Adoption of an innovation ecosystem of emerging digital technologies- (Artificial Intelligence, Internet of things and Industry 4.0) and the impact on firm innovation performance.

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Abstract

The accelerated progress of emerging technologies has a substantial effect on the competitive landscape of businesses. It extensively confers a competitive edge, rendering it imperative for organisations to comprehend the methods of applying, adapting, or augmenting their products and services to drive growth. Therefore, the presence of an appropriate framework is vital in facilitating well-informed decision-making related to scientific research, thereby enabling the development and implementation of tangible commercial applications of technology. The present study uses a quantitative methodology, incorporating three theoretical frameworks: the diffusion of innovation theory, the technology-organisation-environment framework, and the technological acceptance model. The focus was to examine the correlation between swift technological progress, the preparedness of organisations, and the innovation performance within organisations, particularly in innovative technologies, with a particular emphasis on manufacturing and related organisations. The study involved a sample size of one hundred and fifty-three managerial participants from various organisations across thirteen nations across three developing continents (Middle East, Africa, and Asia). The data obtained from the participants was subsequently analysed using the Structural Equation Model and Chi-square models. Academic scholars acknowledge that digital technologies such as Artificial intelligence (AI), the Internet of Things (IoT), and Industry 4.0 (I4.0) surpass the boundaries of individual organisations, subsequently leading diverse stakeholders to contribute within a distinct and interconnected ecosystem. These developments accentuate the need to understand the impact of emerging technologies. The findings from this research provide an addition to the body of knowledge with the insight that organisations can use to enhance the utilisation of current technologies, adequately equip themselves for forthcoming technologies, and subsequently obtain extensive information and comprehension to attain profound comprehension on how the combination of various technologies can serve as a mitigant to the decline of organisational growth.

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Abbreviations

AI. - Artificial Intelligence	MNCs-Multinational Corporations
AGFI: Adjusted Goodness-of-Fit Index	NPAR - Number of Parameters for each model (default, saturated, and independence).
C.F.I.- Comparative Fit Index	O.I. - Open Innovation
CMIN/DF-Chi-square to degrees of freedom ratio	PNFI: Parsimonious Normed Fit Index
C.R- critical ratio	R and D – Research and Development
C.R.- Cronbach's Alpha	R.B.V. -Resource-Based View Theory
CXO- Chief Level Officer	RMSEA: Root Mean Square Error of Approximation
CMIN -Chi-square minimum	S.E- standard error
DF-Degree of Freedom	S.M.E.s- Small and Medium Enterprises
DOI - Diffusion of Innovation	S.E.M. – Structural Equation Modelling
G.M.- General Manager	T.O.E.- Tecnology Organisation Environnent
GFI -Goodness-of-Fit Index	T.A.M.- Technology Acceptance Model
H.O.D. – Head of a department	TLI: Tucker-Lewis Index
I.E.- Innovation Ecosystem	UAV- Unmanned Aerial Vehicles
I.F.I.: Incremental Fit Index	V.R. – Virtual Reality
ICT-Information communication technology	
ICCT - Information Communication and Computation Technology	
IT-Information Technology	
IoT- Internet of things	
I4.0- Industry 4.0. The Fourth Revolution	

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My remarkable child, I am grateful for your unwavering support; your constant pride in me and belief in me inspired and motivated me through the hardest parts of this journey. Ms. Edirin Akemu, beloved sister, thank you for the exceptional support, your contributions, patience, and emotional stability gave me a solid foundation for this undertaking.

I thank my loved ones, acknowledging your acts of love especially. Your unconditional support is invaluable and an ongoing influence on my life that I could not survive without.

Declaration

I declare that the research contained in this thesis, unless otherwise formally indicated within the text, is the author's original work.

The thesis has not been previously submitted to this or any other university for a degree and does not incorporate any material already submitted for a degree.

Signed:

[redacted]

Dated:01-04-2025

Chapter 1 Introduction

1.1 Introduction to Chapter 1

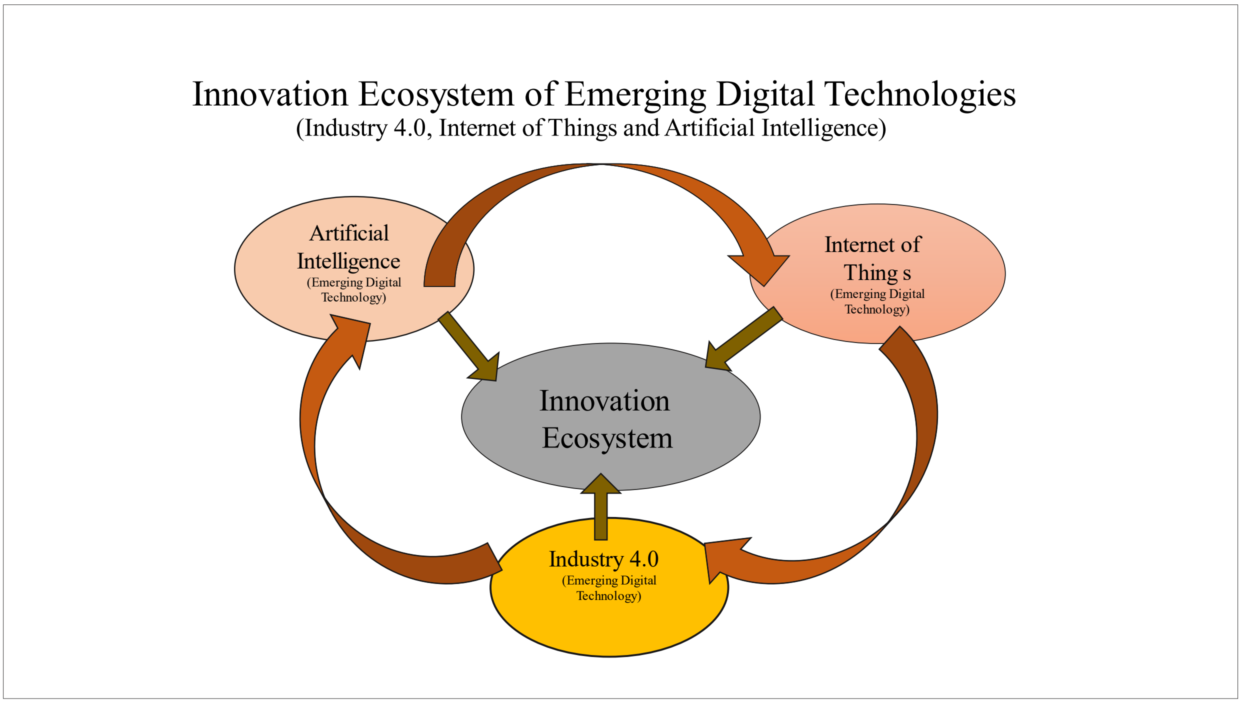
The rudimentary changes and advancements of emerging digital technologies are creating a significant evolution, forcing a crucial, beneficial, and unavoidable focus on adopting various forms of innovation. Such a guide will drive rapid changes that enable the questioning and in-depth analysis of traditional methods. The ability to gain more cognisance of the fundamental drivers for integrating emerging digital–technology–related elements with existing models and reconstructing more relevant ones will create a considerable difference in innovation across various industries and link to multiple strategic goals for organisations. Since the advent of fast-moving technological global awareness, there has been an increasingly emphasised focus on productivity across all sectors, accompanied by transformative advances in information and communication technology (I.C.T.). These advances result in many new prospects for the adoption of technological innovation, making research relevant and critical. In reassessing the definition of innovation, a related pattern that has materialised in recent years is the spread of various emerging digital technologies within innovation ecosystems.

Digital technology enables innovation processes within an ecosystem, wherein the methods have distinct properties that evolve in an effective and rapid form; according to Kreuzer et al. (2022), digital technology and its elements are platforms facilitating continuous innovation spread and can create noticeable changes given the right circumstances. Previous research has also shown the significance of competition in developing novel techniques. However, the exploration of competition from the perspectives of technology and digitalisation remains limited, reiterated by the study of Ancillai et al. (2023) with the firm realisation that there are research gaps within the field.

According to Matt et al. (2021), there is an increasing gap in the implementation of various emerging technologies inside innovation ecosystems, as opposed to merely deploying technology. Therefore, it creates a more viable and extensive purpose for a research study. Consequently, this study intends to add to the academic know-how by uniquely evaluating the use of three emerging technologies within an innovation ecosystem to understand their collective impact on firm performance in large organisations. It also adds to the knowledge of the gaps identified within this area. An innovation ecosystem can also be regarded from the view of a significant player company or 'incumbent' as discussed by (Kim et al., 2022), focusing on its core expertise and capabilities (Prahalad and Hamel, 2009) while working with partners and various stakeholders (Granstrand and Holgersson, 2020) with the view of merging capabilities for competitive advantage and differentiation (Adner, 2017). Innovation ecosystems require significant collaboration and innovative combinations of emerging technologies driven by partnerships from various industries (Benitez, 2021). According to multiple studies (Adner et al., 2010; Granstrand and Holgersson, 2020), innovation ecosystems are a web of various digital technologies required to enable novelty or improvement that facilitates products and services. One case study related to using the three emerging technologies discussed within this study occurred with Toyota, a global multinational focusing on emerging technologies within manufacturing (I4.0) to keep abreast of its competitors. They are also partnering with non-competitors like telecom organisations and research institutes, particularly in self-driving, all requiring a blend of I4.0, IoT, and AI (Kim et al., 2022). Occurrences have led to ongoing investments in various multinationals involved in the combination of AI with I4.0, which as Mahardhika and Putriani (2023) discussed, is required by the Toyota Research Institute for different purposes, including association with batteries for electronic vehicles.

For organisations that want to employ radical and disruptive innovation, there is a necessity to examine the effect, as the interdependence between an ecosystem could either have a detrimental or beneficial effect (Mahto et al., 2020). Therefore, as discussed by Burford et al. (2022), this necessitates identifying the key variables that can provide guidance and insight in addressing problems as they occur.

Figure 1 Depiction of the Innovation Ecosystem of Emerging Digital Technologies within this study.



Embracing the innovation ecosystem compels established market leaders to compete with formidable competitors and emerging digital platform challengers, with whom they must forge strategic interdependencies and complementary relationships. However, in many digital platform-based ecosystems, the complementary parties (often independent producers) are at a competitive disadvantage to the platform owner, who ultimately controls the ecosystem. Examples include Amazon and Facebook's control over competitors and Apple's influence on app developers, which have been explored in several studies (Kirk, 2023; Marsden and Brown, 2023; Martens, 2023).

Inadvertently, and from a growth perspective, technological organisations like Samsung, Google, Amazon, and Apple may be directly responsible for the surge in popularity of ecosystems built on digital platforms. According to the study by Zhu and Du (2023), the advantage of rapid growth has led to the use of platform-based ecosystems when one party (the platform owner) actively encourages the development of new complementary technologies by other parties (the "ecosystems"). As further discussed by Fu et al. (2023), digital platforms with technological elements benefit large organisations like eBay, Tencent, Amazon and various parties participating in and within the platform. The study of Barrett and Tsekouras (2022) also discussed the double-edged collaboration approaches between evolving or smaller firms and multinationals with the need for intermediary mediation from collaborators like the government or research centres. Such discussions lend further credence to the research questions within this study, which discussed the need for organisations to combine various emerging technologies with an innovation ecosystem that provides mutual benefit. Over the last ten years, organisations have been affected by the disruptive effects of emerging digital technology on the modern corporate environment. There are massive requirements of financial, human capital, and R&D resources to invest in their digitalisation operations, which, according to the examples of organisations like Johnson and Johnson, use new technologies like AI through technological partners to reduce manufacturing costs, indicated by Kim and Cho (2023) that, organisations would benefit from forming alliances with ecosystem members across several networks and with various capabilities.

Therefore, this study proposes the need for organisations to collaborate or cooperate in dissolving their digital silos to lessen the dangers associated with high costs and competition. An occurrence that, according to Pushpananthan and Elmquist (2022), will invariably support closing gaps in how a firm can use developing integrated or combined technology platforms within an ecosystem for growth. It is critical to driving ecosystem-based cooperation and collaboration, which can only be enhanced by the transformative digitalisation facilitated by emerging technologies. Studies (Thomas and Autio, 2019) discuss that success depends on its internal resources and relationships with other businesses in the system, which presupposes that organisations should not exist in a vacuum. Consequently, elements can be viewed as part of a broader process where various organisations collaborate to improve products and services, ultimately satisfying customer needs. Each ecosystem's uniqueness stems from symbiotic development, and the continuous exchange of information and ideas depends on the success of all participants within it (Adner et al., 2010).

Innovation ecosystems emerge or develop from a central point, a technological platform, or a mix of social and economic factors. An innovation ecosystem is described by Zahra and Nambisan (2011) and Zahra et al. (2023) as a group of progressive businesses with a shared ambition to grow and support the innovation activities of a single central innovative enterprise using new ideas with a network of various stakeholders across various sectors. Such a coalition creates fertile ground and opportunity for rival businesses, as discussed by Remneland Wikhamn and Styhre (2023), as providing an opportunity to co-create value by bringing their capabilities together to form innovation ecosystem hubs. In this regard, value co-creation is achieved through the common usage of emerging digital technology like I4.0, IoT, and AI solutions by organisations in the ecosystem, which continues to be a recurring question in research. Therefore, as also discussed within the study of Mikalef et al. (2023), this study is investigating a gap in the ability to emerge digital technologies to drive firm innovation performance using a multi-continent approach.

Technology has subsequently opened up new options for firms to disperse and fragment their operations, thereby shifting from local production processes to spreading the value chain across borders. The use of digital technological innovation can be viewed from many angles; as defined by Kaartemo and Nyström (2021), it is an instrument that can be used to achieve business goals, with a principal focus that facilitates fundamentally drastic changes in different industries and shapes markets. Based on multiple characteristics of digital technologies such as "programmability", "accessibility", "associability", and "interactivity", all terms, according to Wang et al. (2022), that could pertain to the fact that technology can be guided, controlled, and used to serve various purposes while extending across multiple stakeholders. To this end, digital technology must, therefore, continue to emerge, and this realisation means that there will be a need to continue to study the gaps created as the changes occur. Therefore, various individuals are becoming more interested in developing technologies due to globalisation and rising competitiveness now and in the future. There has been a dramatic increase in articles published about innovative technology in the last decade. While some definitions of emerging technologies overlap, there are references to other facets and aspects of this phenomenon; there is no consensus on what constitutes an "emerging digital technology." Especially since, according to Kumar et al. (2019), newness and growth are significant elements of emerging technology. There is, therefore, the need for continued comprehension of the all-encompassing meaning of the word, which is a problem. Technology that has yet to be recognised but is projected to affect most organisations soon could be summarised as an emerging technology (Zamani et al., 2022).

Although several definitions of emerging technologies exist, each research or scientific paper uses a different one to describe the same technology. According to the studies by Kaartemo and Nyström (2021), emerging digital technologies have been defined as a 'market and platform shaping tool' in an investigation centred around wireless technology. The rationale behind a technology could be viewed as having the fundamental requirement of making an impact, which may not be limited to a market or a platform but extends across industries and countries. Still, the goal is revenue and firm performance for a profit-making organisation. The intent of creation led the study of Silva and Oliveira (2020) to define emerging digital technology as elements that enable structure and involve tangible (products, services, equipment, devices, building) or intangible (intellectual skills, patents, research and development). However, according to Halaweh (2013), uncertainty, network effect, social and ethical problems, expense, limits in certain nations, and a lack of research are the only characteristics affecting emergent technologies with a need for more understanding as occurrences emerge.

One such evolving technology is artificial intelligence (AI). In the 1950s, many mathematicians, physicists, and philosophers investigated the possibility of developing robots to solve problems and make judgments like humans do without artificial intelligence. Artificial intelligence research has advanced in the past few decades, and many systems have been constructed and are now in widespread use. Automation is becoming increasingly commonplace, according to Radanliev et al. (2021), which varies regardless of whether it occurs within a virtual assistant like Siri or the autopilot on an aeroplane. Several organisations are investing in innovative ecosystems to drive the growth of artificial intelligence by merging existing technologies like IoT and Industry 4.0 and combining skills and knowledge. As discussed by Schüller (2023), large organisations like Bosch and Samsung have set up AI research centres worldwide. However, to ensure full utilisation of such technology, the organisation actively partners with other institutions within a diverse technological ecosystem to develop new-age devices, electronics and equipment.

A technological innovation ecosystem incorporates the interaction between industry, government, and academia, indicating that research capabilities would be able to drive the growth of multiple innovations as opposed to one with the view of changing and adapting with the goal of firm innovation performance. To this end, Jiang et al. (2019) described an ecosystem as a membership created and managed by a single company, which is a description emerging as the most common backdrop for the birth of new businesses from organisations like Haier, Microsoft, and Alibaba. Some benefits of innovation membership include access to well-established markets, advantages in branding and reputation, and intellectual property and technical know-how to produce knowledge and transmit that information to assist commercial growth for firm innovation performance. Deep learning algorithms, capable of processing substantial amounts of data, make it feasible to create an automated system that learns from unstructured material such as text, images, or video. Machine learning algorithms are developed for robots capable of mimicking human cognition and behaviour, culminating in AI. With each new piece of information discovered about artificial intelligence, there will be more knowledge to determine whether it will be beneficial or dangerous. Many people are afraid that intelligence will transcend human understanding as it improves. However, fears are arising regarding AI, as mentioned by Kavitha et al. (2023), primarily because AI involves the application of machines with human-like features, such as the capacity to understand and solve problems with the ability to reason and execute actions without human supervision or involvement.

Nevertheless, this fear is also being reduced by studies showing that humans and AI can collaborate to merge their cognition to attain maximum performance. The use of AI mechanisms may limit the effects of single-mindedness, allowing humans to reap the benefits of superintelligence and its impact on growth. Additionally, the reliance by consumer experts, organisations and enterprises will adjust methods and rapidly advance innovation adoption plans accordingly (Cuevas-Vargas et al., 2022). Studies such as Boburbek et al. (2022) and Mikalef and Gupta (2021) emphasise that numerous industries, including medicine, teaching, telecommunications, security, and manufacturing, use techniques developed in these subfields, sometimes in tandem with one another. Therefore, AI refers to systems demonstrating a certain level of independence by understanding their surroundings and performing executions using the information to achieve defined and requested objectives.

Another emerging technology is the Internet of Things (IoT), a network of linked devices that gather and store data on their use and surroundings. The IoT is a set-up of linked gadgets connected to a single platform and can include different devices of various shapes and sizes. Simple IoT devices with sensors are now available in some houses. These devices may recognise the location of people in some areas of the home and can automatically modify heating, lighting, and other home features (Lee et al., 2022). IoT technology comprises a wide range of computer and networking methods. As discussed by Langley et al. (2021), devices can communicate with each other wirelessly with Bluetooth technology as an example. Therefore, wired and wireless Internet connections and linked devices may interact with each other throughout the globe and serve various purposes. Therefore, organisations can utilise digital technology to improve the firm's overall performance and spread into a new market within their local environment or beyond borders. However, it would have to be the same way they would employ a traditional strategy like innovation or pricing to overcome international market challenges like cultural differences and institutional distance (Wang, 2022).

I4.0 ecosystems use complex systems linked by fundamental technologies like IoT, cloud, big data, and artificial intelligence, and the study by Sharma (2023) discussed resourceful use as achievable if technology providers collaborate to co-create solutions by combining technologies such as AI and IoT. Subsequently, creating a solid indication that such cooperation will drive emerging digital technologies to provide effective communication and collaboration between human actors, machines, and other organisation resources inside production and innovation ecosystems. Additionally, smart manufacturing, sometimes known as the fourth industrial revolution or Industry 4.0, is discussed by Rafiquea et al. (2022) as the surge in information and interconnectivity that accelerates interactions between the brain and technological functions. Despite its significance from the standpoint of individual businesses, I4.0 is a widespread occurrence that calls for the compatibility of technologies with a wide range of players, including corporations, governments, regulators, educational institutions, and think tanks. I4.0 is an emerging digital technology facilitated by new technological manufacturing activity within an innovation ecosystem, which Matt et al. (2021) discussed as including groups of individuals with a variety of specialised knowledge. Subsequently, the constant realignment of symbiotic links between people, information, and resources to co-create would drive incremental and transformative value for a firm. Therefore, the notion of an innovation ecosystem is being used in I4.0, a growing study area. A strategy primarily based on the results of studies like Chowdhury et al. (2022) that discuss that one company cannot generate value solely. Subsequently, this indicates that knowledge and creativity flourish when exposed to various types of technology, encouraged by multiple institutional and organisational ties and interactions. An observation that makes it critical to understand how organisations within or related to manufacturing identify methods and manage the expansive and exponential growth changes associated with new technology and its impact on firm innovation performance, with gaps arising that, according to Hermann et al. (2019) and Machado et al. (2021), are required to classify and address the rapid expansion accompanied by swift changes.

Innovation performance, as described by Hameed et al. (2021), refers to having the capacity to achieve significant differentiation by using advanced business strategies. To improve this performance, Usai et al. (2021) indicate that organisations could benefit from a range of emerging digital technologies. These technologies act as instruments to aid and enhance innovation endeavours, perhaps resulting in increased innovation results and overall performance. According to the studies by Bogers et al. (2021), these elements can be used to overcome environmental, quality assurance, cultural differences, and institutional distance issues that affect their growth. However, there could be issues based on practical examples from organisations such as Nokia, which the studies by Gavric et al. (2021) discuss as having access to technology but failed to focus on innovation as a strategy to improve their devices, attend to market changes, and were unable to maintain their growth or enter new markets. The strategy leads to several types of innovation that could be either a deterrent to change, as in the case of Kodak, discussed within the study by Weinreich et al. (2022), as an organisation with the first-mover advantage that did not evaluate possibilities by themselves or with a partner, to transform photographic memories digitally. Another example of the immense competitive advantage strategy Anindita (2021) mentioned is Amazon. The organisation has to continue using various forms of emerging digital technology to innovate and sustain market entry and growth through disruptive innovation. An example of radical innovation is Netflix, the global streaming company that made the physical renting of videos obsolete and eroded the business of incumbents like Blockbuster, who had unlimited access to entertainment but did not use technology to digitalise it. The concept of radical innovation is identifying dormant needs for a product and service and using forceful change to fulfil those requirements. This example of various forms of innovation as a business, growth, and sustainable strategy could, as discussed within the study of Baker et al. (2022), inevitably drive a firm to evolve to higher performance even as technology creates a symbiotic relationship.

Some studies have established a significant relationship between specific forms of innovation and firm innovation performance, like incremental innovation, with examples from organisations like DHL that focus on time management as a value add. The organisation has efficient and profitable digitalised logistics powered by emerging technologies like I4.0 and AI (Tyagi et al., 2023) and IoT (Salih et al., 2022). These diverse types and functions of innovation are also prompting partnerships between organisations, with the mind-set to expand the scope of the impact-increasing occurrence of organisations partnering to use IoT technology to increase data insights for logistics, delivery, and the development of connected devices. One organisation cannot have the ability to self-apply all the required digital technologies needed for any form of innovation, and this could indicate that varied elements like partnership will add to the impact on firm innovation performance. Although the thought that arises from the gradual growth of in-depth evaluation and the subsequent application of new technologies targets an unknown need. It presupposes, as highlighted in various studies (Freixanet and Rialp, 2022; Ho, 2021), that regardless of the innovation being disruptive, incremental, or radical, the emergence of novel technological advances has the potential to bring about changes that can either have an advantageous or detrimental effect on organisations and their overall performance.

Studies such as Hermann et al. (2019) and Kraus et al. (2021) have highlighted theoretical gaps in the comprehension of the way digital technologies can be employed to implement unique innovations. They argue that identifying and addressing these gaps can lead to growth in different sectors, particularly for specific organisations or sectors that lack standardisation. Definitions, impact, usage, and effects blur across the emerging technologies as they are enhanced (Machado et al., 2021), indicating the gaps requiring research; therefore, there is a wide range of differentiating performances in industries regarding adopting IoT and a requirement for more understanding (Alabdali, 2022). In closing gaps and adding to the knowledge within the innovation and digital technology field, Barbosa et al. (2021) and Yan and Huang (2022) discussed that academics tend to specialise in providing guidance or help in a specific area. However, there could be more growth in the adoption of innovation if there is more focus on a range of products or services in which the company would be commercially invested or is managing to make a profit. Identifying organisational readiness and growth characteristics influences their ability to implement and adapt to fast-growth technologies for fostering open innovation and improving performance. Backed by the realisation that previous research studies have provided limited insights on these topics, several factors were established as influencers for organisational readiness to embrace emerging digital technology, including as evidenced in the studies of (Jöhnk et al. (2021) and Zhao et al. (2022) culture, competence, top management support, government support, and vendor and partner support.

Organisational readiness has also been connected to digital change, and the studies by Halpern et al. (2021) mention that it is based on the positioning of the application of emerging digital technology as a deliberate intent to transform the organisation. Such an objective is facilitated by fostering innovation and increasing productivity, which is why businesses like Apple, IBM, Ford, and Walmart are often recognised as leaders in innovation ecosystems. These invest in innovation partnerships that advance the knowledge, productivity, prosperity, imagination, and creativity of their suppliers, customers, and other ecosystem participants. The ecosystem of innovators highly values the firm that acts as its foundation. The ecosystem's players' services, tools, and technologies within a hub may aid one another in innovating more successfully, coupled with the inclusion of new applications and complementary products that raise the ecosystem's value. By cooperating in an innovation ecosystem, as collaborated by Achrol and Kotler (2022), businesses may produce value that would be hard for any firm to create alone. All firms depend on the entire market's health and vitality for their existence and development. As a result, competition is exchanged between different enterprises at an ecosystem level.

Digital technology could be a behind-the-scenes element compelling organisations to formulate plans to contemplate forward-looking techniques to invent goods and services (Appio et al., 2021). Those plans and actions support more efficient operations and will subsequently account for the impact of digital transformation. Organisations must initially reconsider established innovation models, then change and reorganise their business models to respond quickly to a changing business environment and take full advantage of digital opportunities (Vaska et al., 2021). Although the study by Denicolai et al. (2021) discussed that digital innovation is widespread throughout businesses, executives and managers have needed support for adaptation to digital evolution. Innovation is the management and improvement of new technology and business opportunities. Therefore, the constant evolution and transformative changes of emerging digital technology force distinct approaches from organisations to enable development, management, and ways to maintain their growth. Technological innovation is required to develop alternative outcomes for organisations to attain strategic goals. Therefore, applying such emerging digital technologies increases adaptability in developing value propositions. However, the results often need continuous improvement to keep abreast of actions, which indicates that organisations must ensure rapid progression and maintenance of the impact of such technology (Yoon and Kwon, 2022). Specific fields of innovation and emerging digital technologies have been evaluated to understand the growing array of digital technologies and their influence on competitive strategic innovation organisations. An advantage of digital technology is that it can be deployed by small, medium, and large enterprises due to the various available modes of innovation. However, Alvarez-Aros and Bernal-Torres (2021) discuss that implementation requires high capital outflow, more substantial intellectual capacity, and fortitude to enable organisations to apply diversification techniques to succeed within their industry; consequently, rapid technological growth is often limited to larger organisations.

Adopting innovation and emerging digital technologies are critical topics with a substantial transformative view for any industry. Regarding innovation and digital technology, today's fourth industrial revolution is unlike any other in history, with necessary modifications controlled in an integrated way that allows continuous adaptability. Manufacturing firms must adapt their production procedures to meet the evolving global demand to expand and survive.

To compete in today's business for growth, organisations incorporate digital technologies for decision-making, which indicates the need to understand the readiness of organisations to use emerging digital technology effectively and accurately. An example highlighted by Javaid et al. (2022) is identifying spare parts in a machine failure and creating a ready-made solution by filtering vital information from generated data to enable decision-making. Collaboratively, the discussed technologies within this study have a growing interconnection that makes manufacturing and industrial systems increasingly sophisticated. Technological innovation has fundamentally reshaped workplace environments and output capacity owing to the aspirations of Industry 4.0, including mechanisation, task performance excellence, and heightened operational yield.

Furthermore, a growing element of the adoption of innovation studies, as suggested by Benitez et al. (2022), is the necessity to enhance the route and techniques of digitisation due to the inadequate capacity of organisations to integrate digital technologies. As a result, more prominent organisations might assist smaller organisations in developing minor categories of emerging digital technologies, subsequently establishing a mutually beneficial digital orientation. This research focuses on the impact of a specific blend of emerging digital technology within an innovation ecosystem on firm innovation performance. Hence, the following proposal is a petition to assess the topic further to understand how the specified emerging digital technological elements influence innovation adoption.

1.2 The rationale for the research

To explore applying a specific combined and collaborative set of Emerging digital technologies within an innovation ecosystem to drive innovation adoption. The findings on rapid advancement and organisational readiness will be used to develop relevant explanations supporting organisations that intend to apply emerging digital technologies to drive innovation and improve organisational performance. To contribute to the body of research knowledge by providing quantitative evidence on the impact of AI, IoT and I4.0 on firm innovation performance.

1.3 Background

Various overlapping occurrences, such as individuals' aspirations for personalised medical, tourism, education, and leisure services, have resulted in the predominance and need for innovative differentiation throughout socioeconomic structures. This necessity undergoes exponential growth in developed and developing economies, fostering sporadic and unrestricted progress throughout various industries. Therefore, external assistance and new technological innovation efforts are the catalysts for digital transformation for organisations, enabling public and private intermediaries to assist businesses and organisations. Furthermore, such an observation is furthered by the fact that innovation ecosystems that include the technologies discussed within this study, according to Bahoo et al. (2023), come together based on multi-layered networks with similar characteristics and goals. Such could include creating a system of unique goods and services or the provision of solutions that are dependent on the ecosystem's features. It has the potential to enable the formation of networks that foster growth in particular industries or organisations, comprising members with diverse levels of technical proficiency. The emphasis has moved away from the characteristics and qualities of the firm and gradually gravitated toward the benefit (or experience) co-created with other elements like technological and service innovation adoption for organisational performance.

The ability of an organisation to understand and meet its consumers' needs, regardless of whether it is a business – or consumer-oriented organisation, is a determinant of growth. In meeting the consumer's needs, information is gathered throughout the phases of formation with the primary purpose of value-creation, which may be monitored to equip organisations with value-added services to carry out their core functions more successfully. The value-added services include providing technical expertise and using emerging technologies like IoT, AI and I4.0. According to Polas et al. (2023), they are driving the growth of "smart manufacturing," or "digital manufacturing', which enhances knowledge and adds value with a competitive advantage to firms. Although gaining progress affects practical innovation, it requires reliance on the strength of these organisations to develop new networks and become insiders in the existing networks of customers. However, in some cases, a particular innovation frequently fails independently, and it depends on improvements in its surroundings. Significant growth is embedded in an ecosystem of interdependencies that results from developments.

Therefore, studies such as (Nittala et al.,2022) assert that a transparent approach to organisational innovation issues and technology innovation capabilities of external partners may be required to grow performance.

Considering recent changes, Dearing (2020) lists research objectives that call for answers to the question, "How will we reach the marketplace of the future?". In the last decade, perceptions of the nature and process of innovation have shifted dramatically. Furthermore, many innovations focus on intangible offers connected with or without stand-alone products with an elevated level of information content, i.e., an information-centric focus. A guide indicates a growing emphasis on the innovation's characteristics and qualities that gravitate toward the benefit (or encounter) directed at organisations or consumers. According to Veile et al.(2022), this co-creation occurs by pushing a combination of some of the technologies within this study with other resources, including stakeholders from various platforms — creating can be termed a value-centric approach as an organisation extracts value from its products or services to gain a competitive edge. However, this derived value is often assessed in comparison to its rivals, particularly in the case of businesses that generate revenue. The ability of the organisation to innovate efficiently performs a vital part of producing substantial benefits and value. As a result, many organisations actively seek to be technological pioneers in their sector by offering new, improved, or revolutionary technologies. The core purpose is to gain the advantage that drives focus and enables a thriving, innovative environment. (Liu, 2022).

Artificial intelligence is one of the technologies driving the quest for learning and gradually becoming a force in the mandate to grow additional revenue from new avenues. According to Kopalle and Lehmann (2021), to achieve this goal, it is vital to prioritise decisions concerning managing and operating businesses or carrying out essential responsibilities where technologies are used to add value. Therefore, it is poised to profoundly impact diverse facets of organisational performance, requiring a novel approach to foster expansion and augment business competitiveness. Emerging technologies are constantly evolving, introducing advancements that bring greater convenience and cost-effectiveness to monitoring operational processes. The results of such evolution are highlighted by the studies of Banalieva and Dhanaraj (2019), which discuss that implementing state-of-the-art technologies like artificial intelligence supports smaller organisations in enhancing their offerings and establishing a technological ecosystem.

Consequently, to achieve moderate growth, manufacturing firms need to modernise their production processes by effectively incorporating digital technology, aligning themselves with the constantly evolving demands of global markets. Organisations that integrate digital technologies into their services will consistently maintain a competitive advantage in terms of growth. The IoT within manufacturing and industrial frameworks is swiftly progressing in intricacy, fuelled by the ambitions of Industry 4.0: automated processes, workflow enhancement, and amplified productivity.. Consequently, the simultaneous implementation of these technologies enhances their effectiveness and enables them to operate independently as self-governing systems.

1.4: Research Questions: The following are the questions that the research study proposes to evaluate:

1.4.1 RQ1: What impact does the rapid advancement of a combination of emerging digital technologies, such as Artificial intelligence, the Internet of Things, and Industry 4.0, have on the adoption of innovation?

Innovation has been discussed as an increasingly successful exploitation of emerging ideas for its implementation. It can be further described as a series of connected technologies that involve tasks related to improving the existing technology's state while shifting towards adopting a completely different or unique technological trajectory. Consequently, organisations fostering technological innovation to improve their operations are commonly found to adopt other related technologies continuously. Existing literature (Hanelt et al., 2021; Tiwari et al., 2021) has highlighted that most organisations often utilise emerging digital technologies to implement their business strategies, impacting their firms' processes to foster innovation for firm innovation performance.

Therefore, necessitates the crucial role of digital technologies in supporting innovation in a company because it enhances competitiveness through achieving its goals. The increased use of these technologies globally has an omnipresent impact on the radical restructuring of industries that create digital innovations and are deeply influenced by other organisations considered early adopters. Subsequently, such occurrences facilitate the rise of new roles like Chief Digital Officer to drive and monitor the adoption of technological innovation. The literature by (Benitez et al., 2022; Chen et al., 2021) highlights that the adoption of innovation is closely linked to the internal competencies and capacities of large organisations and their implementation of innovative strategies. The adoption and deployment of digital technologies implemented by organisations can be exploited to facilitate the creation of several types of innovation, such as incremental innovation, which includes radical breakthroughs that enable the acquisition of superior capacity. Organisations often apply digital technologies, according to Rayna and Striukova (2021), to implement and create innovative products and services to increase competitiveness. Therefore, innovation can no longer be synonymous with new product innovations but should now be seen as more encompassing than other types of invention. However, upon analysing the existing literature, such as Vaska et al. (2021), one can infer a high interdependence between these distinct types of innovation that most firms, including international organisations, apply to achieve superior organisational performance. Consequently, it is becoming increasingly important for organisations to adopt and use a portfolio of emerging technologies.

Digital solutions are increasingly involving the application of smart sensors, augmented reality, cloud computing, and advanced robotics. As a result of such advancements, decisions may be made more rapidly and accurately. Since these technologies primarily increase production while lowering operating expenses and failure rates, some organisations could use the opportunity to emerge as leaders and solicit technologies from other organisations by developing and providing support within an innovation hub, which will drive advantages for both the members and host organisation within the ecosystem; an example being AstraZeneca, another large organisation discussed within the studies of Remneland Wikhamn and Styhre, (2023).In the surge to drive business models through digital technologies, according to Iizuka and Ikeda (2021), innovations are created with rapidly evolving technology that improve productivity and influence the quality of life . However, colossal risk implications are associated with such innovation, resulting in governments of various nations constantly trying to mitigate the risk. Government authorities use regulations and certifications as tools, but rapid progress and technological changes also affect the adoption and implementation of regulatory innovation practices.

