process architecture diagram	Are these the right CMPs that match to UOWs? **Answer: checked and right**
Applied heuristics in the 2nd cut diagram	4 CMPs were merged in CPs and 1 empty CMP with no instances of CP was omitted	Are these the right merged and omitted CMPs in the CCBPA 2nd cut diagram? **Answer: checked and right**
Other evaluation criteria		**Approval check**
Support understanding, presenting, and the ease of use of the CC domain		Approved to support understanding, presenting, and the ease of use of the CC domain
Recognizing CC usefulness		Approved recognizing CC usefulness
Supporting the decision to adopt CC in business		Approved supporting the decision to adoption
Supporting the integration of CC with other related disciplines		Approved supporting the integration of the CC with other related disciplines

7 Conclusion

Developing a BPA for CC can support the understanding and simplifying of this domain. It also allows CC utilization and integration with other fields. An object-based BPA method called Riva has been adopted to achieve this aim. Riva has precise steps that have been applied to the CC domain. Accordingly, the main elements of Riva BPA have been generated. These elements characterize the CC domain including EBEs, UOWs diagram, and first and second cut process architectures.

Developing a CCBPA using the Riva method implies many implications. These implications are reflected through clarification and high-level presentation of CC models, services, and elements that a business might need, in addition to determining the track that an organization should follow in CC. The implications are also reported in support of resolving problems of complexity, compatibility, and technological readiness in CC. Furthermore, the managers' awareness of CC usefulness is higher, and their decision on CC adoption is getting easier.

In conclusion, developing a CCBPA has provided a comprehensive view of CC and its business flow. It also paves the way to further business modeling and cloud computing research.

8 Research Limitations and Future Direction

Different business process architecture model lines that could be used as a benchmark to evaluate CCBPA in this paper are still not evident to the researchers. This includes approaches such as goal, action, and function-based approaches.

Further research is recommended to evaluate CCBPA by engaging new case studies that plan to adopt CC in the work environment. Also, knowledge life cycles and knowledge management processes are suggested to be mapped with elements of CCBPA.

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Solar Farms, Sustainability and Mitigating CO_2 Emissions: A Technological Approach

Ahmed Sami, Allam Hamdan, and Salem Aljazzar

1 Introduction

For the past 250 years, humans have been burning coal, oil, and gas as means to produce energy. The industrial revolution was possible due to the exploitation of fossil fuels. This revolution provided the world with economic growth and an increase in technological progress, but these came with a price. As the world economy grows, the reliance on fossil fuels increases, and the emission of carbon dioxide (CO_2) into the atmosphere causes major threats to the earth's climate. Since 1760, the earth's temperature has increased by 1 °C, and by continuing the use of fossil fuels, it is expected to increase by 2 or 3 °C. This increase in temperature causes ice to melt, thus leading to an increase in sea levels. Rising sea levels can affect Bahrain, as 27–50% of its islands may be covered by water by 2100. Without any other sources of energy, Bahrain relies heavily on fossil fuels, from which it obtains more than 99% of the energy consumed. The population of Bahrain depends on electricity for cooling due to the arid climate, thus increasing CO_2 emissions. This has resulted in 36.672 megatons of CO_2 in 2020 alone, an increase of 206% since 1990. Therefore, building a solar farm may help lower Bahrain's fossil fuel usage and reduce CO_2 emissions. The purpose of this study is to shift Bahrain from the second industrial revolution (relying on non-renewable resources) to the third industrial revolution (relying on renewable resources) by studying and implementing solar energy as an energy source. The research objectives are listed below:

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- To identify the viability of using solar energy as an energy source
- To uncover the benefits that may be gained from using solar energy in Bahrain
- To analyze the effectiveness of solar energy in Bahrain's economy
- To calculate the amount of CO_2 emissions reduced while using solar power

2 Literature Review

This chapter highlights the meteorological location of Bahrain (by discussing global horizontal irradiance [GHI], direct normal irradiance [DNI], and horizontal diffuse irradiance [HDI]), types of solar panels, and types of inverters. It also explores articles about solar power plants in terms of financial evaluation, software used, and cost–benefit analysis.

2.1 Meteorological Information

Bahrain has a high potential for the use of solar energy due to its location and landscape. Bahrain is near the equator, which means the sun's rays strike the earth's surface at a narrower area when compared with higher latitudes. Because sunlight is focused, the temperature is higher, and more energy is received. The sun's energy that is absorbed by the surface per unit area is represented by solar irradiance. The three magnitudes related to solar irradiance used to measure solar energy are as follows:

- GHI is an important measurement for predicting the output of solar panels. It is the total electromagnetic radiation emitted from the sun above a surface at a specific location and time. Its unit of measurement is watts per meter squared (W/m^2).
- DNI measures the amount of radiation emitted from the sun. Its values are affected by the changes in the weather, including dust, smoke, and cloud cover.
- HDI is the measurement of scattered solar radiation. When there is cloud cover, the HDI value increases.

Bahrain has high GHI and high DNI, meaning that its photovoltaic power potential is high (Singh, 2021). Figures 1 and 2 show the GHI, DNI, and photovoltaic (PV) power potential of Bahrain (Solar Resource Maps of Bahrain, n.d.). The figures are from the Global Solar Atlas, which specializes in calculating solar energy around the globe (Figs. 1 and 2).

Bahrain has an arid climate with only two seasons. The summer is extremely hot and the winter is mild. Table 1 shows the GHI, HDI, clearness index, ambient temperature, wind velocity, and yearly averages in Bahrain. The meteorological data were collected from a simulation program called PVsyst (Table 1).