An example is that the fourth industrial revolution is at a consistently conceptual phase when many technological concepts are combined into a single framework, driving the growing blend of the lines between digital and physical innovation within manufacturing. The fourth industrial revolution is revolutionising human productivity with emerging technological elements like artificial intelligence and consistently improving service delivery and organisational performance by allowing processing and increasing intelligent choices more rapidly than ever. The fourth technological revolution is established as a significant growth driver, which is described by Cardona et al. (2023) as a significant and critical technology that drives an encompassing evolution of other technologies like AI and IoT and is still having a considerable impact generally due to the ability to enable the connectivity across these technologies and facilitate the use of them for continuous innovation. This unique interconnection with the physical and digital worlds requires significant automation supported by machine-like collaborative robots. Innovation has changed production, reduced monotonous and life-threatening occupational risks, supported climate change factors like reduced, neutral, or zero carbon emissions, and linked to advanced technology like augmented reality and virtual reality. As asserted by Giberti et al. (2022), these are considered the main drivers that combine the real and digital worlds. Subsequently, creating such an immersive experience ensures innovation is rapidly enhanced and consistently provides an advantage to stakeholders across various verticals. The goal is to drive a more efficient and productive environment, a fundamental requirement for industrial evolution, but implementation requires a considerable capital outlay.

As these technologies become more widely used across many industries, from healthcare to automobiles to banking to gaming to environmental monitoring to agriculture to sports to energy management to safety, people's outlooks on work and play are shifting quickly with the constant need for more development. The gradual usage will inevitably lead to what is described by the study of Tavera Romero et al. (2021) as the development of hyper-automation and connection, paving the way for I4.0. Large organisations such as the ones this study intends to survey are known to use novel technology, including IoT, to analyse their data and make informed decisions. Therefore, the utilisation of such technology is a determinant of rapid growth for these organisations, with technical advancements playing a vital role in their varied method of operation. Similarly, AI is increasingly being used by such organisations to complement human labour across various industries, providing a level of expediency for market adaptation and a competitive advantage.

Despite adopting AI-based technology and its advantages, organisations face a series of issues during implementation, primarily because AI is still in its infancy. Organisations are just now beginning to grasp the ramifications of the new management difficulties and organisational consequences that AI will bring. As a result, it is expedient for businesses to create AI applications that provide economic value and open new avenues for coordinating human and machine labour (Tavera Romero et al., 2021). Consequently, leaders must recognise and plan for the effects of technological advancement on their workforce, which includes upskilling people to complete current tasks with AI and retraining and recruiting additional workers to fill the new positions required to stay abreast of the burgeoning growth. Furthermore, the study will involve technological process innovation, which is considered one of the distinctive organisational occurrences adopted by innovative technology and existing organisations. For due acknowledgement, there is a need to evaluate initial approaches and develop business models to drive the adoption of innovation's current and future growth in multiple industries. Therefore, in considering this perspective, the first research question that this study will try to answer is stated below:

R.Q. 1: What impact does the rapid advancement of a combination of emerging digital technologies have on the adoption of innovation?

1.4.2 RQ2: How does the organisation's readiness for combining emerging digital technologies affect innovation adoption?

Novel technologies arise throughout the industry as a critical source of organisations' capabilities to create new wealth and provide opportunities that foster and capitalise on digital transformations for innovative products and services. Vital attributes or factors influence the ability of an organisation to foster innovation, and one of those factors strongly connected to the availability of specific features can be collectively termed organisational readiness. Organisational readiness can be defined as the internal availability and combined internal and external application of elements such as human resources, technological skills and expertise, financial resources, training and skill development, and the availability of partners and systems Mikalef and Gupta (2021) as well as the high level of requirement and trust in the capability of the technologies.

Besides knowledge, an organisation's readiness to adopt technological innovation is a fundamental attribute of innovation. In this regard, past studies have also explored these concepts associated with innovation and readiness. The two elements can be assessed from various correlated perspectives; for example, one is linked with the organisation's readiness concerning creation. The other concept highlighted by Machado et al. (2021) relates to the organisation's willingness to enable or deliver innovation. However, by analysing the existing literature, one can infer that the concept of "readiness" of firms to adopt innovation (especially emerging digital technologies) and its impact on performance is understudied. According to Sharma and Venkatraman (2023), the need to analyse firms' organisational readiness for digital innovation assists them in making changes within their operations using digital technologies The implication is that change management is essential in organisations since the business must invest money in new skills, systems, management, digital culture, and physical infrastructure. Therefore, in today's increasingly digitally oriented workplace, collaboration has increased and, to this extent, supports the emergence of automated and networked processes. Therefore, presupposing that the ensuing transformation necessitates greater cognition, analysis, and interaction skills, which makes increased cooperation with the company's external partners vital for quantifiable growth (Matt et al.,2021).

Some factors like scalability, accessibility, availability, and ease are associated with organisational readiness for adopting digitalisation as a means for organisations to foster innovation. Subsequently, according to Leavy (2023), the contention is that organisations' readiness to embrace digital innovation can also depend on their willingness to automate their operations by digitising critical parts or processes within the firm and adopting new ways of growth to achieve firm innovation performance. Omnipresent digitisation also impacts or influences the ability of organisations to provide differentiated and novel innovations within their products, services, processes, and industry. The ensuing differentiation evolves and relates to critical business developments made possible due to the evolving prevalence of digitised innovation globally. Therefore, various scholars and authors have contended that organisations' readiness to foster innovation by adopting and using digital technologies directly impacts their innovation outcomes, which is also inversely proportional to innovation risk (Halpern et al., 2021; Machado et al., 2021).

Digital technology is neither a product nor a series of products, a rapidly expanding frontier of new computer capabilities woven with interconnectivity across platforms. AI systems are more independent, capable of learning far more comprehensively, and more difficult to decipher than any previous intelligent I.T. product. Therefore, creating an increasing and wide range of requirements for AI technologies, face recognition, natural language processing, and virtual agents of various kinds and applications necessitates evolving organisational readiness (Borges et al., 2021; Zhu et al., 2021). These breakthroughs are critical because technology like AI can improve people's lives in various facets, such as their homes, healthcare and education, jobs, entertainment, safety, and transportation. Businesses now have unparalleled access to AI, opening new avenues for creating smart goods and services and innovative business models and organisational structures. Despite this, the technology, however novel, is not a cure-all for all ills: human–AI. Interactions, data privacy and security, ethics, labour rights, and national security are among the many complicated concerns accompanying the potential and problems of the growing use of AI and its blend with other emerging technologies like IoT and I4.0. Subsequently, organisations must address automation and quickly develop modern technologies to stay successful (Jöhnk et al., 2021). Therefore, AI adoption requires a thorough knowledge of relevant readiness factors, operationalised readiness assessment, and customised alignment between the current level of AI readiness in an organisation and the desired purpose of subsequent implementation. Adopting the technology depends on a thorough understanding of how the ideas of AI readiness and adoption relate to one another Zhu et al. (2021) but differ from other digital technologies due to their usage and difficulty of use or deployment. However, research on the adoption inside organisations and organisations' preparedness for AI is still preliminary (Jun et al.,2021). Since the digital economy increasingly uses various methods to conduct business, including online payments and receipts, it is increasingly obliged to adapt to these developments.

When implementing emerging digital technologies, organisations face technical (such as inadequate technological capabilities) and non-technical (such as a lack of leadership support) obstacles. However, successful adoption necessitates coordinated efforts throughout the business to nurture its preparedness, considering these complex and new organisational requirements. Subsequently, due to their uniqueness and knowledge limitations, as corroborated by Zhu et al. (2021), an explicit debate in the context of studies on technology adoption and preparedness is necessitated at the corporate level. Although digital technology has been seen as a proponent of innovation, research has proven that inefficient organisational readiness creates severe limitations in the growth of innovation adoption. A significant percentage of the technological applications may create pathways that are deterrents with limited fruition for growth, consequently emphasising the need for a focused organisation's preparedness level. Some large organisations operating in today's digital economy confront a significant challenge due to their inability to react swiftly to the digital revolution. However, firms increasingly adjusting their level of organisational preparedness will have to make the necessary modifications and implement new strategies to overcome these hurdles.

This study's essential contribution is that an organisation's willingness to enhance knowledge and apply or augment the discussed technologies to innovation may boost firm innovation performance. There are limitations in the study of organisational readiness for technological innovation, where digital innovation is coined from the combination of digital technology and innovation (Hussain and Papastathopoulos, 2022; Jöhnk et al., 2021), therefore creating a complex set of elements that require foresight, planning and preparedness. The growing rationale required to analyse the impact of the organisational readiness of international firms to adopt digital innovation will be driven by the second research question that has been proposed for this study:

R.Q. 2: **How does the organisation's readiness for combining emerging digital technologies affect innovation adoption?**

1.4.3 RQ3: What impact does the adoption of a combination of emerging digital technologies have on firm innovation performance?

This study describes firm innovation or innovative performance using factors such as products and services and organisational and process innovativeness. According to (Anning-Dorson et al., 2018; Gunday et al., 2011), the concept involves adapting the organisation's process, coupled with the viability of developments using new technology, and aligning with required changes in the business terrain. Previous studies such as Maoxiang et al. (2022) depict a beneficial relationship between corporate digitisation and external cooperation, enabling multinationals to use digital technology to seek and take advantage of new business possibilities. Earlier, IoT was used in manufacturing plants to monitor the production process. However, other industries have also adopted IoT technology to improve their business processes and decision-making abilities over time. Due to this, there could be a prediction that the development of IoT technologies will drive innovation adoption based on the rapid growth and rise in the evolution of the Internet, with the use of interconnected devices creating a platform for developing and sharing innovative ideas. The IoT has advanced in several ways, with organisations like Amazon, Apple, and Google leading, and as discussed by studies such as Tiwari et al.(2021), there is visibly increased innovation as more devices connect and as more devices become attached to the Internet, there is increased creation. Organisations may efficiently gather and assess customer data, enabling prompt decision-making and greater competitiveness.

Consequently, this opens up additional opportunities for developers to create new applications for these networked platforms, thereby making IoT ever more critical when it comes to improving worker effectiveness. According to Rehman et al. (2023), the strategic incorporation of the IoT is a crucial determinant of firm innovation performance, given its role in facilitating the growth of commercialisation. Therefore, it is inevitable that the implementation of this strategy would lead to a decrease in operational expenses and an increase in market dominance. I4.0 is distinguished by automation and intelligent machines and is showing signs of significantly impacting the economy, business models, and international relations. It is a digital transformation due to the rapid changes in technology and globalisation, changing our traditional business ways, and as Torrent-Sellens et al. (2023) discuss, it extends far beyond technological disruption. It is an observation that, as described by Guo and Xu (2021), creates a multi-faceted vehicle that could enable a competitive advantage. I4.0 has allowed firms to innovate by applying emerging technologies such as AI, nanotechnology, augmented reality, and other digitalised technologies. Subsequently leading to transformative and upwardly changing growth in start-ups across industries. Due to this, I4.0 relationships between nations and industries could majorly transform the economy's future. Intelligent technology in the industry has increased productivity for organisations by implementing and, according to Ciasullo and Lim (2022). allows new business models to emerge and new ways for economic development. Multinational corporations operate in many countries and are often the first to adopt innovative technologies because they have a global reach. For example, IBM is a multinational corporation that has innovated since its inception and continues to evolve. According to Mohan and Devi (2023), the organisation is one of the firms adapting rapidly to I4.0 as an emerging technology. The implementation of company-wide adoption across various products and service extensions is due to the availability of a network of connections with other industries with its IBM Watson IoT platform, which supports manufacturing growth, therefore indicating that the use of AI can enhance stakeholder cooperation.

Artificial intelligence is a disruptive force in the workplace, with the power to make things easier and more efficient for organisations, but it comes with risks. Rapid innovation can grow monopolistic organisations and create barriers to new entrants. According to the studies of Bahoo et al. (2023), AI-driven innovation practises directly impact firm innovation performance when organisations capitalise on the capabilities of AI. Therefore, organisations can drive continuous improvement and nurture the establishment and maintenance of a high level of innovation performance. Subsequently, the collaborative application of various actors across platforms within both a dependent and independent circle for firm innovation performance will be driven by the third research question that has been proposed for this study:

R.Q. 3: **What impact does the adoption of a combination of emerging digital technologies have on firm innovation performance?**

1.5 Gaps and Contribution to the Knowledge

Although external innovation dependencies in such innovation systems have been confirmed in the literature, studies conceptualising these dependencies are limited. Various gaps have been identified in the field, and the gaps related to the three research questions and independent variables in this study are as follows:

Firstly, gaps in research on enabling technologies and their innovation adoption framework are limited to either one technology or have focused predominantly on the perspective of Western countries (Pasi et al., 2021).

Secondly, gaps in further research on the evolution of a technological innovation ecosystem are warranted, providing valuable insights for organisations to make strategic choices regarding organisational readiness and strategically allocate assets within the ecosystem. There are vital issues that affect the role of innovation ecosystems in upgrading processes towards smart practices in the industry (Pushpananthan and Elmquist,2022).

Thirdly, gaps in how organisations can understand the impact of digital technologies on firm innovation performance are also needed for further investigation (Kraus et al., 2021).

The initial review of related work demonstrates that much area remains to be covered within the study of the theoretical and administrative implications of emerging digital technologies.

The significant contributions of this study to the academic field are:

1) The research study focused on large enterprises in emerging economies (Middle East, Asia, and Africa) to evaluate factors that foster emerging digital technologies to enhance innovation adoption in organisations.
2) The research focused on rapid advancement, organisation readiness, and firm innovation performance as significant variables in adopting an emerging digital technology-driven innovation ecosystem.
3) The research focused on manufacturing-related organisations and their use of specific, combined emerging technologies within an ecosystem to drive firm innovation performance.

The goal was to discover and comprehend the perspective and limitations of the applications of specific emerging digital with a focus on Middle Eastern, Asian, and African organisations. To this end, the research will assist emerging digital innovation adoption growth and the ability to devise relevant strategies related to the collaborative use of novel digital technologies to improve organisation growth and performance.

Figure 2 Depiction of the Theoretical Conceptual Framework

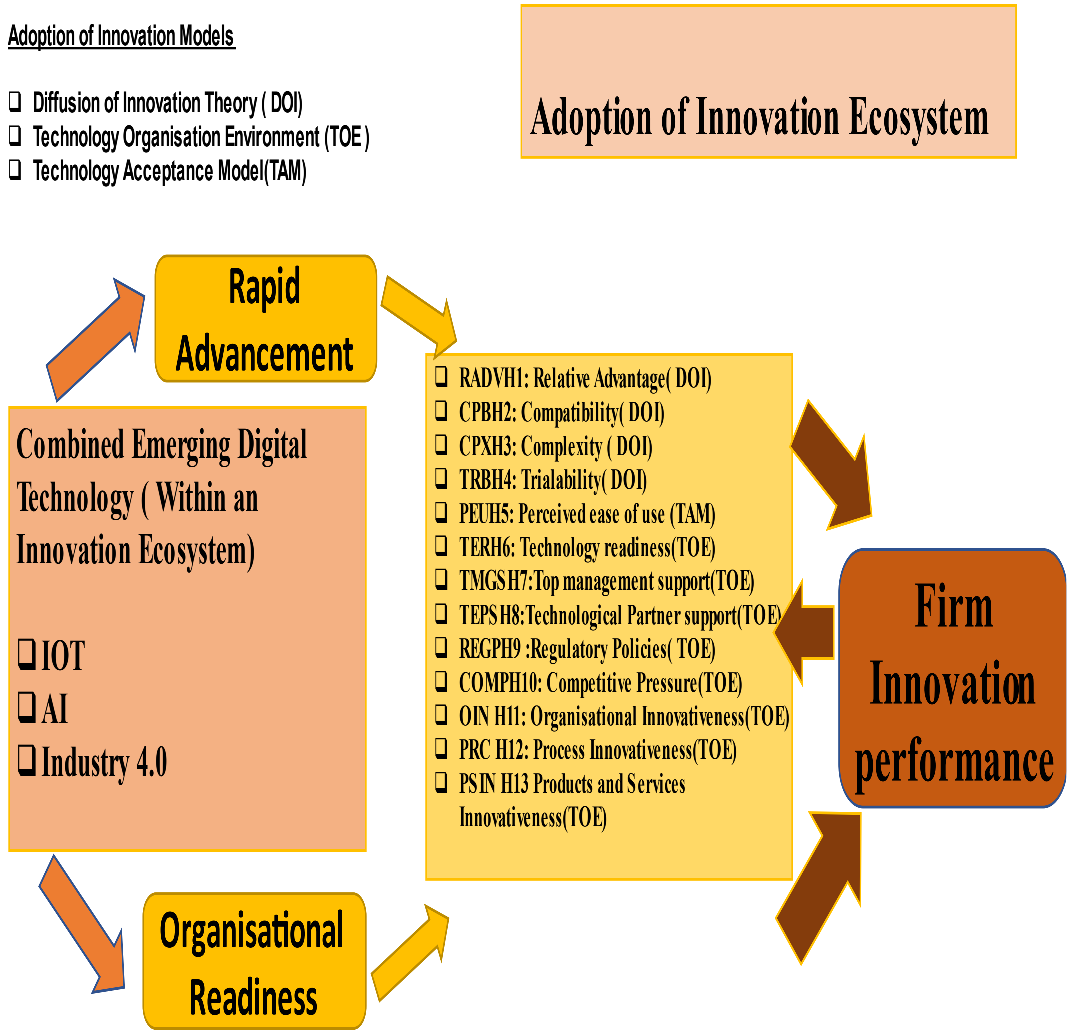


Table 1.1 illustrates the theoretical definitions of the independent variables within this study. Organisational Readiness, Rapid Advancement and Firm Innovation Performance constitute three interconnected variables that impact the adoption of innovation in organisations.

The technological and user-centric facets of innovation are illustrations of the elements that contribute to rapid advancement which the first research question focuses on and is established subsequently as the first dependent variable. This category covers "Compatibility" with current technologies and user preferences (Al Hadwer et al., 2021; Chen et al., 2021) and "Relative Advantage," which assesses the innovation's superiority over current solutions (Al Hadwer et al., 2021; Chen et al., 2021). The category also considers "Trialability" for testing ahead of full deployment (Ullah et al., 2021; Yuen et al., 2021), "Complexity" in implementation and comprehending (Chen et al., 2021; Stjepić et al., 2021), and "Perceived Ease of Use" that influence user acceptance (Chatterjee et al., 2021; Yuen et al., 2021).

Organisational Readiness factors focus on internal and external preparedness for innovation adoption. This category, which the second research question focuses on and is established subsequently as the second dependent variable, includes "Top Management Support," which ensures strategic alignment and resource allocation (Al Hadwer et al., 2021; Chen et al., 2021; Oliveira et al., 2019; Premkumar and Roberts, 1999; Stjepić et al., 2021), and "Technology Readiness" reflecting organisational preparedness (Oliveira et al., 2019; Moldabekova et al., 2021; Musyaffi et al., 2021). External factors in this category include "Technological Partners" support (Chen et al., 2021; Holmstrom, 2021), "Regulatory Policies" influence (Chen et al., 2021; Malik et al., 2021), and "Competitive Pressure" from market rivals (Al Hadwer et al., 2021; Chen et al., 2021; Stjepić et al., 2021).

Firm Innovation Performance involves three variables of an organisation's innovation success, which the third research question focuses on, and is established subsequently as the third dependent variable. "Organisational Innovativeness," which focuses on the implementation of new management approaches, workplace structures, and administrative systems to enhance operational effectiveness (Anning-Dorson et al., 2018; Ghosh and Srivastava 2021; Gunday et al., 2011), and "Process Innovativeness" reflecting the adoption of new or improved production methods, delivery approaches, and operational procedures (Anning-Dorson et al., 2018a;

Anning-Dorson et al., 2018b; Tweneboah-Koduah et al., 2020). The third measure, "Product and Services Innovativeness," captures the organisation's ability to develop and introduce new or significantly improved market offerings to meet evolving customer needs (Anning-Dorson et al., 2018a; Anning-Dorson et al., 2018b). These three variables are further explained within the study in greater detail and serve as dependent variables that collectively indicate success of an organisation's innovative initiatives across its operations, processes, and market offerings.

Table 1. 1 Theoretical definition of factors affecting the adoption of innovation.

Rapid Advancement		
Factors	**Definition**	**Reference**
Relative Advantage	The innovation is considered superior to the idea that it supports.	(Al Hadwer et al., 2021) (Chen et al., 2021)
Compatibility	The level at which the technological, idea, design or product is in accordance with the existing advantages, features, characteristics and demands or preferences of prospective consumers.	(Al Hadwer et al., 2021) (Chen et al., 2021)
Complexity	The extent of complication and intricacy involved in applying, understanding, and successfully implementing the innovation.	(Chen et al., 2021) (Stjepić et al., 2021),
Trialability	Trying the idea or process before successfully implementing the idea in the organisation can be referred to as trialability.	(Ullah et al., 2021) (Yuen et al., 2021)
Perceived Ease of Use	The level at which technology is usable without difficult manual physical or intellectual capacity.	(Chatterjee et al., 2021) (Yuen et al., 2021)

Organisational Readiness		
Factors	**Definition**	**Reference**
Technology Readiness	The level of preparedness of an organisation to embrace innovative technology or combine or adapt the latest technology to existing technology.	(Oliveira et al., 2019) (Moldabekova et al., 2021) (Musyaffi et al., 2021)
Top Management Support	The participation of senior executives in establishing the strategy, implementation, and application of emerging digital technology in the organisation.	(Al Hadwer et al., 2021) (Chen et al., 2021) (Oliveira et al.,2019) (Premkumar and Roberts ,1999) (Stjepić et al., 2021)
Technological Partners	The capability and availability of technology partners to work with the organisation to adopt innovation.	(Chen et al.,2021) (Holmstrom ,2021)
Regulatory Policies	The level to which government policies affect the adoption of innovation.	(Chen et al., 2021) (Malik et al., 2021)
Competitive Pressure	The extent of competitiveness within marketplace rivals and the resultant push and demand for adopting innovation.	(Al Hadwer et al., 2021) (Chen et al., 2021) (Stjepić et al., 2021)

Firm Innovation Performance		
Factors	**Definition**	**Reference**
Organisational Innovativeness	Leveraging forefront technology-driven management methods and innovative digital practices to improve organisational performance	(Anning-Dorson et al., 2018; Ghosh and Srivastava 2021; Gunday et al., 2011)
Process Innovativeness	Combining digital manufacturing approaches and emerging technologies to increase productivity.	(Anning-Dorson et al., 2018; Thomas Anning-Dorson et al., 2018; Gunday et al., 2011; Tweneboah-Koduah et al., 2020).
Product and Service Innovativeness	The development and deployment of new technology-enabled products and services to satisfy evolving requirements.	(Anning-Dorson et al., 2018; Gunday et al., 2011).

The following section discusses the rationale for each variable in more details.

1.6 Research Hypothesis for Adoption of Innovation of Emerging Technologies

1.6.1 Dependent Variable 1: Rapid Advancement

1.6.1.1 Independent Variable 1: Relative Advantage

The relative advantage of innovation refers to the superiority consideration associated with current innovation over an existing one and is increasingly stated as one of the most accurate signs or predictors of innovation adoption by several technological innovation studies such as (Al Hadwer et al., 2021; Chen et al., 2021; Yuen et al., 2021). Innovation is more likely to be embraced within an organisation if its importance, coupled with the relative economic benefits of technological innovation, shows a considerable advantage that will make a significant difference. It was found in the study of Chen et al. (2021) that relative advantage assists organisations in making successful decisions when adopting creative and original ideas or technologies inside their organisations. Hence, it is feasible to ascertain the relative benefit of any such technology by conducting assessments among the organisations currently using it or thoroughly investigating the theoretical application. According to the diffusion innovation theory, adoption is a process that depends on the organisation that is adopting the technology. Holmstrom (2021) asserts that a significant factor that needs to be kept in mind is the relative advantage of the technology. Subsequently, relative advantage serves as a measure to assess and compare established practices, tools, and technologies with new ideas or approaches introduced within a working environment or organisation. It empowers organisations to gain knowledge and make well-informed decisions regarding adopting innovative ideas or technology by evaluating their advantages concerning past methods or systems. The knowledge can then be used to develop a strategy that aids in successfully implementing technology that aligns with the core objective, leading to the formulation of the following hypothesis:

H1:* "*The relative advantage of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."

1.6.1.2 Independent variable 2: Compatibility

Technology compatibility describes innovation as aligning and integrating old, current, and future applications, usage, experiences, and future requirements of prospective adopters. The greater the level to which an innovation is harmonious with the current situation and requirements of the user, the lower the switching costs and uncertainties, and the greater the likelihood that an innovation will be accepted (Jeon et al., 2023). Empirical investigations, including the study by Foroughi et al. (2023), have confirmed the beneficial impact of compatibility on persons' intention to use technology. Moreover, it is widely acknowledged that engaging in technology experimentation can offer valuable insights into its compatibility, enable the evaluation of associated hazards, and facilitate the implementation of effective risk mitigation strategies. With that knowledge, an organisation can choose the most appropriate choice for innovation adoption and, according to Al Hadwer et al. (2021), proceed to make the most appropriate decision for organisational growth. Compatibility is essential for the successful implementation of innovation during the adoption phase. Numerous studies (Ali and Freimann 2021; Mabad et al., 2021), have indicated that before implementing any novel idea or concept within an organisation, it is essential to assess its compatibility with the established practices. In such an occurrence, since the diffusion of innovation model states that the innovation's users and drivers should evaluate its risks, the organisation would need to assess the possible changes they may need to consider after adoption for successful implementation and, subsequently, make informed decisions about synchronising that technology to or with their process, objectives, or policies. Then afterwards, the organisation can choose the most compatible manner to adopt the technological innovation and make the right decision, leading the company towards increased capacity and attaining a competitive edge (Ghaleb et al., 2021). This evaluation of this process ultimately resulted in the development of the subsequent hypothesis:

H2: "The compatibility of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."

1.6.1.3 Independent variable 3: Complexity:

In seeking or adopting innovation, many organisations need to focus on the complexity of the innovation, or invariably, it may lead to failure for several reasons. Because technology is multi-layered, depending on the needs and nature of the emerging technology, it will be expedient for the organisation to have knowledge or training on the technicalities that can support an understanding of the complexity of the technology. For instance, if an organisation wants to implement a system to improve capacity. Failure to complete the change correctly will result in several obstacles and complications that could potentially cause the business to experience setbacks or significant financial losses. Therefore, organisations must possess a comprehensive understanding and recognition of the complex nature of innovation before deciding to embrace it. Numerous studies (Chen et al., 2021; Ghaleb et al., 2021; Stjepić et al., 2021), have used this variable to understand technological adoption better. Consequently, this study formulated the hypothesis below:

H3: "The complexity of emerging digital technologies has a negative influence on the willingness of an organisation to adopt technological innovation."

1.6.1.4 Independent variable 4: Trialability

The rate at which an innovation is adopted is determined by its trialability, which occurs when a service or product may be employed without additional resources. It refers to putting an idea or process through its paces before implementing it successfully within an organisation.

According to the study of Alhashem et al. (2023), trialability as an idea, concept, product, or service allows the organisation to understand better how people perceive the innovation and describes if it will be accepted and impacts how quickly it is assimilated. Initially, the practice of engaging with clients through social media was implemented to conform to established protocols and standards; however, this approach was subsequently discontinued due to its widespread acceptance (Wu et al., 2022). Consequently, organisations have been gaining recognition for their endeavours in effectively communicating with clients on social media platforms, as they have exhibited remarkable dedication in satisfying client needs and reaching their expectations. Each organisation has implemented a strategic approach to actively involve customers and increase their knowledge about the company's offerings and solutions. Every organisation has achieved success through the implementation of this strategy, which has now become the established norm. The study by Ullah et al. (2021) emphasises the importance of individuals engaging in experimentation with innovation before its adoption. Therefore, the present study has formulated the following hypothesis:

H4: "The trialability of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."

1.6.1.5 Independent Variable 5: Perceived Ease of Use

Organisations are required to embrace innovative solutions that restructure work processes for employees and enhance the ease of conducting business for consumers. However, the advancement must encompass the active participation of all relevant parties, fostering an environment where innovation is embraced. Subsequently, the organisation may require additional resources to utilise all the necessary technology effectively, which invariably provides a guarantee for the dissemination of comprehensive knowledge regarding the advantages and merits of the technology in question. To achieve a thorough comprehension of the applicability level of a technology, it is advisable to incorporate a pre-adoption phase into the initial stage of technology adoption. Multiple studies have included the variable of perceived ease of use under the Technology Acceptance Model to investigate technology. This model focuses on individuals' opinions regarding the benefits, advantages, and utilisation associated with technology-based products, services, or applications. A correlation has been identified between the perception of ease of use and qualities such as trust, convenience, and positive perception by several research studies (Vahdat et al., 2021; Yuen et al., 2021). Therefore, the variable can also be referred to as a measure of the discernment of technological innovation leading to the development of the hypothesis below:

H5**:** ***"The perceived ease of using emerging digital technologies has a positive on the willingness of an organisation to adopt technological innovation".***

1.6.2. Dependent Variable 2: Organisational Readiness

1.6.2.1 Independent variable 6: Top management support

The acceleration of technology advancement signifies a significant change. It highlights the importance of decision-makers across different industries embracing an adaptable mindset towards transformation, which is discussed as being essential in establishing organisational readiness for the incorporation of emerging digital technologies (Marei et al., 2023). Additionally, decision-makers should demonstrate a willingness to implement changes, generate novel ideas, products, or processes, promote diversity, and foster innovative thinking. According to the study by Ghaleb et al. (2021), this refers to the strategic acumen of an organisation's leadership and their capacity to exert influence on the adoption of innovation through engaged involvement throughout its implementation and execution. For an organisation to foster innovation, the top management personnel must exhibit qualities of innovation, such as a willingness to take calculated risks and pursue new concepts without concern for adverse consequences. The acquisition of advanced skills necessary for developing technologies such as artificial intelligence is often hindered by internal constraints, such as limited resources or the organisational context.

Consequently, organisations are progressively adopting open-source technologies for product and service development. The decision to undergo a strategy shift is motivated by the acknowledgement, as indicated in the studies by Soto Setzke et al. (2023), that the implementation of these technologies necessitates specialised knowledge and skills in advanced technology, which may be deficient within the organisation or a specific geographical region. The rationale behind the collaboration of certain organisations in cross-continent labour exchange can be attributed to the increasing importance of intellectual property and proprietary knowledge in the adoption of innovation (Oliveira et al.,2019). As a result of the confidentiality involved in such interactions, the significance of managerial support has been acknowledged as an essential requirement for organisational viability, irrespective of the specific industry. In organisational settings, it is customary for strategic objectives and performance goals to originate from the uppermost level of the hierarchy; these objectives and targets are then disseminated and implemented by following planning and cascading down the organisational structure.

Therefore, highlights the importance of encouraging comprehensive organisational support for technological advancements, as well as the requirement for significant commitment and supervision in managing and implementing emerging digital technologies. The development of the requisite knowledge and skills for this incremental transformation is often focused on senior-level executives, creating a channel for the integration of advantageous innovations to disseminate throughout the entire business. Hence, the offering of support from top management can facilitate the integration of intricate emerging technologies into organisations, and this support can be achieved by assuming the role of internal owners who steer the organisation's innovation goal and establish statistically significant associations with the firm's success (Oliveira et al., 2019). Several studies (Al Hadwer et al., 2021; Oliveira et al., 2019), have studied this variable in adopting technological innovation. Therefore, the present research formulates the following hypothesis:

H6: "Top management support of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."

1.6.2.2 Independent variable 7: Technology readiness

Technological readiness refers to the rate at which an organisation or an economy self-accelerates, and according to the study by (Durst et al., 2023), pertains to competencies, and proficiencies of individuals and organisations concerning advanced information, as well as the continuous evolution and adaptation of technology. Organisations undertaking or preparing for a highly immersive adoption of emerging digital technology coupled with the organisation's existing structural build-up will be heralded as displaying the traits of technological readiness (Moldabekova et al., 2021). Technology readiness is described as an organisation's willingness or openness to accept and apply emerging digital technologies to achieve rapid advancement in various areas of application. This variable depicts organisational readiness based on its linkage to industry leadership and advantage, indicating how integrating the existing and new infrastructures will support the adoption of emerging technology (Abd El-Hamed et al., 2021). In an approach comparable to the application of the variable shown in the research conducted by Oliveira et al. (2019), the present study proposes the following hypothesis:

H7: ***"Technology readiness for emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."***

1.6.2.3 Independent variable 8: Technological Partners:

The availability, access, and support from partners have been shown to impact such organisations' adoption of technological innovation. Organisations often must engage partners to support the readiness of emerging digital technology due to expertise, products, services, or application requirements. Organisations usually need multiple external stakeholders to implement deliverables; this focuses on selecting appropriate technological partners, especially hardware, software, and development related to emerging digital technologies.

Creating a constant, efficient network of technology partners can provide the partnership level needed to adopt emerging digital technologies and guarantee differentiated and high-calibre support to suit such technology. Due to this, several studies have found items like pressure from the partner, expertise from the partner, and influential partners. This element is critical in determining how the organisation engages in innovative practices (Chen et al., 2021; Holmstrom, 2022) and leads to the development of the hypothesis below:

H8: "Technology partner support has a positive influence on the willingness of an organisation to adopt technological innovation."

1.6.2.4 Independent variable 9: Regulatory Policies:

Regulatory support includes government compliance processes and policies that significantly impact organisations' adoption of innovative technology. Influence in this regard could be one with limitations, such as the government imposing taxes on specific activities to deter organisations from implementing certain technological innovations (Malik et al., 2021). However, a more prevalent occurrence is one where favourable regulatory policy provides a supportive environment to encourage investments and actions in technology. For example, some African countries drive I4.0 by offering free land for factories to develop and enhance technological innovations and infrastructural development, while other cases include enacting policies regulating fast-growing technology use to control content or make revenue. Similar to Chen et al., (2021), the term regulatory policies in this study pertains to the regulations established by the government in different industries or nations inside an organisational framework. These policies encompass implementation, compliance, and application and can have either advantageous or adverse impacts on the organisation's preparedness.

Different regulatory policy changes regarding technology have occurred in multiple countries across multiple continents. The US enables policies to allow organisations to achieve "innovation through reusable and open-source software" based on the “Memorandum M-16-21 Federal Source Code Policy (FSCP)” (United States Department of State.,2022). In the United Kingdom, the government has a roadmap to address gaps in the regulatory application of emerging technologies (UK Department for Business, Energy, and Industrial Strategy 2020). In Europe, the regulation allows e-commerce platforms to operate differently from physical media (Digital Regulation). In Africa, there is the creation of an Africa Union High-level Panel on Emerging Technologies (APET) to guide the African Union member states on “supporting identifying and prioritising emerging technologies as significant growth drivers for the African continent" (Neped org., 2022). A multitude of scholarly investigations (Chen et al., 2021; Malik et al., 2021), have been conducted to enhance comprehension of technology adoption by examining this variable. As a result, the present study developed the hypothesis:

H9: “Regulatory policies for emerging technologies have a positive influence on the willingness of an organisation to adopt technological innovation.”

1.6.2.5 Independent variable 10: Competitive Pressure

The level of competition can enhance specific organisations' efforts to adopt technology, giving them some competitive advantage. Emerging digital technologies have significantly altered the fluctuations in competition in the industry, business models, organisational structures, and processes, among other things. Technological innovation has been known to breed competition, primarily because technological innovation requires a change or enhancement of systems, coupled with a bid to retain existing, gain new market share, or even diversify to maintain firm innovation performance. According to Al Hadwer et al. (2021), there is enormous pressure to maintain a competitive edge, and the proliferation of emerging digital technologies has created more determination for organisations to evaluate their holistic strategy. The presence of pressure contributes to the survival instinct of the organisation, which serves as an essential driver in fuelling technical innovation. Organisations face an urgent obligation to employ strategies for product, service, and process innovation to effectively and expeditiously address the challenges posed by emerging competitors. Irrespective of the specific sector, established organisations generate a demand that serves as a prominent catalyst for innovation. These conditions have the potential to go beyond the boundaries of specific organisations and industries and may even have a global impact. A notable illustration of this occurrence is the differences in features that exist in mobile devices, as well as the annual release of new devices and equipment by manufacturers, which are motivated by their obligation to maintain profitability (Stjepić et al., 2021). Several studies have examined this variable to comprehend technological adoption within different contexts, and as a result, for the intent of this study, the following hypothesis was developed: this study developed the hypothesis:

H10: "Competitive pressure for emerging technologies has a positive influence on the willingness of an organisation to adopt technological innovation."