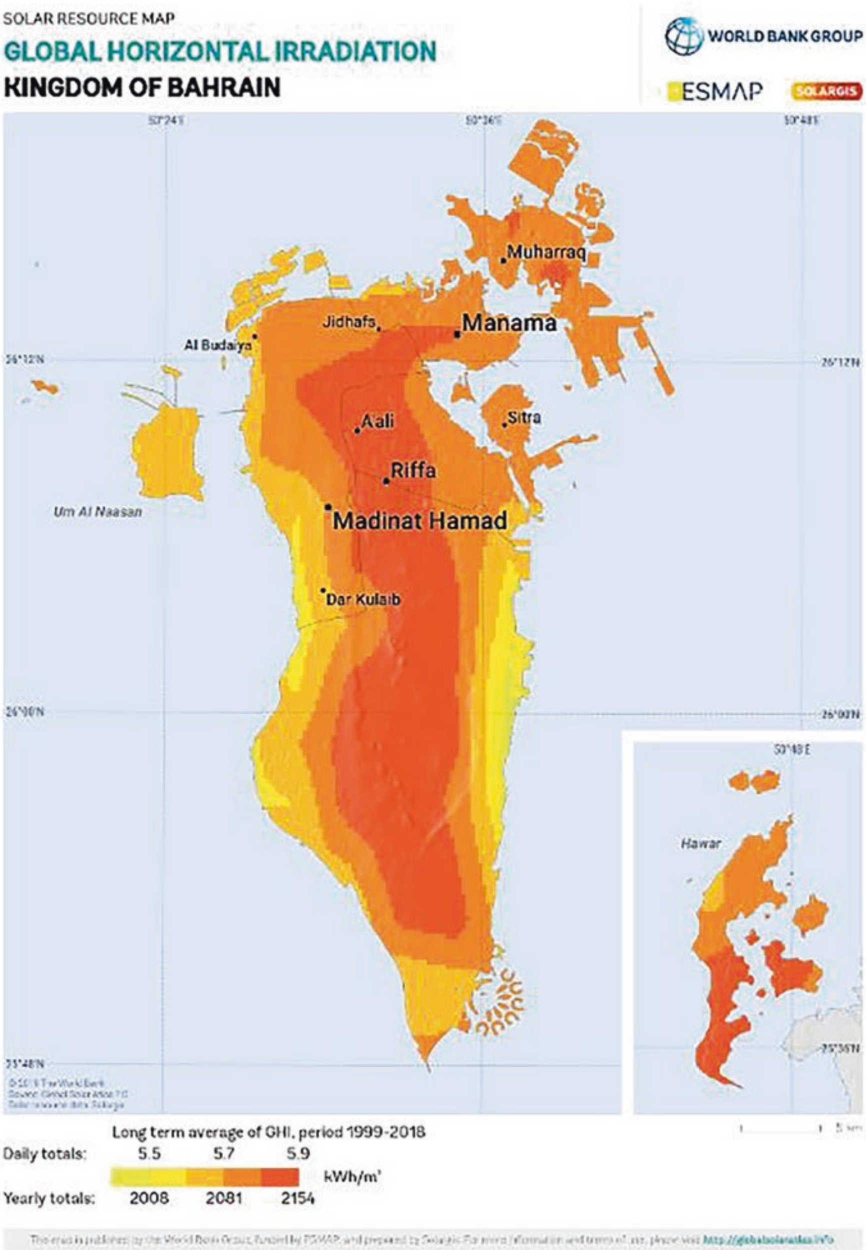

Fig. 1 Global horizontal irradiance of Bahrain

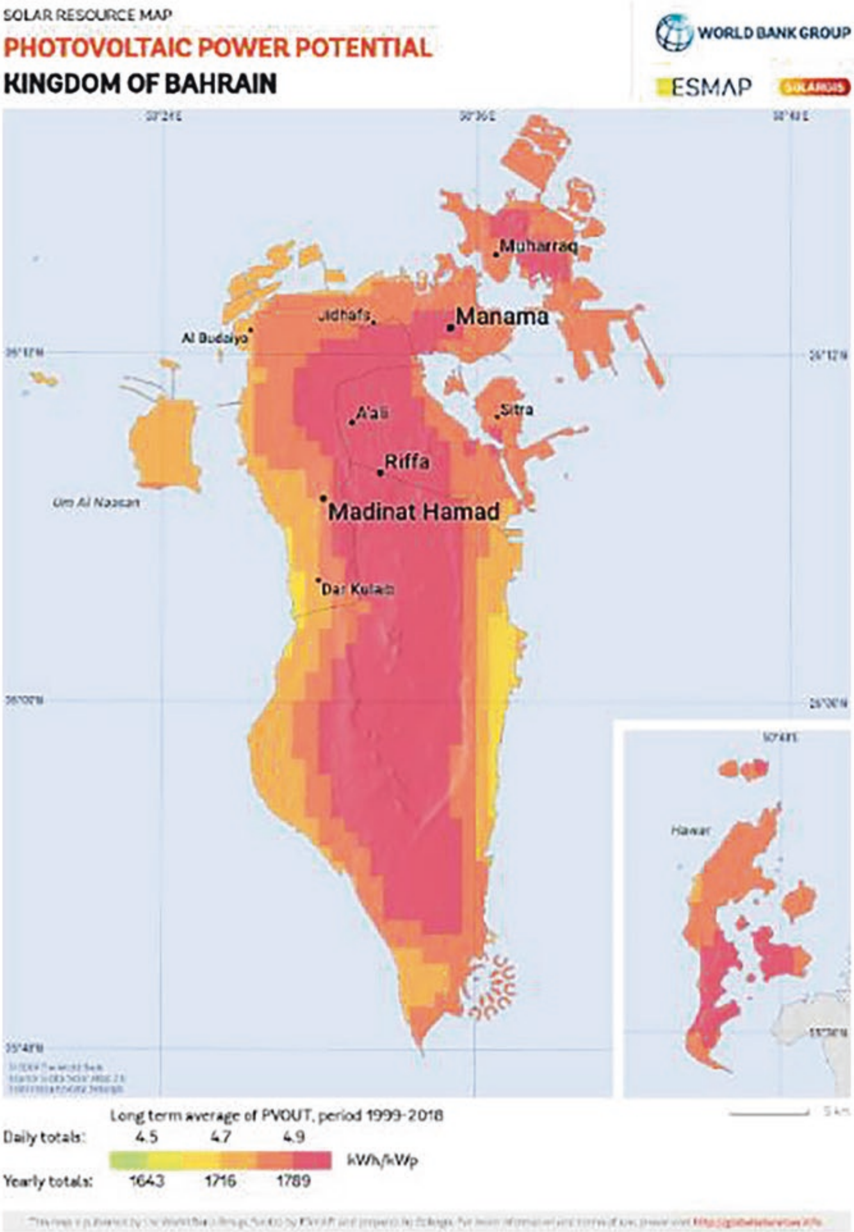

Fig. 2 Photovoltaic power potential of Bahrain

Table 1 Meteorological data of Bahrain

Month	GHI	HDI	Clearness index	Ambient temperature	Wind velocity
January	3.94	1.51	0.596	16.0	4.0
February	4.53	2.19	0.577	17.4	4.3
March	4.88	2.77	0.530	21.9	4.2
April	5.87	3.12	0.564	26.7	3.9
May	6.75	3.25	0.611	32.9	4.1
June	7.21	3.45	0.640	35.3	4.6
July	6.69	3.32	0.599	36.9	4.0
August	6.31	3.15	0.592	36.4	3.2
September	6.02	2.44	0.623	33.1	3.2
October	5.11	2.04	0.615	29.6	3.0
November	4.02	1.70	0.579	23.3	3.7
December	3.60	1.48	0.579	18.1	3.9
Yearly average	*5.41*	*2.54*	*0.594*	*27.3*	*3.8*

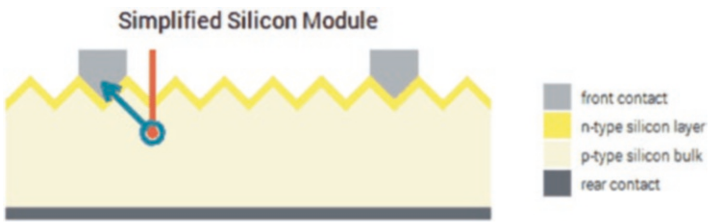

Fig. 3 Simplified silicone module

2.2 Solar Panels

Solar panels convert energy from the sun to electricity. A solar panel is composed of individual solar cells made from layers of boron, silicon, and phosphorus. The positive charge is provided by the boron layer, while the negative charge is provided by phosphorus. The semiconductor is the silicon wafer. When the surface of a solar panel is struck by the sun's photons, electrons move from the silicon into the electric field generated by the solar cells. This creates a directional current for usable power (How Does Solar Work*?*, n.d.) (Fig. 3).

The conversion of light energy into electric energy is known as the PV effect, which is why solar panels are also referred to as PV panels.

Fig. 4 Overview of a solar inverter

2.3 *Solar Inverters*

By harnessing power from the sun to produce electricity, solar panels are the most important piece of equipment when building a solar power plant. However, the power they produce is alternating current (AC), while the power used in homes, businesses, and industries is direct current (DC). Therefore, solar inverters are needed to convert the electricity generated by solar panels into a more usable form of electricity (Solar Inverter - What It Is and How to Choose the Right One, 2020) (Fig. 4).

2.3.1 Types of Solar Inverters

Solar inverters are of four different types: string inverters, central inverters, micro-inverters, and battery-based inverters/chargers (Solar Inverters: Types, Pros and Cons, n.d.).

Fig. 5 String inverter

2.3.1.1 String Inverter

Solar panels are installed in strings, which is the term used for rows. For instance, if 30 solar panels are being installed, they are usually placed in six strings (rows) of six panels. Each string is connected to a single string inverter (hence the name string inverter). Multiple strings of solar panels produce DC electricity, which is directed to the string inverter that converts it to AC electricity. A disadvantage of string inverters is that when one of the solar panels is shaded, the performance is decreased. However, they have been used extensively, and the technology is trusted and cheaper than their counterparts Shoaib, (2022). They are mostly found in commercial and residential applications (Fig. 5).

2.3.1.2 Central Inverters

Central inverters have many similarities to string converters; however, they are larger in size and can handle more strings of solar panels. The strings of solar panels are connected to a combiner box, which transmits the DC electricity to the central inverter, thus converting it into AC. Central inverters are mostly found in solar power plants and solar farms (Fig. 6).

Fig. 6 Central inverter

Fig. 7 Microinverter

2.3.1.3 Microinverters

Microinverters are installed in each panel, as they are module-level electronic parts. Whereas string inverters convert DC electricity to AC electricity on a string of panels, microinverters perform the conversion right on the panels. Since each panel has its own microinverter, if one panel is shaded, only that shaded panel will have reduced performance. This is a major advantage compared with string inverters, but the downside is that they are more expensive (Fig. 7).

The 200-MW solar power plant studied in this paper is built using monocrystalline solar panels. The PV modules are installed on fixed ground mounted racks and arranged to ensure the most efficient capture of solar radiation. As explained in the solar panel section, the purpose of the PV cells is to generate electricity by converting solar radiation to electricity.

2.4 Type and Orientation of PV Panels

The type of PV panels best suited for Bahrain has been studied in a research paper titled "Solar Systems Analysis and Estimation for Buildings in Bahrain and GCC countries," which used a quantitative research methodology to examine the effects of different PV modules. Monocrystalline panels stood out as the best in this category due to their ability to withstand high temperatures. Monocrystalline panels can operate efficiently and produce adequate power, and they have a long lifespan and require less maintenance (Christine et al., 2017).

Various articles and research papers have studied the orientation of PV panels. The research paper mentioned in the previous paragraph discussed the optimal angles and orientation of PV panels in Bahrain. The tilt angle is determined by the latitude of the location; Bahrain has a latitude of 26°, so the tilt angle is 26°. The azimuth and orientation of the panels are based on the hemisphere. Bahrain is located in the northern hemisphere, so the orientation of the panels should be toward the opposite direction (south) with an angle of 0°. Thus, the optimum tilt angle, azimuth, and orientation are 26°, 0°, and south, respectively. Moreover, Christine et al. (2017) highlighted the rules to be followed for the angles of the PV panels, such as the tilt angle should be within 0–50°, and the azimuth should not be above 70° from the south.

2.5 Design of the PV Power Plant

The design of the power plant was chosen from two research papers: "Design of 50 MW Grid Connected Solar Power Plant" and "The Cost Benefit Analysis of Commercial 100 MW Solar PV: The Plant Quaid-e-Azam Solar Power Pvt. Ltd." Both used a quantitative research methodology to design a power plant in their respective locations. PVsyst was the main software used for the designs and simulations. The research papers showcased the types and sizes of power plants used, the types of PV modules and inverters selected, and the financial evaluations of the projects (Asad et al., 2022; Hindocha & Shah, 2020). The costs of the modules and inverters were taken from ENF Solar, a website dedicated to solar energy prices.

2.6 Operations and Maintenance of the PV Power Plant

Two research papers provided the details of the operations and maintenance of the power plant. The first studied the operations of a 200-MW photovoltaic power project based in Egypt. It highlighted the construction of the power plant by discussing the location, objectives, geological information, and cultural heritage of the area. It also showcased key insights into how the power plant would be operated once it is completed, including the manpower required, shift patterns, and organizational structure (200 MW Photovoltaic Power Project Kom Ombo – Aswan Arab Republic of Egypt, n.d.).

The second research paper about the maintenance of the power plant was provided by the Electricity and Water Authority of Bahrain, which contained design recommendations for solar PV systems, including the types of PV modules, the mechanical design of the mounting systems, and, most importantly, weather-related phenomena. The last section discussed sandstorms, hail, and debris and dust accumulation and provided recommendations for cleaning the panels by addressing the high humidity in Bahrain and the type of PV technology to use (Technical Expert to Develop Grid Connection Guidelines and Standards ..., n.d.).

2.7 Cost–Benefit Analysis

For this study, we referred to a research paper that provided the cost–benefit analysis of a commercial 100-MW power plant. It used a quantitative method to determine whether the project would be feasible. The RETScreen software analyzed the financial information of the project by finding the net present value (NPV) and payback period (Rikhi Ramkissoon, 2015).

Another research paper evaluated the performance and financial details of solar power plants in Iran. The main takeaway from this paper was that the internal rate of return (IRR) was used as a discount rate to evaluate the NPV of a 10-MW power plant (Makkiabadi et al., 2021).

2.8 Literature Gap

The reviewed literature contains useful information for building a 200-MW solar power plant in Bahrain. Sustainable energy has been researched extensively since the discovery that fossil fuels are toxic to the environment; however, financially evaluating a power plant in Bahrain is unique, since most of the research does not involve a power plant of this size and capacity.

3 Methodology

The methodology used is a cost–benefit analysis. A quantitative research design and a predictive model are implemented. The cost–benefit analysis highlights the total cost of the project, the amount of electricity generated, economic development, and the total profit from the project.

Table 2 Initial framework

Costs	Benefits
Total installation costs	Electricity sold
Operating and maintaining the plant	Carbon dioxide emissions

Note: The cost and benefit variables may increase or change as more research becomes available

3.1 Research Design

The methodology used for this research aims to determine the profitability of using solar energy as the main source of energy in Bahrain.

The initial framework of the cost–benefit analysis is shown in Table 2.

The NPV and IRR are used in the calculations of the cost–benefit analysis. The NPV is calculated as a ratio to determine the feasibility of the project. The equation used in the cost–benefit analysis is

$$\mathrm{CBA} = \frac{\sum \text{Present value of future benefits}}{\sum \text{Present value of future costs}}.$$

The first step is to determine the amount of electricity generated in Bahrain. Bahrain's peak electricity generation per month is 4000 MW, which occurs in July. This is used as a reference point to figure out how much electricity the solar panels need to generate.

PVsyst is used to simulate the electricity generation and economic evaluation of the plant. PVsyst is a simulation program for solar energy, which determines the total energy output and efficiency of a power plant. The 200-MW solar power plant is designed with the help of PVsyst, including its solar arrays, mounting systems, and inverters. The amount of CO_2 emissions saved is also calculated using the software.

The component requirements of a grid-connected PV power plant are as follows:

- Solar arrays

These are the solar modules connected in arrays. When the modules are connected in a series, the voltage increases. When connected in parallel, the current increases. The series of connections of the solar arrays are discussed in detail later.

- Mounting systems

For this design, we use fixed mounting systems, as they are cheaper and easier to install and require less maintenance. The abundance of sunlight in Bahrain (an average peak of 5.75 hours per day) means sufficient sunlight throughout the year.

The optimum tilt angle of the mounting systems is the latitude of Bahrain (location of the site), which is 25.72°.

The ideal azimuth angle, which is the direction of the mounting systems, is geographically south, as Bahrain is located in the northern hemisphere.

- Inverters

As the PV modules generate DC electricity, inverters must be used to convert it to AC electricity. The inverters can be arranged either in a string or in a central configuration. For this solar power plant, a central configuration is used, as it is more applicable for multi-megawatt power plants.