1.6.3 Dependent Variable 3: Firm Innovation Performance

1.6.3.1 Independent variable 11: Organisational Innovativeness

Organisational innovativeness refers to the implementation of new and original changes within an organisation. Research conducted by Mai et al. (2023) suggests that this innovativeness can be associated with various factors, such as organisational structure, internal procedures, financial capacity, resources, and information derived from both internal and external sources. Additionally, organisational innovativeness serves as a driver for the capacities and capabilities of an organisation to be used to create unique and distinct value-added products and services as a strategy to build and grow firm innovation performance (Prifti, 2019).

Organisational innovativeness has been associated with firm innovation performance due to the profit associated with cost reduction from improved methods of operational cost reduction and is defined as "A new organisational method in business practises, workplace organisation or external relations" (Doloreux et al., 2019; Tweneboah-Koduah, E. Y. et al., 2020; OECD, 2005, p. 49). As a result, this research will use this variable to gain a deeper understanding of firm innovation in an approach consistent with previous studies conducted by (Anning-Dorson et al., 2018; Ghosh and Srivastava 2021; Gunday et al., 2011), subsequently led to the development of the following hypothesis:

H11: "The greater the adoption of organisational innovation, the more the firm's innovation performance improved."

1.6.3.2 Independent variable 12: Process Innovativeness

Process innovation is related to the commencement of modes of operations that shift from previous methods and drive more efficiency in the product or service outputs (Gunday et al., 2011). Process innovation is described as "a new or significantly improved production or delivery method, including significant changes in techniques, equipment and software" (Doloreux et al., 2019; OECD,2005, p.49). Process innovativeness facilitates organisations to implement transformative, radical, technological leading-edge approaches that can bridge the gaps between the continuous demands of customers with the end goal of higher organisational achievement. Some studies found a disparity in how process innovation affected firm innovation performance in developing and developed countries, with the latter experiencing a more substantial impact. The study of Anning-Dorson et al. (2018) has examined this variable to comprehend technological adoption, and as a result, this study will use measurements items from that study, leading to the development of the hypothesis below:

H12: ***"The greater the adoption of process innovation, the more the firm's innovation performance improved."***

1.6.3.3 Independent variable 13: Product and Services Innovativeness

This variable is defined as "a good or service that is new or significantly improved", which incorporates but is not limited to "significant improvements in technical specifications, components and materials, software in the product, user-friendliness or other functional characteristics" (Doloreux et al., 2019; OECD,2005, p.49). Success in product development leads to a surge in sales and revenue due to its contribution to acquiring and retaining new customers. Consequently, product and service innovativeness will be measured using similar items from previous research on innovation and firm innovation performance (Anning-Dorson et al., 2018; Gunday et al., 2011). As a result, the hypothesis below was developed:

H13: "The greater the adoption of product and service innovations, the more the firm's innovation performance improved."

1.7 Research Objective

The research study will evaluate innovation adoption via emerging digital technologies. It will also assess the factors that affect the rapid advancement of emerging digital technologies (the IoT, I4.0, and AI). There will also be an evaluation of factors influencing the organisational readiness to use emerging digital technologies to drive innovation adoption.

1.7.1 Research Methodology Outline

The research will use quantitative methods, focusing on using detailed questionnaires with the management staff of large organisations that use the emerging digital technology studied within the research.

1.7.2 Research Scope and Limitations

The research will focus on organisations located across three continents involved in manufacturing directly via their product and services or in partnership with the manufacturing industry. The following sectors (telecommunications, banking, construction, healthcare and insurance, energy, and transportation) will be included in the data collection to have a diverse product and service mix.

1.8 Structure of the Thesis

The thesis is currently structured into the following chapters:

Chapter One discusses the introduction to the adoption of innovation's initial rationale for various emerging digital technologies and applications, leading to the background for the research and questions. This chapter discusses the foundation and development framework using theoretical models.

Chapter Two This chapter discusses a literature review of the adoption of innovation, several types of innovation, theories, and discussions on the adoption of innovation and firm innovation performance. This chapter also discusses emerging digital technology and its types and highlights the specific classes that will focus on the study. The chapter also highlights the interrelationship between the IoT, AI and I 4.0 with examples from various industries.

Chapter Three discusses research methodology, purpose, and strategy, highlights similar studies applying the same method and the data collection.

Chapter Four discusses data analysis of the research hypothesis and the associated variables.

Chapter Five discusses the answers to the research questions and highlights all the impact on the variables.

Chapter Six discusses the research contribution, limitations, and future research recommendations.

Chapter 2 Literature Review

2.1 Theoretical Framework

The following section discusses the literature review that builds the theoretical framework for independent and dependent variables. Each research question, its associated variable and the rationale behind the selection from theoretical frameworks will be discussed separately, with each hypothesis stated afterwards for clarity.

2.1.1 RQ1: Theoretical Framework for Rapid Advancement:

There is a heightened pace at which modern technologies are being developed and implemented, even as significant discrepancies persist in the global acceptance rate. Advancements in emerging technologies significantly affect the real economy, society, and culture. Although, as discussed within several studies (Rajan and Sushil, 2022; Shulla and Leal-Filho, 2023), these provide a huge opportunity to contribute to the "2030 Agenda" and the "Sustainable Development Goals", the rapid advancement of technology is raising new concerns for the government, which could indicate a requirement for additional knowledge. Consequently, there is a need for a shift in the capacity development of organisations, governments, and human civilisation to adjust to transformations that arise from emerging digital technologies, especially given the influence they may have on labour markets, the perpetuation of disparities, and the emergence of ethical dilemmas. Fulfilling needs that are facilitated by technological innovation and adoption and are experimental and unique enables extensive and more significant goals, an occurrence that makes it imperative for organisations to expand for competitive growth (UNCTAD, 2020).

According to Amini and Jahanbakhsh Javid (2023), the growth of emerging digital technologies has been associated with rapid advancement in various areas like jobs, products, services, and industry mergers and acquisitions, and even affecting governmental decisions due to the sheer amount of data generated at a fast pace and required for decision-making. Although the role of digital technologies like IoT and I4.0 in the instantaneous rate of growth and evolution within organisations has increased, there have also been limited studies evaluating the effect of the rapid advancements of technologies within an organisation and the ensuing impact on innovation adoption. An example is the Industrial Revolution, which is also a rapidly growing form of digitalisation that is enhanced, swift, readily available, and increasingly visible through emerging digital technologies. The unprecedented growth and advancement necessitate organisations to continually adapt, evolve, and implement new forms of technology to transform their business and ensure continuity.

Table 1. 2 RQ1: Research Hypothesis

RQ1: What impact does the rapid advancement of a combination of emerging digital technologies have on the adoption of innovation?		
Factors Affecting Adoption of Innovation (Variables)	**Hypothesis**	**References**
Relative advantage	H1: **Positive**: "The relative advantage of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."	(Al Hadwer et al., 2021) (Yuen et al., 2021)
Compatibility	H2: **Positive**: "The compatibility of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."	(Al Hadwer et al., 2021) (Yuen et al., 2021)
Complexity	H3: **Negative:** "The complexity of emerging digital technologies has a negative influence on the willingness of an organisation to adopt technological innovation."	(Al Hadwer et al., 2021)
Trialability	H4: **Positive**: "The trialability of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."	(Ullah et al., 2021)
Perceived ease of use	H5: **Positive**: "The perceived ease of using emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."	(Vahdat et al., 2021) (Yuen et al., 2021)

Information from this table (thesis) was also extracted for publications, as stated in the bibliography.

The rapid advancement of innovation has been attributed to the lower cost of synchronisation and transmission of various forms of digital technology, making the dispersion faster than anticipated ((BEIS, 2020). Consequently, as more innovation elements are made mainstream through open innovation strategies, the penetration of the technologies is itself compelling a growth that pushes across the blend of physical and digital development of platforms that are adding to the transfer of knowledge, skills, and expertise of these complex technologies (Sriram and Hungund, 2021). A considerable number of emerging technology and adoption studies have applied the Diffusion of Innovation Theory (DOI), the Technology Organisation Environment Theory (T.O.E.), and the Technology Acceptance Model (T.A.M.) in numerous ways. Selected variables from those four theories will be used in this study to establish the impact of emerging digital technologies. For the dependent variable of rapid advancement, factors from the diffusion of innovation theory and the technology acceptance model will be merged to measure the variable.

2.1.2 RQ2: Theoretical Framework for Organisational Readiness:

Organisational readiness is the association between the procedures, systems, people, and performance measurements. According to (Yuen et al., 2021), organisational readiness can be attained through synchronisation and coordination to achieve successful implementation. In the case of the adoption of innovation in any organisation, it is essential to ensure readiness, or else the core purpose of the adoption will not be achieved. Organisations, therefore, design the process and align people with it to coordinate the efforts and exchange alterations. Technological advancements have made it essential for organisations to adopt technology to be competitive. Adoption is generally initiated by recognising the organisation's needs and researching them to develop a practical solution.

The organisation's readiness for digital technology is becoming an area of focus attributed to the "rapid emergence and scaling of new digital technologies”, with studies such as those of (Zhu et al., 2021) identifying the need to investigate the impact of organisational readiness for artificial intelligence on growth and activities. In other words, AI readiness may be defined as an organisation’s prelude to changes involving applications and technology associated with the technology. Emphasising the notion that organisations could potentially derive advantages from the identification of gaps to facilitate the effective adoption of artificial intelligence, an evaluation may be required to decide whether to use AI; such in-depth investigations could lead to organisations using AI readiness assessment processes to guide the growth of their assets, skills, and commitments. Hence, by accurately assessing its AI readiness and obtaining the necessary implications and possible conclusions before implementation, an organisation has the potential to mitigate risk and augment the adoption process.

The present study, like various studies (Chen et al., 2021; Ghaleb et al., 2021; Stjepić et al., 2021), hypothesises that adverse effects are attributed to the increased complexity of select emerging digital technologies or the lack of understanding of their application. Consequently, the concept of technological dispersion is increasingly necessary for diverse organisational practices. As a result, multiple decisions are required to ensure organisational readiness to embrace emerging digital technologies, invest, implement, and apply modern technologies, or evaluate and adapt to existing technologies, as mentioned by the study of (Ye et al.,2022) necessitating a focus on the ability of the organisation to be abreast of technological developments. The relationship between organisation readiness and innovation is related to studies that have proposed that an organisation's implementation and the need for innovation are borne from the need for a versatile external environment. Therefore, an organisation needs to tap into new external elements of emerging digital technology to enable its readiness internally and innovate, and in examining organisational readiness for further understanding this study used various variables from Tornatzky and Fleischer, (1990)’s TOE Model.

Table 1. 3 RQ2: Research Hypothesis

RQ2: How does the organisation's readiness for a combination of emerging digital technologies affect innovation adoption?			
	Factors Affecting the Adoption of Innovation	**Hypothesis**	**References**
Technology	**Top management support**	**H7: Positive** "Top management support of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."	(Oliveira et al., 2019)
Organisation	**Technology readiness**	**H8: Positive** "Technology readiness for emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."	(Oliveira et al., 2019)
Environment	**Technology partners support**	**H9: Positive** "Technology partner support has a positive influence on the willingness of an organisation to adopt technological innovation."	(Chen et al., 2021) (Holmstrom ,2021)
	Regulatory Support	**H10: Positive** "Regulatory policies for emerging technologies have a positive influence on the willingness of an organisation to adopt technological innovation."	(Chen et al., 2021) (Malik et al.,2021)
	Competitive Industry pressure	**H11: Positive** "Competitive pressure for emerging technologies has a positive influence on the willingness of an organisation to adopt technological innovation."	(Chen et al., 2021) (Holmstrom ,2021) (Stjepić et al., 2021)

Information from this table (thesis) was also extracted for publications, as stated in the bibliography.

2.1.3 RQ3: Theoretical Framework for Firm Innovation Performance:

The study examines firms' innovation performance, which studies Ortega and Serna (2020) refer to the organisation's capacity to generate sustainable revenue through its operational activities, with this performance evaluated using specific metrics. The rapid advancement of emerging technology has caused a surge in applying such elements to facilitate the growth and sustainability of firms. Accordingly, the study of Guo and Xu (2021) discusses that the ability to adapt to the competitive terrain in most industries is driving an insatiable surge in emerging technologies like the three discussed within this study to support the drive for profitability. The indication is that growth involves creating new opportunities for various segments, categories, and strategic business units and staying ahead of the competitive curve through the usage of internal and external capabilities. Specific emerging technologies substantially impact firm innovation performance more than others due to the distinctive characteristics and ensuing benefits of the various emerging technologies. This study focuses on three significant impacting technologies intertwined into applications that are influential technologies cutting across all segments, categories, clusters, and multiple industries and creating transformational change. Therefore, organisation, process, and product and service innovativeness will be used to evaluate firm innovation performance, similar to studies (Anning-Dorson et al., 2018; Gunday et al., 2011).

Table 1. 4 RQ3: Research Hypothesis

RQ3: What impact does the adoption of a combination of Emerging Digital Technologies have on firm innovation performance?			
	Factors Affecting the Adoption of Innovation	**Hypothesis**	**References**
Firm innovation performance	**Organisational Innovativeness**	**H11: Positive** "The greater the adoption of organisational innovation, the more the firm's innovation performance improved."	(Ghosh and Srivastava, 2021)
	Process Innovativeness	**H12: Positive** "The greater the adoption of process innovation, the more the firm's innovation performance improved".	(Anning-Dorson et al., 2018)
	Products and Services Innovativeness	**H13: Positive** "The greater the adoption of product and service innovations, the more the firm's innovation performance improved."	(Anning-Dorson et al., 2018)

Information from this table (thesis) was also extracted for publications, as stated in the bibliography.

2.2 Explanation of the combination of theoretical Framework, selection process and justification

The following section discusses the literature review that builds the theoretical framework for independent and dependent variables. Each variable will be discussed separately, with each hypothesis stated afterwards for clarity. The research design demonstrates an intertwined integration of theoretical frameworks to examine technology adoption and innovation dynamics in organisations (Venkatesh et al., 2003). This consolidated approach addresses three distinct research questions through the integration of four key theoretical frameworks: the Diffusion of Innovation theory (DOI), Technology Acceptance Model (TAM), Technology-

Organisation-Environment (TOE) framework, and Resource-Based View (RBV) theory (each theory has been explained in detail in the next section).

Several recent studies have successfully combined these theoretical models to examine emerging technology adoption. The integration of TOE and DOI frameworks has been effectively used to study AI adoption (Chen et al., 2021) and IoT implementation (Ali et al., 2021; Mabad et al., 2021). TAM and DOI combinations have proven valuable in examining Industry 4.0 adoption (Yuen et al., 2021), while TAM and TOE integrations have been successfully applied to AI implementation studies (Na et al., 2022). Additionally, the TAM framework alone has demonstrated its versatility across various technological contexts, including mobile applications (Vahdat et al., 2021), AI (Ali and Freimann, 2021), and IoT/Blockchain technologies (Ullah et al., 2021).

The research combines DOI with TAM to understand rapid advancement insights. This combination effectively bridges the gap between organisational and individual perspectives on technology adoption (Rogers, 2003; Davis, 1989). DOI contributes essential elements for understanding innovation diffusion, including relative advantage, compatibility, complexity. These constructs provide valuable insights into how innovations permeate organisational systems (Frambach and Schillewaert, 2002). Complementing this organisational view, TAM introduces critical individual-level factors, particularly perceived ease of use, creating a holistic framework that captures both the systemic spread of innovation and individual acceptance factors (Klein and Sorra, 1996).

In examining organisational readiness, the research employs a merger of TAM with the TOE framework (Tornatzky and Fleischer, 1990). This integration elevates TAM's acceptance constructs to the organisational level whilst incorporating contextual elements through TOE (Baker, 2011). The framework considers both internal and external influences through specific variables: top management support, technological partner support, regulatory policies, and competitive pressure (Henderson et al., 2012). This approach enables a comprehensive assessment of organisational preparedness that accounts for both technological acceptance and environmental conditions.

The evaluation of innovation performance relies primarily on the RBV theory (Barney, 2007). This theoretical foundation examines three key innovation parameters (Grant, 1996). Firstly, organisational innovativeness encompasses internal resource capabilities, dynamic capability development, organisational learning, and knowledge management capabilities (Teece et al., 1997). Secondly, product/service innovativeness considers new product development capabilities, service innovation competencies, market responsiveness and customer value creation (Damanpour and Gopalakrishnan, 1998). Finally, process innovativeness examines the organisation's capacity to implement and expand internal procedures.

The integration of these theoretical frameworks is justified through several critical considerations. While DOI provides a macro-level view of how innovations spread through social systems, TAM fills the gap by explaining individual acceptance behaviours. TOE complements both by adding crucial organisational and environmental contexts that neither DOI nor TAM fully address. Recent empirical studies demonstrate the limitations of using single frameworks, with TOE and DOI combinations proving particularly effective in AI adoption studies (Chen et al., 2021) by simultaneously capturing both organisational readiness and innovation characteristics.

This multi-level approach is important because technology adoption decisions in organisations are influenced by factors at various levels - individual users' perceptions (TAM), innovation characteristics (DOI) and organisational context (TOE). The combination also addresses temporal aspects of innovation adoption. While TAM effectively predicts initial acceptance, DOI better explains the diffusion process over time, and TOE captures the evolving organisational context (Damanpour and Gopalakrishnan, 1998).

Therefore, selection of variables reflects both theoretical rigour and practical applicability (Teece et al., 1997), ensuring the framework can generate valuable insights for both academic knowledge and managerial implementation (Grant, 1996). Therefore, this balanced approach creates a concrete foundation for examining technology adoption and innovation in contemporary organisational settings.

2.2.1 Theory 1: Diffusion of Innovation Theory (DOI)

The DOI theory is a description of the way goods or services are spread, gain momentum, and dissipate via a particular population or social system (Rogers E. M, 2003). DOI explains the ability of a product or service to gain momentum from the process of adaptation and usage. Hence, adoption can be characterised as the act of implementing alternative approaches that yield improved outcomes in terms of effectiveness and efficiency. According to Rogers E. M (2003), the disparity leads to individuals implementing contemporary concepts and disseminating innovative ideas or products. In this regard, adoption refers to an act that is different from the norm or operates in contrast to how the business typically performs its operations. DOI theory examines the use of internal capabilities and strengths to create a hybrid web of novel ideas that are leveraged externally and spread using technology to become an internal performance facilitator. The notion of diffusion comes from the ability of the innovation to prompt ongoing use after initial access. Subsequently, the constant conversion can be likened to the unabated spread associated with an infectious disease, which facilitates the creation described by Das (2022) as ensuring a constantly regenerative organisational, process service or product innovativeness. Innovation diffusion has also been discussed as unlimited and undeterred by the ability to grant unfettered access to the adopter. An observation coupled with the fact that this complete access leads to emerging, enabling, radical, disruptive innovations transforming the development and profitability of cross-border commercial goods. The study of Attie and Meyer-Warden (2022) discussed that it is an indicator of how novel technologies developed and are still evolving in a permeating manner across continents, improving lives and driving knowledge and economic growth.

Potential users tend to use or apply technology when they expect modern technology to provide superior benefits over currently available technologies. Therefore, there is a predetermined expectation regarding technology, its occurrence, and how it is adopted in the environment. Hence, while incorporating a novel concept or technological advancement, it is imperative to acknowledge that individuals may vary in their ability to adapt, with some readily embracing the change. In contrast, others may require a more extended period to assimilate and integrate it into their daily routines. Consequently, the study by Mabad et al. (2021) discusses that organisations must train employees to comprehend the innovation and, at the same time, drive its adoption smoothly and successfully. The COVID-19 pandemic has contributed to the adoption of various techniques to provide uninterrupted and adaptable organisational operations. For instance, according to the study by Van Zyl et al. (2022), the "work-from-home policy" has caused many organisations to suffer huge losses, while some have experienced notable improvements in their efficiency and productivity, resulting in cost savings. The reason behind that is the diffusion of the innovation concept, whereby the organisation that adopts innovation as a process becomes successful and uses it to set a new working benchmark regardless of their industry.

On the other hand, organisations that fail to comply with the theory regard the approach as failing and bear the losses or ramifications. Organisations that consider this idea new and innovative generate a considerable level of advantage that also minimises operational costs. Additionally, others who merely consider it an option continue to struggle to survive in an evolving terrain (Heinonen and Strandvik, 2021). Therefore, in adopting any new policy or technology in any organisation, it is essential to consider certain factors that aid in understanding the relevancy and efficiency of embracing innovation. This theory will be discussed further as one of the predominant models used to develop the theoretical framework for this study.

2.2.2 Theory 2: Technology Acceptance Model (T.A.M.)

As a result of the many detailed studies carried out on T.A.M. since its introduction in 1989, compared to other competing models, it is primarily regarded as the most stringent, predictive, and powerful tool available for assessing acceptance of innovative technological innovation improvements. The Technology Acceptance Model was introduced to understand the purpose of utilising a technical or technologically oriented innovation. It is linked to how individuals or organisations perceive how they want to use technology (Davis, 1989). The model as discussed by Mohr and Kühl (2021) predicts the appropriateness of technology and identifies requirements or modifications that users will accept, therefore observing how individuals and organisations try out innovative technologies to enhance overall performance.

T.A.M. examines innovation in the workplace and identifies two components as fundamental reasons for its reception. Firstly, customers' beliefs shape their attitudes toward advancements, and secondly, they shape their goals to enable them to take advantage of the innovations. It studies the concepts of utility and usability from the outside in terms of exterior qualities; therefore, this study will combine one of the elements of T.A.M., perceived ease of use, with other adoption of innovation theories like DOI and similar studies on emerging digital technologies and adoption of innovation. T.A.M. has been used and combined for research on various emerging technologies and the adoption of innovation theory and will be used within this study similar to other studies (Ali and Freimann, 2021; Vahdat et al., 2021; Yuen et al., 2021).

2.2.3 Theory 3: Technology Organisation Environment Theory (TOE)

TOE embodies an organisation's processes to develop, implement, and maintain technological innovations. Three significant elements according to Tornatzky and Fleischer, (1990) influence these processes within the technical, organisational, and environmental contexts.

Technological Context

The technological context illustrates the evolution and adaptation of technology in an organisation. It includes emerging digital technologies the organisation wants to adopt as part of its innovation and existing technology the organisation already uses. The concept is that emerging digital technology can be significantly beneficial to existing technology (Baker, 2011).

Organisational Context

The organisational context constitutes the internal structure that impacts technology adoption. The three major ones according to Tornatzky and Fleischer (1990) are top management alignment due to strategy and decision-making, organisational size, and technology readiness, which refers to the organisation's skills, structure, and willingness to adopt technology.

Environmental Context

The environmental context covers firm size, regulatory pressure, and competitive pressures. Additionally, it highlights differentiating factors between industries: some organisations with rapid advancement embrace innovation and technology faster than others. Some organisations as discussed by Tornatzky and Fleischer (1990) adopt government policies, and some are based on competitive pressure, all of which are embodied within the environment Therefore, as part of the assessment, this study will use a few variables from each of the elements of the TOE model, similar to studies (Ali et al., 2021; Srivastava et al., 2022)

2.2.4 Theory 4: Resource-Based View

According to the Resource-Based View Theory founded by Barney (1991), a firm's competitive advantage does not originate from tangible (raw materials, physical assets) and intangible (knowledge, competence, capability) resources alone. Instead, it arises from the availability of valuable insights that can direct an organisation into sustainable long-term growth within its environment. Resource-based view theory is discussed by (Chauhan et al., 2021) as based on the connection between diverse resources and a firm's ability to attain business objectives as it manages and organises these resources. The firm's resources must be varied enough to establish a strategic competitive advantage with innovative techniques that are eventually planned to enhance the firm's overall effectiveness and performance. Diversity often focuses on research and development to improve the knowledge that facilitates innovation and business efficiency for firm innovation performance (Ngo et al., 2022). If the firm uses the existing resources effectively, it will improve and enhance growth, and the study by (Hanelt et al., 2021; Rehman et al., 2023) discusses that if the business applies the available resources efficiently, the resulting action will cause the company to attain its aims and objectives and sustain growth, which will always be the aim and objectives of firms. The company's resource-based view (RBV) has been cited as an explanation that facilitates the profitable growth of a firm's technological innovation investment, including internal and external resources. In the past few years, research scholars Chand and Tarei (2021) have discussed funds' investment in one phase to reap advantages and then invest funds in the next phase to augment the ongoing project. The impact of those actions becomes magnified, leading various organisations to continue investing at a higher rate than their historical investment and that of their rivals.

2.2.5 Theory 5: Creative Destruction

The term 'creative destruction is identifiable with the Austrian economist Joseph Schumpeter, who in 1942 recreated the work of Karl Marx and popularised it as the modern theory of innovation and the business cycle. Creative destruction can be characterised as innovations in the production process that enhance organisational productivity through the radical transformative procedure of industrial mutation, which revolutionises the old structure with novel techniques from an emergent system.

Technological innovation linked to creative destruction is associated with a significant risk, which could be connected to the rapid evolution of emerging digital technologies. Organisations require new thought processes and developments to replace, complement, or combine with the existing thought process and current product to survive in business. A further explanation, as discussed by the study of Kaur et al. (2023), is the action of penetrating an area from within and transforming the existing characteristics into new ones to create newness for economic growth and development. A description that leads to industrial mutation with a continuous movement awakening a revolution from within destroying old features and bringing forth new and evolved features that improve an organisation's economic state. Therefore, creative destruction could be termed an invasion in terms of referring to the ability of the innovation adopted since diversifying business for firm innovation performance involves modifying the current business terrain by using novel techniques as a market entry technique for diversification, with the sole goal of profitability and being at the forefront of an industry in a competitive, evolving Industrial era. Subsequently, this leads to a description supported by Cefis et al. (2023) that innovation is not merely about creating destruction but about its formation and is at the core of competitive growth at the company and industry levels on both a micro and macro level.

2.3 Adoption of Innovation Ecosystem and Firm Innovation Performance

Several perspectives, as discussed, including IoT technical viewpoints, information technology capabilities of businesses, and contextual aspects, including relationships with outside parties, have been used to study emerging technological innovation. Adopting combined technological innovation ecosystems should be seen as a coevolving process in which actor dependencies are essential for organisational inputs, outputs, and performance mobilisation. Several ecosystems facilitated by emerging technologies are rising to enable growth in organisational performance. Therefore, based on the assertion of Soldatos et al. (2022), it is a high priority to encourage mergers of technological capacity and capability, leading to the surge of emerging technologies like IoT being used in new ways that progress automation and virtual manufacturing.

The progression is primarily supporting the growth of another term discussed by (Zhu and Du 2023, p 2) as “business ecosystems”. The concept is that compatibility with corporate networks such as academic institutions, forward-thinking organisations, and technology suppliers creates products and services that provide consumer value, advancing firm innovation performance metrics within the organisations. An example mentioned in the study by Zhu and Du (2023) is using Google's capability within emerging technologies to partner with car manufacturers on a self-driving car. Implementing such a strategy allows an organisation to access an entirely new group of customers, providing an opportunity for the company to demonstrate its increasing utilisation of innovative technology without having to collaborate with rivals out of concern about losing market dominance. Such growing strategies indicate that an organisation can still successfully achieve competitive organisational performance within an ecosystem if they focus on their core competence and continue to drive innovation that appeals to customers' growing needs. The fundamental idea is to collectively facilitate the exploration and exploitation of novel ways of growth, with the distinct element that binds these ecosystem types being the requirement for the unique capability that technology can enable. Adoption of innovation involves the practical application of ideas that result in differentiated or enhanced products or the provision of high-performing services to customers. Innovation is also defined as a modified entity that realises or redistributes value by rapidly developing procedures and services and engaging in technological advancement (Tiwari et al., 2021).

Innovation is adopting and assimilating value-added innovation across financial and social spheres, including transforming the product or service's capabilities. Innovation can be examined as a by-product of any progressive thought or development by the adopter, indicating that the right innovation strategy could consistently assist the organisation in gaining control over the issues they face as they contend in the market. As an achievement and vital tool for competitive advantage, the firm's innovation process is instructed by an implicit or explicit innovation strategy, which guides the use of specific resources. It could also assist in concentrating the efforts of the whole business entity to attain the firm's daily innovation goals (Hanelt et al., 2021). Technological innovation ecosystems are characterised by a mobile and flexible collaborative structure, which facilitates competition without confrontation between individual businesses due to the rising complexity and ambiguity of tasks in today's fast-paced business environment. The intense rivalry between industry partners encourages the shift from mechanical to ecological and organic forms of innovation, creating fierce competition externally, internally, and within ecosystems. However, within these ecosystems, organisations are expected to collaborate actively, which means that competition within an ecosystem is not hostile if it is mutually beneficial. Therefore, the growth of ecosystems is pivotal to the longevity of businesses. As a result, YuSheng and Ibrahim (2020) mention that organisations pay more attention to environments that foster co-dependent innovation. Some multinationals like Apple, Airbus, IBM, Procter and Gamble, Siemens, Microsoft, Google, and Haier are a few global leaders that have introduced collaborative and integrated innovation paradigms and developed enterprise-focused and open innovation ecosystems. The successful execution of resource collaboration and knowledge sharing, which the study by Olan et al. (2022) highlights as resulting in industry-altering originations, boosting a firm's growth potential and innovation capabilities.

Continuous innovation adoption enhances competitiveness and long-term growth, creating a borderless innovation ecosystem. The implication is that technological innovation and stakeholder management are related and lead to a steady expansion of global commercial and industrial clusters, which, as corroborated by the study of Haefner et al. (2023), affects firm innovation performance. Due to the growth advantage, new entrants or market followers have favoured unrestrictive technological advancement. Incumbents are initially cautious for several reasons, including but not restricted to the trepidation attached to applying profits or assets to purchase high-cost technologies, research and development costs, the longevity of emerging technologies, and the risk of liability and its effect on the organisational revenue bottom line. The ensuing tepid approach to technological innovation could be counterproductive and eventually result in a decline in industry advantage. However, for organisations with the tenacity to move past the fear, emerging and enabling technologies like AI, IoT, and I4.0 are integrated, combined, and effectively implemented, increasing differentiation, creating massive dispersion, and permeating across sectors, countries, and continents (Chen et al., 2021; Ghosh et al., 2021; Maddikunta et al., 2021). Many organisations still require convincing on the reliance on technology and use it primarily for experimental purposes or as a pilot or proof-of-concept initiative. Due to this, studies by Enholm et al. (2021) highlight that organisations may fail to attain their desired return from their AI investment, for example, when only implementing technology for practical purposes. Therefore, this is driving the suggestion that implementing AI in production or divergent organisational functions could increase revenue and experience exceptional growth.

Based on the reports and studies conducted in this regard, the growth and performance of any organisation are increasingly occurring due to the rapid adoption of advanced technology. Businesses worldwide have expanded their operations and increased their revenue due to technology. As technology advances and is accepted worldwide, Gans (2023) explains that organisations need to adopt AI-based technologies or other digital technologies to sustain themselves in the competitive market. Innovation is a complicated process related to modifying the organisation's strategy and business processes to develop and enhance distinctive technological competence. The adoption of innovation applied to the use of various resources a firm receives, combined with the internal adaptation of those resources, are fundamental factors that drive the performative abilities of the firm. After analysing the context, as corroborated by Hanelt et al. (2021), it is judicious to agree on the importance of organisational innovation adoption across various industries and countries. Although implementing any form of technological innovation requires a company to spend sufficient and considerable financial resources, it also propels the availability of unique and innovative products to meet consumer needs, demand, and market changes, invariably leading to firm innovation performance.

Meeting the ensuing needs and demands drives customer satisfaction and supports business profitability by giving the organisation a market advantage. Innovation and the firm's performance are related to inward economic growth and the country's development of the level of technology organisations use for industry maturation. The technology level would heavily rely on the company's revenue invested in research and development, and as Liu (2022) discussed, it could be seen as a function of the industrial innovation growth rate. The traditional approach of business entities focuses on main markets by using internal procedures and sources for profitability, further highlighting the importance of organisational readiness. Innovation adoption is facilitated by creating internal research and development units that support the continuous pursuit of innovation to target current or predetermined profitability areas. Firms must constantly innovate by staying ahead of their industries' latest trends and changes. As such, the sources by Chand and Tarei (2021) discussed that internal research and development are tools that organisations use to maintain the rampant existence of business innovation for high-quality products and services.

Innovation adoption and its impact on firm innovation performance have also been studied through types of innovation, and some of the most discussed types of innovation are incremental, radical, and disruptive. Incremental innovations can be seen as minor improvements to existing products, processes, or services that lead to a more efficient production process with higher-quality results at reduced expenses for the organisation. They could be minor improvements on existing products or processes to foster graduated change. Radical innovations are significant changes with breakthrough technologies that are further discussed by Kamal et al. (2023) as having the ability to affect an entire industry or create commercial markets in a new frontier. Disruptive innovations are discussed in the study by Antonio and Kanbach (2023) as large-scale changes in any form or fashion to the industry with a critical component of sustainable growth and a precursor to the engine of economic growth and progress. Due to the various definitions, innovations respond to outside forces such as modern technologies, regulatory or environmental changes, or changing customer needs. Therefore, Moring (2022) noted that innovations are visible in many industries and sectors, such as technology, architecture, health care, and recreating unexplored spaces or markets. Although there is increasingly a strategic focus on ecosystems of independent emerging digital technologies, the term is now used by many academics in various settings and has different meanings to add to existing knowledge. A common factor is that it involves collaborations, with a further instance of this discussed in the studies of Dupont et al. (2023), which described the concept of the innovation ecosystem as a "Do-It-Together" (DIT) network that fosters invention and is open to interaction, which is similar to the definitions of emerging technological infrastructures and is complementary. An ecosystem is described by Yang et al. (2022) as an analogue of an ecosystem, defined by biology as "a complex network of interactions to maintain a state of sustainable equilibrium, and subsequently, the fundamental idea has been applied to innovation management.

Innovation ecosystems can be defined from a macroscopic perspective that focuses on the organisational level of activities blended with cooperation and innovation. Such activities foster environments that encourage original problem-solving in businesses. Therefore, based on the assertions that an ecosystem's efficiency and stability result from various interactions within its surroundings. The ties inside an innovation ecosystem transcend those of a conventional value chain because of the ease with which suppliers, partners, and consumers may traverse international boundaries. It is an occurrence that could be valuable financially. Businesses operating inside innovation ecosystems might employ a competitive strategy, striving to gain market leadership while simultaneously driving the expansion, growth, and profitability of the ecosystem. In other words, a single business may participate in several nested ecosystems, and Hamilton (2021) discussed that each nest applies various technological techniques to fulfil its distinct function while still achieving a common purpose.

Digital innovation based on interconnection enables an expansion of the application of technologies that facilitate the combination of an ecosystem of emerging technologies like IoT, invariably opening more growth opportunities. The study of Coccia et al. (2023) elaborated on innovation as requiring a combination of capabilities and knowledge derived from various elements that impact the organisation, its products, and its services. Therefore, the definition within this study borders on the fact that innovation ecosystems require a collaborative, co-existing, and multifaceted combination of specifically selected technologies for strategic positioning that leads to organisations gaining a growth edge within their industries. The structure of technological interdependence within an innovation ecosystem affects firm innovation performance in new technology generations. According to the definition of an innovation ecosystem by (Adner et al., 2010), it is a breakdown of several innovation ecosystems that involve the use of emerging technologies combined to complement each other's capabilities and usage in creating value. Therefore, participants in the AI innovation ecosystem can integrate complementary resources through open collaboration, improve innovation efficiency and effectiveness, and ultimately achieve higher firm innovation performance. Based on the discussion by Redchuk et al. (2022), emerging technologies like I4.0 can act independently to suit the purpose of the application and, on the other hand, can be combined within an ecosystem to solve a larger purpose. Therefore, this indicates how organisations can use technologies like IoT and AI to adopt I4.0 as a tool for firm innovation performance. Some organisations are leaders, while others are followers who use combined technologies to achieve a competitive advantage. An illustrated example by Zhao and Yi (2022) is Xiaomi. It created an ecosystem of emerging technologies within a technological ecosystem that produces hardware and software powered by various technologies, working with partners and alliances and using their capabilities to drive consistently viable growth for the company. Conceptually, this study offers the framework of emerging digital technological ecosystems as an innovation adoption perspective that affects firm performance.