- Data types and sources

The type of data used for this research is quantitative in order to conduct a financial evaluation of the project. The sources include documents from websites, journal articles, database records, and internet pages.

3.2 Data Collection Techniques

The data are collected from the sources mentioned in the previous section. Database records are used to collect the metrological and electricity generation data, which can be found in government records. The Electricity and Water Authority in Bahrain has comprehensive data about the monthly usage of electricity. Journal articles are an extensive source containing valuable information about cost–benefit analysis techniques and relevant solar farm information. Websites and internet pages provide insights into performing specific types of calculations to find the costs and benefits of the project.

3.3 Data Analysis and Interpretation

Before the data are entered into the PVsyst software, a supervisor verifies their accuracy and reliability. PVSyst determines the NPV, payback period, and return on investment. The main purpose of collecting these data is to investigate whether it is profitable to run a solar plant in Bahrain and reduce Bahrain's dependency on fossil fuels.

3.4 Research Hypothesis

A cost–benefit analysis is used to determine whether the project is feasible. If the calculated cost–benefit ratio is above one, then the project is deemed feasible. Otherwise, the project is not feasible.

4 Discussion

4.1 Location

The location of the project is next to Al Zallaq, a small town in the southern part of Bahrain. It is 31 km south of Bahrain's capital Manama, 12 km north of Durrat Al Bahrain, and 7 km east of Isa Air Base. The total area of the project is 943.371 km^2. Figure 8 shows the proposed location of the project using Google Earth to configure the land area required. The red square represents the solar power plant, which is approximately 943.371 km^2 in size. The coordinates of the project are shown in Table 3.

Fig. 8 Location of the solar power plant

Table 3 Longitude and latitude of the power plant

Latitude	Longitude	Altitude
25.9668° N	50.5219° E	53 m

4.2 Components

The solar system's working process and different types of solar panels and inverters are discussed in the previous sections. In this section, the main components of the solar power plant are listed along with their specifications and prices. The Fig. 9 below represents the operations of a solar power plant.

The components of the solar power plant include the following:

- PV modules

The PV module selected for the power plant is from the Omnis Power USA Cortex series. The specifications of the module are listed in Table 4 along with the price (ENF Ltd., n.d.).

- Central inverters

The central inverter selected for the power plant is the Sungrow Trnsfo 6250kVA-MV (ENF Ltd., n.d.). The specifications and price of the module are listed in Table 5.

- Mounting system

The mounting system used for the power plant is a ground-mounted galvanized steel solar mounting system from Xiamen Kseng Metal Tech. It has an anti-corrosion resistance mechanism and scratch resistance. It is priced at €0.0899/Wp. Figure 9 shows the product.

Fig. 9 Solar ground-mounted system

Table 4 Photovoltaic module specifications

Omnis power USA Cortex Si-Mono	
Module type	OP600M60-P4
Power output	600 Wp
Open circuit voltage	41.5 V
Short circuit current	18.52 A
Panel efficiency	21.2%
Nominal operating cell temperature	41 °C (±3 °C)
Operational temperature	−40 °C ± 85 °C
Price	€0.26/Wp

Table 5 Inverter specifications

Sungrow	
Inverter type	6250kVA-MV
Maximum PV input	1500 V
Maximum inverter output current	2*3308 A
Efficiency	99%
Operating ambient temperature	−35 to 60 °C
Price	€0.21/Wp

Note: The prices are from Enfsolar.com. The prices are in euros, and the conversion rate as of September 25, 2022, is 1 euro, i.e., 0.37 Bahraini dinars.

4.3 Operational Requirements

The operations and maintenance of the project are performed internally by hired employees. The routine activities performed by the employees include the following:

- Cleaning the PV panels
- Maintaining the plant
- Providing security
- Staffing management and administration
- Supplying electricity from the plant to the grid
- PV plant operators and technicians

The manpower required to fulfill these duties is a minimum of 30 employees operating the plant on a three-shift basis. The plant operates 24 hours a day, so a shift system is a must. Shift employees work eight hours per shift, while non-shift employees work during office hours. Office hours are from 7:00 am to 3:30 pm, Sunday to Thursday. Table 6 shows each position, the number of employees, number of shifts, and salary per hour. The salaries are in euros (Salary and Cost of Living Comparison, n.d.).

Figure 10 illustrates the organizational structure of the operations and maintenance of the power plant. The plant manager acts as the head of operations, and the

Table 6 Manpower requirements

Position	Number of employees	Number of shifts	Salary per hour
Security	6 operators	3 shifts	€1.99
Technicians	9 technicians	3 shifts	€3.19
Operators	12 operators	3 shifts	€4.28
Plant manager	1 manager	Office hours	€10.20
HSE officer	1 officer	Office hours	€2.56
Electrical engineer	2 engineers	Office hours	€5.13

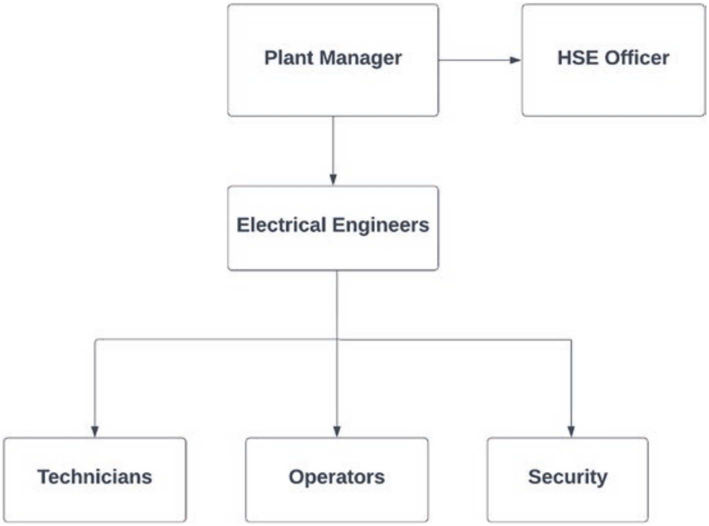

Fig. 10 Organizational structure of the plant

HSE officer is responsible for promoting and maintaining the health and safety requirements to operate the plant. The electrical engineers' role is to design and test the plant's components, while the technicians are responsible for fixing and maintaining the components. The operators take care of running the plant, while security guards the plant and ensures everyone's safety.

4.3.1 Maintenance Procedures

This section provides insights into how the solar panels, inverters, mounting systems, wiring, and connections should be maintained. These procedures are required to increase the efficiency and lifespan of the equipment.

4.3.1.1 Solar Panels

The solar panels must be cleaned regularly, as any dust settling or water drops (because of humidity) on the panels can negatively impact the overall performance of the plant. The surface of the panels can be maintained by following these steps:

1. If there is a layer of dust or dirt on the panels, a simple wash with water should remove the debris. But if the panels have thick dirt or bird droppings, they should be washed with cold water and cleaned with a sponge.
2. A visual inspection is required to locate any cracks, discoloration, delamination, and water leaks on the panels (Fig. 11).

4.3.1.2 Central Inverters

A central inverter is an important component in a power plant. As mentioned earlier, it converts DC electricity to AC electricity (usable electricity). Dust, dirt, and wear and tear can negatively impact the performance of an inverter, so proper maintenance is required to ensure that the inverter is running efficiently throughout its lifespan. The required maintenance steps are listed below.

1. The cable connections should be inspected by the technicians.
2. Any debris should be cleaned.
3. Any worn or torn parts should be replaced (Fig. 12).

Fig. 11 Maintenance of the photovoltaic modules

Fig. 12 Maintenance of the inverters

4.3.1.3 Wiring and Connections

The wiring installations should be checked regularly to ensure that there are no cracks, breaks, or deterioration in the insulation. The connections should be inspected for any corrosion or burning.

4.3.1.4 Sample Checklist for Solar Power Plant Maintenance

The sample maintenance checklist below shows the requirements during a general maintenance procedure. These ensure that the solar panels run smoothly and efficiently throughout their lifespan (Table 7).

4.4 Panel Orientation

The orientation of the solar panels comprises the tilt angle and azimuth, and it is important because it affects the efficiency of the plant. For this design, the tilt angle used is 25.7° and the azimuth is 0°. Figure 13 shows when the tilt angle and azimuth are at these degrees, and the loss percentage is 0%.

Table 7 Maintenance checklist

Maintenance checklist	
Action	Requirements
Electrical inspection (performed by shift technicians): recommended once every 12 months	The cables, conduits, and clamps should be intact and undamaged. The earthing point and earth cable should be connected and corrosion-free. The inverter should be operating normally without any error code messages. If there is an unexpected grid power loss, then the inverter should be tested.
Visual inspection (performed by operators): recommended daily	The solar panels should not have any discoloration or cracks. Any debris under the panels should be removed. Dust or dirt around the inverter should be removed. The panels should be checked for dirt or animal feces.
Panel cleaning (performed by operators): recommended once a week or if there are any deficiencies found during visual inspection	The solar panels should be cleaned similarly to washing windows. The panels should be cleaned with a detergent solution listed in the instruction manual provided by the manufacturer.

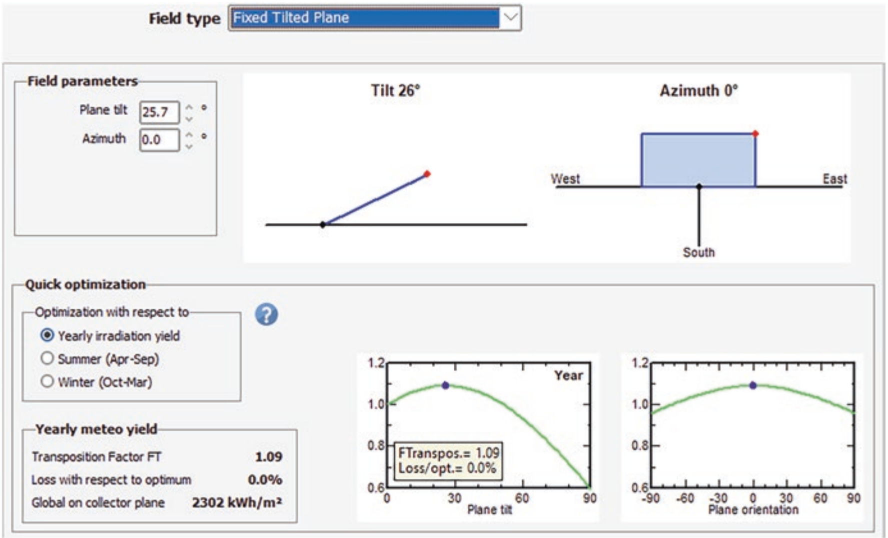

Fig. 13 Orientation of the panels

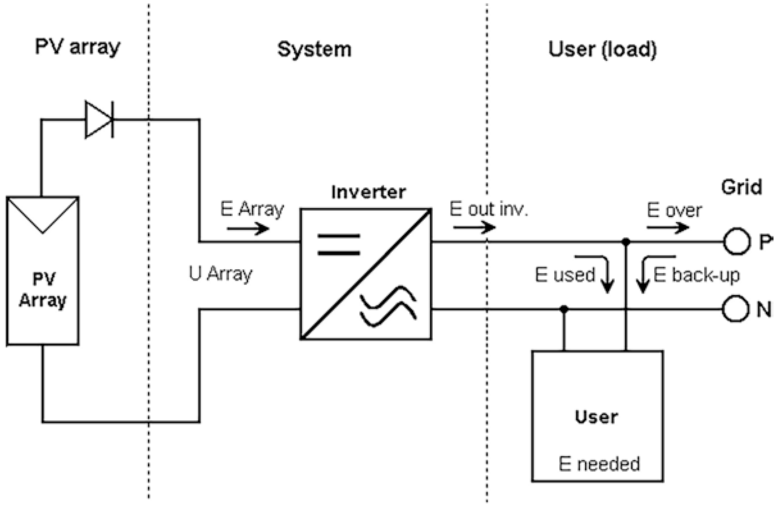

Fig. 14 Simplified sketch of the system

4.5 System

The PV modules for the solar power plant are from Omnis Power USA, and approximately 333,330 modules are needed. Thirty modules are arranged in series, and 11,111 modules are arranged in strings. To convert DC electricity to AC electricity, 23 central inverters from Sungrow are necessary. The required space for the power plant is 943.371 km^2 (Fig. 14).

The diagram above is a simplified sketch of the layout, with the system connections and electricity flow. The power plant is grid connected, and it includes a PV array, user load, grid connection, and inverters.

4.6 Simulation Results

The results of the simulation are discussed in this section. The 200-MW solar power plant is simulated using the values obtained from the previous sections. The produced electricity, performance ratio, financial evaluation, and CO_2 emissions are detailed next.

4.6.1 Produced Electricity and Performance Ratio

The 200-MW solar power plant is expected to produce 375.9 GWh per year, and the performance ratio is 81.74%. Table 8 lists the GHI, ambient temperature, energy output of the array, energy injected into the grid, and performance ratio.

Table 8 Main results from the simulation

Month	GHI kWh/m^2	T_Amb °C	EArray GWh	E_Grid GWh	PR ratio
January	114.4	17.64	28.39	28.07	0.884
February	130.2	19.13	29.28	28.95	0.870
March	165.5	22.36	32.58	32.22	0.855
April	187.2	27.60	32.22	31.86	0.832
May	223.8	32.85	33.67	33.29	0.799
June	240.3	35.25	33.23	32.68	0.772
July	231.6	36.82	32.87	32.50	0.771
August	221.6	36.59	33.59	33.22	0.764
September	198.6	33.70	34.13	33.76	0.779
October	171.1	29.55	34.62	34.25	0.813
November	125.1	24.49	29.42	29.10	0.853
December	103.9	19.95	26.14	25.84	0.878
Year	2113.3	28.04	380.13	375.92	0.817

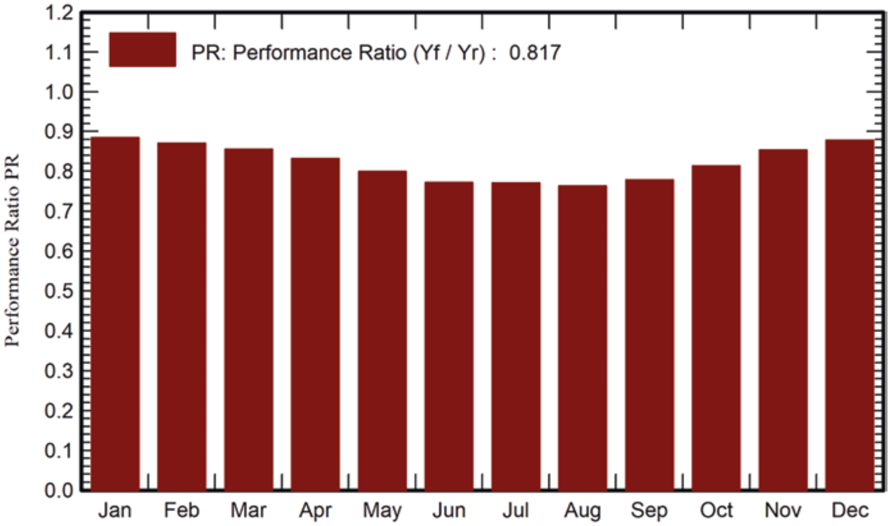

Fig. 15 Yearly average performance ratio

The performance ratio indicates how well the power plant performs. Specifically, it is a quality factor that determines whether a plant is running smoothly and whether there is a substantial amount of losses in the system. At 81.74%, the performance ratio of the power plant is exceptional. System losses are expected, so a performance ratio of around 80% is a good indicator of the effectiveness and efficiency of the system. Figure 15 shows the monthly performance ratio of the plant.

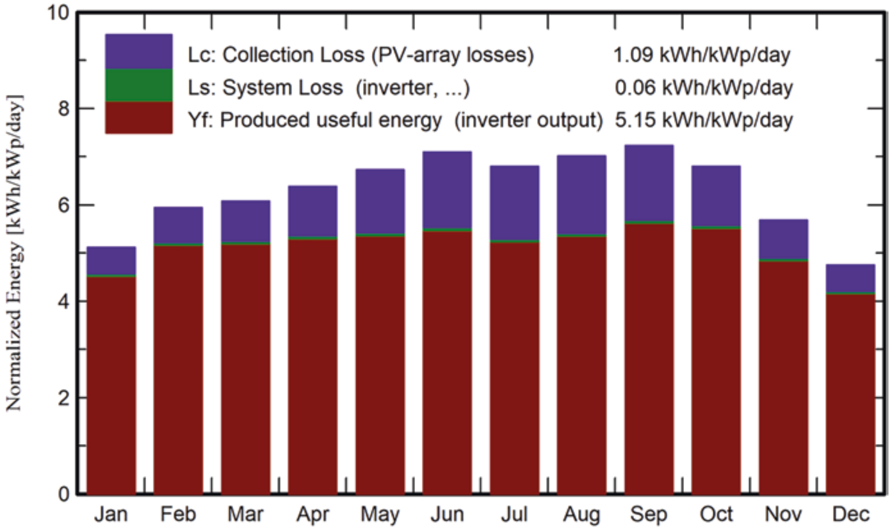

Fig. 16 Normalized production

The next figure represents the normalized production of the solar power plant. It highlights the losses of the PV modules, losses in the system, and the converted energy output of the inverters (Fig. 16).

4.6.2 CO_2 Emissions

The use of a solar power plant can have a positive impact on the environment. Generally, it helps reduce greenhouse gas emissions, providing a green alternative to burning fossil fuels for electricity. The amount of CO_2 emissions saved during the lifetime of the project (25 years) is 5,008,139.7 tons, as shown in Fig. 17.

4.6.3 Financial Evaluation

This section illustrates the total costs, total profits, and cost–benefit analysis performed to determine the feasibility of the project. The inflation rate used is 3.5% (as of 2022), the discount rate is 7%, and the lifespan of the project is 25 years.

4.6.3.1 Costs

The total cost of the power plant is in Table 9.

The operations and maintenance of the plant are performed internally by the employees mentioned in the operational requirements. Comprising 5% of the total installation cost of the power plant, "other components" include accessories

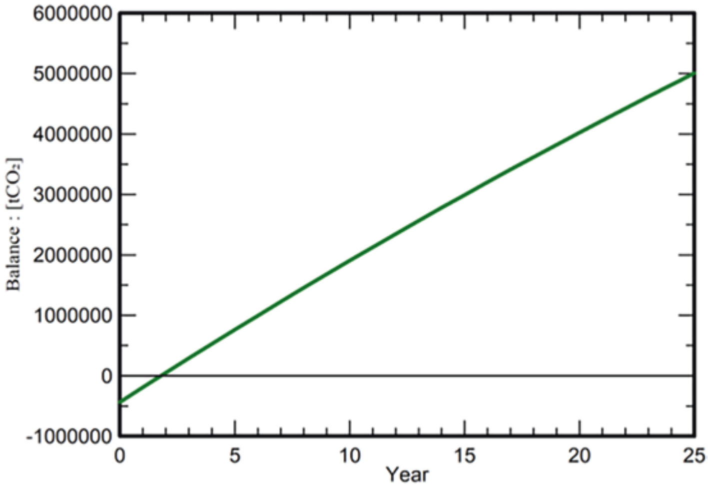

Fig. 17 Carbon dioxide emissions

Table 9 Costs of the power plant

Name	Quantity	Unit price €	Total cost €
Solar modules	333,330	154.80	51,599,484.00
Mounting system	333,330	54.00	17,999,820.00
Inverter	23	1,799,982.00	41,399,586.00
Installation modules	333,330	53.40	17,799,822.00
Installation inverters	23	1,565,201.74	35,999,640.00
Other components	–	–	11,959,905.42
Automatic cleaners	30	1650.00	49,500.00
Land rent	–	–	1,000,000.00
O&M (per year)	–	–	1,026,912.92

Table 10 Total cost of the power plant

Costs	Price €
Total operating cost	2,026,912.92
Loan payment cost	15,171,965.82
Total yearly cost	17,198,878.74
Total installation cost	176,807,757.42

(fasteners and bolts), wiring, a combiner box, monitoring systems, measurement systems, and a surge arrester (Rooij, 2022). A loan from the Kuwait Finance House in Bahrain is expected to fund the project, with an interest rate of 7% for 20 years. The land rental cost is estimated at €1 million per year (Dave, 2021). This value is justified by the location and size. The size is around 943,371 m^2 and the location is in the desert, with the closest suburban area of Zallaq approximately 13 km away. The land is flat with minimal shading to enhance the efficiency of the panels (Table 10).

The table above shows the total operating and installation costs of the plant. The total operating costs is computed by adding the yearly salaries of the employees (€2,026,912.92) and the lease of the land (€1,000,000). The loan payment cost represents the loan from Kuwait Finance House with a fixed annuity and a 7% interest rate. The following formula is used to calculate the yearly loan payment cost, represented by LP:

$$\text{Total Installation Costs} = \text{LP}\left[\frac{1-\frac{1}{(1+r)^{n}}}{r}\right]$$

$$176{,}758{,}257.42 = \text{LP}\left[\frac{1-\frac{1}{(1+0.07)^{25}}}{0.07}\right]$$

$$\text{LP} = 15{,}167{,}717.49.$$

The total yearly cost is the sum of the yearly loan payment and total operating cost. The total installation cost includes the solar modules, inverters, mounting systems, their installation, and the cost of other components.

4.6.3.2 Benefits

The total benefits are evaluated in Table 11.

The fixed in tariff is the price of the produced electricity, which is based on the average household electricity cost in Bahrain. The energy sold per year is computed by multiplying the fixed in tariff with the energy produced per year, as shown below.

$$\text{Energy sold per year} = \text{fixed in tariff} \times \text{energy produced per year}$$

$$= 0.048 \times 375{,}918{,}000$$

$$= \in 18{,}044{,}064.00$$

Table 11 Benefits of the power plant

Benefit	Price €
Fixed in tariff	0.048/kWh
Energy sold per year	18,044,064.00
Emissions saved per year	≈200,325.59 (200,325.59 tons/year)
Total profit per year	18,244,389.59

The power plant can save around 200,325.59 tons of CO_2 emissions per year. The emissions are one of the main reasons for building the solar power plant; therefore, utilizing the amount of emissions saved and equating it to a price may increase the feasibility of the project. The value of €1 euro is assigned to 1 ton; hence, the benefit is €200,325.59. Adding the energy sold per year and the emissions saved per year results in the total profit per year.