In addition, the innovation ecosystem can be discussed as co-creating value and driving firm innovation performance by consolidating tangible and intangible assets with the combination and input of various technologies, facilitating a valuable co-dependent result instead of providing independent outputs. It is concluded by Adner et al. (2010) that most innovation tends to fail if applied as a single element due to a high dependency on adjustments, improvements, and restrictions of the environment. Avoiding such failure leads to the rationale behind combining the technologies, which is to harness the collective capability that can arise from emerging technology dependencies like artificial intelligence, IoT, and I4.0 and their application within a network to achieve firm innovation performance for an organisation.

2.4 Adoption of Innovation and various types of Innovation

Innovation is explained by converting neoteric views and thoughts into universally used practices to produce creations. Innovation is not merely related to forming ideas but involves a broad classification of functions and business procedures engaged in exploited thoughts. Han et al. (2023) addresses the progression of digital technologies throughout their lifespan as they develop into complex systems that form the basis for the emergence of innovation. Subsequent innovations arising from specific procedure-based life cycle approaches can be summarised as action-based, targeted-oriented, and outcomes-oriented functions, forming a part of the collaborative work required for successful execution (Bustinza et al., 2021). Therefore, applications have the potential to offer a relative advantage, which, in turn, enables a holistic approach to nurturing innovation and fostering sustainable competition as innovative approaches unfold. Consequently, innovation should be distinguished from creation and necessitates a persistent, unconventional mindset that enables an organisation or individual to enhance their business over time through incremental improvements.

Innovation materialises due to unique and collaborative interactions among what the study by Chen (2022) discusses as a collaboration between various parties, platforms and technologies permeating various sectors and connected in a constantly adaptable network, including government agencies and business entities of all sizes. The rapid development of adaptable and flexible features is essential for technological innovation, as demonstrated by the evolution of the current online landscape and is instrumental to the global proliferation of information (Bogers et al., 2021). Innovation is a factor that empowers organisations to embrace flexibility in response to market dynamics, technological advancements, and competition, thereby catalysing growth and expansion across different industries and various purposes. Innovation tends to affect the structure of organisations with risk implications, wherein the successful application of innovation strategy requires tremendous changes with risk elements to be made during the company process. Various innovation adoption research has concentrated on the changes in characteristics that distinguish between already innovated and innovative organisations. Some research studies, by Gunday et al. (2011), have also looked at differentiators like product, process, and organisational innovativeness. The importance of the type of innovation relates to having a more robust comprehension of the organisational innovation functions, which is discussed as differentiating between innovation-generating and innovation-adopting-oriented organisations Shonubi O (2023). In the latter, innovation is not seen as a fundamental aim of the organisation but as a means of facilitating and contributing to the attainment of the company's primary goals, as opposed to the former, where innovative practises are primarily the reason for the organisation's existence. The decision by the innovation adoption-oriented organisation to apply innovative technology will be determined by whether the innovative technology fulfils the requirement that enables its adoption. Subsequently, the identical method is used to guarantee that embracing the emergent technological innovation would inevitably have a favourable impact on its capacity to utilise that advantage to maximise productivity while enhancing organisational performance, as concluded by the study by (Liu et al., 2022).

The "individualist", the "structuralist", and the "interaction process" perspectives are three fundamental perspectives in drivers of innovation adoption research. The "individualist perspective" indicates that individuals are the primary change agents driving organisational digital innovation; the structuralist perspective contends that the organisation's characteristics are the sole determinant of innovation adoption. The interaction level combines behaviour, acceptance, and practical routine use of information technology innovation at the individual level as the determinant driver of innovation Chakrabarty (2022). Based on the classification system used in research studies and by the OECD (2005), the upcoming section will describe different categories of innovation.

2.4.1 Open Innovation

Open innovation focuses on the purposefully organised flow of novel ideas across an organisation and its surroundings. Innovation can be defined as the change in how things are done or used by humans and linked to machines to generate ideas. Innovation is a series of continuous processes that can be defined as changing how we do things, think about something, or use ideas. Innovation does not have to be formalised into a group project or idea that needs to be reviewed by upper management before being implemented due to the heterogeneity associated with emerging technologies. The study by Livieratos et al. (2022) asserts that open innovation entails a clear emphasis on driving research and technological progress by harnessing the capabilities and capacities of stakeholders, all with the ultimate objective of achieving a specific goal. Furthermore, open innovation can be perceived as a technological advancement that facilitates the continuous transformation of market needs, predominantly driven by emerging technologies (Bigliardi et al., 2021).

The connection between open innovation, technological innovation, and firm innovation performance has been studied in various categories, encompassing 'inbound', 'outbound', and 'combined 'forms of creation. According to Chabbouh and Boujelbene (2022), inbound-open innovation centres on the “outside-in” approach that exposes the organisation to specialised expertise to improve capability and performance. The capability is known as the 'outside-in 'approach. It could be technical expertise, capacity, machinery, hardware, or other elements that enable an organisation to expand, diversify, or differentiate itself. Inbound-open innovation pertains to the exploitation of information in many ways; manifesting internal knowledge through outbound innovation opens the route toward commercialisation, spin-off, licensing, and open-source knowledge transfer.

In contrast, outbound-open innovation is centred on the 'inside out” system that enables progressive technological organisations to farm out their intellectual, patent, license or capacity to other firms or governments in return for the economic value of some kind. This category centres on the continuous and rapid internal advancement of emerging technologies to provide new concepts, ideas, and enhancements to for-profit external stakeholders. Implementing inbound-open innovation would make it easier for the firm to improvise its business operations and generate a larger share of profits from within the organisation (Sriram and Hungund, 2021; Tang et al., 2021).

The combined approach, predominantly linked to firm innovation performance, merges outbound and inbound innovation to improve efficiency from within and outside. The reason is to transfer skills, expertise, and tangible or intangible resources to increase the origination. This approach enables the organisation to create an avenue for growth, opportunity, or transformation with the unique combination of the internal and external capacity and capability to obtain a higher yield for and with technological innovation, leading to more extraordinary firm innovation performance (Bigliardi et al., 2021). The coupling of both types of innovation is the birth of emerging technologies through mergers and acquisitions of technological drivers like intellectual ability, proprietary information, bespoke licences, open-source, patents, and hardware. In multiple studies, the combined innovation involves a looped circle of competencies essential for emerging techniques and logical growth linked to firm innovation performance. The combination approach was explained by Chauhan et al. (2021) as improving efficiency, productivity, and access to technological advancements that the organisation would not otherwise be available. The combination approach, which incorporates either and outbound knowledge flows in the firm, can be described as the specific and targeted inward and outward flow of information that facilitates the overall innovation process. An occurrence that has also increased the market need and exploration of external innovations.

2.4.2 Product and Service Innovation

A product or service can be described as any physical good or the use of raw materials modified through various technologically advanced processes to satisfy a need. However, Blichfeldt and Faullant (2021) discusses that there is no prerequisite to having a prevalent blueprint in the market to generate revenue for the organisation.

Product and service innovation is significant to implement because the organisation must achieve its aims and objectives in a constantly modifying global world where inertia poses tremendous business risks that deter success. Innovation offers a way for the business entity to respond to all the threats, and Bustinza et al. (2021) describe it as a way to expand and use opportunities as they materialise over time. The organisation would need to constantly enhance innovation to meet the client's requirements, increase the customer base, and promote their services as goods to sustain growth. An example is the multipurpose business model strategy illustrated by the company Alibaba through its financial product Alipay. As highlighted by Sun (2023), the online financing product they offer provides inclusive financial assistance facilitated by purchasing products in its exclusive marketplace and provides information that enables the government to support innovation growth for firms, which invariable drives firm innovation performance.

Regarding the importance of enabling transformative growth, early in the Twentieth Century, watches were regarded as a type of jewellery, a complicated and specific product to develop, and expensive to purchase due to the process and the cost elements that go into its manufacturing. Swiss Watches brand excelled in developing prestige watches; regardless, they were increasingly thrust into competition with increased availability of low-cost manufacturers who started producing watches using technologically based innovations known as 'Swatch watches. The invention of the Swatch Wristwatch was a modification made to a regular watch by including a sequence of innovations using manufacturing-based technology. The change, coupled with the periodic introduction of various models made possible by technological development, enabled lucrative growth in the watch industry on a large scale (Moon, 2004). The Swatch manufacturers are located in Biel/Bienne, a town in Germany renowned for manufacturing multi-platform product enhancements, which, according to Jeannerat and Theurillat (2021), was developed with emerging I4.0 technology. The application of evolving technology was used as a profitable expansion tool for the new business division of the watch industry. It was described by Morisson de la Bassetiere et al. (2021) as redefining the product and changing the watch market exponentially, primarily due to product innovation for design and performance optimisation.

2.4.3 Process Innovation

Process innovation offers various advantages, with multiple aims to reduce the cost of production, enhance the product's quality, increase productivity, and improve stability and efficiency, with mutually beneficial gains for both the organisation and its customers. According to Seclen-Luna et al. (2021), the modalities within process innovation have a unique tendency to be invisible to the firm's clients, indicating that this type of innovation is a back-staged (internal) function in the organisation. However, its importance could create a ripple that affects products and service delivery and inadvertently negatively influences an organisation's performance if there is a lag within the internal structure. Therefore, process innovation is also the new way of manufacturing or delivering products and services through unique scenarios, such as innovative production procedures that include creating road maps of the technology or the equipment or components used in the production. An example was given in the study by Fukawa and Rindfleisch (2023), which discusses how Siemens uses AI to reproduce a simulation of organs that could use IoT connectivity through other manufacturing equipment that uses technologies supported by I4.0.

2.4.4 Organisational Innovation

Organisational innovation has been defined in several ways across several studies**.** It can be known as the innovation that facilitates adaptation or changes in an organisation's processes by immersing and absorbing modernistic skills and knowledge. An organisation can adopt innovation through emerging digital technologies. It is still considered novel if it is a new entry or emerging technological innovation for the organisation requiring its application (Chatterjee et al., 2021; Data, 2005). According to the study by Muehlburger et al. (2022), organisational innovation has been recognised as a means to thrive by seamlessly integrating diverse technologies for varied purposes and using them to create transformation. An illustration of organisational innovation is depicted with Lego, a global toy maker that innovates consistently to retain relevance. The concept is that the innovative transformation that drives continuity can be achieved by consistently evolving the application of various emerging technologies that cut across business functions and permeate the organisation internally and externally and is also reliant on business or consumer demand and the need for an outlet for the consumption of that innovation.

2.5 Exploring the Emergence of the Internet of Things

An Internet of Things (IoT) network is global, uniquely addressable, distinctive, and transmittable, and it works within a constantly changing worldwide network built on a distinct and coherent communication network and self-configuration competencies. Interconnected digitally simulated "objects" are given physical properties to become simulated and computer-generated with acute and enmeshed user interfaces incorporated within a unique network infrastructure. As a part of the IoT (IoT), Langley et al. (2021) discuss ‘things ‘as the ability to apply interconnected communication systems to combine various elements and create "Smart things" that are consistently adaptable and serve a purpose. Therefore, governments, academics, and industry discuss the Internet of Things (IoT) in various modes and goals with diverse approaches to IoT and the digital age in multiple sectors worldwide, with varying outcomes and processes. There is a noticeable shift in how products, processes, and organisational structures are influenced by new digital technology, which enables the restructuring of global social interaction and entire sectors to occur on numerous occasions. The thought supported by the study of Kasilingam and Krishna (2022) is that digitalisation, exponential growth, and innovative ways to integrate and combine contexts characterise this new digital age under the IoT values-enabled environments. Due to the ensuing competitive advantage, new entrants can use digital technology to challenge established enterprises. From the business perspective, start-up firms join the IoT industry to develop and launch new products and services based on the IoT start-up ecosystem. This digital transformation offers existing organisations the opportunity to expand their product and service offerings to new levels. Additionally, it enables them to create commercial models that were previously inconceivable. Consequently, the study by Roe et al. (2022) characterised this phenomenon as influencing the distribution of resources and the movement of commodities and services.

In addition, "things" become vigorous players and are digitally contextually cognizant elements that can create, interact, and develop facilities without human involvement. Connecting people and "things" via the Internet of Things (IoT) will allow for a symbiotic connection between the physical and computer-generated worlds, allowing them to connect at anytime, anywhere, with any 'thing' (machine) and any 'body' (human), preferably over any system. As a result, the unique combination of Machine-to-Machine(M2M) communication, interconnection, and intellect as a singular entity has become a foreseen outlook. Devices can now process information and data separately, making human-like intelligent decisions without needing a person to intervene or be involved in making them. An occurrence which will, according to (Ghosh et al., 2021) help create a better society where "things" around people know what they want and need but do not have to be told explicitly by humans what they want or need to do.

2.6 Exploring the Emergence of Artificial Intelligence

Previous definitions of AI included computers that can reason and make decisions as people do. It represents a rapidly advancing technology with diverse applications, spanning from robotic assistance in households to transformative self-service solutions in various sectors, such as hospitality and dining establishments. Defining the scope of AI has been the focus of numerous efforts; therefore, noticeable advancements include and are not limited to AI applications used to replace supervisors and social robots that can interact with humans, among other things.

Various studies (Hoffmann, 2022; Jeyanthi et al., 2022), discussed categorisation, which includes categorising smart virtual companions, biometric systems, and digital visual and search tools” as software-based AI structures. In contrast, hardware-based AI systems include devices and unmanned aerial vehicles, indicating that AI is an expansive field with a continuous need for definition. Human-machine interaction interacts with human and automated systems through gestures, sensors, touch, and voice. However, Kopalle and Lehmann (2021) explain automated analysis as the automatic generation of images, text, video, and images through AI, which could be a driver of various positive and negative influences on business conditions. To this end, digital technology researchers have indicated the rapid growth of AI as an influential factor for decision-making and strategy development. The primary reason for its effectiveness in driving organisational change is its capacity to improve and influence important decisions. According to Heinonen and Strandvik (2021), that capacity enables the adaptation of business models to the impact of AI by facilitating the recreation, readjustment, and redevelopment of strategies to encourage innovation, compliance, and market adjustment. As a growing study, AI and innovation adoption indicate that AI will be incorporated into each new software product and linked service annually (Gartner, 2017). Progression in hardware development has propelled AI technology to a commercial level of sophistication. AI is described by Chen et al. (2021) as a technology that can enhance productivity by assisting individuals in making better, faster decisions; however, compatibility across all business units could pose some difficulties for assorted reasons, like technology complexity.

AI is speculated to deliver better quality, more noteworthy effectiveness, and preferable results than human specialists, furthered by the consideration that AI can be integrated into existing systems and applied to enhance conventional 'human' roles. An example highlighted in the studies by Benbya et al. (2021) is that many hotels have adopted digital technologies in the hotel industry that have enabled people to check out of the hotel with the tap of their mobile phone without human assistance, a development further heightened by global pandemic and facilitated by the adoption of emerging technologies. Similarly, technology usage has made it easier for people to work collaboratively from any corner of the world in unique ways. For medical purposes, digital technologies have enabled doctors to examine their patients remotely, take doctors or experts on board in emergency and complex cases, diagnose diseases, and become more convenient. In any organisation or field of work, decision-making plays an influential role in leading the organisation towards success. Subsequently, as opined by (Tabim et al., 2021), organisations need innovative and advanced technologies to align data and successfully implement business intelligence. Such technology is essential to making accurate decisions based on data availability, which has a significant impact on technology and can provide long-term benefits for the organisation.

In addition, there is a requirement for these technologies to respond quickly to issues, which is a purpose that AI is significantly serving while also enabling organisations to adapt and attain a competitive edge. The successful implementation of technological tools, such as business intelligence, which will allow businesses to make effective decisions through information processing, can be increasingly and successfully achieved through these innovative technologies. AI adoption implies a high implementation complexity, given its technological qualities and knowledge hurdles, compared to other digital technologies that are often simple to use and install. However, since AI technology is termed innovative, this heightens the ongoing discussions and the need for research to understand the intricacies of the inevitable advancement (Haefner et al., 2021).

2.7 Exploring the Emergence of Industry 4.0

I4.0 is the power of conventional industries combined with novel technologies that merge digital and physical processes of intelligent products—end-to-end digitalisation of all physical properties, enabling flawless analysis and data communication. There is a technological alignment of increasingly individualised customers, boosting the availability of real-time information by connecting all the physical and digital stakeholders engaged in the process. According to studies by Pinheiro et al. (2022), the technology contends with and facilitates multi-platform interconnectivity, optimising organisational performance. Manufacturing advancements are highly performance-driven, discussed by Rosin et al. (2022) as smart factories, which were initially researched as an application of (IoT) in production and have become an essential element of the I4.0 revolution in the manufacturing industry, primarily because it was used to augment smart factories or manufacturing processes to enhance performance.I4.0, a complex emerging digital technology, has improvements, developments, and inventions that have transformed the global industrial scene over the past few years. The technology is distinguished by its unique characteristics and interconnected production processes. As a result, digital transformation using I4.0 allows organisations to increase their profits by redefining the foundation of their business model around the creation of customer value. Although many aspects of modern life have been altered by digital technology to a significant degree, many studies overlook the value-creating activities carried out by corporations and how I4.0's achievements might benefit these activities. According to Grabowska and Saniuk (2022), it could be safe to infer that the impact of digital technologies continues to change innovation and force fundamental changes in value creation and its delivery.

The influence of digital technology and its various elements in reshaping developments in multiple spheres affect organisational development across industries, and this influence grows as technology adapts and changes. An illustration is a significant improvement in logistics efficiency where a close relationship exists between logistics and digitisation that extends from back-end vendor sourcing and the components and hardware selections to the manufacturing floor and eventually to the customer's doorstep. Hence, taking advantage of advanced forecasting logistics tools, as emphasised in the study conducted by Tabim et al. (2021), is a primary determinant for achieving noticeable enhancements. These tools enable the intentional transformation of information into data, facilitating the identification of inadequacies and enabling better decision-making based on data.

Typically, traditional data processing architectures operate in a one-way fashion, rendering them incapable of adapting to the varied requirements of a multi-scenario application. However, I4.0 involves modern significant data manufacturing with a computing architectural style capable of performing numerous functions such as batch and stream data processing, decentralised access and storage, and accurate regulation. Compared to other data processing architectures, when merged with feedback and edge computing regulation, the architecture enables complex industries like the aerospace manufacturing industry to meet various requirements. Moreover, the innovative architectural design is both adaptable and robust, allowing the equipment to function autonomously under various conditions within a manufacturing facility. The progress considerably improves the efficiency, durability, and scalability of emerging technology-driven industry processes (Corallo et al., 2022). In recent years, existing digital frameworks using I4.0 have allowed problems to be broken down, solved, or deciphered with innovative tools and ideas that have become increasingly common. The study by Dupont et al. (2023) discussed that this opens up the floodgates to an entirely new set of innovation-derived business opportunities, a notion supported by the rising interest in the role of I4.0 and AI in global and national economies, individual industries, labour markets, and capital markets is affecting current expectations that indicate that activities in this direction will result in collaborative, structural and methodological changes in manufacturing. Therefore, substantial changes in consumption levels have a direct influence on economic progress, as the application of Industry 4.0 enables businesses to reinvent their approach to innovation. Hence, by harnessing the advantages of mechanisation and smart manufacturing through connectivity, fundamental processes may be synchronised with the improved technological structure, resulting in a greater degree of innovation.

Table 2. 1 RQ3: Research Hypothesis Studies on Adoption of Innovation and Firm Innovation Performance

Industry/ Country	Results	Authors
Manufacturing/ India	A strong correlation exists between innovation and firm performance.	(Chauhan et al.,2021)
Manufacturing/ Pakistan	A strong correlation exists between innovation and firm performance.	(Younas and Rehman, 2021)
Manufacturing/ China	A strong correlation exists between emerging technologies and firm innovation performance.	(Guo and Xu, 2021)
Manufacturing/ Tunisia	A strong correlation exists between innovation and firm innovation performance.	(Chabbouh and Boujelbene, 2022)
Manufacturing/ Malaysia	A strong correlation exists between innovation and firm innovation performance.	(Lee et al., 2022)

2.8 Emerging Digital Technologies

Emerging digital technology has been defined as a fast-growing requirement for knowledge (Ceipek et al., 2021). According to Ciarli et al. (2021), such emerging digital technologies are grounded in scientific research, to enhance existing concepts while raising the bar on the generation of ideas and, concurrently, promote progress and excellence across multiple sectors and a wide range of purposes. Therefore, laying emphasis on the fact that emerging digital technologies enable radical change and require a swift response, and the changes bring about the need and requirement to innovate, creating an urgent necessity for more understanding and proactive actions (Acemoglu et al., 2021). The ever-increasing importance of digitalised innovation in achieving business objectives has resulted in dramatic organisational rethinking, with a broader range of organisational goals requiring novel technology. Subsequently, this creates the need to evaluate businesses' previous assumptions about their product and services, administration portfolios, computerised environments, and methods for completing development projects on time and within a budget.

The effectiveness of emerging technologies such as AI in tackling a range of human difficulties and efficiently fulfilling various demands is widely acknowledged. The implementation of these technological improvements speeds up the process of innovation within organisations, allowing for faster entry into the market and higher revenues. These technologies subsequently enable the advancement of smart manufacturing processes and protocols, improving the manufacturing of devices, equipment, and products. According to Bhattacharyya and Shah (2021), their applications include interactive features, prompts for multitasking, and interconnected controls, all while preserving separate independence for various outcomes. Since growth strategies could emerge from gathering massive amounts of data and interpretation, emerging digital technologies that facilitate the co-creation of environments where various stakeholders may pool resources to collect and analyse data, agree on standard approaches, and continuously run actual life scenarios must be emphasised. Applying these technologies with specific applications to business practises will, as highlighted by the study of Kurtz et al. (2021), help make research and business accessible to those with fewer resources and are primarily driven by adaptation within an ecosystem.

2.8.1 History of Emerging Digital Technologies (IoT, AI and 14.0)

These are historical discussions of the three emerging digital technologies discussed in this study.

Internet of Things:

The IoT refers to assembling linked machines and equipment of varied sizes that collect and transmit various types of information. The information is then gathered, deciphered, and used to develop, create, or make decisions on products, services, marketing, customer experience, or operations. According to Hassan (2023), the IoT requires a vast distribution connection, is adaptable, and can be used interchangeably with other technologies. The data amassed from connected devices can create innovative solutions that synchronise customer needs or create a better solution, which Ghosh et al. (2021) opine signifies change that combines connectivity, machines, a blend of physical and digital, and continuously changing technology that make value-adding solutions. Therefore, the resultant rapid change could guarantee a continuous competitive advantage for organisations that keep pace using technological edge.

Yang (2022) defines the IoT as a global infrastructure network with increasing spread, including a blend of physical and virtual aspects of things, with the capabilities of interoperable self-configuring protocols. The Internet is responsible for connecting people to machines, or people and devices to machines, within an ecosystem, and as the name implies, the IoT is derived from the Internet's source. In 1980, some students introduced a concept where they proposed that a sensor should be added to the vending machine so that the objects in it could be tracked from anywhere. Still, limited progress was noticed, so the concept was disregarded; however, according to Bharany and Sharma (2022) in 1999, the idea of the IoT was discovered and established by a scientist known as Kevin Ashton, who is considered the founder or originator of the vision. An intelligent and networked physical object can obtain autonomy and digital intelligence, with the data being collected and shared simultaneously across the Internet. An enormous transformation can be seen regarding IoT; Cunningham (2022) discusses IoT as being adopted across various verticals and cites examples: manufacturers of LG products in 2000 introduced a refrigerator that can connect to the Internet.

The concept of multiple IoT technologies was blended for various transformative purposes, with the IoT being presented and introduced formally at an international conference in 2008 (Bharany and Sharma, 2022; Nidagundi, 2022). IoT has undergone various stages, from using telephones and short message services to growth in 2009, followed by mobile devices and electronic emails, and imminently preceded by active commercialisation and sales of products and services, which is also being driven by social media tools and regular Internet use. The number of IoT-connected devices has grown to over 30 billion, indicating that IoT is now graduating to a phase of connecting via machines (via I4.0) and facilitating a combination with other technologies like AI-enabled by immense needs and requirements from various stakeholders. The growth creates more questioning needs for understanding the impact, which the studies by Nagajayanthi (2022) discuss will allow further development, restructuring, and application.

A thriving IoT ecosystem that spans business, education, and government members was established and organised into working groups with horizontal and vertical axes, allowing for the intersection of all possible interests. Therefore, leading to the attempt to foster technological ecosystem growth, the primary objective of the FP7-ICT project "IoT Architecture" (IoT-A) was to “promote the interoperability of IoT systems”. In outlining the principles and guidelines for developing appropriate protocols, interfaces, and algorithms in 2013, the project succeeded in setting a reference architecture for IoT platforms. The “Alliance for Internet of Things Innovation (AIOTI)” was established in 2015 to foster more communication and cooperation among European organisations working in the IoT space (Chowdhury et al., 2022). In addition, AIOTI publishes research and suggestions, hosts conferences, and facilitates test programmes that can provide reliable IoT solutions for global use (Pushpakumara et al., 2019).

Another growth area was when the "Industrial Internet Consortium" released the "Industrial Internet Reference Architecture (IIRA)" in 2015 as a component of the "Industrial Internet of Things" (IIC-IIoT) standards to 'offer an open and standards-based architecture for industrial IoT systems' (Lin et al., 2015, p. 8). With usability by a wide range of industries for things like interoperability, mapping suitable technologies, and general direction in systems development, it represents a combination of universal qualities, norms, and trends within various sectors. The architecture strategically breaks down the overall solution into smaller sub-solutions based on the perception of stakeholders within an ecosystem. Therefore, as Pham and Vu (2022) mention, it affects how IoT is implemented, what functions it serves, how it is used, and how it affects the organisation.

Since 2010, IoT has been a massive part of life and is very prominent, whether in the form of embedded systems or electro-mechanical systems, the use of the Internet or wireless communication in daily life. IoT is increasingly permeating every sphere, with developed cities utilising IoT to use energy efficiency, taking waste reduction measures with the help of IoT researchers, and scientists developing satellites and using GPS. Uses in 2022 include areas of daily living like online food and cloth shopping, messages and video calling, and other areas with billions of devices estimated to be linked with various usage applications to the Internet by 2025 (Cunningham, 2022; Yang, 2022).

Artificial Intelligence:

AI has primarily been obscured since the 1950s, with a gradual progression to the 2000s when elements of AI like speech recognition and translation were incorporated with emerging technology like IoT and applied to machine production under the fourth revolution, creating an unexpected explosion of rapid growth. According to the study by Zhang and Lu (2021), this growth is partly due to the added capacity and capability to access a range of information globally.AI was founded in 1956 at the Dartmouth Conference and was centred around using computers to solve significant algebra, use theories, and communicate back to the user in English. Therefore, creating the concept of intelligence in machines is similar to one that would determine human intelligence through comprehending complex situations, and subsequently, McCarthy (2007) defined the term AI. Although AI had previously been used predominantly by the government and its scientists, organisations started adopting AI machines in the 1980s, which led to the development of Apple and IBM desktops with fatter processors and increased applications across the industry. From the 2000s to date, a third phase has been heralded by the ability to redevelop and manufacture those machines to work seamlessly with equally growing other technologies like IoT (Perez et al., 2018). In 1950, software intelligence theory was established as the Turing test, which according to Hoffmann (2022) stated that if a prediction or certainty cannot be made that the communication is with a computer or a human, then the software will be considered intelligent.

The growth and collaborative efforts were primarily driven by the need for rapid innovation across various technological verticals, which is also geared towards ensuring limited errors like bias, wrong interpretation, and machine failures. Discussions further highlighted by Boburbek et al. (2022) state that AI, combined with other emerging technologies, is cited as having the potential to work independently with the sole ability to mimic multiple human skills in the next forty years and incorporate algorithms, machine programmes, and systems that imitate humans' intellectual conduct. Therefore, it can be described as an emerging technology that includes standard language processing, neural connections, and machine learning that, according to Huynh-The et al. (2023), facilitates the capabilities of technologies and has a sweeping transformative influence on the economy labour, and society, consolidating various technologies and processes the human brain carries to create a predominant advantage for issue resolutions (Chen et al., 2021).

Industry 4.0

I4.0 is the increased application of technological machinery and equipment for industrial use developed by the German Federal Government in November 2011(Tortorella et.al., 2023). The intent was to expand the technological advancement of their manufacturing industry by using a higher degree of automated, controlled machinery with the intention of growth, enhancement, and consistency. In recent years, studies by Grabowska and Saniuk (2022) posited that organisations have gained more profit through the fourth industrial revolution due to enhanced processes, efficiencies, and technology for continuous development. Following the Acatech Industrie 4.0 Maturity Index, the first revolution between 1784–1870 was linked to steam, the second between (1870–1969) was related to electricity and mass production, and the third from 1969 to today was linked to factory automation and the eradication of manual work, also linked to the use of computers. Finally, the fourth revolution, one of the technologies within this research, extends to many decades (Grabowska et al., 2022; Harland et al., 2022; Klingenberg et al., 2022). A significant benefit of I4.0 is that it facilitates the combination of an array of technologies, including augmented reality, AI, additive manufacturing, robots, cybersecurity technology, cloud, simulations, and the IoT. According to (Awan et al., 2021), such technologies are now being utilised or implemented by every kind of organisation, from mining industries of oil and gas to manufacturing or processing industries. I4.0 has a wide-reaching impact on innovation that will create shifts in some significant areas, including changes in the industry, with a transformation that makes diverse economic impacts. However, Chatterjee et al. (2021) state that I4.0 must resolve organisations' challenges as it transforms in an increasingly digitalised world. In this regard, I4.0 works around the key trend in technology development that Alvarez-Aros and Bernal-Torres (2021) discuss enabling a fusion of the digital and physical world to support demand and supply within the manufacturing industry.

Table 2. 2 Theoretical Review of Adoption of Innovation and Emerging Technology Research Studies -Models and Type of Emerging Technology that combined models and also applied the quantitative data collection approach.

Adoption of Innovation Theory(ies)	Type of Emerging Technological	Similar Analysed Variables	Authors
TOE and DOI	AI	Relative Advantage, Complexity, Compatibility	(Chen et al.,2021)
TOE and DOI	IoT	Top management, Complexity, compatibility, Trialability, Trading partners	(Ali et al., 2021)
TOE and DOI	IoT and I4.0	Relative advantage Compatibility, Complexity Observability, Top management support, Government regulation	(Mabad et al., 2021).
TAM and DOI	I4.0	Perceived ease of use	(Yuen et al., 2021)
TAM and TOE	AI	Perceived ease of use, Technology, Organisation, Environment	(Na et al., 2022)
TAM	Mobile application	Perceived ease of use	(Vahdat et al., 2021)
TAM	AI	Perceived ease of use	(Ali and Freimann, 2021)
TAM and TOE	I4.0, AI	Perceived ease of use	(Na et al., 2022)
TAM	IoT, Blockchain	Compatibility, relative advantage, Perceived ease of use	(Ullah et al., 2021)

2.9 Multi-Industry Application of Innovation Ecosystems of (Internet of Things, Artificial Intelligence, and Industry 4.0) to Drive Firm Innovation Performance

This chapter will discuss the link between IoT, AI and I4.0 and their interconnection, focusing on manufacturing with immersion and application across industries related to their collaboration within an ecosystem. This chapter contains a detailed literature review on the connection between the IoT, I4.0, and AI, focusing on adopting specific emerging technology innovations. The study will cut across sectors with links to manufacturing, like telecommunication, food manufacturing, health and insurance, banking, and transportation. Recently, there has been a shortage of efficient and well-organised synthesis of the present knowledge on the trajectory of change in the field, leading to gaps in understanding established innovation ecosystems. The ultimate goal is to provide a framework for discovering, setting up, and executing complex technology services and platforms with human intervention. Therefore, the demand for combined use with other relevant and complementary technologies focuses on areas that cannot be achieved within a singular ecosystem. The gap in exploring I4.0, AI and IoT with an innovation ecosystem perspective centre on the premise that value creation is not achievable or created by one player, actor, or technology. However, to ensure that an impact on firm innovation performance and growth is made, Matt et al. (2021) mention that there has to be a coalition of relationships, applications, and usage that vary across various actors or organisations with a common goal but carry an effect at each step.

An innovation ecosystem is an interdependent circle of organisations and providers that own or have developed skills, resources, or capabilities around a shared set of emerging technologies like IoT, AI and I4.0. Therefore, it could point to the fact that these actors need the knowledge to create a competitive advantage in new products and increase performance. A technology like IoT provides access to information through connectivity, is linked through machines, and requires input into machines to perform functions necessary for activating instructions. I4.0 involves using AI and IoT to improve efficiency in operations. A new paradigm is now attainable due to the convergence of several essential technology enablers, making experts and observers refer to AI as a transformative revolution that has an even more extensive range of influence than previous technologies. Using AI within an ecosystem can be likened to how infrastructural growth shifted economic power to more developed countries.

Such a point is further validated by the studies of Papyshev and Yarime (2023) on the role of several countries developing AI-specific strategies, coupled with an increase in the vital interest of policymakers worldwide. International organisations like the O.E.C.D. promote the widespread adoption of AI, continuously striving to mitigate its potential risks and challenges and striking a balance between innovation and regulatory reforms. The European Union, South Korea, and Japan are supporting actors in this global trend, with the United States and China leading the charge aggressively (Arenal, 2020).

Although AI technologies may be implemented within an organisation without complexity, it is essential to note that several circumstances and considerations may exist during their actual application. To this end, the interpretation that lends to a solution provided by a machine is found, according to Burford et al. (2022), within the combination of the technology within an ecosystem, which leads to the subsequent and ongoing improvement in the technological manufacturing of the device Therefore, building emerging innovation ecosystems within the corporate context is becoming a key trend among executives from various industries who want to protect their organisations from rising economic turbulence and their market advantage. The capacity of the business ecosystem to maximise the utilisation of company resources is valued more highly, which can accelerate development and competitiveness and enhance internal resource integration. Such an occurrence would benefit all participating enterprises, which is increasingly leading many businesses to view the technological ecosystem as a fundamental strategic option. Invariably, creating cooperations that Redchuk et al. (2022) highlight as resembling the structure of a natural ecosystem driven by organisations.

The IoT has many potential applications in smart homes, logistics, healthcare, and other industries. It is considered the third wave of change in the information business after the computer and Internet eras and, therefore, is leading many digital giants to seek rapid development and growth by building a vast IoT ecosystem. Furthermore, as mentioned by Brusoni et al. (2021), the innovation ecosystem uses enhanced technology created by 5G commercial deployment. Multinational firms like Google and Microsoft developed the “Android Things system” and the “Microsoft Windows IoT system”, respectively, with studies by (Sergi et al., 2019; Zhao and Yi, 2022) discussing that the intent was to grow the IoT industry quickly. As a result, various tools, including operating systems, processors, communication protocols, and cloud infrastructure, have been made available, providing a complete platform for the various technologies. Businesses from various sectors seek to combine their current resources and benefits to create an IoT ecosystem that best uses each company's competitive advantages. Although different sectors have looked at potential IoT business models, as observed by Kim et al. (2020), issues including poor intelligence, uneven protocol standards, and pervasive product uniformity still need to be addressed. Therefore, a literature survey on the IoT and related topics revealed that the IoT's innovation ecosystem had not received enough in-depth study. Like the Internet, the IoT is another revolution in the global technology sector. By building an extensive IoT ecosystem within the business ecosystem, many organisations hope to accomplish rapid growth and development, which Rocha et al. (2019) state will make the human experience and reliability an essential requirement for IoT and AI use. In areas like smart energy, manufacturing, and driving, just a few of the many sectors, the IoT may be seen as the layer that integrates physically separated and virtual processes (such as AI modules) with the actual world.