4.6.3.3 Cost–Benefit Analysis

The cost–benefit analysis is conducted by using the IRR as a discount rate. The IRR is calculated by utilizing the future values of the costs and benefits and setting the inflation rate of 3.5% as the interest rate. The formula below shows how the future value (FV) is determined:

$$\mathrm{FV} = \mathrm{PV}\left(1+r\right)^{t}.$$

Table 12 lists the future values of the costs and benefits of the project calculated with Microsoft Excel. The profit column is used to compute the IRR (discount rate), which is found to be 8% (Table 12).

In the previous section, the yearly loan payment was calculated to determine the amount owed to the bank. Table 13 shows how the payment is taking care of the installation costs and the interest that is owed to the bank.

For the first payment at the end of the year, the interest is paid to the bank along with the loan payment. The loan payment decreases the value of the interest, and the loan principal (remainder of the loan payment) helps reduce the beginning balance. The calculations were performed using Excel. The equations below show how the values were found:

$$\text{Loan interest} = \text{starting balance} \times 7\%\left(\text{loan interest rate}\right),$$

$$\text{Loan principal} = \text{loan payment} - \text{Loan Interest, and}$$

$$\text{Year} - \text{end balance} = \text{starting Balance} - \text{loan principal}.$$

The cost–benefit analysis is also calculated using Excel. The operating costs, electricity sales, loan payments, and IRR are the most crucial values in determining whether the project is feasible. Table 14 lists the operating costs and electricity sales with inflation, loan payments, cash flows, and NPVs.

The results show that the NPV of the project is positive and it is around 57 million euros. The cash flows indicate that the project will be positive from the start till the end with a total of around 188 million euros. Figure 18 shows yearly cash flows (Fig. 18).

The cost–benefit analysis is conducted using the sum of the present values of the benefits divided by the sum of the present values of the costs. Table 15 shows the

Table 12 Future values of the costs and benefits

Year	Costs €	Benefits €	Profit €
0	176,807,757.42	–	176,807,757.42
1	17,198,878.74	18,244,389.59	1,045,510.85
2	18,423,868.88	19,543,846.24	1,119,977.36
3	19,068,704.29	20,227,880.85	1,159,176.57
4	19,736,108.94	20,935,856.68	1,199,747.75
5	20,426,872.75	21,668,611.67	1,241,738.92
6	21,141,813.30	22,427,013.08	1,285,199.78
7	21,881,776.76	23,211,958.53	1,330,181.77
8	22,647,638.95	24,024,377.08	1,376,738.13
9	23,440,306.31	24,865,230.28	1,424,923.97
10	24,260,717.03	25,735,513.34	1,474,796.31
11	25,109,842.13	26,636,256.31	1,526,414.18
12	25,988,686.61	27,568,525.28	1,579,838.67
13	26,898,290.64	28,533,423.66	1,635,133.03
14	27,839,730.81	29,532,093.49	1,692,362.68
15	28,814,121.39	30,565,716.76	1,751,595.38
16	29,822,615.64	31,635,516.85	1,812,901.21
17	30,866,407.18	32,742,759.94	1,876,352.76
18	31,946,731.43	33,888,756.54	1,942,025.10
19	33,064,867.03	35,074,863.02	2,009,995.98
20	34,222,137.38	36,302,483.22	2,080,345.84
21	35,419,912.19	37,573,070.14	2,153,157.95
22	36,659,609.12	38,888,127.59	2,228,518.47
23	37,942,695.43	40,249,212.06	2,306,516.62
24	39,270,689.78	41,657,934.48	2,387,244.70
25	40,645,163.92	43,115,962.18	2,470,798.27

present values for electricity sales, emissions saved, operating costs, and loan payment costs. The following formula calculates the present value (PV):

$$\mathrm{PV} = \frac{\mathrm{FV}}{(1+r)^n}.$$

The equation below shows how the cost–benefit analysis was performed. The sums of the benefits and costs were divided as follows:

$$\mathrm{CBA} = \frac{245{,}502{,}890.34 + 2{,}915{,}511.54}{29{,}499{,}416.72 + 161{,}957{,}339.47}$$

$$= 1.28.$$

Table 13 Loan payments

Year	Starting balance €	Loan interest €	Loan payment €	Loan principal €	Year-end balance €
1	176,807,757.42	12,376,543.02	15,171,965.82	2,795,422.80	174,012,334.62
2	174,012,334.62	12,180,863.42	15,171,965.82	2,991,102.40	171,021,232.22
3	171,021,232.22	11,971,486.26	15,171,965.82	3,200,479.56	167,820,752.66
4	167,820,752.66	11,747,452.69	15,171,965.82	3,424,513.13	164,396,239.52
5	164,396,239.52	11,507,736.77	15,171,965.82	3,664,229.05	160,732,010.47
6	160,732,010.47	11,251,240.73	15,171,965.82	3,920,725.09	156,811,285.38
7	156,811,285.38	10,976,789.98	15,171,965.82	4,195,175.84	152,616,109.54
8	152,616,109.54	10,683,127.67	15,171,965.82	4,488,838.15	148,127,271.39
9	148,127,271.39	10,368,909.00	15,171,965.82	4,803,056.82	143,324,214.57
10	143,324,214.57	10,032,695.02	15,171,965.82	5,139,270.80	138,184,943.77
11	138,184,943.77	9,672,946.06	15,171,965.82	5,499,019.76	132,685,924.01
12	132,685,924.01	9,288,014.68	15,171,965.82	5,883,951.14	126,801,972.87
13	126,801,972.87	8,876,138.10	15,171,965.82	6,295,827.72	120,506,145.15
14	120,506,145.15	8,435,430.16	15,171,965.82	6,736,535.66	113,769,609.49
15	113,769,609.49	7,963,872.66	15,171,965.82	7,208,093.16	106,561,516.34
16	106,561,516.34	7,459,306.14	15,171,965.82	7,712,659.68	98,848,856.66
17	98,848,856.66	6,919,419.97	15,171,965.82	8,252,545.85	90,596,310.81
18	90,596,310.81	6,341,741.76	15,171,965.82	8,830,224.06	81,766,086.74
19	81,766,086.74	5,723,626.07	15,171,965.82	9,448,339.75	72,317,746.99
20	72,317,746.99	5,062,242.29	15,171,965.82	10,109,723.53	62,208,023.46
21	62,208,023.46	4,354,561.64	15,171,965.82	10,817,404.18	51,390,619.29
22	51,390,619.29	3,597,343.35	15,171,965.82	11,574,622.47	39,815,996.82
23	39,815,996.82	2,787,119.78	15,171,965.82	12,384,846.04	27,431,150.77
24	27,431,150.77	1,920,180.55	15,171,965.82	13,251,785.27	14,179,365.51
25	14,179,365.51	992,555.59	15,171,965.82	14,179,410.23	(44.73)

Based on the cost–benefit analysis, the project is feasible, and Bahrain has a high potential for the construction of solar power plants. As Bahrain's electricity consumption per capita is among the highest worldwide, introducing solar energy in Bahrain will increase awareness of renewable energy. This solar power plant can be a gateway to producing solar energy in Bahrain, as it has large uninhabitable desert areas that can be converted to solar farms. Moreover, Bahrain is an archipelago, so offshore wind energy can be used as an alternative clean energy source.

4.6.3.4 Sensitivity Analysis

A sensitivity analysis is conducted to determine the lowest price to sell electricity and still achieve a profit. In Bahrain, electricity costs around €0.048/kWh for a household and €0.077/kWh for a business. Table 16 shows the sensitivity analysis performed by comparing electricity tariffs against revenues and NPVs.

Table 14 Net present values (NPVs)

Year	Operating costs €	Electricity sales €	Emissions saved €	Loan payments €	Cash flows €	NPVs €
1	2,026,912.92	18,044,064.00	200,325.59	15,171,965.82	1,045,510.85	968,065.60
2	2,097,854.87	18,545,785.74	207,336.98	15,171,965.82	1,483,302.03	1,271,692.41
3	2,171,279.79	19,061,458.03	214,593.78	15,171,965.82	1,932,806.20	1,534,323.88
4	2,247,274.59	19,591,468.78	222,104.56	15,171,965.82	2,394,332.94	1,759,906.19
5	2,325,929.20	20,136,216.67	229,878.22	15,171,965.82	2,868,199.88	1,952,048.64
6	2,407,336.72	20,696,111.48	237,923.96	15,171,965.82	3,354,732.90	2,114,050.78
7	2,491,593.50	21,271,574.36	246,251.30	15,171,965.82	3,854,266.33	2,248,927.39
8	2,578,799.28	21,863,038.19	254,870.09	15,171,965.82	4,367,143.19	2,359,431.58
9	2,669,057.25	22,470,947.90	263,790.54	15,171,965.82	4,893,715.37	2,448,076.06
10	2,762,474.25	23,095,760.75	273,023.21	15,171,965.82	5,434,343.89	2,517,152.70
11	2,859,160.85	23,737,946.75	282,579.03	15,171,965.82	5,989,399.10	2,568,750.61
12	2,959,231.48	24,397,988.96	292,469.29	15,171,965.82	6,559,260.95	2,604,772.77
13	3,062,804.58	25,076,383.89	302,705.72	15,171,965.82	7,144,319.20	2,626,951.34
14	3,170,002.75	25,773,641.83	313,300.42	15,171,965.82	7,744,973.68	2,636,861.80
15	3,280,952.84	26,490,287.28	324,265.93	15,171,965.82	8,361,634.55	2,635,935.93
16	3,395,786.19	27,226,859.32	335,615.24	15,171,965.82	8,994,722.55	2,625,473.77
17	3,514,638.71	27,983,912.01	347,361.77	15,171,965.82	9,644,669.26	2,606,654.65
18	3,637,651.06	28,762,014.83	359,519.44	15,171,965.82	10,311,917.38	2,580,547.31
19	3,764,968.85	29,561,753.08	372,102.62	15,171,965.82	10,996,921.02	2,548,119.27
20	3,896,742.76	30,383,728.34	385,126.21	15,171,965.82	11,700,145.97	2,510,245.34
21	4,033,128.76	31,228,558.92	398,605.62	15,171,965.82	12,422,069.97	2,467,715.60
22	4,174,288.26	32,096,880.32	412,556.82	15,171,965.82	13,163,183.06	2,421,242.57
23	4,320,388.35	32,989,345.71	426,996.31	15,171,965.82	13,923,987.85	2,371,467.95
24	4,471,601.94	33,906,626.42	441,941.18	15,171,965.82	14,704,999.84	2,318,968.73
25	4,628,108.01	34,849,412.46	457,409.12	15,171,965.82	15,506,747.75	2,264,262.82
Total	78,947,967.76	639,241,766.02	7,802,652.94	379,299,145.50	188,797,305.70	56,961,645.69