I4.0 is derived from the process of combining or merging different elements or components offered by the IoT in the industry and the widespread usage of digital technologies like cloud storage, extensive data analysis, and AI. Linking physical items like goods and equipment to construct hybrid systems enables new technological applications like additive manufacturing, adaptive robotics, and flexible machinery. Before the emergence of I4.0, most suppliers would collaborate one-on-one to develop supply chain solutions, focusing on technology deployment for trading specific items (Sun et al., 2022; Zahra et al., 2022). Indicating that each supply chain member offered separate technology modules constructed independently of one another and largely depended on financial exchange as their primary method of value transfer. However, I4.0 solutions based on the study of Georgios et al. (2019) are increasingly creating a complex network of linked digital, informational, and processing technologies, necessitating high skills and technology dependence, facilitating more revenue and organisational performance.

The prevalent examples of applying AI and the IoT with the consolidation into I4.0 are beneficial in generating impactful applications and favourable outcomes when employed smartly within varied industries. Machine learning can provide intelligence and decision-making to save finances, energy consumption, and other resources. Concisely, the collaborative application of these technologies has brought a drastic and considerable revolution across various industries across the globe and has played a vital role in improving the performance of firms across multiple sectors, such as manufacturing, telecommunications, healthcare, airline, banking, and finance. These examples in the next section, backed by studies like Bogers et al. (2022), illustrate the impact of combining emerging digital technologies within an ecosystem to drive firm innovation performance.

2.9.1: Telecommunications - IoT, AI and Industry 4.0

Telecommunications has been at the forefront of the evolution of emerging technologies because of the nature of the industry. From implementing 4G technologies to the proposed development of 5G technologies, innovation enables enormous cross-spectrum, media, and equipment integration across regulatory strongholds that facilitate a mixture of I4.0, IoT, and AI usage. Specifically, it is a power horse of active, dependent, and independent communications that can transform radically and strengthen the requirement to engage with those technologies with continuous directing, evaluation, and ubiquitous dispersion. As described by Khan M. K (2023), emerging technology creates a fusion that can enable applications, platforms, and devices to synthesise for communication, connectivity, collaboration, and growth unprecedented within the telecom industry. IoT has changed the digitalised global community by linking billions of electrical gadgets via the World Wide Web. IoT devices are critical today as conventional gadgets become more independent and intelligent, even as higher-speed data transmission is a vital issue requiring 5G-enabled technology. Large enterprises are also increasingly entering strategic partnerships that work closely to develop innovative solutions for their clients. For example, Samsung and IBM partnered with a telecoms provider in Singapore to combine IBM's expertise in I4.0 with Samsung's IoT connectivity and AI to enhance 5G connectivity for M1, a prominent Singapore telecommunications provider (Samsung, 2021).

These IoT devices transmit data through protocols premised on a centralised architecture, resulting in several data protection problems. Combining AI and 5G wireless technologies, as concluded by Dhar Dwivedi et al. (2021), addresses several accuracy and performance issues with the strategic use of automatic and independent robots, automated automobiles, and simulated realisation. The targeted approach also alleviates security concerns and attempts to foster faith and confidence in technology as a separate support force. Therefore, to boost firm innovation performance, organisations are increasingly looking for ways to upgrade and apply novel procedures in various sectors to increase productivity and quickly achieve targeted results. Another example is tower management, a critical requirement in the telecommunications industry due to its facilitation of cellular transmissions. Telecommunication operators build the sites in various locations, with equipment like batteries, electricity-generating devices, warnings, light alert systems, and base station machinery available to ensure optimal communication. The required resources and continuous supervision make stabilising tower sites in isolated places challenging.

Telecommunications service providers require various elements to maintain network regularity, including frequency band, heating rate, wind velocity, and other sensor technologies. Due to the constant need for the service, there is rapid digitalisation growth, which, according to Deevela et al. (2023), is partly due to the combined connectivity from emerging technologies enabling field technicians and site supervisors to pre-emptively identify issues on the surface through information generated in the background.

2.9.2: Agriculture - IoT, AI and Industry 4.0

Advancements in agricultural innovation with combined technologies are increasingly connected to the modernisation and innovation of agriculture. Due to the various operational complexities within the farming sector, the studies by Ahmad et al. (2023) discussed that AI and IoT are being integrated within an ecosystem to map out scenarios to support predictability in crops, weather, and harvest, lending to internal commercial growth. The feasibility of the growth occurs through a myriad of activities revolving from planning to communication networks to data transfer that provides a trail of exchange between stakeholders to logistics processing, soil, irrigation crop type evaluation, discoveries of new crop hybrids, and assessment and results that lead to commercialisation. The introduction of emerging technology to agriculture provides a reprieve to farmers. It supports the availability of profit, which Bigliardi et al. (2023) discuss as critical intelligence that is gathered and used to reduce the weather, predict demand and supply, eradicate waste, and apply sensors powered by various technologies by creating a chain that links with the manufacturing process of I4.0 to generate higher productivity.

One updated term associated with adopting agricultural innovation powered by emerging technologies is "precision farming", which uses technology to decide the right place, quantity, and suitable method. In contrast, 'smart farming' refers to using the information to make astute choices, including equipment and production processes. ‘Digital farming” is described by Aggarwal and Singh (2021) as a combination of intelligent and precision farming supported by adopting emerging technological innovation. Agricultural Things (IoT) organises modernised methods to offer a well-crafted technique to track and trail the supply processes of substances effectively. The Internet of Agricultural Things could counter the well-being problem related to sustenance. The Web and the IoT will assume a significant role in understanding and comprehending the latest changes the strategy brings, as mentioned by (Malik et al., 2021; Passarelli et al., 2023). Emerging technologies, therefore, offer exceptionally remarkable opportunities that organisations can apply to enhance contemporary horticulture for organisational growth.

2.9.3: Transportation - IoT, AI and Industry 4.0

Robust technologies are harnessed to strengthen smart airports' current and gradual proliferation worldwide, and the study by Chae and Olson (2021) articulates that traditional and common standards and techniques lead to futuristic and modern development. The application of emerging technology elements has strategically and practically modified the mode of operation of conventional airports while enabling modernised interconnected applications. The creation of a new-age smart airport requires high-level intelligent automation, and the study by Surianarayanan et al. (2023) articulated that such transformation could only be achieved through the innovative combination of emerging technologies like AI that usually provide complicated and valuable services to worldwide users due to their advantages, enabling various network protocols and technologies for ample functionality. For example, the luggage handling procedure involves the manufacture of smart equipment (I4.0) powered by

Connectivity (IoT) and data-enabled systems (AI) to provide a high degree of service innovation.

AI uses a robust algorithm that digests the most critical data, recognises all the patterns, forecasts processing timelines, analyses queue length productivity, and manages airport security lanes open. AI techniques and models enable a company like Uber to relocate the needle around various verticals to transport the client with assistance and steer the partner's navigation effectively (Dave et al., 2022). The efficient application of emerging technologies in airports improves capability by effortlessly incorporating IoT and AI, consequently facilitating tasks. The integration of IoT-enabled technologies in smart airports has greatly advanced their evolution, enhancing their resilience, efficiency, and real-time surveillance capabilities (Jian, 2022). However, the process of digitisation also brings about security threats, which arise from vulnerabilities in IoT and AI-operated networks. These risks are further exacerbated by hardware constraints in obsolete Industry 4.0 equipment. Additionally, cyber-attacks can still have catastrophic repercussions, including obstructing network connections, rescinding flights, or stealing confidential material from flights. Such concerns, as discussed by Vocelka (2023), create the need to acquire and use innovative AI-enabled cyber-defence strategies for smart airports that tackle the obstacles posed by integrating innovative systems into airport architectures and procedures and the continually shifting existence from traditional hardware to emerging technology-based modern equipment and devices. Consequently, technology can effectively support smart airports' IoT network infrastructure, guarantee services' availability and reliability, and ultimately gradually alleviate the challenges as they occur.

The ability of a business to successfully generate more value than its rivals is essential; therefore, when organisations can innovate successfully, they can boost the value provided. Many aim to become industry leaders to take advantage of the growth opportunities of being the first to market with ground-breaking technology. However, a particular innovation does not always work well in isolation; instead, it is dependent on adjustments or adaptive behaviours that co-occur in the workplace, as Ammar et al. (2022) pointed out. These external developments need new players; the primary firm eventually gets entangled inside an ecosystem of interdependent technologies, creating a unique combination that results in the interdependence of technologies like AI, IoT, and I4.0. An example is Airbus's major undertaking with the A380, the first of its type in the market for super-jumbo passenger aircraft. Airbus, as a significant and vital global player in aviation, has enormous challenges considering the development and production of the plane's main airframe. The fact that the firm buys the necessary components and pre-assembled materials from many third-party suppliers contributes to the business's extra challenges. While some of these suppliers will not be required to meet any of these innovation criteria to provide Airbus with the essential components (for example, an engine or a navigation system), other partners, as Bai et al. (2022) pointed out, will be required to meet these standards. After all these pieces have been delivered, the next step for Airbus will be to integrate them with the airframe so that the company can provide fully operational aircraft to its airline customers. However, for airlines to effectively use the plane, various technological partners must meet additional innovation problems. As Davoudi et al. (2018) mention, all these elements extend beyond Airbus's direct supply chain, highlighting the need for cooperation.

Complementarily, airports must incur costs to construct new infrastructure that can handle the requirements of larger planes. At the same time, regulators will need to define new safety procedures and training simulator manufacturers will need to construct new simulators to teach pilots and flight attendants. Since Airbus is the primary innovator behind the A380, the company's ecosystem comprises upstream suppliers, consumers, and competitors. For the A380 to generate value, a consideration is not whether Airbus will be able to solve the innovation problems that it currently faces; it is how the organisation consolidates its requirements and uses all the resources available to evolve and excel as a major world player continually. Although, according to (Airbus, 2022; Ammar et al., 2022 Goritiyal et al., 2022 Sigov et al., 2022), the organisation has embraced the concept of combining emerging technologies within an ecosystem, the most vital concern is whether or not the other ecosystem partners will be able to solve the innovation problems.

2.9.4. Healthcare -IoT, AI and Industry 4.0

Combined, emerging technologies are reshaping the eHealth ecosystem and integrating technology that facilitates a new accessible and innovative delivery of conventional services drives expert knowledge to meet growing healthcare system requirements (Kaur et al., 2023). Numerous studies have researched the link between the three emerging technologies and healthcare, with the advantage of IoT and AI emerging technologies proliferating and using augmented, higher-quality, and enhanced development and manufacturing of high-grade medical services and equipment (Paul et al., 2021). Significant technologies associated with the Fourth Industrial Revolution, notably the IoT, emphasise their combined implementation in the healthcare services industry. The mode of execution depicts the stages of an industry already heading towards ICT-enabled e-health, which will require continuous and radical transitions in the modern setting of healthcare 4.0 (HC4.0). The technologies enhance traditional systems and processes, including cloud-based health information systems, highly developed surveillance of physiologic and pathologic indicators, prescription drug consumption, and operations, and encourage and enable previously unimaginable strategies, procedures, and actions (Vyas et al., 2022).

I4.0 is working with other transformative emerging technologies in the healthcare industry to create a drastic transformation and the trend known as eHealth, innovative health. Combined, emerging transformative technologies are used to manufacture devices like smart cards, intelligent devices, and equipment, and these devices use the connectivity of platforms to support and provide health information. Subsequently, the machines require a significant amount of data from various platforms powered by the IoT; according to (Subhan et al., 2023), this data is then used to monitor health and healthcare on a revolutionary level. As integrated technology evolves, more devices are being manufactured; an example of the technology combination is the device known as "Aria, " which is manufactured and used in South Korea. The "Aria" device can be activated by voice, with the data subsequently transmitted to the government platform that evaluates the data and dispatches services to support people. This device works with an Internet connection powered by a significant telecom company, synthesising and combining the three types of technology in full circle (Lee and Yoon, 2021).

A combination of the technologies within this study was used to manufacture devices to reduce the transmission of COVID-19 with an IoT and unmanned aerial vehicles (UAVs) based strategy for collecting raw data utilising onboard temperature sensors to limit the influence of COVID-19. Unmanned aerial vehicles (UAVs), outfitted during manufacturing and linked with

AI settings and IoT connectivity, can gather raw data and capture images that require processing and analysis to make intelligent decisions without human assistance (Barnawi et al., 2021). The thermal images obtained by the device are used to identify probable COVID-19 carriers inside a vast crowd in a public area; depending on the heat detected, a hybrid technique is presented to visualise persons in photos with elevated body temperatures using infrared images recorded in real-time and with the combined use of emerging technology. Additionally, a face mask detection technique is developed to determine whether an individual is wearing a mask on their face, with performance measured using a variety of deep learning classifiers and machine learning, which leverages computer resources (onboard actuators and sensors) to accelerate real-time predictive analytics for recognition. According to Le et al. (2021), multiple performance assessment measures are used, giving accurate results that demonstrate the suitability for use in real-world circumstances.

2.9.5. Banking- IoT, AI and Industry 4.0

Modern technology has opened up the possibility of more interaction between clients and banks. It also excludes obstacles such as physical location or even forms of exchange directly with the banks. I4.0 is changing banking fundamentals in the banking sector by using AI to transform partner channels, products, and services with the computerised integration of physical and digital technology to produce tangible results. According to the studies of Gupta (2023), such unification heralds digital banking and transactions, one of the most popular innovations adopted in the banking industry, to provide services faster than traditional banking with more possibilities. Digital banking, enhanced by the combination of devices like QR codes, biometric recognition, and reader applications, is creating rapid access to innovative banking. As discussed by Kathirvel et al. (2023), this is a fact that is leading to an augmentation of accessibility to services and should invariably increase firm innovation performance for the banks embracing such technology. Therefore, emerging technology enables organisations and their customers to access one another, allowing a fusion of both worlds to create a mutually beneficial impact for businesses and consumers.

Therefore, studies like Dewasiri et al. (2023) elaborated on using a blend of emerging technologies, including AI methods, to improve focus and satisfaction while saving costs. This is an observation partly because, while chatbots can only answer basic inquiries, they are already helping real-world financial institutions like banks and insurers have more productive dialogues with their consumers at a lower cost. The ramifications of using AI for beneficial purposes spread widely across various facets of business, urban computing, sustainability, health, and public welfare. Another invention is screenless banking, driven by smartphones and smartwatches with ease of use and secure retail financial transactions (Wen et al., 2021). However, the subsequent procedure required a screenless user experience that uses voice as a new and innovative platform to interact with Internet technology. Therefore, it further facilitates emerging digital technology like I4.0 manufactured devices with voice-based AI devices, such as Alexa or Google Home, powered by the IoT. It establishes those technologies as enablers that give access to bank accounts by using voice recognition as authentication. The combination provides adequate justification for potential use cases for the IoT-based platforms connected to voice-based AI systems to offer the best services to customers at a reasonable charge (Mustafa,2021).

2.9.6: Construction- IoT, AI and Industry 4.0

The construction sector is a minorly digitised industry globally, contributing little to the international economy in terms of production efficiency compared to its average capability. According to Yap et al. (2023), emerging technologies play a vital role in ensuring construction safety and improving output quality. Currently, there is a strong emphasis on using technology to boost production capacity and enable informed decision-making in construction. Digital technology transforms the construction sector, enhancing resources like machinery, materials, and labour. Automated processes, cyber-physical structures, cognitive and cloud computing, and immersive technology are reshaping construction practices. The Internet of Things (IoT) introduces new opportunities for innovation, influencing various construction methods, such as offsite and lean construction, as well as intelligent assembly (Na et al., 2022).

Technological innovation in construction involves the use of cyber-physical building models, offshore production, on-site assembly, supply chain management, safety measures, communication systems, energy conservation techniques, waste management strategies, remote inspection methods, and lean construction practices. To meet these requirements, it is essential to incorporate digital technologies such as AI and IoT, which will facilitate the advancement of intelligent homes, buildings, and cities. The actions enable real-time data facilitated by communication connections like WIFI, 4G networks (required to transmit the data access to the devices), data-driven applications, machines, equipment, and sensors (manufactured using I4.0 enhanced technology). These applications are interconnected with infrastructure like power to provide easy access to essential and transform homes and appliances into standalone digital structures (Kumar et al., 2021).

2.91 Definitions (Developed for this study)

2.9.1.1: Innovation Ecosystem

An innovation ecosystem can be described as new ways of collaboration, innovation, and disruption that have emerged with emerging technology applied across various global platforms to perform diverse functions. An innovation ecosystem, which borrows from ecology, is a network of technologies studied, used, and utilised by related institutions and organisations to foster the growth of new ideas and techniques for achieving value creation for the intended purpose. This study will further define the innovation ecosystem as gathering ideas, information, data, knowledge, and skills internally to be used externally. It could include humans and machines, with the results of inputs translated into a tangible output to achieve mutually beneficial goals.

2.9.2.2: Artificial Intelligence

AI incorporates varied aspects of technology by consolidating interaction between humans and machines or computers to enable the device to perform similar tasks in an adaptable environment for higher decision-making.

2.9.2.3: Internet of Things

The IoT combines physical and digital applications that allow communication between various technologies to achieve multifaceted functions that cut across industries, requirements, and outputs.

2.9.2.4: Industry 4.0

I4.0 is the combination of various technologies within manufacturing that enhance self-driven functions, involving the development of the technology that has enabled the platforms that have combined demand and supply needs.I4.0 is a set of manufacturing environments that are highly combined, digitalised, and automated and can be described as the digitisation of the industrial subdivision with integrated devices in all product components and industrial equipment driven by various technical categories that include connectivity, analytics, human intellect, and robot communication with the end goal of facilitating digital-to-physical transformation.

2.9.2.5 Summary of gaps

Emerging digital technologies are proliferating to increase the low adoption of innovation and technology that had previously permeated the construction industry. As consumers become more sophisticated, they increasingly need smart homes like smartphones. Such changes are hastening the embracing of I4.0 and the accompanying combined technologies that come with it. The goal is to remove the burden from humans and transfer them to machines or robots, expanding the need to push strong technological alliances between stakeholders from various sectors, locations, and skill sets to develop products with specialised service delivery. However, several studies reiterate the need for more knowledge on the concept of adopting emerging technological innovation. The goal, as collaborated by Kumar et al. (2021), will be to significantly add to the body of knowledge regarding digital technology solutions to reshape activities and establish the groundwork for future research on IoT implementation.

There is a continual surge in industry and academic interest, leading to more gaps and research despite the specific limitations of information and confidentiality associated with technology. The evolution of digital technology has been rapid and has formed a considerable presence in various industries to the point of gradual normalcy but with the need for more understanding. There is no limit to the IoT, which includes connection through different network technologies and, according to the study by Kumar et al. (2021), integrates many networking and communication technologies and applications, including cellular phones, autos, critical infrastructure controls, healthcare, manufacturing, and logistics, increasing the need to understand the impact of their adoption. Technology advancements in the industrial and technology industries have significantly impacted productivity and performance. A competitive edge can only be gained by adopting new technologies like I4.0, as concluded by Javaid and Haleem (2019). However, comprehending the impact of adoption, whether favourable or unfavourable, necessitates the need for more investigation of the correlation between performance and manufacturing processes. Therefore, it underlines the importance of conducting research and developing organisational awareness of constantly changing technologies. Despite the many articles published in the ecosystem-based emerging digital technology literature, many open research questions exist. Research gaps exist in the potential technological impact on firms adopting new technologies within an innovation ecosystem (Gu et al., 2021). In a broader sense, there is still room for research into how organisations, business associations, universities, research centres, and governments can work together to facilitate the adoption of emerging technologies. To this end, applying these technologies within an ecosystem is a future research priority since they are in the middle of the innovation adoption crossroads. A topic further explained by Khin and Kee (2022) is that establishing best practices for the exploitation of emerging digital technology necessitates establishing a framework to support adoption.

Chapter 3 Research Methodology

3.1 Research Purpose and Strategy

The purpose is to evaluate how rapid advancement and organisational readiness of applying a specific combination of emerging technologies affect the firm innovation performance of organisations. The research is multi-continent and ranges across various manufacturing industries. The research questions are stated below:

R.Q. 1: What impact does the rapid advancement of a combination of emerging digital technologies have on the adoption of innovation?

RQ2: How does the organisation's readiness for a combination of emerging digital technologies affect innovation adoption?

RQ3: What impact does the adoption of a combination of emerging digital technologies have on firm innovation performance?

Exploratory research enables the connection between respective variables to explain why or how. The goal is to answer questions raised by Saunders et al. (2009), such as: What are the occurrences? What is the new development? How do we demystify the concept, enlighten ourselves and others on the product, progress, or trend, "and 'Is there a new way or can we change it? Specific literature within chapters one to three provides the guide that the study applied concerning the literature review and quantitative research methods to understand and work towards filling the gaps.

The survey comprises multiple segments; the initial segment included information regarding gender, age, and other related questions on a five-level Likert rating scale. The subsequent segment presents questions for the respondents to mention which of the three technologies is adopted within their organisation. The third segment entails questions explained in the framework and hypothesis development segments within chapter two using the theories. The study focused on managers who can provide relevant insight based on the large enterprises and multinational organisations employed, primarily due to the understanding that the organisations will also have implemented the discussed technologies.

3.2 Research Data Collection

Research methodology performs a key role in conducting the study successfully, and the current research study employs a literature review and a quantitative approach. The questions within the survey are from the framework and based on similar studies on various emerging technologies (Bhattacharyya and Shah, 2021; Chen et al., 2021; Mabad et al., 2021; Na et al., 2022). This study used questionnaires from managerial respondents from large enterprises to understand the real-life application of the challenges within their organisations related to the study and add to the body of knowledge. The actual data collection commenced, and the survey was sent to three hundred and fifty-three managers and above employed by large enterprises in the Middle East, Africa, and Asia. The study received two hundred and eighteen responses, of which forty-nine were used for the pre-test for the questionnaire. Out of one hundred and sixty-nine responses after the pre-test, one hundred and fifty-three were used because sixteen were incomplete or invalid, similar to questionnaires within several studies. Therefore, the study obtained a 43% response rate, which was deemed sufficient based on findings discussed in various studies. For instance, the studies by Falconer and Hodgett (1999) observed that managerial responses typically fall from 42% to 58%. Additionally, Tanaka (1987) explored this area and determined that a minimum of 50 responses is adequate for Structural Equation Modeling (SEM) analysis, and the current study surpassed this threshold with a higher response rate.

3.2.1 Research Ethics

A process was undertaken for ethical approval by the university's ethics committee. Subsequently, approval, illustrated in Appendix 1, was received to conduct the research after ensuring that all the ethical issues had been stated. The approved participant information sheet and the consent form were all included in the questionnaire sent to all respondents and are in

Appendix 2 to 4, respectively. Consideration has also been given to ensure the respondents fully understand the process and their rights to consent, anonymity, and confidentiality.

3.2.2 Literature review:

This study used a literature review as a stepping stone, discussed by Baumeister and Leary (1997), as a necessity to construct the conceptual model upon which a study is predicated. The literature review stage is a significant position in the research process, primarily since it gives the idea of studies conducted and highlights gaps. In the current research, the literature review stage highlighted the void in the literature and the need for further quantitative analysis. The literature review method offers various benefits to the research process, including its use as a foundation for identifying research gaps and developing theoretical knowledge (Davis et al., 2014; Snyder, 2019), which includes using the method as a pillar for filling gaps and growing theoretical knowledge. As a result, the study used academic journals, articles and research studies to gather relevant data. In addition, the data collected by the organisation for survey purposes may also be employed for critical analysis. Secondary sources included past journal articles, books, research reports, and relevant online sources. In addition, the literature review within this study involved various case studies from secondary sources, which also provided the foundation for the quantitative research.

Another advantage of literature review is that it supports re-evaluating existing theories or associations (Tranfield et al., 2003). Often, the rationale for determining the relationship between various measurement items is used within this study to determine the relationship between organisational readiness, the rapid advancement of firm innovation performance and a specific set of emerging technologies regarding innovation adoption. For this purpose, the databases of Google Scholar, Research Gate, Emerald, Elsevier, Taylor and Francis, Wiley, library resources, and other academic reference sources were accessed to find the relevant research papers that helped the critical analysis of the literature review under the current research. The research shows a literature review and analyses case studies of successful organisations with manufacturing verticals to examine their strategies, including the digital technologies they have used to foster innovation and successfully provide emerging products and services.

3.2.3 Rationale for Quantitative Research Data Collection and Analysis

3.2.3.1 The Justification of the Quantitative Method

Quantitative research involves a systematic methodology to enhance the efficiency of problem-solving or issue resolution through the meticulous organisation of theoretical constructs and hypotheses, yielding a comprehensive summary of sequences, mindsets, and insights to facilitate in-depth analyses and further exploration of relationships (Jamieson et al., 2023). Due to the combination of three emerging technologies and focus on three continents, it was critical to ensure limited subjectivity, which, according to Zyphur and Pierides (2020), is associated with the quantitative research method and ultimately allows a more objective view to emerge. Technological advancements facilitating online questionnaires' digital reach are undoubtedly vital to their creation and quick expansion, which Limone et al. (2022) discussed as a rationale for using the method. The study employed a quantitative approach to communicate quantitative findings accurately through the use of unbiased statistical approaches, which, according to the studies by Gupta and Gupta (2022), can be used to reinforce the goals and structure of the research study. Therefore, using the method within this study supports the indication of adequate planning required for hypotheses testing as discussed by Kalinichenko et al. (2015), finding new information, and making predictions, all of which are necessary to validate or refute the hypothesised relationship. As a result, the research study derived evidence for or against a specific theory to explain how or why a particular occurrence occurs. Quantitative research includes an array of approaches, each having distinct characteristics and applications. Survey research is highly effective in collecting extensive and detailed information from a significant number of participants (Sukamolson, 2007).

Additionally, as discussed by (Glasow, 2005), survey research offered an ideal balance of accuracy, comprehensiveness, and applicability, given the availability of resources. Experimental research is a dependable approach for establishing causal relationships by carefully controlling and manipulating variables (Key, 1997). Cause-comparative research provides valuable insights into the current disparities between groups, indicating potential causes and reasons (Gay, 2006). The decision to use the technique of survey research for the present study was based on its compatibility with our research aims, as well as various studies within the field, as outlined in Table 3.1. The approach enabled us to obtain standardised and measurable data rapidly from a broad and diverse sample across emerging economies, as previously outlined.

Moreover, the inclusion of surveys is consistent with the methodological procedures employed in comparable studies within the social sciences (Gideon, 2012; Stern et al., 2014), which improves the ability to assess findings within the existing body of literature. Quantitative research demonstrates a clear advantage over qualitative approaches, as indicated by its widespread utilisation in studying emerging technologies (Bhattacharyya and Shah, 2021; Chen et al., 2021; Na et al., 2022; Rawashdeh et al., 2023). The prevalence facilitates easier replication and application to novel phenomena, a challenge frequently encountered with qualitative methodologies. The numerical format of quantitative data serves to alleviate personal biases and subjectivity, ensuring the robustness and comparability of findings across diverse groups, periods, or contexts. Furthermore, quantitative research's capacity to generate objective valuation metrics stands in contrast to the subjective nature and limited theoretical applicability of qualitative methods in comprehending technological innovation adoption. Consequently, quantitative research offers a structured and objective framework for gaining insights into technology adoption patterns (Caputi and Balnaves, 2001; Martin and Bridgmon, 2012).

There are some limitations on the quantitative research study, which, according to the study by Xiong (2022), includes researchers overlooking the uncovering of underlying meanings and explanations within participants' viewpoints due to their primary focus on numerical data and statistical analysis, often through tools like the Likert scale. However, by supplementing quantitative methods with various case studies and alternative survey formats, such as using a text entry version alongside a Likert scale version of the questionnaire, this limitation was addressed within this study. The text entry version allowed respondents to respond in their own words, thereby enhancing the depth of understanding and enriching the analysis of participants' viewpoints, which was included in the conclusion. At the same time, case studies explore internal intricacies through a theoretical lens intending to issue a resolution, which Hussain et al. (2023) further discussed as a tool to gain knowledge of more successful implementation approaches. Consequently, the Likert scale, case studies and text entry were included in this study. Since quantitative research can be conducted in an unbiased manner with the use of reliable and methodical techniques and emphasising practical relevance, similar to other studies by Nayak and Singh (2021), this approach provided this research study with the ability to expedite the gathering and evaluation of data, regardless of sample sizes. The research methodology to be used for the research is outlined in subsequent sections. However, the gaps this study intends to fill, like rapid advancement, organisational readiness, and firm innovation performance, have yet to be covered in one study related to the ecosystem of emerging technologies. The table below shows the numerous studies and applied research methodologies similar to this study.

Table 3. 1 Research Studies with quantitative data collection approach

Emerging Technological Type	**Research Methods**	**Research Size**	**Location**	**Authors**
AI	Questionnaire	289	China	(Chen et al., 2021)
AI, IoT	Questionnaire	21	India	(Bhattacharyya and Shah, 2021)
IoT and I4.0	Questionnaire	297	Australia	(Mabad et al., 2021)
I4.0	Questionnaire	268	Vietnam	(Yuen et al., 2021)
IoT	Questionnaire	42	Malaysia	(Lee et al., 2022)
Mobile application	Questionnaire	770	Australia	(Vahdat et al., 2021)
AI	Questionnaire	353	USA	(Rawashdeh, et al., 2023).
AI, I4.0	Questionnaire	241	South Korea	(Na et al., 2022)

3.2.3.2 The Justification for using large Enterprises and MNCs for quantitative data collection.

Accurate deciphering of industry patterns drives better planning and growth; therefore, information from large enterprises was used within this study due to the availability of raw insights and access to real-life visualisation. The data analysis of the multinational corporation allows researchers to study customer patterns and then develop and offer their products to the customers' preferences, as evidenced in the study of (Yuen et al., 2021). Furthermore, significantly scaled data analysis is required for organisations to study their consumer base, comprehend their customers' wants, design products accordingly, and as corroborated by the study of Niu et al. (2021), to provide a revenue-driven growth strategy. This study focused on managers and above within large-scale organisations to capitalise on the insights. Large enterprises play a pivotal role in the realm of data collection due to several reasons. One prominent factor is the significant rate of innovation failure observed in a substantial proportion of new products and services, and Ribeiro-Navarrete et al. (2021) discuss the necessity for quantitative data utilisation by various stakeholders, including academics, large enterprises, and multinational corporations, to comprehend target audiences and use insights to meet specific market demands effectively. Large enterprises have ample resources and extensive reach and are uniquely positioned as comprehensive data tools. The organisations themselves recognise that the initial stages of product development are critical, and data is the foundation upon which they build their strategies. By meticulously collecting and analysing data, these corporations seek comprehensive insights into potential outcomes and better understand market dynamics and consumer preferences. To achieve such an objective, large enterprises and multinational corporations (MNCs) as sources for collecting quantitative data are a vital and invaluable method for enhancing academic development models and improving organisational theories.

The success rate of using data from large enterprises and multinational corporations is increasing based on the availability of enormous data sets required to improve their corporate productivity. For example, PepsiCo is an organisation that applies quantitative analysis to manufacturing and logistics. Although Pepsi, Mountain Dew, Lays, Seven Up, and Doritos are the most popular items sold by PepsiCo around the world, Pepsi is the company's most popular product and requires extensive insight gathering. The organisation often experiences logistics challenges due to the size of its global reach across various consumer segments, so to alleviate the issue, PepsiCo applies extensive quantitative research to gather information on multiple aspects of the business. The data collection and analysis range from direct and indirect sales, point of sale information, locations, queries, geographic data, demographic data, and consumer tastes, with each piece of information being pooled to support end-to-end decision-making. Some of the results of such ongoing exercises have enabled PepsiCo to adopt emerging technologies as tools to get quantitative data. Such enormous data are then analysed and used to improve manufacturing processes within an internal innovation ecosystem; this enables them to create products that suit their diverse consumer base worldwide (Tang et al., 2022).

3.2.3.3 The Justification for managerial employees as participants

The role of a manager involves the operation model of working internally and externally to maintain the organisation's structure and ensure productivity. Managers are essential in driving operational strategies, conducting performance evaluations, and overseeing all daily operational activities that help keep the firm productive and efficient while maintaining the necessary structure that ensures customer satisfaction and organisational performance. As organisations grow, studies (Awan et al., 2022; Suknunan and Bhana, 2022) discussed that it becomes challenging to mine data for relevant insights, making it even more necessary for managers to access appropriate and suitable data for accurate decision-making.

In addition to another rationale, Plachy and Smut (2022) discusses that a manager ensures that the organisation's strategies are implemented with the proper knowledge, skills, and capability for optimal long-term growth. Quantitative approaches involve applying numerous aspects of quantities, such as numbers, symbols, and mathematical expressions, to make meaningful contributions to an issue. Therefore, most quantitative research across fields similar to this study used managers for business simulations, statistics, and information models because of their strong decision-making power. Survival in business depends on the ability to make fast and effective decisions, which are predicated on the managers for various reasons, including growth, diversification, knowledge, and retention (Shaver,2021). Therefore, this study sought out that segment selectively due to the know-how of their organisations.

However, as discussed by Riedmeier and Kreuzer (2022), parameters can result in different or unexpected results for a particular decision or set of possibilities. Therefore, it creates a precedent that knowledge from managers can be used to make decision models. As mentioned by Han et al. (2022), researchers used quantitative methods using managers to determine the industry's performance rate. As such, the quantitative research on technology within this study seeks to use the data obtained from the managers to understand how those technologies affect firm innovation performance. Quantitative studies on technology aim to make predictions, find facts, and test existing ideas. This study follows similar studies to evaluate business hypotheses about how or why a particular occurrence can occur by utilising data as a primary support tool while also, according to Brees and Ellen III (2022), helpful in studying the decision-making power of managers to analyse business procedures such as quality control, scheduling, and budgeting.

3.2.3.4 The Justification behind the use of countries within emerging economies

According to Maurya et al. (2023), emerging economies are nations making substantial advancements in adopting and implementing novel innovations. According to Anand et al. (2021), developing nations termed within this study as emerging economies are characterised by continued expansion and the ability to transition to even more heightened growth. These innovations transform global business practises swiftly, presenting prospects and formidable organisational obstacles and, as highlighted within the studies by (Cavusgil et al.,2021; Cavusgil 2021), the growth driver could be associated with the significant amount of knowledge that has been transferred from developed economies over the years. The studies of Zhao et al. (2022) discussed the rationale behind selecting emerging economies for research, highlighting these nations' remarkable growth and widespread adoption of digital technology across diverse sectors. These economies are significant magnets for foreign direct investment Sivalogathasan and Wu (2014), and the attraction is attributed to various factors, among which regulatory policies play a prominent role. As highlighted in the preceding chapters, regulatory policies are a significant variable that substantially impacts fostering innovation within these emerging economies. These policies often influence the decisions of multinational corporations, making this an added rationale for focusing on emerging economies. Therefore, these economies offer significant case studies that provide a comprehensive grasp of both the advantages and obstacles related to digital technology in diverse contexts. Subsequently, their strong predisposition towards adopting digital solutions paves the way for ongoing research opportunities in emerging economies' ever-expanding digital technology landscape.