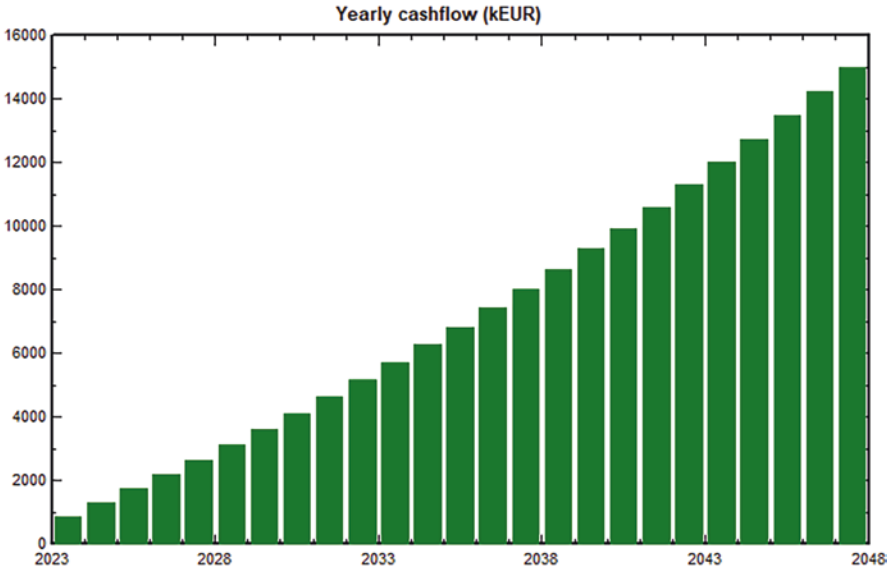

Fig. 18 Yearly cash flows

Table 15 Cost–benefit analysis

Year	Electricity sales €	Emissions saved €	Operating costs €	Loan payments €
1	16,707,466.67	185,486.66	1,876,771.22	14,048,116.50
2	15,900,022.07	177,758.04	1,798,572.42	13,007,515.28
3	15,131,599.95	170,351.46	1,723,631.90	12,043,995.63
4	14,400,314.42	163,253.48	1,651,813.91	11,151,847.80
5	13,704,370.72	156,451.25	1,582,988.33	10,325,785.00
6	13,042,060.85	149,932.45	1,517,030.48	9,560,912.04
7	12,411,759.33	143,685.27	1,453,820.88	8,852,696.33
8	11,811,919.26	137,698.38	1,393,245.01	8,196,941.05
9	11,241,068.48	131,960.95	1,335,193.13	7,589,760.23
10	10,697,805.98	126,462.57	1,279,560.09	7,027,555.77
11	10,180,798.48	121,193.30	1,226,245.08	6,506,996.08
12	9,688,777.10	116,143.58	1,175,151.54	6,024,996.37
13	9,220,534.31	111,304.26	1,126,186.89	5,578,700.35
14	8,774,920.94	106,666.59	1,079,262.44	5,165,463.28
15	8,350,843.33	102,222.15	1,034,293.17	4,782,836.37
16	7,947,260.70	97,962.89	991,197.62	4,428,552.20
17	7,563,182.56	93,881.10	949,897.72	4,100,511.29
18	7,197,666.29	89,969.39	910,318.65	3,796,769.72
19	6,849,814.82	86,220.67	872,388.70	3,515,527.52
20	6,518,774.45	82,628.14	836,039.17	3,255,118.07
21	6,203,732.72	79,185.30	801,204.21	3,013,998.21
22	5,903,916.44	75,885.91	767,820.70	2,790,739.09
23	5,618,589.79	72,724.00	735,828.17	2,584,017.67
24	5,347,052.52	69,693.83	705,168.66	2,392,608.96
25	5,088,638.19	66,789.92	675,786.64	2,215,378.66
Total	245,502,890.34	2,915,511.54	29,499,416.72	161,957,339.47

Table 16 Sensitivity analysis

Electricity tariff €	NPV €	Revenue €
0.032	(24,872,651.09)	163,668,593.56
0.033	(19,758,007.54)	168,783,237.11
0.034	(14,643,363.99)	173,897,880.66
0.035	(9,528,720.44)	179,012,524.21
0.036	(4,414,076.90)	184,127,167.75
0.037	**700,566.65**	**189,241,811.30**
0.038	5,815,210.20	194,356,454.85
0.039	10,929,853.75	199,471,098.40
0.040	16,044,497.30	204,585,741.95
0.041	21,159,140.85	209,700,385.50
0.042	26,273,784.40	214,815,029.05
0.043	31,388,427.95	219,929,672.60
0.044	36,503,071.49	225,044,316.14
0.045	41,617,715.04	230,158,959.69
0.046	46,732,358.59	235,273,603.24
0.047	51,847,002.14	240,388,246.79
0.048	**56,961,645.69**	**245,502,890.34**
0.049	62,076,289.24	250,617,533.89
0.050	67,190,932.79	255,732,177.44
0.051	72,305,576.34	260,846,820.99

Based on the analysis, electricity can be sold at €0.037 per kWh, resulting in a positive NPV of around €700,000 and revenue of €189 million. This indicates that a solar power plant in Bahrain can reduce the cost of electricity and provide clean energy throughout the kingdom.

5 Conclusion

The objective of this research was to help reduce CO_2 emissions in Bahrain by using a solar power plant as a clean energy source. In the literature review, research papers were studied, and the findings could be summarized as follows:

1. The type of PV panel that best suits Bahrain is a monocrystalline panel.
2. The orientations of the panels should be 26° for the optimum tilt angle, 0° for the azimuth, and south.
3. PVsyst is the simulation software used to design the power plant. The costs for the modules and inverters are from a website dedicated to solar energy called ENF Solar.
4. The operation and maintenance of the power plant can be done internally by hiring qualified personnel.

5. The IRR is used as a discount rate to calculate the costs and benefits of the project. The NPV is calculated along with the cost–benefit ratio to determine the feasibility of the project.

A gap found in the literature was that building a power plant of this size and capacity and financially evaluating the project have not been carried out in Bahrain.

The methodology for this study was a quantitative research design using a predictive model. Cost–benefit analysis helped determine whether the project is feasible. The hypothesis of this research was as follows: if the cost–benefit ratio is higher than one, then the project is feasible; otherwise, it is not feasible.

The location of the simulated power plant was next to Al Zallaq, with a total area of 943.371 km^2. The precise location was 26° N latitude and 50° E longitude, with an altitude of 53 m. The main components of the power plant were PV modules, solar inverters, and mounting systems. The PV module used was from the Omnis Power USA Cortex series, the central inverter was the Sungrow Trnsfo 6250kVA-MV, and the mounting system was from Xiamen Kseng Metal Tech. The manpower required to operate the facility was a minimum of 30 employees, with some working in a three-shift system. The office hours were from 7:30 am to 3:30 pm, Sunday to Thursday. The maintenance of the power plant was performed by the employees. The tasks included inspecting and cleaning the solar panels, checking the inverters weekly, and inspecting the wiring and connections of the power plant.

The results from the PVsyst simulation showed that a 200-MW solar power plant could produce 375.9 GWh per year with a performance ratio of 81.74%. During the lifetime of the project, the estimated carbon dioxide emissions saved was 5,008,139.7 tons. The total cost of the project was €176,807,757.42, while the yearly O&M cost was €1,026,912.92. The total costs of the modules, mounting systems, and inverters were €51,599,484.00; €17,999,820.00; and €41,399,586.00, respectively. In addition, the installation costs of the modules, inverters, and other components were €17,799,822.00; €35,999,640.00; and €11,959,905.42, respectively. The rental of the land had a yearly cost of €1,000,000.00. The inflation rate was set at 3.5% and the discount rate for the loan at 7%.

The total benefit of the project was determined as €18,244,389.59 per year with an electricity tariff of €0.048/kWh and emissions saved per year of €200,325.59. The NPVs, costs, and benefits were calculated at an interest rate of 8%, resulting in a positive NPV of around €57 million euros and total cash flow of about €188 million. The cost–benefit ratio was 1.28, indicating that the project was feasible. The sensitivity analysis showed that the electricity tariff could be set €0.037/kWh while maintaining a positive NPV and positive revenue. The findings proved that utilizing solar energy in Bahrain can be financially positive and reduce CO_2 emissions.

5.1 Recommendations

Based on these conclusions, we recommend the following:

- Bahrain can view this project in the public or private sector as a reference to start developing solar power plant.
- This project can be executed in the public sector to demonstrate that Bahrain's energy consumption is too high and must be lowered by using less electricity or creating renewable energy sources.

5.2 Limitations

The limitations of the study were that the prices for installation, land, and maintenance tools were not widely available and could only be based on assumptions.

5.3 Future Work

- The project produced positive results; however, it is better to test a larger solar power plant to see whether it can yield a positive NPV and favorable cost–benefit ratio.
- Alternative renewable energies, such as wind energy, should be studied, as Bahrain has a potential for producing wind energy, and it may yield more than solar.
- This project would only increase renewable energy sources by 1% in Bahrain. Thus, researching and studying different clean energy sources can help provide a brighter and cleaner future for Bahrain.

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Renewable Technologies: Solar Power and Wind Power Energy Utilization – Advantages and Disadvantages

Bayan Ahmed, Muneer Al Mubarak, and Mohammed Khouj

1 Introduction

Energy and technology work hand in hand to improve the economy. Nowadays, many industries use technologies that are dependent on electricity such as housing, schools, hospitals, manufacturing companies, and so on. With the increasing worldwide population, the demand for technology and energy has been above average. This began after the industrial revolution in Europe when the use of fossil fuels increased at the same rate as the increased expectations of living standards. Using conventional energy resources, such as oil, natural gas, and carbon, has limits, and with the intensity of economic expansion, they might not be sufficient to keep up with the growth. Experts have warned that these resources will be consumed before 2040. However, the consumption of resources is not the only issue. Although using conventional energy in industry is effective, it leads to many environmental problems such as global warming (Dincer, 2000), which occurs via the process of using energy and emitting greenhouse gases. Not only do emissions affect climate change, but they also affect sea levels and wildlife lifecycles, creating an unbalanced system around the world (Marks-Bielska et al., 2020).

Utilizing a limitless resource like renewable energy is a controversial topic, and knowing what source to use and why is a cause for concern. Many factors should be

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considered such as environmental effects, cost, efficiency, cleanliness, and stability. Unfortunately, many industries are still using and depending on fossil fuels to generate electricity, and there is no doubt that fossil fuels are very efficient in power production quality. Nevertheless, it should be noted that the continued use of fossil fuels will be harmful in the long run, and the fact that it is a limited resource should encourage the use of other sources of energy such as renewable energy (NASA, 2018). Renewable energy can be defined as a continuous generation of energy directly from the sun (photoelectric, photochemical, and thermal), indirectly from the sun (energy stored in biomass, hydropower, and wind), or from the natural movement of the environment (geothermal and tidal energy), which makes it a sustainable solution for generating power. Even though many countries are leaning toward renewable energy, it is not yet the main energy source across industries. Like any system, the renewable system has shortcomings, and if many industries use renewable energy, the advantages and disadvantages are easier to spot. This paper aims to discuss the advantages of renewable energy regarding the three sources mentioned above, that is, directly from the sun, indirectly from the sun, and from natural movement. The advantages will be compared with the disadvantages of each source, followed by a discussion about the new and improved technologies that have been developed to create better systems and reduce the disadvantages as much as possible (Ellabban et al., 2014).

The literature review will first discuss the background and history of renewable energy sources, focusing on solar energy and wind energy. It will also outline how to use each resource correctly, what to expect, and what to be aware of before choosing a preferred source. The review will also highlight the mechanisms of each system for a deeper understanding of the technology, compare the advantages and disadvantages, and describe the latest technologies used in each system. Data are collected from different sources to draw conclusions about how to improve the existing technology to make it sustainable in the long run without harming the environment. This research will help scientists understand the challenges in renewable energy and how they might affect the environment.

2 Literature Review

2.1 Solar Energy

The sun is the earth's most abundant energy source. Solar energy is the source of all wind, fossil fuel, hydro, and biomass energy, and it falls at a rate of 120 petawatts (1 petawatt = 1015 watts) onto the earth's surface. This indicates that all of the solar energy captured from the sun in a single day could meet the world's needs for almost 20 years. Figure 1 presents the forecasts and calculations for the future potential of each source of renewable energy based on today's technology. The more advanced the technology, the more potential it has as an energy source. The

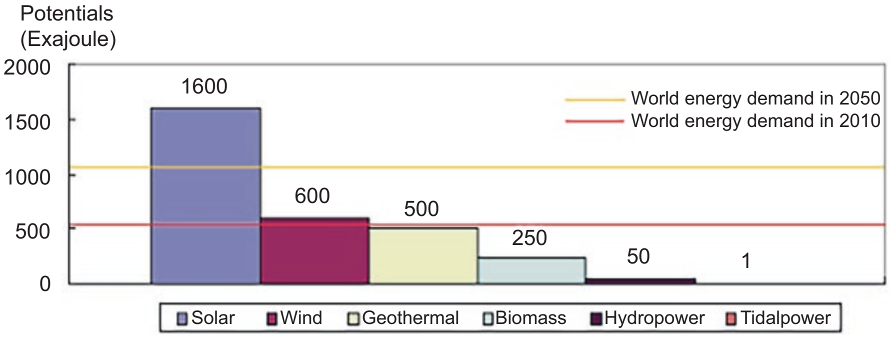

Fig. 1 Potential for renewable energy sources (based on today's technology level)

world's energy requirements are expected to increase by 5% every year; therefore, solar energy might be the best option to fulfill the ever-increasing demand.

2.1.1 Background and History

Edmond Becquerel, a 19-year-old French experimental physicist, discovered photovoltaic effects during an experiment with electrolytic cells. During the nineteenth century, inventors and businessmen in Europe and the United States created solar energy technology that would later provide the foundation for current designs. Augustin Mouchot, a French mathematician, received funding from the French government to study an alternative source of energy and constructed a solar-powered steam engine in 1878. Using parabolic dish collectors, he built the first solar steam-powered plant, which was a major draw at the 1878 World Exposition in Paris. Although the French government did not grant more financing because it was too expensive, this method of generating solar energy is still employed today. Over the next few decades, there was a lot of buzz about the solar energy's possibilities (Jones & Bouamane, 2012).

2.1.2 Technology Mechanisms

Electromagnetic radiation and solar radiation are synonyms for light that is discharged from the sun. Sunlight might vary from one country to another and from one season to another, and it might also be scattered, absorbed, or reflected by clouds, ducts, pollution, air molecules, etc. Solar technology captures light, or so-called solar radiation, and converts it from one form of energy into a useful form of energy such as electricity. Solar energy technologies can be divided into two main types: photovoltaics (PV) and concentrating solar-thermal power (CSP). PV is the most familiar technology as it comprises installed solar panels that turn light into electricity. A single PV device is a cell that can produce 1 or 2 watts of power.

Semiconductors are used to build these cells, which are of the same thickness as that of human hair. The cell is between two isolated layers of plastic or glass, and it lasts for decades. "When the sunlight passes on a solar panel, the PV cells in the panel collect the energy from the sun. This energy causes electricity to flow through, forcing electrical charges to move in response to an internal electrical field in the cell."

CSP is on a larger scale and can be built in a very large power plant that contains mirrors to reflect the sun onto a receiver that gathers the solar energy to transform it into heat to produce electricity that can be used or stored. Many types of systems use the same mechanism to convert the concentrated sunlight into heat to produce electricity, for example, the Power Tower System CSP or CSP that uses concave mirrors and many other methods (Figs. 2 and 3).

Solar power by PV or CSP is not only limited by the amount generated, but its integration into these systems should be applied to existing electrical grids, businesses, and homes in different combinations of traditional and other renewable energy sources (Office of Energy Efficiency & Renewable Energy 2017).

2.1.3 Advantages and Disadvantages

Solar energy has advantages and setbacks, both of which will be discussed in this section. In terms of advantages, installing solar panels on homes and commercial and educational buildings allows users to become less dependent on electric utilities, as the solar panels will generate electricity and reduce the monthly electricity

Fig. 2 Solar panel tower (www.energy.gov/eere/solar/how-does-solar-work)

Fig. 3 Concave solar system (https://www.alamy.com/concave-mirror-technology-of-the-solar-power-plant-la-risca)

bill. It also gives the user a feeling of independence as they are generating their own electricity. Another advantage is that solar panels will typically last between 20 and 25 years; therefore, monthly bills will be reduced for decades. Furthermore, it is assumed that solar panels work better in hot climates, but they can function in more than one climate and actually function more efficiently in colder weather because extreme heat may lead to a voltage output reduction.

It is also a common assumption that the more a solar panel is exposed to sunlight, the more electricity it might generate; however, today's technologies are very effective, even when dealing with a minimal amount of light. One of the main advantages of solar energy is that it is considered to be renewable energy that will not harm the environment and, in particular, the climate. Additionally, solar power systems have no moving parts, thus reducing the likelihood of noise pollution. The fact that it is not noisy makes it favorable to other types of renewable energy that do create noise, for instance, wind turbines. Solar panels just need to be positioned at the correct angle.

One of the core disadvantages of solar panels is that they are initially costly, and they should be considered an investment for the future. Furthermore, solar panels may cause problems during installation on some roofs, as they do not work on every type of roof material. For example, old houses with slate or cedar roof tiles are tough for solar technicians to work on and pose a challenge because certain solar cells need to use elements that are both costly and scarce. This is particularly true for thin-film solar cells made of cadmium telluride (CdTe) or copper indium gallium selenide (CIGS). Some industrial procedures used in the production of solar panels are linked to greenhouse gas emissions. Unfortunately, sulfur hexafluoride and nitrogen trifluoride have been tracked back to the manufacture of solar panels. A subjective setback is that solar panels are sometimes considered ugly or unappealing once they are installed on buildings.

However, solar energy is gaining popularity in several European nations, including Poland. It is frequently chosen by occupants in single-family dwellings who build PV systems and allow them to generate power. When putting such systems in place, the benefits and drawbacks of solar energy should be considered.

2.1.4 Latest Technologies

The continuous development of solar power has tried to achieve maximum effectiveness at the lowest cost. As previously mentioned, solar panels use semiconductors to produce electricity, and the three main semiconducting materials that have been developed are crystalline Si, thin films, and next-generation perovskite solar cells (PSCs). Crystalline silicon is one of the most common and popular materials that is low-cost and slightly less efficient than theoretical efficiency (which is around 20%). The National Renewable Energy Laboratory (NREL) is developing a hybrid that is low-cost but more efficient at 11%. Thin film is a standout technology for the future with a very narrow design (the light-absorbing layers are 350 times smaller than standard Si-panels), and it is flexible, lightweight, and easy to install. Usually, the following four materials are used for production: CdTe, amorphous silicon, CIGS, and gallium arsenide (GaAs). The toxicity of CdTe is a problem because of the cadmium, but CIGS solar cells are emerging as a more promising highly efficient and cost-effective alternative for both residential and commercial installations, with an efficiency of up to 21%. PSCs are an emerging technology yet to be tested for their efficiency. However, it might have a bright future as it is less costly, has a thinner design, is lightweight and flexible, and can work in lower temperatures.

The materials for capturing light are also improving along with the technology. For example, the Swiss have developed Insolight, which uses embedded lenses as optical boosters in the panels' protective glass to focus light beams 200 times while maintaining a 30% efficiency. Furthermore, a recent prototype development is a reverse solar panel that generates electricity at night using the heat irradiating from the panels (Fig. 4).

Another technology in the near future might be solar paints, including solar paint hydrogen (which generates energy from PV water splitting), quantum dots (PV paint), and perovskite-based paints. The innovative transparent solar window has already achieved 10% efficiency. The solar energy industry is predicted to expand in the next 5 years, thanks to the rapid development of low-cost, high-performance semiconducting materials, space-saving thin films, and simple installable technologies. Despite the pandemic's setback, the projected cost drop from 15% to 35% for solar systems by 2024 is optimistic and might make this renewable energy more accessible.

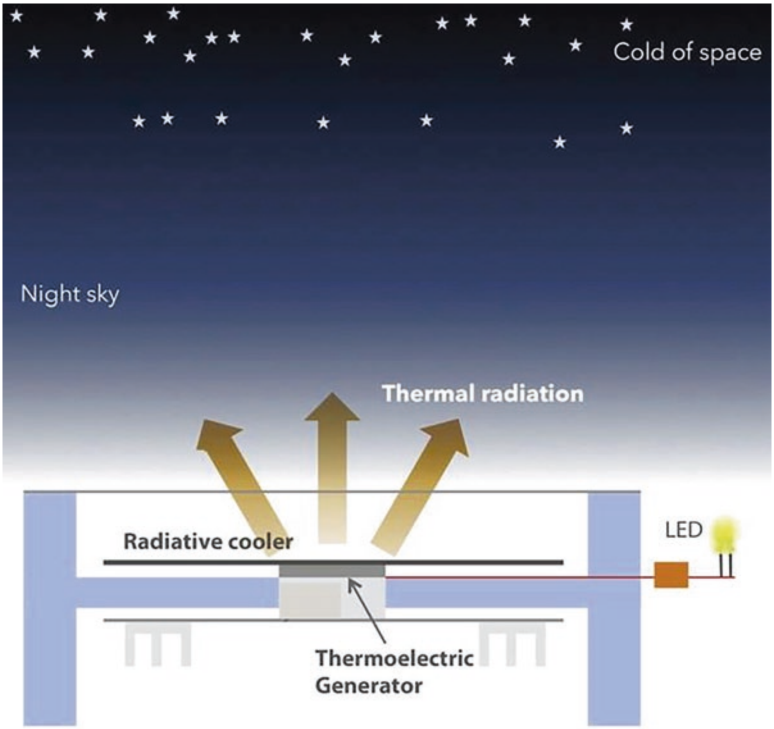

Fig. 4 Graphical abstract showing how the concept of reverse solar panels works (www.energy.gov/eere/solar)

2.2 *Wind Energy*

Wind energy is a form of solar energy. Wind is created when the earth has different temperatures in different places. Even though the wind consists of air particles that are light and transparent, wind force can be powerful, but it can be used as an advantage. One of the earliest applications of wind force is sailing, as wind is used to guide and move a ship in the sea. Wind energy is the utilization of wind force to generate electricity. Wind is generated when the atmosphere at the equator is warmer than the rest of the world, and the warm air travels from the equator to the poles, creating a low-pressure system. In contrast, cooler and denser air from the poles can move to the equator to create a high-pressure system. The movement of the wind is usually caused by moving from high to low pressure (National Geographic Society, 2012).

2.2.1 Background and History

The use of wind energy and wind power is rapidly expanding because it is cheaper. According to the International Renewable Energy Agency (IRENA), the latest global statistics suggest that capturing power has increased 75 times more in the last 20 years from 7.5 gigawatts (GW) in 1997 to 564 GW in 2018. Between 2009 and 2013, wind generation capture recorded twice the output of wind energy output, and in 2016, it was 16% of the total renewable energy generation. The location of wind turbines is very important, and the largest capture of wind power is either remote or offshore, which is a promising sector, as wind turbines have been there for centuries. In the 1830s, engineers tried to extract turbine movement and generate electricity after the electric generator was invented. In 1887 and 1888, wind power was generated in the United Kingdom and the United States, but modern wind power is said to have been invented in Denmark, where horizontal-axis wind turbines (HAWTs) were built in 1891, and a 22.8-meter wind turbine started working in 1897 (IRENA, 2016).