Emerging markets have risen as catalysts for economic expansion, exhibiting a remarkable surge in their share of the global economy. The studies of (Hoskisson et al., 2000; Sudhir et al., 2015) mentioned that China, India, and Indonesia, consisting of the three most populous emerging markets, have demonstrated significant average yearly expansion rates. Consequently, the continents included within the classification of emerging economies for this study are Asia (Bangladesh, China. India, Pakistan, and Taiwan) and the Middle East / Africa (Ghana, Nigeria, Saudi Arabia, and South Africa), respectively. According to the study by Cavusgil et al. (2021), there is a divergence among emerging markets, with a distinction made between "mature" emerging markets that have successfully transformed their economies into competitive ones and those facing obstacles in their economic transformation, the countries from the respondents within this survey encompass both classifications. The following studies classified the selected countries as emerging markets: Ghana, Nigeria, Tanzania (Asenso et al., 2023), Bangladesh (Hasan et al., 2023), and (Kamarudin et al., 2022), China, India, Pakistan, South Africa, Khan (2022) (Haque et al., 2023). UAE, Saudi Arabia (Wang et al., 2015), China, South Korea (Acolin et al., 2022). Uganda, (Bui and Lo ,2022) Taiwan. Technologies like I4.0 present an opportunity for emerging economies to elevate their development through increased productivity and innovative technologies. Emerging economies have latent capacity in both tangible and intangible resources that can be harnessed to improve innovation performance (Akpan et al., 2022), and therefore, this study sought responses from those economies and, particularly, the countries within the continents.

Furthermore, as shown by the studies of Gregoriou and Ghosh (2009), understanding capital spending and current spending as a percentage of GDP serves as a valuable starting point for assessing growth potential. Therefore, it provides an opportunity to integrate emerging technologies for driving innovation and gaining a competitive edge. To further support the utilisation of emerging economies, data from the World Bank was gathered and used to analyse capital spending and current spending as a percentage of GDP. This approach was necessary to justify using emerging economies in this study. Researching innovation adoption in Middle East Asia and Africa offers valuable insights into optimising operational processes and resource utilisation. It is essential to acknowledge the need for further research to comprehend the potential for innovation adoption and its impact, considering each continent's diverse regional characteristics and economic policies. These research efforts have the potential to drive progress, stimulate economic development, and foster inclusive innovation across Africa, Asia, and the Middle East. The analysis below is based on the study of Hooks et al.(2022) that countries that allocate a substantial portion of their gross domestic product (GDP) to capital investments, investing in their future, and fostering economic growth show an emphasis on long-term investments and infrastructure development based on the increase in spending year on year, indicating that exploring innovation adoption in these regions can also lead to transformative advancements in various sectors that can lead to firm innovation performance. Table 3.2 below presents data on capital spending (% of GDP) and current spending (% of GDP) for various nations, categorised by continent. Each table row represents a country, and the columns provide information on each country's current spending's mean (average) and standard deviation (SD).

Middle East:

Table 3.2 provides information on current and capital spending as a percentage of GDP for the Middle East. Pakistan has a mean capital expenditure of 3.1% of GDP, with a standard deviation of 0.14. However. by contrast, the United Arab Emirates (UAE) has a mean of 3.9% of GDP, with a standard deviation of 0.14. Across all Middle Eastern nations, the average current spending is 16.3% of GDP, with a standard deviation of 0.157.

Asia:

Table 3.2 displays current and capital spending as a percentage of GDP for several Asian nations. The mean capital expenditure for China is 5.7% of GDP, with a standard deviation of

0.14. Bangladesh has a mean capital expenditure of 5.35% of GDP, with a standard deviation of 0.21. India's average GDP allocation for capital spending is 3%, with a standard deviation of 0.14. South Korea allocates a substantial share of its GDP to capital expenditures, with a mean of 9.7% and a standard deviation of 0.14. Taiwan's average capital expenditure is 3.65% of GDP, with a standard deviation of 0.07%. In terms of current spending, Bangladesh spends an average of 14.65% of GDP, while China spends an average of 19.05% of GDP, both with a standard deviation of 0.21. India's average current spending is 11.8% of GDP, with a standard deviation of 0.14. South Korea's average is 11.1% of GDP, with a standard deviation of 0.14. Taiwan's average current spending is 15.2% of GDP, with a standard deviation of 0.14. The average for current spending across all Asian nations is 14.36% of GDP, with a standard deviation of 0.168. Across all Asian nations, the average capital expenditure is 5.48% of GDP, with a standard deviation of 0.14.

Africa:

The table provides information on capital and current spending for several African nations as a percentage of GDP. Ghana has a mean capital expenditure of 6.95% of GDP, with a standard deviation of 0.21. Guinea's mean capital expenditure is 4.4% of GDP, with a standard deviation of 0.14. Nigeria's average GDP allocation for capital spending is 2.25%, with a standard deviation of 0.07%. South Africa allocates a substantially higher percentage of its GDP to capital expenditures, with a mean of 18.35% and a standard deviation of 0.21. Tanzania's average capital expenditure is 7.85% of GDP, with a standard deviation of 0.07%. For current spending, Ghana allows an average of 25.45% of GDP, with a standard deviation of 0.21, while Guinea's average is 12.7%, with a standard deviation of 0.14. Nigeria's average current spending is 12.4% of GDP, with a standard deviation of 0.14. South Africa's average is 28% of GDP, with a standard deviation of 0.14. Tanzania's average current spending is 21.5% of GDP, with a standard deviation of 0.14. Across all African nations, the average current spending is 20.01% of GDP, with a standard deviation of 0.154.

Table 3. 2 Emerging Economies Capital Spending

Continent	Country	2022 Capital Spending (% of GDP)	2023 Capital Spending (% of GDP)	Mean ± SD	2022 Current Spending (% of GDP)	2023 Current Spending (% of GDP)	Mean ± SD
Asia	Bangladesh	5.2	5.5	5.35 ± 0.21	14.5	14.8	14.65 ± 0.21
Asia	China	5.8	5.6	5.7 ± 0.14	18.9	19.2	19.05 ± 0.21
Asia	India	2.9	3.1	3 ± 0.14	11.7	11.9	11.8 ± 0.14
Asia	South Korea	9.6	9.8	9.7 ± 0.14	11.2	11	11.1 ± 0.14
Asia	Taiwan	3.7	3.6	3.65 ± 0.07	15.3	15.1	15.2 ± 0.14
Average of Asia		**5.44**	**5.52**	**5.48 ± 0.14**	**14.32**	**14.4**	**14.36 ± 0.168**
Africa	Ghana	7.1	6.8	6.95 ± 0.21	25.6	25.3	25.45 ± 0.21
Africa	Guinea	4.5	4.3	4.4 ± 0.14	12.8	12.6	12.7 ± 0.14
Africa	Nigeria	2.3	2.2	2.25 ± 0.07	12.3	12.5	12.4 ± 0.14
Africa	South Africa	18.5	18.2	18.35 ± 0.21	27.9	28.1	28 ± 0.14
Africa	Tanzania	7.8	7.9	7.85 ± 0.07	21.4	21.6	21.5 ± 0.14
Average of Africa		**8.04**	**7.88**	**7.96 ± 0.139**	**20**	**20.02**	**20.01 ± 0.154**
Middle East	UAE	4	3.8	3.9 ± 0.14	12.6	12.8	12.7 ± 0.14
Middle East	Pakistan	3.2	3	3.1 ± 0.14	17.2	17.4	17.3 ± 0.14
Middle East	Saudi Arabia	8.9	9.2	9.05 ± 0.21	9.8	10.1	9.95 ± 0.21
Average of Middle East		**6.388**	**6.356**	**6.37 ± 0.163**	**16.2**	**16.384**	**16.292 ± 0.157**
Data Sources: a) https://www.imf.org/en/ b) https://data.worldbank.org/indicator/							

3.2.3.5 Population

According to the OECD (2022), which focuses on manufacturing organisations, large enterprises employ 250 or more people. A multinational corporation is a firm that McKee (2021) describes as providing business services in more than one country with the intention of increased profitability, expansion, and growth of market presence. As asserted by Erola et al. (2022), creating an international presence provides cooperative access to new markets and increased sales unavailable in the local market. For instance, establishing a company in a foreign continent such as Africa, the Middle East, or Asia enables an American or European firm to address the vast demand for specific items in those continents without paying the transaction fees associated with long-distance transportation. Multinational corporations can also take advantage of the lower tax rates offered by countries to attract investment in technological know-how, capital, and support for increasing the employment rate.

Therefore, this study sought managers and others who work in such organisations on the specified continents through the predominant use of digital and online professional platforms using Qualtrics as the survey platform. The target population was managers and above who worked in commercial, financial, or technical roles and, as such, would know about technological changes, advancements, and improvements in their organisation.

3.2.4 Questionnaire Survey and Distribution

3.2.4.1 Development of Questionnaire Measurement items

Each independent variable was represented by at least two measurement items primarily since research has shown that relying on a single measurement item to represent a variable or test a hypothesis can lead to inaccuracies and inconsistencies, whereas using multiple measurement items can improve the validity and reliability of the findings within a research study. According to the study by (DeVellis, 2017; Nunnally and Bernstein, 1994), using multiple items can mitigate the potential for measurement error. Furthermore, studies (Judge et al., 2005; Schunk and Pajares, 2002) discuss that using multiple items to measure variables resulted in higher validity and reliability than using a single item by reducing measurement error and improving the robustness of statistical analyses. The availability of various measurement items within the questionnaire also ensured that respondents understood the questions, enabling them to provide sufficient responses for data analysis. The quantitative data was collected through a multi-section questionnaire. The formulation of the survey instrument was of high importance in accumulating relevant and practical data from past studies, with their questionnaires considered for aadaptation.Therefore,the questionnaire contained questions aligned with the study's objectives and was based on scaling, allowing respondents to respond based on their knowledge and perception.

As illustrated in Table 3.3 and the detailed questionnaire in appendix 2a, the development of the research instrument was methodically structured around three key research questions, drawing from established theoretical frameworks to examine emerging technology adoption.

For Research Question 1 (Rapid Advancement), the questionnaire integrated specific constructs. Relative advantage, supported by Holmstrom, J. (2021) and Chen et al. (2021), included four items examining how "Adopting AI, IoT, and I4.0 enables our organisation to decrease expenditures," "provide bespoke offerings," "improve the versatility and agility," and "enhance financial gains and favourable business outcomes." Compatibility, drawing from Stjepić et al. (2021) and Holmstrom (2021), assessed whether "the adoption of AI, IoT and I4.0 is in line with our current business practises, systems and routines," whether technologies "ought to be compatible with current organisational objectives," and should "have compatibility capability with the existing technology structure." Complexity measures, based on Stjepić et al. (2021) and Chen et al. (2021), evaluated whether "implementing AI, IoT, and I4.0 technologies is complicated," "mastering the complexities can be difficult," and whether adoption "has incurred significant expenses." Trialability, informed by Ullah et al. (2021), examined access to "experiment with emerging technologies on a trial basis," ability to "carefully evaluate any newly developed technology," "thoroughly test new technology," and "explore emerging technologies before making a decision." Perceived Ease of Use, based on Yuen et al. (2021), assessed whether "the process of using an emerging technology-driven work set-up is easily understandable," ability to "make use of the emerging technology-driven work model," and whether "development of products and services using emerging technologies is a straightforward process."

Research Question 2 (Organisational Readiness) incorporated Technology Readiness measures from Oliveira et al. (2019), examining whether "my organisation is inclined to adopt and utilise emerging technology," confidence that "machines will carry out the commands," and whether "products and services that include advanced technologies offer significantly greater convenience." Top Management Support, drawing from Stjepić et al. (2021), Holmstrom (2021), and Chen et al. (2021), assessed whether "senior leadership endorses the implementation," whether executives show "dedication in pioneering the implementation," whether "managers show an in-depth understanding," and management's likelihood of "allocating financial resources." Regulatory Policies Support, based on Malik et al. (2021) and Chen et al. (2021), evaluated whether policies "facilitate the adoption," "provide economic benefits," whether "Government is crucial for our organisation to foster innovation," and the impact of "clarity and uniformity of regulatory regulations."The questionnaire continued with Technology Partner Support measures from Chen et al. (2021) and Holmstrom (2021), assessing the importance of "technology partner assistance," experience with "acquiring support," whether "support of a technological partner is crucial," and maintenance of "particularly close interactions with suppliers and partners." Competitive Pressure items, supported by Chen et al. (2021), Stjepić et al. (2021), and Holmstrom (2021), examined awareness of competitors' implementation, the need to "sustain and retain its edge," influence of competitive pressure, and whether industry adoption "will apply pressure on my organisation."

Research Question 3 (Firm Innovation Performance) included Organisational Innovativeness measures from Gunday et al. (2011), Ghosh and Srivastava (2021), and Phirouzabadi et al. (2013), assessing how the "organisation stays updated on the most recent technological innovations," whether "structure is being updated to encourage mutually beneficial collaborations," and regular updates to "procedures, methods and mode of operations." Process Innovativeness, based on Anning-Dorson et al. (2018) and Tweneboah-Koduah et al. (2020), examined whether "Management expedites and encourages new ways," establishment of "new management strategies," and modification of "service procedures to meet demands." Products and Services Innovativeness items from Anning-Dorson et al. (2018) evaluated whether the "organisation is ahead of the industry," "consistently differentiates our products and services," and has "introduced a more significant number of innovative products and services."All items employed a consistent 5-point Likert scale from "Strongly disagree" to "Strongly agree," with items modified and adapted from the various academic sources to specifically address the contexts of the research study.

Table 3.3: Research Hypothesis and Measurement Items for the Study

Dependent Variable	Independent Variables	No. of measurement Items	Hypothesis
Rapid Advancement	**Relative Advantage**	4	**RADVH1**: **Positive**: "The relative advantage of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."
	Compatibility	3	**CPBH2**: **Positive**: "The compatibility of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."
	Complexity	3	**CPXH3: Negative:** "The complexity of emerging digital technologies has a negative influence on the willingness of an organisation to adopt technological innovation".
	Trialability	3	**TRBH4**: **Positive**: "The trialability of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."
	Perceived ease of use	3	**PEUH5**: **Positive**: "Perceived ease of using emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."

Organisational Readiness	**Top Management Support**	4	**TMGSH6: Positive**: "Top management support of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."
	Technology Readiness	3	**TERH7: Positive**: "Technology readiness for emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation."
	Technology Partners Support	4	**TEPSH8**: **Positive**: "Technology partner support has a positive influence on the willingness of an organisation to adopt technological innovation."
	Regulatory Support	4	**REGPH9: Positive**: "Regulatory policies for emerging technologies have a positive influence on the willingness of an organisation to adopt technological innovation."
	Competitive Industry Pressure	4	**COMPH10: Positive**: "Competitive pressure for emerging technologies has a positive influence on the willingness of an organisation to adopt technological innovation."

Firm Innovation Performance	**Organisational Innovativeness**	3	**OIN H11: Positive**: "The greater the adoption of organisational innovation, the more the firm's innovation performance improved".
	Process Innovativeness	2	**PIN H12: Positive**: "The greater the adoption of process innovation, the more the firm's innovation performance improved".
	Products and Services Innovativeness	3	**PSIN H13: Positive**: "The greater the adoption of product and service innovations, the more the firm's innovation performance improved".

3.2.4.2 The Justification for Sample Selection and Participant Recruitment

The questionnaire is one of the measuring tools used in this study for quantitative research investigations. However, based on the study of Einola and Alvesson (2021), quantitative research could be affected by the collection time and the time required to analyse data; they assist with reducing prejudice, which is necessary. In addition, according to Sammut et al. (2021), the advent of digital questionnaire surveys is an inexpensive and proven effective data-gathering technique. Therefore, the method used also facilitates the study's completion within the time and resource limits. A pilot test and a questionnaire method (quantitative research) were conducted to examine the views of the management staff across various industries. The target participants were managerial employees (a detailed cross section is illustrated within (Table 3.4) who work in large enterprises (of 250 employees and above) and additional justification has been provided within Chapter 3.2.3.3 and who are involved in manufacturing organisations directly or indirectly, including a cross-section of the following:

1) Individuals who are managers and above of organisations with over 250 employees via LinkedIn Premium.
2) Organisations with locations in the Middle East, Africa and Asia within manufacturing directly or indirectly.

Data was gathered via a Qualtrics platform link for convenience, stored with confidentiality, and then analysed through statistical techniques. The study focused specifically on management-level personnel and above, ensuring respondents held positions with sufficient strategic oversight and decision-making authority within their organisations. The identification process leveraged paid subscription-based LinkedIn platform services as the primary platform for locating suitable participants as their professional profiles were visible. Additionally, LinkedIn was utilised in this study for participant recruitment, aligning with previous research published in Sage, Emerald and Elsevier journals (Alzain et al., 2021; Baruffaldi et al., 2017; Bodani et al., 2023; Ecleo and Galido, 2017; Kaur). An approach that has also been validated by Schwarz et al. (2023, p. 4), who described LinkedIn as "the world's largest online professional network" and confirmed its effectiveness for "scientific data collection." Additionally, the study by Horani et al. (2023, p. 9) used LinkedIn, noting "its potential to approach a large and diverse number of respondents in terms of educational level, position, and location which allows for generalisability".

The participant selection process targeted organisations with over 250 employees in various manufacturing-related industries. Within these organisations, individuals at managerial levels and above were randomly selected based on their visible profiles. To ensure multi-regional representation, participants were further randomly filtered by geographic location. Initial contact was made through a personalised introductory message. After establishing a connection, participants received the approved participant information and consent forms via the Qualtrics platform.

Some participants chose to receive the materials via email and provided their email addresses, and the materials were sent using the University of Brighton doctoral researcher email account. Additionally, aside from the cost of subscription and dedicated daily time, the online distribution method offered significant cost advantages by enabling access to respondents across various countries, continents and disciplines (Griffin et al., 2022; Sammut et al., 2021).

Although obtaining qualified participants presented challenges, this was addressed through targeted searches of continent-based and large enterprises. Potential survey participants were carefully categorised before seeking their consent. Each manager received an approved participant information sheet, with questionnaire links as the primary distribution method. However, email distribution was also accommodated when preferred, and willing respondents were asked to share the survey links with colleagues. The recruitment phase was carried out over six to nine months. The Qualtrics platform eliminated risks associated with duplicate entries and manual data input, while facilitating real-time response tracking and error checking (Carter and Del Ponte, 2022).To address questionnaire fatigue (Sammut et al., 2021), timeline expectations were communicated in advance, with participants informed of the approximate ten-minute completion time, although they were encouraged to proceed at their own pace. This pre-notification approach, supported by Galesic and Bosnjak (2009), demonstrated respect for the participants' time constraints. The study addressed Internet bot concerns (Griffin et al., 2022) through GDPR-compliant Qualtrics platform security measures.

3.2.4.3 Overview of Respondents (Demographics)

The first section of the questionnaire presents demographic information about the survey respondents.

Table 3.4: Demographics (Gender, Age, Designation, Industry, Country of Location)

Demographic	Category	Frequency	Percentage
GENDER	Male	131	85.6
	Female	22	14.4
	Total	**153**	**100**
AGE	30- 40	61	39.9
	41-50	67	43.8
	51 and above	25	16.3
	Total	**153**	**100**
DESIGNATION	GM, CXO, Director and above	52	34
	Head of the department	27	17.6
	Senior manager	29	19
	Manager	45	29.4
	Total	**153**	**100**
INDUSTRY	FMCG manufacturing	52	34
	Devices, hardware, and Equipment Manufacturing	46	30.1
	Consumer Electronic Manufacturing	18	11.8
	Telecommunications	12	7.8
	Pharmaceutical Manufacturing	9	5.9
	Others	16	10.4
	Total	**153**	**100**
COUNTRY OF LOCATION	Nigeria	31	20.3
	South Africa	22	14
	China	24	15.7
	Bangladesh	14	9.15
	Ghana	14	9.2
	UAE	11	7.2
	Taiwan	13	8.5
	South Korea	9	6
	Pakistan	7	4.6
	India	5	3.3
	Others	3	2.05
	Total	**153**	**100**

3.2.4.4 Overview of Respondents (Type of Emerging Digital technologies)

The second section of the questionnaire evaluated the use of combined emerging technology from a present and future perspective regarding the organisations where the respondents worked. The questions and responses are summarised below:

3.2.4.4.1: Please specify which of the emerging digital technologies listed below that your organisation uses in its commercial processes. (You may choose more than 1):

In response, 98 respondents out of 153 respondents mentioned that their organisation uses a combined number of emerging technologies, with a significant number (25.5 %) stating that all three emerging technologies, IoT, AI and I4.0 and 17.6 % and 20.9 %, respectively saying a mixture of IoT, AI and IoT, I4.0. The remaining respondents used at least one emerging technology.

3.2.4.4.2: Please specify which of the emerging digital technologies your organisation is most prepared to implement in its commercial processes from the options provided below (You may choose more than 1):

In answering, 13% of participants said IoT and I4.0, while others said IoT and AI (19 %). However, most respondents (43%) said that their organisation would be ready to apply a combination of IoT, AI, and I4.0.

3.2.4.4.3: Please specify which of the emerging digital technologies has contributed to the rapid advancement or growth of your organisation (You may choose more than 1):

In answering, 24% of participants said IoT, AI and I4.0, while others said IoT and AI (17%). However, most respondents (51 %) said their organisation uses IoT, AI, and I4.0.

3.2.5 Sample and Pilot Testing

Quantitative data may be gathered by various tools, such as surveys, questionnaires, and polls, which provide researchers with a certain level of manageability and ease of use. A sampling strategy was implemented, and the survey was initially sent to a subset of the target respondents to gauge their understanding of the questionnaire, similar to the studies (Nayak and Singh, 2021; Nemoto and Beglar, 2014). The questionnaire was sent to a group of respondents, and 49 responses were initially received. Based on the successful pilot testing, it was strengthened by using Qualtrics as a platform coupled with varied dissemination options, including emails and digital links. Qualtrics also has a feature that enables the researcher to know which questionnaires were unfinished and, as corroborated by Harrison and Hernandez (2022), further strengthens the efficient conclusion of the survey.

3.2.6 The use of the Likert Scale

The Likert scale was founded in 1932 by Rensis Likert and has been defined as a measurement of attitudes with the knowledge that attitudinal responses can provide insights that can then be interpreted accordingly. Likert is one of the most used techniques for collecting survey data since it is straightforward and has scales. The answers may be measured objectively and analysed with relative ease. The respondent can respond with detailed or neutral responses since they can respond with a level of agreement instead. Scaling allows a progression of values based on the measurement items and facilitates using a single numeric value that may represent each participant's answer; they are simple to compile for in-depth data analysis (Batterton and Hale, 2017; Likert, 1932). Similar to the studies of (Chow, 2021, p. 15; Taherdoost, 2022 p.4),"all items were categorised using a five-point Likert scale ranging from Strongly Disagree, Disagree, Neither Agree nor Disagree (Neutral), Agree and Strongly Agree".

The studies by (Cohen et al., 2002; Harpe, 2015) have critiqued rating scale items such as the Likert scale, pointing out that the intervals between rating options may not be consistent, which could result in variations. Nonetheless, prior studies, such as those carried out by (Baker et al., 1966; Labovitz, 1867), which examined the effects of modifying the measurement levels, indicate that these differences are primarily insignificant and have limited bearing on the validity of the results. Additionally, a benefit of using Likert scale questions is their universal nature, which makes the questioning approach simple, and it was asserted by Taherdoost (2019) that the Likert method enables those questions to be analysed and summarised into reports, charts, and other visual formats for quantitative research. The Likert scale helps the research analysis maintain consistency, which is essential for identifying emerging outcomes, gaps, and opportunities by comparing current metrics to those established in the past. The scaling method used in this study was closed so that the respondents could select a level of agreement, disagreement, and neutrality based on the statements within the questionnaire. The most popular scales are either seven or five -points with sliding numerical values attached to each point. However, this study used the five-point like other studies of emerging digital technologies (Murati-Leka and Ramadani, 2022; Musyaffi et al., 2022; Taherdoost, 2022). However, from a limitation perspective, with indications from studies by (Kandasamy et al., 2020) that it may have comprehension gaps, researchers Nemoto and Beglar (2014) recommend the inclusion of a text input option to address these limitations, which is further discussed in the next section.

3.2.7 The use of the Text entry version

According to Sadan (2017), structured questionnaires consisted of both open and closed-ended inquiries, and this study followed the theoretical guidelines proposed by Polit and Beck (2015) for constructing structured questionnaires. Open-ended questionnaires provide researchers with significant insights into the opinions and experiences of participants. Nevertheless, there are certain disadvantages, as with every data collection method, with participants showing a hesitancy to type long, unrestricted responses, especially with confidential topics, which are covered with scale-driven answers for closed-ended questions. Furthermore, according to Reja et al.(2003), web surveys are more likely to have missing data points for open-ended questions, which is because respondents may need a longer time to submit answers due to worries about anonymity, leading to often arbitrary non-responses for such topics, and another reason why emerging digital technologies and innovation adoption linked research uses the Likert scale, as evidenced by several studies mentioned in chapter three. Within their study, Chaudhary and Israel (2016) examine the challenges related to text entry questionnaires and propose using a sentence that expresses ambition or admiration as a potential solution. Subsequently, as suggested by previous studies to avoid attrition and acknowledge the value of participants' expertise, there was an explanation that the follow-up questionnaire aimed to gather further insights based on participants' Likert scale responses. The statements that were used in the follow-up questionnaire were "Kindly use the text entry boxes to answer the same questions in your own words". "I offer sincere apologies for taking your valuable time again, as I appreciate your additional expert insights". Consequently, the questions were presented and collected in both Likert scale format and later sent again and collected additionally as a text entry alternative. Although there are difficulties, open-ended questions remain capable of yielding significant outcomes, especially when combined with other methods as a complementary method supported by previous research in which a percentage of respondents who had previously filled out Likert scale questionnaires also filled out the text entry option questionnaire.It is notable that even various groups of participants, such as the fifteen respondents from the studies by Powell and Wright (2008), the eleven participants from the study by Nambisan et al. (1999), and the nine participants from the studies by Wynekoop and Walz (2000), were enough to get valuable insights. Additionally, according to Fugard and Potts (2015, p. 671), "a range of ten to fifty responses is considered adequate for participant-generated text". Subsequently, over thirty responses were received, and unduplicated phrases were extracted and explained further within chapter five.

The open-ended questions were strategically designed to complement the quantitative Likert measurements, enabling participants to provide nuanced, contextual insights that might remain obscured through structured responses. Drawing on Creswell and Creswell's (2017) perspective, such methodological triangulation significantly enhances the research's validity and reliability. Additionally, Johnson and Onwuegbuzie (2004, p. 22).) highlight this approach, emphasising the importance of "seeking convergence and corroboration of results from different methods and designs studying the same phenomenon". Subsequently including the open-ended questions enables strong data triangulation, providing a multifaceted understanding of the complex adoption process under investigation.

Moreover, each open-ended question was meticulously mapped to specific constructs within the DOI, TOE, and TAM frameworks (see Appendix 2b), ensuring that the gathered responses would directly produce insights into the key variables under investigation. An approach that aligns with Popping's (2015, p. 27) assertion that such methods 'may generate richer and more spontaneous information'.

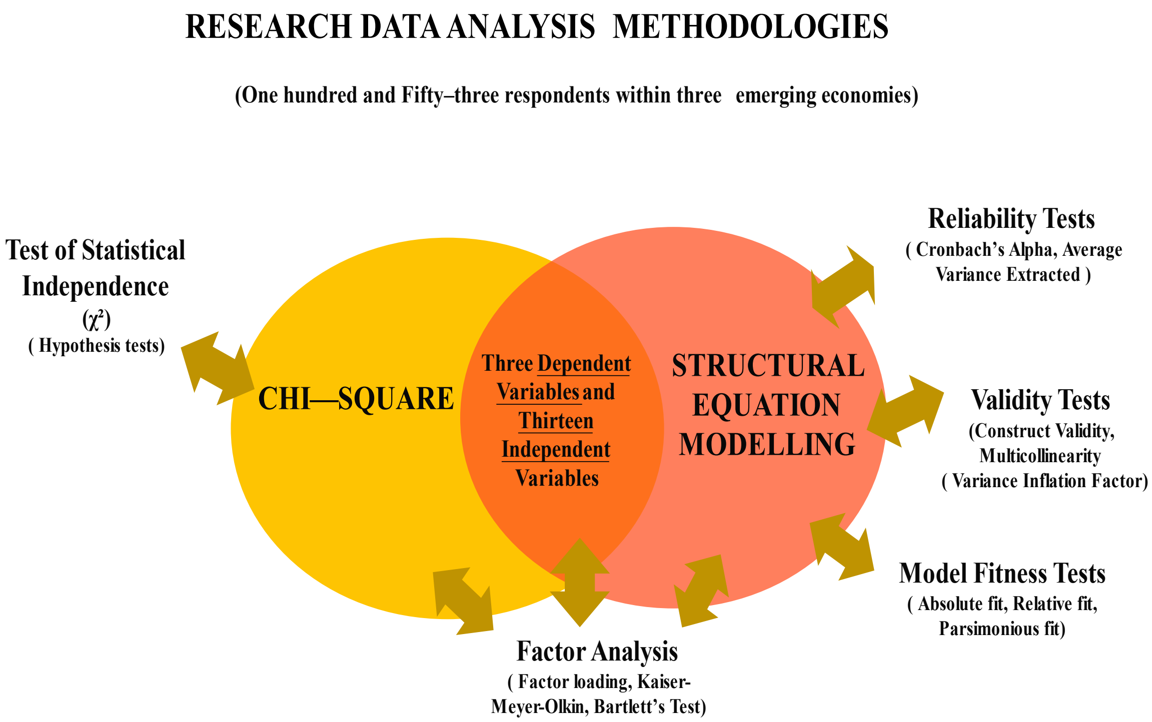
The literature comprehensively addresses related constructs, including rapid advancement (Chen et al., 2021; Holmstrom, 2021; Stjepić et al., 2021; Ullah et al., 2021; Yuen et al., 2021), organisational readiness (Chen et al., 2021; Holmstrom, 2021; Malik et al., 2021; Oliveira et al., 2019; Stjepić et al., 2021), and firm innovation performance (Anning-Dorson et al., 2018; Ghosh & Srivastava, 2021; Gunday et al., 2011; Phirouzabadi et al., 2013; Tweneboah-Koduah et al., 2020).

Utilising Qualtrics Text IQ, the analysis of quantitative responses was systematically structured according to theoretical measurement items and described in Chapter 5. This approach facilitated the comprehensive categorisation of insights that validate and extend the quantitative findings, as advocated by Hair et al. (2019).

3.2.8 The Justification for Data Analysis Software

The study utilised IBM SPSS Statistics and IBM SPSS Amos for data preparation and analysis**.** IBM® SPSS® Statistics is one of the most popular statistical platforms in the world, and it enables researchers and organisations to derive information from various data types and elements. As discussed, (Blunch, 2012; Pallant, 2020), SPSS supports the transition between numerical values and the derivation of the theoretical model. The software was therefore used to understand the various hypotheses and derive meaning. Using SPSS also enabled this study to prepare data properly, enabling more concise analysis and interpretation, and similar studies researching emerging digital technologies (Kim and Cho, 2023; Liu and Yu, 2022; Sureshchandar, 2023) also used IBM SPSS for data analysis and interpretation.

Figure 3 Research Data Analysis Methodologies Chart



3.2.9 The Justification for the Use of Structural Equation Modelling

According to Kline (2016), SEM is a wide-ranging framework that incorporates numerous statistical methods and is used to investigate the association between variables. The variables can be observed in various ways, which include directly or indirectly, with the end goal of assessing the influence of a dependent variable on an independent variable or vice versa as applicable to the study. The method was applied within this study to represent data and help validate and verify how different variables within a study are connected, as advised by studies (Stein et al., 2017; Zyphur et al., 2022). As stated in several studies (Bogers et al., 2022; Bollen, 1989; Bollen et al., 2022; Brown, 2015; Zhang, 2022) across the years, the purpose of structural equation modelling (SEM) is to model intricate interrelationships between both overt (observable) and covert (latent). Subsequently, it was used within this research study to evaluate the significance and fit of the model reflected by the relationships between variables. SEM can assess and measure impacts that other models may not quickly identify (Grace, 2006; Grace et al., 2012; Grace et al., 2015), while the studies by Sancho-Zamora et al., (2022) discussed the model as a translation of the path diagram into a set of linear (structured) equations, each evaluated independently.

3.2.9.1 The Justification for the Use of Chi-square Test Statistics

An investigation of hypotheses based on chi-square inferential statistics was done, and afterwards, structural equation modelling was applied to investigate the integrated impact of dependent variables such as rapid advancement, organisational readiness, and firm innovation performance on adopting innovation ecosystems. As explained in the previous section, figure 4.1 further depicts the combination of various methods within this study.

Karl Pearson invented the Pearson Chi-Square distribution, and according to (McHugh 2013 p.143), the Chi-square can also be known as the “test of independence”, “nonparametric, distribution-free” test, (Plackett,1983 p.59) “goodness of fit” technique that tests hypotheses about population distribution. Chi-Square is the most used global fit that evaluates the fit between the hypothesis for the survey variable and measurement item (Magnello, 2009; Plackett, 1983; Rana and Singhal, 2015).

Specific criteria and assumptions are required for using the Chi-squares test, and according to various studies (Ghayyadah, 2022; Yates, 1934), firstly, the data is randomly drawn from a population with a minimum sample size of 20. The criteria of having a sufficient sample size were fulfilled in this study, considering that 153 respondents were successfully enrolled. Therefore, the method was used in the data analysis sections to test our research hypotheses. A chi-square is used to compare observed and expected or hypothesis variables, and similar to the studies of (Rahman et al., 2023; Sharafuddin et al., 2022), it was used to evaluate the connection between different variables and gain visibility into their significance or relationship to each other.

3.2.9.2 Similar Research Studies with Chi-square Test Statistics Application

Research Topic	Statistical Method	Author
Innovation adoption	Pearson Chi-Square	(Sharafuddin et al., 2022).
Digital technology	Pearson Chi-Square	(Rangaswamy et al., 2022).
I4.0 Technologies Adoption	Pearson Chi-Square	(Akkad et al., 2022).
AI, IoT and Edge Computing	Pearson Chi-Square	(Stadnicka et al., 2022).
Technology readiness and AI	Pearson Chi-Square	(Rahman, et al., 2023).
IoT, firm performance	Pearson Chi-Square	(Bhagat et al., 2022)

The subsequent studies used the Chi-square test in studies relating to innovation adoption, firm performance, and emerging technologies similar to the variables in this study to validate the application.

Table 3. 3 Similar Research Studies with Chi-Square Test

3.2.9.3 The Justification for the Combination of SEM and Chi-Square Analysis Methods

This study employed a methodological approach that as suggested by Kline (2015) integrates structural equation modelling (SEM) and chi-square analysis for complementary purposes, this combined approach facilitated a uniquely extensive and accurate perception of the intricate relationships between variables, allowing one method to compensate for any limitations or assumptions of the other method and supporting the gaps identified in the field. Furthermore, using both SEM and Chi-square analysis in this study contributed to obtaining more robust and reliable findings, as Brown (2015) discussed, which enhanced the validity and generalizability of the results. In addition, the combination of SEM and Chi-square analysis corroborated by Mueller and Hancock (2019) facilitates a defined level of interpretation, leading to more comprehensive and insightful discussions. This methodology enabled a more comprehensive analysis of the study's results, leading to deeper insights regarding the research questions and hypotheses. The combination of these approaches enhanced the empirical support for the theoretical model while bolstering the significance of the study's contributions and findings. Integrating these techniques also strengthened the experimental evidence for the theoretical framework and the study's contribution and outcomes.

3.3 Description of application of Factor analysis

Factor analysis has been used as a supplementary analytical technique in structural equation modelling (SEM) to gain an additional, comprehensive understanding; during factor analysis, when applied to a substantial amount of data, it compresses the dataset into a more attainable and comprehensible subset. The aim was to ascertain the degree of association between each variable in the dataset and a shared theme or factor, and additionally, it is intended to offer an interpretation of the shared factors within the dataset (Costello and Osborne, 2005; Costello and Osborne, 2019). Multiple measures were implemented to ensure the comprehensiveness and dependability of the factor analysis process. Initially, the dataset was placed through careful processing and thorough verification of any instances of missing values. This phase was important as it guaranteed the completeness and accuracy of the data. Subsequently, the dataset's appropriateness was determined by calculating the Kaiser-Meyer-Olkin measure founded by Kaiser (1974) and similar to Shrestha (2021), conducting Bartlett's test of sphericity. These measurements facilitated the understanding of the relationships between variables and ensured the dataset's suitability for subsequent research.

Following this, principal components analysis, with varimax rotation, was chosen as the extraction technique and designated to streamline and improve the comprehensibility of the dataset as it is a well-used method (Costello and Osborne, 2019; Hooper, 2021). According to Pallant (2020), the primary approach used for extraction in SPSS default settings is often principal components analysis and the varimax approach, which is a rotation strategy that simplifies the factor structure. After extracting the factors, a thorough assessment of the factor loadings was conducted to identify useful patterns and connections between variables and factors. Both convergent and discriminant validity were evaluated to confirm the strength and reliability of the findings, and subsequently, for the exploratory phase, confirmatory factor analysis (CFA) was performed to authenticate the findings. Several fit indices, including CFI, TLI, RMSEA, and SRMR, were utilised to assess the model fit and confirm its accurate representation of the observed data. Ultimately, the results were analysed by examining the Rotated Component Matrix, which revealed the factor loadings for each variable (Costello and Osborne, 2005; Costello and Osborne, 2019; Goretzko et al., 2021; Hooper, 2021; Samuels, 2017).

3.3.1 Exploratory factor analysis- SEM- EFA

Exploratory factor analysis (EFA) determines how variables are related by identifying the most important underlying factors that explain these relationships and testing hypotheses at an unrefined level. However, research studies by Creasy (1959) have discussed some limitations to factor analysis because of the fundamental adaptability of models, techniques, and subjectivity, which may result in conflicts about interpretations. Such limitations are mitigated because, as further discussed by Ferguson and Cox (1993), it was also used in this study to gain insights into the underlying patterns and structures of the data and develop models that can be used in hypothesis testing or predictive analysis. Exploratory factor analysis was used in this study for insights on two perspectives, namely from a correlation perspective to evaluate the levels of interdependence between various variables and from a covariance perspective to make conclusive predictions about the data within this study (Williams et al., 2010).

3.3.2 Confirmatory Factor Analysis SEM-CFA

CFA exhibits strength that supports closing the gap between theoretical proposals and actual responses within a study, and according to Mueller et al. (2001), completing the SEM model has become fundamental in research studies. A sample size of one hundred and fifty and above, as discussed by Memon et al. (2020), is deemed sufficient, and sample sizes over four hundred may create a large extent degree of sensitivity that could affect the goodness of fit within SEM (Wolf et al.2013). Therefore, the sample size of one hundred and fifty-three responses within this study is sufficient to use SEM to test the hypothesis.

3.3.3 Similar Research Studies with SEM-CFA and EFA Application in Hypothesis Testing

The subsequent studies used confirmatory factor analysis to validate the data in studies relating to innovation adoption and emerging technologies similar to the variables in this study.

Table 3. 5 Similar Research Studies with SEM-CFA-EFA

Research Topic	**Statistical Method**	**Author**
Innovation adoption	SEM-CFA and EFA	(Chaveesuk et al.2023).
I4.0	SEM-CFA and EFA	Sureshchandar (2023)
IoT, Adoption	SEM-CFA and EFA	Negm (2023)
IoT	SEM-CFA and EFA	(Bader, et al,, 2023)
AI	SEM-CFA and EFA	(Rahman, et al., 2023).

3.4 The Justification for the Various Data Analysis Tests

Various tests were conducted to assess the reliability Cronbach (1951), validity (Hair et al., (2010), factor loadings Field, (2013) and model fitness (Hair et al., 2019) within the study.

3.4.1 Tests for Reliability of the Constructs

3.4.1.1 Cronbach's alpha

According to Cronbach (1951), the test is used to measure reliability; if the Cronbach alpha is less than 0.5, the items are poor; if it is between 0.5 and 0.6, they are unacceptable and acceptable between 0.6 and 0.7. Although a coefficient of 0.7 to 0.9 is considered satisfactory, anything beyond 0.9 is considered exceptional. Therefore, the greater the coefficient, the more the construct can be viewed as dependable (Ebrahimzadeh et al., 2015; Kachooei et al., 2015; Lai and Nagapan, 2022).

3.4.1.2 Composite reliability

Composite reliability helps ensure that the measurement items correctly measure the concept. The study by Fornell and Larcker (1981) discussed that a composite reliability of higher than 0.6 “indicates satisfactory validity.

3.4.2 Factor Loadings

The loadings of the pattern matrix were examined with an item loading of more than 0.30, which was considered necessary because factor loadings above 0.30 can be used to determine exploratory analysis (Collier, 2020; Field, 2013; Harland et al., 2022).

3.4.5 Tests for Validity of the Constructs

3.4.5.1 Convergent Validity

The rho_A values were more significant than 0.7, as shown in Table 4.57; therefore, it was determined that the construct was convergently valid, which is corroborated by the studies of Carlson and Herdman (2012), whose study discussed this as the degree to which items of a specific test indicate a single underlying construct.

3.4.5.2 Discriminant Validity

The discriminant validity, as discussed by (Fornell and Larcker 1981; Hair et al., 2010; Hair et al., 2021), is used within this study to evaluate whether one variable can measure a different perspective from the other variable in a way that reflects differentiation, as is statistically expected to help determine the relationship between each variable within the hypothesis.
Fornell and Larcker (1981) proposed a standard method for evaluating discriminant validity through dual approaches. The primary technique compares the square root of Average Variance Extracted with correlation statistics; alternatively, and the AVE values can be examined against squared correlations. This investigation applied both the conventional Fornell-Larcker criterion and the Heterotrait-Monotrait ratio assessment.

3.6 Tests for Model Fitness

The viability of the measurement model was evaluated using the following model fit measures.

3.6.1 Absolute Fit Measures

- CMIN/DF-Chi-square to degrees of freedom ratio
- RMSEA: Root Mean Square Error of Approximation

RMSEA depicts the error between predicted and observed values within a model as used in the studies of (Jia et al., 2023). A model with a good absolute fit indicates that the hypothesis closely matches the observed data without inconsistency or deviation. The studies (Byrne, 2016; Ho, 2006) recommend a CMIN/DF <2 for excellent model fitness. Karl Pearson invented the Pearson Chi-Square distribution, and according to (McHugh 2013 p.143), the Chi-square can also be known as the “test of independence”, “nonparametric, distribution-free” test, (Plackett,1983 p.59).

3.6.2 Relative Fit Measures

- IFI: Incremental Fit Index
- TLI: Tucker-Lewis Index
- CFI: Comparative Fit Index
- GFI :Goodness-of-Fit Index

According to Kline (2015), relative fit corresponds to the extent to which the outcomes derived from the data analysis correlate with the collected data while also considering the complexities of the model's structure. It uses the model with the most relative fit to establish the final model that can be used for interpretation.

3.6.3 Parsimonious Fit Measures:

- PNFI: Parsimonious Normed Fit Index
- AGFI: Adjusted Goodness-of-Fit Index

The principle of parsimony is discussed by Hu and Bentler (1999) as a model that provides clarity, proves the highest possibility of explaining a trend, and is often the most likely to be precise. A model is considered parsimonious when there is a good balance between directness, validity, and reliability while using a minimal number of variables, measurement items, or parameters. According to (Mulaik et al. 1989), the parsimony model reviews or evaluates how well a model has undergone various tests against available data parameters and can provide a simple interpretation. The Adjusted Goodness-of-Fit Index (AGFI), developed by Jöreskog and Sörbom (1984), corrects the primary limitation of GFI by adjusting for model complexity. Classified as a parsimony-adjusted index, AGFI modifies the GFI value using a ratio of model degrees of freedom, thereby imposing a penalty on elaborate parameters. AGFI shares the same 0 to 1 range as GFI, where values closer to 1 represent better fit, with 0.90 conventionally established as the threshold for acceptable model performance. By incorporating this complexity adjustment, AGFI functions similarly to adjusted R^2 in regression analysis—both indices reduce their values when unnecessary parameters are added, promoting more parsimonious solutions that balance explanatory power with simplicity (Mulaik et al., 1989; Wang et al., 2020). The structural model would be utilised to establish whether rapid advancement, organisational readiness, and firm improvement directly influence the adoption of an innovative ecosystem. SEM was used to test and validate the study hypotheses using Amos 26 software. The fit statistics supported the tested model and each fit indicator in the model aligned with the broadly accepted values.

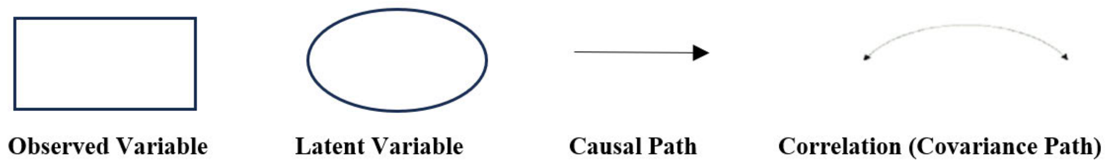
3.7 Path Analysis

As applied across various studies (Bollen, 1989; Brown, 2015; Kline, 2015), path analysis was used within this study to test specific hypotheses, understand how variables are related, and determine the strength and direction of these relationships. The study by Brown (2015) discussed how path analysis could be used to test models across different groups or time points, which can help research studies like this to identify similarities and differences in the relationships between variables across different contexts if they exist. With the knowledge and indication, this study applied path analysis to evaluate the direct effects, which are the relationships between variables that occur without intervening variables, and indirect effects that occur through one or more intervening variables. Furthermore, in path analysis, the "structural path coefficient "or "path weight" shows the relationship between the variables, while standard errors (SE) and critical ratios (CR) are commonly used to assess the statistical significance of the estimated parameters (Bollen, 1989; Kline, 2016).

3.6.4.1 Description of Path Diagram (Shapes and arrows)

Path diagrams are a common visual representation of these networks, where an arrow indicates the direction of connections between variables (Lefcheck,2016). Based on the various studies outlined, the model was drawn out to make a "path diagram" using known facts, and theories were developed to evaluate the model's validity. The studies of (McDonald and Ho, 2002; Pearl, 2000) further elaborate that double-headed arrows show correlations between variables, while single-headed arrows show causal routes between variables; such visualisation in SEM could involve arrows representing the connections while boxes or circles explain the variables. Further discussion from studies by Adelson (2012) highlights that path diagrams use squares to represent observable or measurable variables and circles or ovals to indicate the construct or measurable structures, with the numbers on the arrows being coefficients that measure how strong the relationship is, and the trajectory of the association between variables (Hair et al., 2010). Therefore, with enough prior information about the observation and experimentation, one can formulate a reasonable hypothesis about the causal structure and other factors that moderate their relationship.

Figure 4 Path Analysis Shapes



(adapted from Adelson, 2012; Larsson et al., 2020)

Chapter 4 Data Analysis

The irrevocable need for a dogged focus on innovation permeates all industries. It has been accompanied by unrelenting and rapidly evolving technological transformative advances in recent years. These advances result in new prospects for innovation, and Nittala et al. (2022) discussed that research into them is both relevant and critical. Technological innovation has created a significant impact on the business in every aspect. Irrespective of the industry, technology adoption has become essential for the organisation to sustain or introduce unique goods and services for the targeted audience and do so within standards like environmental management, quality management, ethical standards, and others. In the era of an unforeseen pandemic, many organisations have attained new benchmarks or success due to improvising their services or providing information to their customers to meet their expectations. Technological adoption has rapidly increased in industries using various modes of evolving technologies. Therefore, this study intends to provide more knowledge on how rapid advancement, organisational readiness, and firm innovation performance drive the adoption of the innovative ecosystem of the technologies. This chapter will present the data analysis collected from the research study. The chapter mentions the survey respondents' demographic information, including age and gender, designation, country location, and industry. The chapter also presents the data analysis results of the different hypotheses with methodology details stated in chapter three.

4.1 Research Questions for the Data Analysis

The results in this chapter provide statistical answers to the research questions that outline this research and are as follows:

R.Q1: What impact does the rapid advancement of a combination of emerging digital technologies have on the adoption of innovation?

RQ2: How does the organisation's readiness for a combination of emerging digital technologies affect innovation adoption?

RQ3: What impact does the adoption of a combination of emerging digital technologies have on firm innovation performance?

4.2 Demographics and Descriptives - Overview of Respondents

This section presents demographic information about the survey respondents.

Table 4 1 : Demographics (Gender, Age, Designation, Industry, Country of Location)

Demographic	Category	Frequency	Percentage
GENDER	Male	131	85.6
	Female	22	14.4
	Total	**153**	**100**
AGE	30- 40	61	39.9
	41-50	67	43.8
	51 and above	25	16.3
	Total	**153**	**100**
DESIGNATION	GM, CXO, Director and above	52	34
	Head of the department	27	17.6
	Senior manager	29	19
	Manager	45	29.4
	Total	**153**	**100**
INDUSTRY	FMCG manufacturing	52	34
	Devices, hardware, and Equipment Manufacturing	46	30.1
	Consumer Electronic Manufacturing	18	11.8
	Telecommunications	12	7.8
	Pharmaceutical Manufacturing	9	5.9
	Others	16	10.4
	Total	**153**	**100**
COUNTRY OF LOCATION	Nigeria	31	20.3
	South Africa	22	14
	China	24	15.7
	Bangladesh	14	9.15
	Ghana	14	9.2
	UAE	11	7.2
	Taiwan	13	8.5
	South Korea	9	6
	Pakistan	7	4.6
	India	5	3.3
	Others	3	2.05
	Total	**153**	**100**

(Al-Dmour et al., 2025; Hotessa Warie et al., 2024; Panigrahi et al., 2025; Wang et al., 2025).

4.3 Measurement Model Evaluation (SEM CFA)

The SPSS methodology section draws upon and adapts SEM analytical frameworks from innovation adoption and emerging technology literature. The tables and analysis within this section synthesise research published in high-impact journals (ABS 3-4*) across major reputable academic journal publishers.

The measurement model of this study was assessed using Confirmatory Factor Analysis (CFA), which is discussed in Chapter Three. This analytical approach enabled the evaluation of construct validity, convergent validity, discriminant validity, composite reliability, and average variance extracted (AVE) across all measured constructs. The CFA methodology followed established guidelines from Hair et al. (2010) and Chin (1998), ensuring that factor loadings met or exceeded the recommended threshold value of 0.6. This rigorous assessment framework provided statistical validation for the measurement instruments employed throughout the study, confirming their reliability and validity for subsequent structural model analysis.

4.3.1 Tests for Reliability of the Constructs

Various tests (Illustrated in Table 4.2) were conducted to assess the reliability (Cronbach, 1951), validity (Hair et al., 2010), factor loadings (Field, 2013) and model fitness (Hair et al., 2019) of the variables within the study.

4.3.1.1 Cronbach's alpha

Variables in this study had Cronbach alpha values greater than 0.7, indicating the data can be kept in the model and similar to various studies (Ebrahimzadeh et al., 2015; Kachooei et al., 2015; Lai and Nagapan, 2022).

4.3.1.2 Composite reliability

In this study, all the components passed composite reliability with values considerably over the threshold value of 0.7(Carlson and Herdman, 2012; Hair et al., 2010; Henseler et al., 2015), confirming that the model has a sufficient composite reliability characteristic, which enables proceeding with the final model.

Table 4 2: Reliability and Convergent Validity of the Constructs

		Construct	Cronbach's Alpha	rho_A (Spearman's rank correlation coefficient)
Adoption of Innovation of Emerging Technology	Rapid Advancement	H1 RADV	0.713	0.723
		H2 CPB	0.927	0.948
		H3 CPX	0.892	1.026
		H4 TRB	0.908	0.919
		H5 PEU	0.925	0.928
	Organisation Readiness	H6 TMGS	0.956	0.959
		H7 TEPS	0.917	1.121
		H8 TER	0.972	0.974
		H9 REGP	0.900	0.932
		H10 COMP	0.929	1.116
	Firm Innovation Performance	H11 OIN	0.846	0.849
		H12 PIN	0.947	0.959
		H13 PSIN	0.846	0.9.00

(Hoyos Vallejo and Chinelato, 2025; Huang, 2025; Khan et al., 2024; Khan and Ullah, 2025).

4.3.2 Explanation of Measurement Models (Rapid Advancement, Organisational Readiness and Firm Innovation Performance)

The measurement for this study comprised multiple constructs organised into three key analytical frameworks: Rapid Advancement, Organisational Readiness, and Firm Innovation Performance. Each framework presents reflective first-order variables examined through confirmatory factor analysis (CFA).

4.3.2.1 Rapid Advancement, Measurement model

Table 4.3 depicts the results of confirmatory factor analysis for the Rapid Advancement framework, comprising five constructs: Relative Advantage (RADV), Compatibility (CPB), Complexity (CPX), Trialability (TRB), and Perceived Ease of Use (PEU). Factor loading values across all constructs ranged from 0.699 to 0.973, with most exceeding the threshold level of 0.6 as recommended by Chin (1998).

The construct validity assessment revealed composite reliability (CR) values ranging from 0.63 to 0.92, with most exceeding the 0.7 thresholds recommended by Hair et al. (2010), indicating an acceptable degree of internal consistency. However, Relative Advantage (CR=0.79) showed marginally adequate reliability, and its AVE value (0.48) fell slightly below the recommended threshold of 0.5, suggesting potential issues with convergent validity for this construct.

Compatibility demonstrated high factor loadings (0.930-0.940) but showed the lowest CR (0.63), indicating potential areas for measurement refinement. Complexity (CR=0.92, AVE=0.79) and Perceived Ease of Use (CR=0.92, AVE=0.73) exhibited the strongest measurement properties, with factor loadings ranging from 0.750 to 0.973, demonstrating robust construct validity.

4.3.2.2 Organisational Readiness Measurement model

The Organisational Readiness framework in Table 4.3 comprised five constructs: Top Management Support (TMGS), Technology Partners Support (TEPS), Technology Readiness (TER), Regulatory Support (REGP), and Competitive Industry Pressure (COMP).

All factor loadings for this framework ranged from 0.806 to 0.975, substantially exceeding the 0.6 threshold, which strongly supports indicator reliability. Composite reliability values ranged from 0.89 to 0.93, well above the recommended threshold of 0.7, confirming high internal consistency across all constructs.

Technology Readiness exhibited the highest AVE (0.83), indicating that 83% of the variance in its indicators is explained by the construct. All other constructs demonstrated AVE values between 0.67 and 0.72, exceeding the 0.5 thresholds recommended by Hair et al. (2010), which confirms strong convergent validity throughout the Organisational Readiness framework.

4.3.2.3 Firm Innovation Performance measurement model

Table 4.3 presented the measurement model for Firm Innovation Performance, which included constructs such as Organisational Innovativeness (OIN) and Process Innovativeness (PIN). Factor loadings for these constructs ranged from 0.864 to 0.955, substantially exceeding the recommended threshold.

Composite reliability values were notably strong (CR=0.87 for OIN and CR=0.93 for PIN), demonstrating excellent internal consistency. Average variance extracted values (AVE=0.63 for OIN and AVE=0.79 for PIN) exceeded the 0.5 threshold, confirming robust convergent validity for these constructs.

Under established guidelines, all items were assessed on a 5-point Likert scale, and all factor loadings were confirmed to be statistically significant at $P<0.01$, further validating the measurement models. The results collectively demonstrate that most constructs across all three frameworks exhibit satisfactory construct validity, convergent validity, and reliability, with minor exceptions noted for the Relative Advantage construct.

For Table 4.3, the sources are (Adomako and Nguyen, 2025; Bekata and Kero, 2025; Gameti and Morrish, 2025; Kao, 2020; Khan and Ullah, 2025; Ku and Chen, 2024; Nusir, 2025; Rashid et al., 2025; Sivarajah et al., 2024; Ting and Min, 2025; Virmani et al., 2025; Wang et al., 2025).

Table 4 3: Measurement Models

Rapid Advancement			
Constructs	**Measures**		**Factor Loadings[b]**
Relative Advantage (RADV)			
(CR=0.79, AVE=0.48)	RADV1 .	Adopting AI, IoT, and I4.0 enables our organisation to decrease expenditures.	0.805
	RADV2	Adopting AI, IoT, and I4.0 empowers our organisation to provide bespoke offerings.	0.699
	RADV3	Adopting AI, IoT, and I4.0 will improve the versatility and agility of our organisation.	0.717
	RADV4	Adopting AI, IoT, and I4.0 can enhance financial gains and favourable business outcomes.	0.707
Compatibility (CPB)			
(CR=0.63, AVE=0.79)	CPB1	The adoption of AI, IoT and I4.0 in my organisation is in line with our current business practises, systems and routines.	0.931
	CPB2	The integration of emerging technologies like AI, IoT and I4.0 ought to be compatible with current organisational objectives, and the functions executed by these technologies should actively contribute to the achievement of the organisation's objectives.	0.930
	CPB3	Emerging technologies such as AI, IoT, and I4.0 should have compatibility capability with the existing technology structure and framework within my organisation.	0.940
Complexity (CPX)			
(CR=0.92, AVE=0.79)	CPX1	Implementing AI, IoT, and I4.0 technologies in my organisation is complicated and comes with complexity.	0.750
	CPX2	Mastering the complexities of emerging technologies such as IoT, I4.0, and AI can be difficult.	0.969
	CPX3	Adopting and migrating to AI, IoT, and I4.0 in my organisation has incurred significant expenses.	0.973

Trialability (TRB)			
(CR=0.89, AVE=0.67)	TRB1	I would be granted access to experiment with emerging technologies on a trial basis for a sufficient duration to assess their capabilities.	0.845
	TRB2	Our company would carefully evaluate any newly developed" technology before making a decision to adopt it".	0.893
	TRB3	I would appreciate the opportunity to thoroughly test new technology before deciding to use it.	0.884
	TRB4	Having the ability to explore emerging technologies prior to making a decision could make it less challenging to understand.	0.916
Perceived ease of use (PEU)			
(CR=0.92, AVE=0.73)	PEU1	The process of using an emerging technology-driven work set-up or functional process is easily understandable to me.	0.899
	PEU2	I will be able to make use of the emerging technology-driven work model or functional approach in our organisation.	0.943
	PEU3	The development of products and services using emerging technologies is a straightforward process for our organisation.	0.956

[a]All items were assessed on 5-point Likert scale, anchored by 1=Strongly disagree while 5=Strongly agree
[b]All factor loadings are significant at P<0.01.
Notes: CR= Composite reliability; AVE= Average variance extracted

Organisational Readiness			
Constructs		Measures	Factor Loadings[b]
Top Management Support (TMGS)			
(CR=0.89, AVE=0.67)	TMGS1	The senior leadership endorses the implementation and adoption of AI, IoT and I4.0 innovation.	0.944
	TMGS2	There is an executive in my organisation that exhibits a high level of dedication in pioneering the implementation of AI, IoT or I4.0 Innovation and actively encourages the use of these systems.	0.945
	TMGS3	Managers in our organisation show an in-depth understanding of AI, IoT or I4.0 technologies that may be deployed to improve organisational outcomes.	0.941
	TMGS4	The highest levels of our management are likely to allocating financial resources towards investments in AI, IoT or I4.0.	0.929
Technology Partners Support (TEPS)			
(CR=0.93, AVE=0.67)	TEPS1	I believe that having technology partner assistance is crucial when transitioning from a pre-existing system to an AI, IoT, and I4.0-enabled platform.	0.845
	TEPS2	We have experienced no challenges in acquiring support or dependable services from our vendors/partners.	0.871
	TEPS3	Having the support of a technological partner is crucial for solving any technical operational problems.	0.897
	TEPS4	We maintain particularly close interactions with our suppliers and partners.	0.926

Technology Partners Support (TEPS)			
(CR=0.93, AVE=0.67)	TEPS1	I believe that having technology partner assistance is crucial when transitioning from a pre-existing system to an AI, IoT, and I4.0-enabled platform.	0.845
	TEPS2	We have experienced no challenges in acquiring support or dependable services from our vendors/partners.	0.871
	TEPS3	Having the support of a technological partner is crucial for solving any technical operational problems.	0.897
	TEPS4	We maintain particularly close interactions with our suppliers and partners.	0.926
Technology Readiness (TER)			
(CR=0.91, AVE=0.83)	TER1	In general, my organisation is inclined to adopt and utilise emerging technology in order to accomplish work objectives.	0.971
	TER2	"I feel confident" that machines will carry out the commands given to them.	0.973
	TER3	Products and services that include advanced technologies offer significantly greater convenience.	0.975
		In general, my organisation is inclined to adopt and utilise emerging technology in order to accomplish work objectives.	
Regulatory Support (REGP)			
(CR=0.91, AVE=0.72)	REGP1	Regulatory policies facilitate the adoption and implementation of emerging technologies.	0.864
	REGP2	Regulatory Policies provide economic benefits and gains for the adoption of emerging technologies.	0.806
	REGP3	Government is crucial for our organisation to foster innovation.	0.909
	REGP4	The clarity and uniformity of regulatory regulations are advantageous for us to embrace emerging technologies.	0.923

Competitive Industry Pressure (COMP)			
(CR=0.90, AVE=0.72)	COMP1	I am aware of the fact that competitors in the market have already implemented AI, IoT, and I4.0 technologies within their organisations.	0.949
	COMP2	Our organisation had to adopt AI, IoT, and I4.0 technologies in order to sustain and retain its edge over industry competitors.	0.874
	COMP3	The presence of competitors within our organisation has exerted pressure, hence influencing the choice to adopt and implement new technological innovations.	0.924
	COMP4	The adoption of AI, IoT, and I4.0 within the industry will apply pressure on my organisation to follow similar practices.	0.832

Firm Innovation Performance			
Constructs	**Measures[a]**		**Factor Loadings[b]**
Organisational Innovativeness (OIN)			
(CR=0.87, AVE=0.63)	OIN1	Our organisation stays updated on the most recent technological innovations in all relevant aspects.	0.864
	OIN2	The organisational structure is being updated to encourage mutually beneficial collaborations, collaborative projects, and sustained alliances.	0.881
	OIN3	Our organisation regularly updates the "procedures, methods and mode of operations" used to carry out business activities in an innovative way.	0.878
Process Innovativeness (PIN)			
(CR=0.93, AVE=0.79)	PIN1	Management expedites and encourages new ways of accomplishing tasks.	0.955
	PIN2	Within the "past five years", our company has established a lot of new management strategies for faster and more efficient ways to serve customers.	0.932
	PIN3	We modify our service procedures to meet the demands of our customers.	0.963
Products and Services Innovativeness (PSIN)			
(CR=0.92, AVE=0.70)	PSIN1	Our organisation is ahead of the industry regarding the introduction of products and services in the market.	0.945
	PSIN2	Our organisation consistently differentiates our products and services from industry rivals.	0.735
	PSIN3	Over the "past five years", our organisation has introduced a more significant number of innovative products and services than any other.	0.931
[a]All items were assessed on a 5-point Likert scale, anchored by 1=Strongly disagree while 5=Strongly agree [b]All factor loadings are significant at P<0.01. Notes: CR= Composite reliability; AVE= Average variance extracted			

4.3.3 Tests for Validity of the Constructs

The rho_A values were more significant than 0.7 in terms of convergent validity; therefore, the construct was determined to be convergent (Carlson and Herdman, 2012).In terms of discriminant validity, the HTMT values (illustrated in Table 4.3)

The discriminant validity of this investigation was evaluated using the Fornell-Larcker criterion (Fornell and Larcker, 1981) and HTMT values as illustrated in Table 4.4. According to this approach, the square root of the Average Variance Extracted (AVE) for each construct must be larger than the correlation coefficients between that construct and any other construct in the model. The diagonal values representing the square roots of AVE range from 0.623 (RADV) to 0.959 (TER), indicating that the convergent validity was also established, as the average variance extracted (AVE) measures for all constructs exceed the recommended 0.5 thresholds (Fornell and Larcker, 1981). The HTMT values were found to be well below the 0.90 limits, which shows good discriminant validity (Henseler et al., 2015).

The results demonstrated that all square roots of AVE values were higher than their corresponding correlation coefficients. There was less association between each factor and the other factors in the model when comparing the thirteen constructs with their correlations. Therefore, the criterion provided support for the discriminant validity of all constructs, confirming that each construct shares more variance with its indicators than with other constructs, as established by Fornell and Larcker (1981). This indicates that each construct captures a significant amount of variance in its indicators relative to measurement error, providing further evidence of the measurement model's validity. This comprehensive table demonstrates discriminant validity by showing correlations on the lower left part, HTMT values on the upper right part and the square root of AVE values for each construct along the diagonal enabling efficient assessment of construct distinctiveness using multiple criteria simultaneously (Hair et al., 2019; Henseler et al., 2015).

Table 4 4: Discriminant Validity of the Constructs (HTMT)

Htmt Values	COMP	TMGS	TRB	TEPS	REGP	TER	PIN	CPB	PEU	CPX	PSIN	OIN	RADV
COMP	1												
TMGS	0.406	1											
TRB	0.341	0.556	1										
TEPS	0.042	0.089	0.106	1									
REGP	0.174	0.356	0.175	0.238	1								
TER	0.073	0.434	0.413	0.109	0.282	1							
PIN	0.277	0.354	0.2	0.056	0.093	0.3	1						
CPB	0.275	0.23	0.351	0	0.051	0.183	0.161	1					
PEU	0.484	0.487	0.321	0.089	0.048	0.236	0.37	0.134	1				
CPX	0.025	0.06	0.115	0.158	0.142	0.104	0.028	0.106	0.033	1			
PSIN	0.219	0.21	0.084	0.042	0.108	0.272	0.338	0.263	0.21	0.039	1		
OIN	0.321	0.506	0.42	0.188	0.125	0.31	0.453	0.14	0.284	0.13	0.307	1	
RADV	0.374	0.26	0.337	0.08	0.068	0.109	0.254	0.407	0.312	0.099	0.073	0.267	1

(Al-Dmour et al. 2025; Fernandes, et al. 2025; Jeilani and Hussein, 2025; Shah et al., 2024; Kavitha and Joshith, 2024; Zhang et al.,2025)

Table 4 5: Discriminant Validity of the Constructs (Fornell -Larcker)

Fornell-Larcker	COMP	TMGS	TRB	TEPS	REGP	TER	PIN	CPB	PEU	CPX	PSIN	OIN	RADV
COMP	0.875												
TMGS	0.409	0.919											
TRB	0.335	0.528	0.848										
TEPS	-0.024	0.096	0.108	0.858									
REGP	0.185	0.364	0.197	0.262	0.834								
TER	0.099	0.427	0.42	0.102	0.29	0.959							
PIN	0.292	0.37	0.201	0.074	0.113	0.31	0.924						
CPB	0.288	0.222	0.337	0.006	0.072	0.181	0.181	0.9					
PEU	0.461	0.485	0.319	0.084	0.089	0.253	0.37	0.129	0.903				
CPX	0.011	0.115	0.106	-0.145	0.144	0.122	0.004	0.075	0.044	0.873			
PSIN	0.183	0.194	0.107	0.064	0.077	0.281	0.411	0.287	0.198	0.054	0.828		
OIN	0.326	0.502	0.405	0.211	0.123	0.311	0.457	0.147	0.29	0.175	0.306	0.807	
RADV	0.451	0.337	0.32	-0.012	0.084	0.148	0.253	0.419	0.293	0.105	-0.003	0.301	0.623

(Bekata and Kero, 2025; Benhayoun and Zejjari, 2024; Cuevas-Vargas et al., 2023; Martínez-Falcó et al., 2023; Sabraz Nawaz et al., 2024; Shahbaz et al., 2024).

Table 4 6: (Correlation Matrix)

	COMP	TMGS	TRB	TEPS	REGP	TER	PIN	CPB	PEU	CPX	PSIN	OIN	RADV
COMP	**0.875**	0.406	0.341	0.042	0.174	0.073	0.277	0.275	0.484	0.025	0.219	0.321	0.374
TMGS	0.409	**0.919**	0.556	0.089	0.356	0.434	0.354	0.230	0.487	0.060	0.210	0.506	0.260
TRB	0.335	0.528	**0.848**	0.106	0.175	0.413	0.200	0.351	0.321	0.115	0.084	0.420	0.337
TEPS	-0.024	0.096	0.108	**0.858**	0.238	0.109	0.056	0.000	0.089	0.158	0.042	0.188	0.080
REGP	0.185	0.364	0.197	0.262	**0.834**	0.282	0.093	0.051	0.048	0.142	0.108	0.125	0.068
TER	0.099	0.427	0.420	0.102	0.290	**0.959**	0.300	0.183	0.236	0.104	0.272	0.310	0.109
PIN	0.292	0.370	0.201	0.074	0.113	0.310	**0.924**	0.161	0.370	0.028	0.338	0.453	0.254
CPB	0.288	0.222	0.337	0.006	0.072	0.181	0.181	**0.900**	0.134	0.106	0.263	0.140	0.407
PEU	0.461	0.485	0.319	0.084	0.089	0.253	0.370	0.129	**0.903**	0.033	0.210	0.284	0.312
CPX	0.011	0.115	0.106	-0.145	0.144	0.122	0.004	0.075	0.044	**0.873**	0.039	0.130	0.099
PSIN	0.183	0.194	0.107	0.064	0.077	0.281	0.411	0.287	0.198	0.054	**0.828**	0.307	0.073
OIN	0.326	0.502	0.405	0.211	0.123	0.311	0.457	0.147	0.290	0.175	0.306	**0.807**	0.267
RADV	0.451	0.337	0.320	-0.012	0.084	0.148	0.253	0.419	0.293	0.105	-0.003	0.301	**0.623**

4.3.2.3 Multicollinearity Tests: Variance of Inflation Factor (VIF)

The findings from the variables within this study (illustrated in table 4.7) demonstrate no multicollinearity concerns because the VIF values are less than ten (Hair et al., 2019; Pallant, 2020).

Table 4 7: Variance of Inflation Factor

Collinearity Statistics (VIF)	VIF	Collinearity Statistics (VIF)	VIF
CPB1	4.130	REGP1	2.563
CPB2	3.239	REGP2	2.058
CPB3	3.751	REGP3	3.332
CPX1	1.732	REGP4	4.111
CPX2	7.158	TMGS1	7.724
CPX3	6.989	TMGS2	7.262
COMP1	3.306	TMGS3	5.800
COMP2	4.000	TMGS4	4.791
COMP3	3.344	TEPS1	2.980
COMP4	3.050	TEPS2	3.910
OIN1	1.825	TEPS3	3.316
OIN2	2.186	TEPS4	2.443
OIN3	2.234	TER1	8.257
PIN1	5.067	TER2	8.503
PIN2	4.043	TER3	8.802
PIN3	5.782	TRB1	2.977
PSIN1	3.926	TRB2	4.079
PSIN	1.488	TRB3	2.993
PSIN	3.645	TRB4	4.862
RADV1	1.494	PEU1	2.493
RADV2	1.336	PEU2	5.863
RADV3	1.335	PEU3	6.356
RADV4	1.303		

(Jeilani and Hussein, 2025**;** Salah and Ayyash, 2024; Shah et al., 2024; Sharma et al., 2025; Kavitha and Joshith, 2024).

4.3.4 Tests for Factor Analysis

4.3.4.1 Measure of Sampling Adequacy Check

Bartlett’s Test of Sphericity and Kaiser-Meyer-Olkin's (KMO) tests were used to examine whether factor analysis was appropriate within this study illustrated in Table 4.8.

Bartlett's Test of Sphericity was statistically significant (χ^2 (1035) = 6075.143, $p < 0.001$), suggesting that the data was suitable for factor analysis (Shrestha, 2021).

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.781, which exceeds the recommended threshold of 0.6 and indicates good sampling adequacy (Kaiser, 1974).

Table 4 8: KMO and Bartlet's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.781
Bartlett's Test of Sphericity	Approx. Chi-Square	6075.143
	df	1035
	P-Value	0.000

(Gupta et al., 2024; Sobaih et al., 2024; Thanigan et al., 2025; Wang et al., 2025).