2.2.2 Technology Mechanisms

In the wind, the kinetic energy created by the flowing air is used to generate electricity, which is then converted into electrical energy by wind turbines or wind energy conversion equipment. The blades of a turbine are initially hit by the wind, causing them to rotate and turn the turbine to which they are connected. Kinetic energy is transferred to rotational energy by spinning a shaft coupled to a generator, thereby producing electrical energy through electromagnetic energy. The power that is generated from the wind depends on the size of the turbine and the length of its blades. The output is related to the diameter of the rotor and the cube of the wind speed. The potential for wind energy grows by a factor of 10 (Fig. 5).

Humans have been using the HAWT concept since 5000 B.C. when they used wind energy to move boats down the Nile River, and the design has been continually expanded and upgraded since then. A HAWT is made up of horizontally aligned blades that collect wind and are parallel to the ground. When facing wind flow perpendicularly, the blades rotate due to aerodynamic lift. The HAWT is the most common type of wind turbine and has received more money for research and development because it has a significant advantage over a VAWT in that it is more efficient at extracting energy from the wind when it is placed in a constant wind flow. Its unique design allows it to absorb energy during the whole blade's revolution, as the backtracking effect has no impact. However, one significant disadvantage is that to function properly, HAWTs must always point in the direction of the wind. As wind direction is unpredictable, an additional mechanism is required to guarantee that the blades are always facing the wind to extract maximum power production. Small wind turbines employ a rudimentary wind vane to orient themselves in the direction of the wind, but larger wind turbines need a yaw meter to determine the correct location of the air movement and a yaw motor to position the turbine in the precise

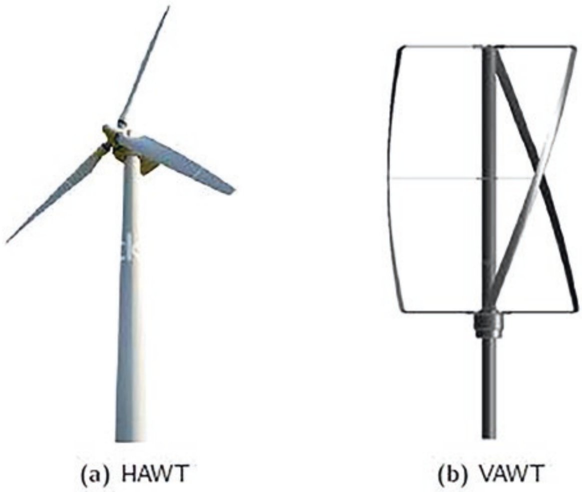

Fig. 5 (**a**) Horizontal-axis wind turbine. (**b**) Vertical-axis wind turbine (VAWT) (https://arivjournal.com/technology/feasibility-study-of-horizontal-axis-wind-turbine/)

direction of the wind. Therefore, HAWTs function best in consistent and low turbulence wind, as they do not need to change orientation as frequently.

In contrast to the HAWT's blades, the VAWT's blades revolve perpendicular to the ground and along a vertical axis. This type of turbine employs drags, lifts, or a combination of both to function. Before HAWTs were developed to become the most common wind turbines, VAWTs were the first windmills that were ever seen. VAWTs are separated into two main designs, each of which follows its own set of rules. The first is Savonius, which uses drag forces to operate like a water wheel, and the second is Darrieus, which uses aerodynamic blades to generate lift and power the turbine. Although VAWTs are less researched and have received less development funding, they have distinct advantages over HAWTs.

VAWTs are omnidirectional and can receive wind from any direction, unlike HAWTs, which must constantly face the airflow for optimal performance. VAWTs can be installed in sluggish and turbulent wind conditions, such as urban areas, because they can start producing power at low wind speeds. The VAWT system, which includes the gearbox and other components, may be bundled together and placed closer to the ground, which lowers maintenance costs and simplifies regulation. Furthermore, VAWTs are quieter than HAWTs.

Nevertheless, the VAWT's disadvantages cannot be underestimated. In high-speed wind settings, the VAWT is inefficient because of its modest beginning torque and worries about dynamic stability. The VAWT's blades are the same as the wind, so it is prone to backtracking because it must return to the flow before being propelled. It is worth mentioning that Johari et al.'s (2018) comparison of VAWTs and HAWTs had mixed results, and possibly, there is not much of a difference between them. "Wind turbine capacity has increased over time. Turbines with a rotor diameter of 15 meters and a rated capacity of 0.05 megawatts (MW) were common in 1985. In today's new wind power projects, onshore turbines with capacities of around 2 MW and offshore turbines with capacities of 3–5 MW are available" (IRENA, 2016).

2.2.3 Advantages and Disadvantages

Various advantages and downsides have been recognized as a result of the greater use of wind power. The low cost of wind energy is one of its most significant advantages, and it is certainly a low-cost alternative. After the production tax credit, a land-based utility-scale wind is one of the cheapest energy sources accessible today, costing 1–2 cents per kilowatt-hour. Wind energy mitigates the price volatility that fuel prices bring to traditional sources of energy because its electricity is provided at a fixed price over a long period (e.g., 20+ years) and its fuel is free. Additionally, the wind energy sector provides new job prospects for those who are currently jobless. Becoming a turbine technician is a rapidly expanding career option in the United States, and over 100,000 people work in the industry, which could actually support 600,000 jobs in production, installation, and maintenance.

Wind energy is a clean form of energy, as it does not pollute the air in the same way as power plants that burn fossil fuels like coal or natural gas do or generate particulate matter, nitrogen oxides, and sulfur dioxide, which are harmful to human health and create economic losses. Pollutants that produce acid rain, pollution, and other environmental issues are not released into the atmosphere by wind turbines. Wind is also a sustainable energy source that may be used in local residences. The good news is that there is plenty of wind in United States, and it may be exploited freely. Wind energy has grown by 15% annually over the previous 10 years, and it is one of the most important sources of renewable energy in the United States because it is a long-term source, with the heat from the sun in the atmosphere being the primary reason.

Wind turbines are frequently installed on farms or ranches. The wind turbine's electricity is sent into the grid and continues to generate as long as the wind blows and the sun shines. This has a significant impact on the economics of rural communities because when it comes to wind, rural areas are the best. Even if the turbines are installed on an existing farm or ranch, the benefit is that they only take up a small amount of space, allowing the farmer or rancher to continue working. They also benefit from the cash generated by renting the turbine's location.

There are downsides to using wind power and issues associated with wind turbines. In terms of cost, despite turbine prices decreasing dramatically over the past decade, wind projects must compete economically to reduce costs and make them feasible when certain areas are less windy than others. It is worth noting that wind projects are typically built on excellent land, which is usually located in remote areas distant from the towns and cities that demand power. Therefore, transmission lines must be built to transport power from the land to the city. Some structures have already made transmission line requests, but if more buildings request lines, the cost will drop dramatically. Unfortunately, erecting a wind turbine on a piece of land might not be the most effective solution. Land space can be used with other methods of power generation that might produce more power on the same piece of land. Turbines with moving parts will create sound pollution when the wind hits and moves the blades. A wind farm might also look aesthetically unpleasant, which causes another type of pollution.

Using wind turbines as a renewable energy source is great; however, they might cause environmental issues. For instance, they can potentially harm local animals, especially birds that fly at the same height as the turbines and could get hit by the moving blades. Bats are also at risk because of the moving blades. A current project is trying to solve this problem by placing wind farms in the right locations (Office of Energy Efficiency & Renewable Energy, 2021).

2.2.4 Latest Technologies

Wind energy has developed throughout the years to try and achieve the most cost-effective solutions. Prototypes of next-generation wind turbines have been developed with a focus on stability and increased power production to megawatt levels. Since 1999, the average generating capacity of turbines has grown, and turbines erected in 2016 averaged 2.15 MW. Longer and lighter rotor blades, higher towers, more dependable drivetrains, and performance-optimizing control systems have been developed as a result of research from the Wind Energy Technologies Office (WETO). Components like control systems, generators, and blades on generations of turbine designs that run to General Electric - GE's 1.5 MW model account for almost half of the nation's installed commercial wind energy fleet and are a key competitor in worldwide markets.

Furthermore, component development is increasing with WETO's collaborations with industry partners to increase system component performance and reliability. The Wind Blade Division of Knight and Carver in National City, California, collaborated with researchers at the Department of Energy's Sandia National Laboratories to create a new wind turbine blade that increased energy collection by 12%. The Sweep-Twist Adaptive Rotor (STAR) blade's main distinguishing feature is a gently curved tip, which, unlike the vast majority of blades, is uniquely engineered to make optimum use of all available angles. An enormous amount of money has also been spent on gearbox enhancement (Office of Energy Efficiency & Renewable Energy, 2021).

3 Conclusion

Renewable energy is the future source of power. After the industrial revolution, more energy and power were generated using fossil fuels, which was an effective source with good power quality. However, fossil fuels are known to be a limited resource, so unlimited resources need to be considered, such as renewable energy, which is a continuous and clean source. Burning fuel is not only problematic because it is limited, but it is also harmful to the environment and human beings; for example, the production of greenhouse gases contributes to global warming. The renewable industry is steadily improving, and two of the main resources, solar energy and wind energy, have been discussed in this article.

PV effects were first discovered by a 19-year-old French experimental physicist who experimented with an electrolytic cell. This marked the beginning of solar panels that use semiconductors to release electricity. Solar energy lasts between 20 and 25 years, and it is sustainable; therefore, users have a sense of independence in terms of generating power. Using solar panels also makes it less expensive when it comes to paying the monthly electricity bill. However, the installation of solar panels can be problematic on certain types of roofs, they also require certain atmospheric conditions, and they have space limitations. Solar energy has grown, and other types of solar panels have been developed using thin films, PSCs, and solar paint.

Wind turbines are becoming more popular sources of renewable energy because of their low cost. When different temperatures around the globe generate high and low pressure, the air moves between the two pressures and creates wind. The mechanism used in wind turbines is easy and has been used for generations, as it converts the mechanical movement of the turbine blades into electricity. Two types of wind turbines are the HAWT and the VAWT, and each has advantages and disadvantages; for example, a HAWT needs height to function properly, whereas a VAWT will work effectively at a lower height. Placing wind turbines on farms and ranches will produce electricity and allow farmers and ranchers to continue working because of the small area needed to house the turbine. Unfortunately, turbines may cause noise pollution and contribute to environmental factors such as killing birds.

It can be concluded that solar and wind energy are a large part of the renewable energy sector. In every renewable project, site conditions and requirements must be identified so that the right technology is used. When implementing projects, experts should be involved to make the right decisions using lessons learned from previous projects. Renewable energy is already applied worldwide as a limitless resource; however, the disadvantages have not yet been revealed, especially in terms of its effect on the environment. Wind turbines are already killing flying creatures, and solar panels are taking up the space of growing trees. The world was excited about the production of energy from fossil fuels without realizing how bad it would be for the environment and potentially the economy. Similarly, research on renewable energy is very important, not only for next-generation development but its effect on the environment. Researchers should also focus on new technologies and how effective it is to use more than one technology to produce energy with fewer effects.

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