4.4.4.2 Factor Loadings

The factor loadings of constructs reveal the strength of the association between observed variables and their underlying factors, (illustrated within Table 4.3). In the context of rapid advancement, variables such as RADV1, RADV2, RADV3, and RADV4 exhibit factor loadings ranging from 0.699 to 0.805, indicating a significant correlation with the latent factor. Similarly, variables related to compatibility (CPB1, CPB2, CPB3), complexity (CPX1, CPX2, CPX3), trialability (TRB1, TRB2, TRB3, TRB4), and perceived ease of use (PEU1, PEU2, PEU3) demonstrate high factor loadings, ranging from 0.750 to 0.973, suggesting a strong relationship with their respective constructs. For organisational readiness, variables such as (TMGS1, TMGS2, TMGS3, and TMGS4) exhibit factor loadings ranging from 0.929 to 0.945, indicating a strong association with the underlying construct. Similarly, variables related to technological partner support (TEPS1, TEPS2, TEPS3, TEPS4), technology readiness (TER1, TER2, TER3), regulatory policies (REGP1, REGP2, REGP3, REGP4), and competitive pressure (COMP1, COMP2, COMP3, COMP4) display high factor loadings, ranging from 0.806 to 0.975. Furthermore, variables associated with firm innovation performance, including organisational innovativeness (OIN1, OIN2, OIN3), process innovativeness (PIN1, PIN2, PIN3), and products and services innovativeness (PSIN1, PSIN2, PSIN3), demonstrate factor loadings ranging from 0.735 to 0.963, indicating a significant relationship with the latent factor. These factor loadings provide valuable perceptions into the underlying structures of the constructs and explain the relationships between observed variables and their respective factors within the context of the study. Factor loadings above 0.70 or near 0.7 (RA2=0.699) were derived, so it can be categorically stated that the indicators can specify the variables that contribute to the particular outcome or result (Collier, 2020; Field, 2013; Harland et al., 2022).

4.4 Structural equation model and research findings

4.4.1 Tests for Model Fitness

The viability of the measurement model was evaluated using the following model fit measures and illustrated in Table 4.9.

4.4.4.1 Absolute Fit Measures

The CMIN/DF value is 1.829, which confirms the model's excellent fitness. The RMSEA value of the final model is 0.074, which is below the recommended threshold of 0.10, indicating a good fit for the model (Byrne, 2016; Ho, 2006; Jia et al., 2023; Ozen and Durkan, 2016).

4.4.4.2 Relative Fit Measures

The Incremental Fit Index (IFI) is 0.8664, the Tucker-Lewis Index (TLI) is 0.857, and Comparative Fit Index (CFI) is 0.863, all of which are greater than the acceptable threshold value of 0.80 (Moolla and Bisschoff, 2013), showing the model's fit. According to (Cho et al., 2022; Torkzadeh, et al., 2005), GFI (Goodness-of-Fit Index) values equal to or greater than 0.90 have conventionally represented acceptable model fit. However, GFI values in the range of 0.7-0.8 can be considered marginally acceptable when evaluating structural equation models, particularly for complex models with many indicators. Sharma et al. (2005) demonstrated through simulation studies that GFI is sensitive to model complexity and sample size. Bagodi and Raravi (2022) reported GFI values between 0.73-0.83 in their research, which they deemed adequate when considered alongside other fit indices. Baumgartner and Homburg (1996) recommended using multiple fit indices rather than relying on any single measure. When other indices show adequate fit and the model is theoretically sound, lower GFI values may be acceptable for complex structural models.

4.4.4.3 Parsimonious Fit Measures:

PNFI (Parsimonious Normed Fit Index) values exceeding .50 signify adequate model fit (Hu and Bentler, 1999). The present study's PNFI value of 0.7123 indicates satisfactory model fit parameters. Regarding AGFI (Adjusted Goodness-of-Fit Index), while traditional cutoff values of 0.9 were initially proposed (Cho et al., 2022; Williams and Holahan, 1994; Jöreskog and Sörbom, 1984), these thresholds are deemed overly restrictive for complex models. Marsh et al. (2004) argued against universal "golden rules" and demonstrated that many misspecified models provided adequate fit even by stringent criteria. Sharma et al. (2005) classified values between 0.7-0.9 as "marginally acceptable," particularly for complex models, noting that "it becomes necessary to use more liberal cutoff values" (p. 941) when models have numerous indicators, confirming that rigid adherence to higher thresholds is inappropriate for complex modeling scenarios.

Table 4 9: Model Fitness

	Absolute Fit Measures		**Relative Fit Measures**				**Parsimonious Fit Measures**	
	CMIN/ DF	RMSEA	IFI	TLI	CFI	GFI	AGFI	PNFI
General range	<3.0	0, 1	0, 1	0, 1	0, 1	0, 1	0, 1	0, 1
Best reference standards	<2.0	<0.08	>0.80	>0.80	>0.80	>0.90	>0.90	>0.80
References	(Byrne, 2016; Ho, 2006; Ozen and Durkan, 2016)		(Moolla and Bisschoff, 2013; Ong et al., 2023;Torkzadeh et al.2005)				(Cho et al., 2022 ; Mulaik et al., 1989)	
The result of the study	1.829	0.074	0.8664	0.857	0.863	0.769	0.724	0.7123

(Ates and Polat, 2025; Banerjee, 2025; Gidage and Bhide, 2025; Hameed et al., 2025; Rana et al., 2024; Shoaib et al., 2025).

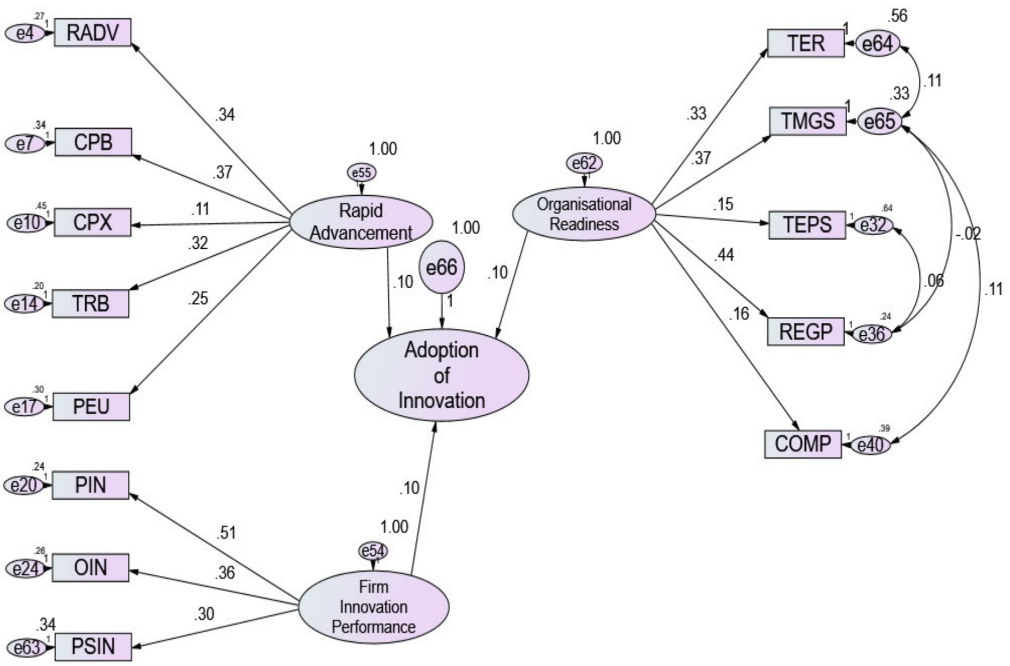
4.4.2 Structural Model (Path Analysis) Hypothesis only

In path analysis, the "structural path coefficient" or "path weight" shows the relationship between the variables (Bollen, 1989; Kline, 2016), while standard errors (SE) and critical ratios (CR) are commonly used to assess the statistical significance of the estimated parameters (the path coefficients).All of the modelled hypotheses were tested concurrently and found to be highly supported (CR > 1.96; significant at P<0.05). The estimated loadings surpass the lower boundary of 0.50, indicating a significant magnitude (Hair et al., 2010). Furthermore, the standard errors demonstrate values below ±2.5, signifying adherence to the established threshold level. The "1" values appearing throughout the structural equation model diagram represent fixed factor loadings, an essential methodological element in SEM analysis. As Bollen (1989) explains, these fixed values implement the reference indicator method, whereby one indicator per latent construct has its loading constrained to 1.0 to establish the scale of the unmeasured variable. This approach is consistently applied across all constructs in the model—with RADV1, CPB1, CPX1, TRB1, and PEU1 serving as reference indicators for their respective latent variables.

The implementation of these fixed loadings serves a critical statistical purpose beyond mere scaling. Kline (2016) discussed that without such constraints, the model would remain mathematically under identified, making parameter estimation impossible. By fixing these loadings, researchers enable the estimation of all remaining free parameters while establishing a clear metric for interpreting the relationships between indicators and their corresponding latent constructs.

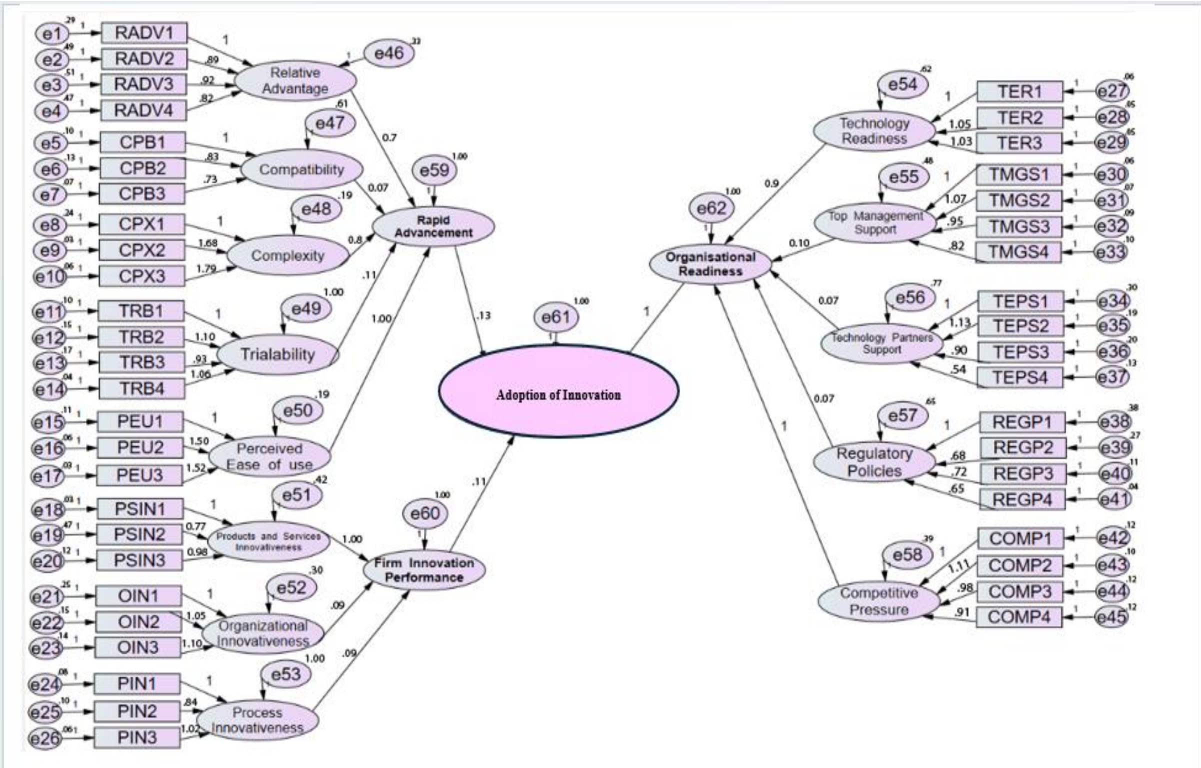
As illustrated in Figures 5 and 6 below, the structural equation model analysis demonstrates the relationships between variables through the examination of path coefficients, standard errors, and critical ratios (Kline, 2016). According to Bollen (1989), path analysis provides structural path coefficients that indicate the strength of relationships between variables. Similar to path diagrams within studies such as (Albastaki 2024; Sundararajan et al.2025) ,the strategic placement of '1' values in this structural equation model diagram reflects established best practices in SEM methodology (Bollen, 1989; Hair et al., 2014). These fixed coefficients serve multiple essential functions: they scale the latent variables represented by oval shapes (such as "Adoption of Innovation") by fixing one pathway at 1 to establish a metric for these unobservable constructs; they provide necessary constraints to ensure model identification, without which parameter estimation would be impossible; and it allows for designate reference indicators when multiple measures relate to a single latent construct (Kline, 2016). This assignment of unit values creates the statistical framework required for valid analysis of the complex relationships between organisational readiness, innovation adoption, and firm innovation performance depicted in the model.

Figure 5 Path Analysis with a Structural Equation Modelling Approach (Hypothesis only)



(Al-Omoush et al., 2024; Ayinaddis, 2024; Banerjee, 2025; Hotessa Warie et al., 2024; Jalil et al., 2022; Kumari et al., 2024; Matindana and Shoshiwa, 2025; Shah et al., 2024; Zaid et al., 2025).

Figure 6 Path Analysis with a Structural Equation Modelling Approach (Hypothesis and measurement items)



(Cornelia et al., 2025; Jeilani and Hussein, 2025; Narwan and Priyadarshinee,2025; Unegbu et al., 2025).

4.4.3 Structural Model (Path Analysis) Hypothesis and Measurement Items

Figure 5 presents a simplified path model showing the main constructs and their relationships with standardised path coefficients. It focuses on the primary relationships between the five factors influencing Rapid Advancement (RADV, CPB, CPX, TRB, PEU), the five factors influencing Organisational Readiness (TER, TMGS, TEPS, REGP, COMP), the three factors influencing Firm Innovation Performance (PIN, OIN, PSIN), and how these three main constructs collectively influence Adoption of Innovation.

Figure 6 provides a more detailed representation of the same model, showing all measurement items for each construct (e.g., RADV1-RADV4 for Relative Advantage), and a more complete visualisation of all paths in the model, for each measurement item and how they impact adoption of innovation. Both diagrams represent the same underlying research model examining the factors that influence innovation adoption, however with different levels of detail.

For Figure 5, to address Research Question 1, which examines the determinants of Rapid Advancement, the structural path coefficients for the following hypotheses reveal significant relationships ($t > 3.29$, $p < 0.001$) with RADV (β=0.34, SE=0.064, t=5.339), CPB (β=0.37, SE=0.071, t=5.164), TRB (β=0.32, SE=0.057, t=5.565) and PEU (β=0.25, SE=0.062, t=4.075). However, CPX (β=0.11, SE=0.070, t=1.586) fails to exceed the critical threshold of $t > 1.96$, indicating non-significance at $p < 0.05$ (Kline, 2016).

To address Research Question 2, which examines the determinants of Organisational Readiness, only REGP (β=0.44, SE=0.196, t=2.267) and TER (β=0.33, SE=0.153, t=2.125) demonstrate significant relationships exceeding the critical threshold ($t > 1.96$, $p < 0.05$). TMGS (β=0.37, SE=0.355, t=1.031), TEPS (β=0.15, SE=0.157, t=0.944) and COMP (β=0.16, SE=0.084, t=1.846) fail to reach statistical significance as their t-values fall below the 1.96 threshold (Bollen, 1989).

To address Research Question 3, which examines the determinants of Firm Innovation Performance, all structural path coefficients demonstrate highly significant relationships ($t > 3.29$, $p < 0.001$). PIN shows the strongest relationship (β=0.51, SE=0.091, t=5.635), followed by OIN (β=0.36, SE=0.070, t=5.069) and PSIN (β=0.30, SE=0.067, t=4.449). As discussed by Kline (2016), these critical ratios exceed the threshold for statistical significance at $p < 0.001$.

For Figure 6, to address Research Question 1, which examines the determinants of Rapid Advancement, the structural path coefficients for the following hypotheses reveal significant relationships ($t > 3.29$, $p < 0.001$) with RADV (β=0.37, SE=0.064, t=5.339), CPB (β=0.48, SE=0.071, t=5.164), TRB (β=0.31, SE=0.057, t=5.565) and PEU (β=0.19, SE=0.062, t=4.075). However, CPX (β=0.11, SE=0.070, t=1.586) fails to exceed the critical threshold of $t > 1.96$, indicating non-significance at $p < 0.05$ (Kline, 2016).

To address Research Question 2, which examines the determinants of Organisational Readiness, only REGP (β=0.44, SE=0.196, t=2.267) and TER (β=0.33, SE=0.153, t=2.125) demonstrate significant relationships exceeding the critical threshold ($t > 1.96$, $p < 0.05$).

TMGS (β=0.10, SE=0.355, t=1.031), TEPS (β=0.07, SE=0.157, t=0.944) and COMP (β=0.07, SE=0.084, t=1.846) fail to reach statistical significance as their t-values fall below the 1.96 threshold (Bollen, 1989).

To address Research Question 3, which examines the determinants of Firm Innovation Performance, all structural path coefficients demonstrate highly significant relationships ($t > 3.29$, $p < 0.001$). PIN shows the strongest relationship (β=0.51, SE=0.091, t=5.635), followed by OIN (β=0.36, SE=0.070, t=5.069) and PSIN (β=0.30, SE=0.067, t=4.449). As discussed by Kline (2016), these critical ratios exceed the threshold for statistical significance at $p < 0.001$.

4.4.4 Hypothesis Results

As shown in Table 4.10, Hair et al. (2016) explain that the t-value, calculated by dividing the path coefficient by its standard error, measures the statistical significance of the relationship between variables in the model. This aligns with various studies on innovation adoption and emerging technologies (Choi, 2019; Park and Choi, 2019; Selase et al., 2019; Wagire and Kulkarni, 2024; Wongso et al., 2024). The path coefficient is statistically significant when the t-value exceeds 1.96 (Arbuckle, 2010). “S.E. serves as an approximation of the standard error associated with the covariance. C.R. is determined by dividing the covariance estimate by its corresponding standard error. When the critical ratio (C.R.) surpasses 1.96, it signifies statistical significance at a confidence level of less than 5% ($P<0.05$)” (Arbuckle, 2010). The research study provides comprehensive statistical evidence for the hypotheses testing. This section presents the results of the hypotheses testing, addressing the research questions and examining the relationships between dependent and independent variables.

For research question 1 Rapid advancement: The path analysis results demonstrated the standardised estimation of respective variables with significance levels and found significant relationships in four out of five hypotheses. The relationship between RADV and Rapid Advancement (H1) has been supported by beta = 0.343, t-value = 5.339, and p-value < 0.001. Similarly, the CPB and Rapid Advancement (H2) relationship has been supported by beta = 0.367, t-value = 5.164, and p-value < 0.001. H3, which examined the relationship between CPX and Rapid Advancement, has not been supported (beta = 0.111, t-value = 1.586, p-value = 0.113). H4 identified the relationship between TRB and Rapid Advancement has been supported by beta = 0.318, t-value = 5.565, and p-value < 0.001. H5 assessed the relationship between PEU and Rapid Advancement has been supported by beta = 0.251, t-value = 4.075, and p-value < 0.001.

For research question 2 Organisational Readiness: The path analysis results for Organisational Readiness demonstrated the standardised estimation of respective variables with significance level and found significant relationships in two out of five hypotheses. H6, which examined the relationship between TMGS and Organisational Readiness, has not been supported (beta = 0.365, t-value = 1.031, p-value = 0.303). The relationship between TER and Organisational Readiness (H7) has been supported by beta = 0.325, t-value = 2.125, p-value = 0.034. Similarly, H8 assessed the relationship between TEPS and Organisational Readiness and that was not supported (beta = 0.148, t-value = 0.944, p-value = 0.345). The relationship between REGP and Organisational Readiness (H9) has been supported by beta = 0.445, t-value = 2.267, p-value = 0.023. Lastly, H10, which examined the relationship between COMP and Organisational Readiness, has not been supported (beta = 0.155, t-value = 1.846, p-value = 0.065).

For research question 3 Firm Innovation Performance: The path analysis results for Firm Innovation Performance demonstrated the standardised estimation of respective variables with significance level and found significant relationships across all three hypotheses. The relationship between PIN and Firm Innovation Performance (H11) has been supported by beta = 0.511, t-value = 5.635, and p-value < 0.001. Similarly, the relationship between OIN and Firm Innovation Performance (H12) has been supported by beta = 0.355, t-value = 5.069, p-value < 0.001. H13, which examined the relationship between PSIN and Firm Innovation Performance, has also been supported (beta = 0.296, t-value = 4.449, p-value < 0.001.

Table 4 10: Summary of the SEM Hypothesis Results

RAPID ADVANCEMENT RA =Rapid Advancement, RADV- Relative Advantage, CPB=Compatibility, CPX=Complexity, TRB-Trialability, PEU=Perceived ease of use)										
	Regression Paths (DV→IV)			Estimate	S.E.	T-value	P	P-Value	Status	Hypotheses
H1	RA	<---	RADV	.343	.064	5.339	***	<0.001	Sig.	Supported
H2	RA	<---	CPB	.367	.071	5.164	***	<0.001	Sig.	Supported
H3	RA	<---	CPX	.111	.070	1.586	.113	NS	Non-Sig.	Not Supported
H4	RA	<---	TRB	.318	.057	5.565	***	<0.001	Sig.	Supported
H5	RA	<---	PEU	.251	.062	4.075	***	<0.001	Sig.	Supported

ORGANISATIONAL READINESS OR=Organisational Readiness, TMGS =Top Management Support, TER=Technology Readiness, TEPS=Technology Partners Support, REGP=Regulatory Support, COMP=Competitive Industry Pressure										
	Regression Paths (DV→IV)			Estimate	S.E.	T-value	P	P-Value	Status	Hypotheses
H6	OR	<---	TMGS	.365	.355	1.031	.303	NS	Non-Sig.	Not Supported
H7	OR	<---	TER	.325	.153	2.125	.034	<0.05	Sig.	Supported
H8	OR	<---	TEPS	.148	.157	.944	.345	NS	Non-Sig.	Not Supported
H9	OR	<---	REGP	.445	.196	2.267	.023	<0.05	Sig.	Supported
H10	OR	<---	COMP	.155	.084	1.846	.065	NS	Non-Sig.	Not Supported

FIRM INNOVATION PERFORMANCE FIP =Firm Innovation Performance, OIN= Organisational Innovativeness, PIN = Process Innovativeness, PSIN = Products and Services Innovativeness										
	Regression Paths (DV→IV)			**Estimate**	**S.E.**	**T-value**	**P**	**P-Value**	**Status**	**Hypotheses**
H11	FIP	<---	OIN	.355	.070	5.069	***	<0.001	Sig.	Supported
H12	FIP	<---	PIN	.511	.091	5.635	***	<0.001	Sig.	Supported
H13	FIP	<---	PSIN	.296	.067	4.449	***	<0.001	Sig.	Supported

(Adam et al., 2025; Al Masud et al., 2024; Banerjee, 2025; Bhat et al., 2024; Çobanoğulları and Özbek, 2025; Ha et al., 2025; Huy and Phuc,2025; Gazi et al., 2025; Jalil et al., 2022; Khan and Zhang, 2025; Liu et al., 2025; Naik and Chanda, 2025; Panigrahi et al., 2025; Saeed et al., 2025; Shah et al., 2024; Ting and Kin, 2025; Zaid et al., 2025).

4.5 Summary and Discussion of Hypothesis

Having established the gaps within adoption identified in several studies (Alabdali, 2022; Chiarini, 2021; Hermann et al., 2019; Kraus et al., 2021; Machado et al., 2021; Pasi et al., 2021; Pushpananthan and Elmquist, 2022; Redchuk et al., 2022; Matt et al., 2021), which reveals the need for actual use of various emerging technologies in innovation ecosystems. A necessity was created to support organisations in reaching important and far-reaching goals, leading to this research study's aim to fill this knowledge gap by providing a unique evaluation of three specific emerging technologies within an innovation ecosystem. The intent is to comprehend these technologies' collective influence on firm innovation performance in large organisations, whose widespread adoption can radically alter their respective industries (Kumar et al., 2021).

This chapter presents a comprehensive examination of the collected data for the study, providing conclusive results that address the research questions and align with the objectives established in Chapters 1 and 2. Furthermore, this chapter builds upon the rationale for data collection and analysis outlined in Chapter 3, demonstrating the application of the proposed methods. The subsequent chapter will examine a comprehensive discussion and summary of the study's primary findings.

Chapter 5 Discussion

5.0 Answers to Research Questions

The study examines how manufacturing organisations and associated industries manage exponential growth, the accelerated changes that come with embracing new technology, and how it impacts revenue, partnerships, and management. The study investigates the potential for increasing innovation adoption through a targeted combination and collaboration of emerging digital technologies within an innovation ecosystem. The results of the study revealed that sixty per cent of the participants affirmed that their organisations integrated multiple emerging technologies to facilitate various activities and processes. Therefore, it reinforces the primary premise of the study and highlights the distinct necessity for adopting and focusing on more than one technology at a time.

The primary objective of this investigation was to address the three critical research questions outlined below. These research questions were assessed using a set of factors backed by theoretical models such as the Diffusion of Innovation Theory (DOI) (Rogers, 2003), the Technology Organisation Environment Theory (TOE) (Tornatzky and Fleischer, 1990), and the Technology Acceptance Model (TAM) (Davis, 1989). Factors from these theories were used as variables, and data collection techniques were subsequently employed to capture the required information. The following results were analysed using the methodology outlined in chapter four and the discussions from the findings outlined in this chapter.

5.1 Answers on The Application of Combined Emerging Technologies

This study aims to contribute to academic knowledge by examining the impact of emerging technologies within an innovation ecosystem on firm innovation performance, with a specific focus on emerging economies. To investigate the integration of these technologies within organisations, survey respondents were presented with questions focusing on three major technological innovations.

The first question was: " Please specify which of the emerging digital technologies listed your organisation uses in its commercial processes ". Survey recipients were given the option to select multiple technologies. The data analysis revealed that 66% of respondents mentioned that their organisations utilise a combination of emerging technologies, as outlined in the questionnaire. The finding sets a precedent for the research, suggesting that many organisations already recognise the necessity of using multiple technologies to enhance their innovative performance. It indicates an inherent demand for diverse technologies to foster innovation and efficiency collaboratively.

The second question, " Please select from the below which emerging digital technology your organisation is most prepared to implement in its commercial processes, " aimed to assess the readiness of organisations to adopt emerging digital technologies" and offered the respondents the opportunity to select more than one option from AI, IoT, and I4.0 technologies. According to the responses received, over 65% of the respondents chose a combination of AI, IoT, and I4.0 technologies that their organisations are most prepared to apply within their organisations. Consequently, many organisations are confident that they will exploit these most recent innovations to improve and simplify their operations. It is worth noting that AI, IoT, and I4.0 are all transformative technologies that can benefit businesses in ways such as improved efficiency, data-driven decision-making, automation, and better customer experiences. The high percentage of respondents selecting this combination indicates a significant interest in and an awareness of the potential advantages these technologies can bring to their organisations.

The third question aimed to identify" which specific emerging digital technology has contributed to the rapid advancement or growth of the respondents' 'organisations". Over 77% of responses were received from managers and above, indicating that these decision-makers understand their organisations' operations and the impact of technology. The responses showed a mix of technologies, including AI, IoT, and I4.0, suggesting that organisations are exploring and adopting these technologies to varying degrees. The rapid pace of technology adoption emphasises the need for research and studies on effectively incorporating and utilising these advancements. Organisations that strategically embrace these technologies exert a profound influence on the processes that enable the development and delivery of advanced products and services to customers.

Consequently, organisations must approach their integration reflectively and be prepared to overcome obstacles that arise during adoption. Conducting studies and research enables organisations to make informed decisions and develop suitable strategies to harness the opportunities provided by a combination of technologies such as those within this study. The three research questions discussed in chapters one and two, which were analysed using statistical methods in this chapter, are stated below, along with the discussions in the preceding chapters.

RQ	**DV**	**IV**
R.Q1: What impact does the rapid advancement of a combination of emerging digital technologies have on the adoption of innovation?	Rapid advancement	H1 Relative advantage H2 Compatibility H3 Complexity H4 Trialability H5 Perceived ease of use
RQ2: How does the organisation's readiness for a combination of emerging digital technologies affect innovation adoption?	Organisation's readiness	H6 Top Management Support H7 Technology Readiness H8 Technology Partners Support H9 Regulatory Support H10 Competitive pressure
RQ3: What impact does the adoption of a combination of emerging digital technologies the Internet of Things, Industry 4.0, and Artificial Intelligence) have on firm innovation performance?	Firm Innovation Performance	H11 Organisational Innovativeness H12 Process innovativeness H13 Products and services innovativeness

5.2 In answering research question I: What impact does the rapid advancement of a combination of emerging digital technologies have on the adoption of innovation?

In addressing the research question, the study examined factors such as relative advantage, compatibility, complexity, trialability, and perceived ease of use to determine how the rapid growth of these technologies impacts innovation adoption (Al Hadwer et al., 2021; Chatterjee et al., 2021; Chen et al., 2021; Stjepić et al., 2021; Ullah et al., 2021; Yuen et al., 2021; Shonubi, 2023). The findings of the hypotheses illustrated in Table 4.10 in Chapter Four are discussed below:

5.2.1 H1 Relative Advantage

The relative advantage of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation. - Supported

At the outset, the adoption of emerging technologies is fundamentally driven by their comparative advantages, particularly regarding cost-reduction potential, as elucidated by Nguyen et al. (2022). Organisations can as a natural progression, achieve substantial cost savings through the seamless integration of technology within their existing business processes. The development demonstrates that technological integration fundamentally transforms traditional business operations as emerging technologies enable organisations to deliver bespoke products and services to their clientele. As discussed by Pilatin (2022), organisations can develop deeper insights into individual customer needs and preferences with the integration of data analytics, IoT and AI systems. The enhanced understanding leads to heightened customer satisfaction and sustainable growth. Therefore, these personalised experiences foster stronger emotional connections, supporting customer retention and favourable word-of-mouth recommendations.

The concept of relative advantage includes increased flexibility, with academic research suggesting that adaptability is important for sustaining competitiveness. As highlighted by Sun et al. (2021), the adoption of emerging technologies enables firms to maintain their agility and swiftly adapt to evolving market demands and industry trends. In conjunction with this, the associated predictive capabilities support organisations in making decisions expeditiously. Additionally, these technologies assist organisations in comprehending uncertainties, capitalising on opportunities, and effectively responding to challenges, which ultimately fosters sustainable growth.

Therefore, organisations are encouraged to meticulously evaluate the relative benefits of these technologies to make adoption decisions that could strengthen their innovative capacity and competitive edge. As substantiated by Pilatin and Dilek (2022), the analysis highlights the considerable advantages that emerge from adopting emerging technologies in organisations. Considering cost improvement, personalised customer experiences, enhanced flexibility, and increased revenues, these relative advantages collectively contribute to fostering innovation and promoting long-term success. Therefore, it is vital for organisations to strategically harness these technologies to gain competitive advantages in their respective industries and nurture sustainability.

The comparative benefit of embracing innovation is evaluated by considering its perceived advantages to the organisation, which, according to recent research by Christiansen et al. (2022), encompass cost effectiveness, broad market reach and economic profitability. Hence, emerging technologies provide a distinct advantage over existing technologies, thereby enabling innovation adoption and promoting organisational growth, which harmoniously aligns with findings from other studies highlighted in the development of the research hypothesis.

5.2.2 H2 Compatibility

The compatibility of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation- Supported.

The proliferation of information transfer has led to the widespread adoption of digital technologies, where the abundance of information serves as valuable input for technological systems to learn and make informed decisions. The compatibility between emerging technologies such as artificial intelligence and existing technology, techniques, and data has facilitated unprecedented growth and development across various sectors (Hamm et al., 2021;

Capone et al., 2024). Several compatibility factors, including existing organisational practices, alignment with objectives and business goals, and congruence with existing systems, were examined to understand their role in shaping the critical choices involved in organisational technological adoption (Aniceski et al., 2024; Chatterjee et al., 2021). Furthermore, the analysis emphasises the importance of testing and experimentation to assess compatibility, manage risks, and ultimately enhance firm efficiency and competitiveness. The findings demonstrate that organisations should prioritise compatibility considerations when planning for innovation and seeking to improve their performance.

Similar research to this study by Alsheibani et al. (2018) also discusses that organisations must assess how effectively innovations align with their existing practices and procedures. Subsequently, alignment with strategic objectives and business goals requires careful consideration (Aniceski et al., 2024). Furthermore, successful implementation depends on the congruence between new technologies and the organisation's current systems and infrastructure.

The findings highlight the significance of perceived compatibility in shaping adoption intentions (Chatterjee et al., 2021). As evidenced by the aforementioned studies, perceived compatibility positively impacts the likelihood of technology usage, creating a focus on the importance of new technology testing and experimentation. Organisations can gain valuable insights into compatibility and evaluate associated risks of innovation, informing a decision-making approach that fosters successful adoption and enhances overall efficiency, potentially leading to a competitive advantage (Capone et al., 2024). When emerging technologies align with the organisation's existing systems, practices, and objectives, they can significantly contribute to firm innovation performance (Hamm et al., 2021). Moreover, technology-driven compatibility promotes efficient integration, minimising resistance to change and ensuring a smoother implementation process.

Compatibility represents how emerging technologies seamlessly integrate with the organisation's existing practices, principles, and infrastructure (Alsheibani et al., 2018; Chatterjee et al., 2021). Consequently, a higher level of compatibility results in faster adoption rates; previous studies have indicated that potential users are more likely to adopt and utilise technologies that best align with their intended purpose (Hamm et al., 2021). When emerging technologies harmonise with other technologies and existing work processes and utilised systems, there is a reduction of expected time and cost of implementation.

Aniceski et al. (2024) emphasise the role of strategic compatibility in technology implementation. A certain level of compatibility is required in examining multiple technologies simultaneously (unlike previous single-technology studies). An insight that is particularly evident in emerging technology-driven smart home environments, which, as Sovacool and Del Rio (2020, p.5) describe as encompassing “home ICTs, connected and automated devices and appliances, and the Internet of Things”. These various technologies provide distinct services and while they can operate independently, often sourced from different technology providers, they are a good indication that emerging digital technologies can operate in unison.

Therefore, compatibility serves as a critical determinant of the successful adoption of emerging technologies and subsequent firm innovation performance (Alsheibani et al., 2018; Capone et al., 2024). Organisations should prioritise compatibility considerations when strategising for innovation and seeking to enhance their overall performance. By understanding and utilising compatibility factors, organisations may maximise the potential of emerging technologies as drivers of substantial innovation.

5.2.3 H3 Complexity

The complexity of emerging digital technologies has a negative influence on the willingness of an organisation to adopt technological innovation. - Not Supported

The relationship between technological complexity and the rapid growth of various technological innovations presents an intriguing paradox in contemporary business environments. Whilst conventional wisdom might suggest that increased complexity would deter adoption, research indicates a more multifaceted reality. The study examines the hypothesis that the complexity of emerging digital technologies negatively influences an organisation's willingness to adopt technological innovation, finding this hypothesis to be unsupported.

Innovative technologies increasingly necessitate novel knowledge acquisition, particularly as systems become more intricate, discussed by Tiits et al. (2024) and becoming a fundamental requirement that sets the stage for organisations to develop a comprehensive understanding of complex algorithms, data structures, and system architectures to implement these technologies.

The study aligns with prior research by Gangwar (2018) who found that complexity in the manufacturing sector specifically showed no statistically significant influence on technological adoption. Similarly, Paiva (2024) demonstrated an insignificant influence of complexity on AI adoption, while Ahmad et al. (2024) also determined that technology complexity's effect was insignificant in adoption. The results from this research study further substantiates these observations, revealing that complexity does not consistently function as a significant barrier to technological innovation across different industrial contexts. Additionally, Alyami et al. (2025) found complexity to be insignificant for computing within technology. According to Prasad (2024), emerging technology presents significant challenges through additional requirements such as specialised training, infrastructure modifications, and enhanced cybersecurity measures. Additionally, the adoption process includes implementing and managing new knowledge, including machine learning algorithms, connectivity infrastructure, and various smart manufacturing concepts. Despite the inherent complexity of technological innovation, organisations consistently show their commitment to overcoming these obstacles through the strategic implementation of knowledge management systems and periodic workforce upskilling activities. Such initiative-taking opportunities effectively decrease perceived complexity, indicating that the potential benefits of technological innovation outweigh the inherent obstacles (Martinaitis et al., 2021). The integration process requires constant development and flexibility as advances in technology occur. Therefore, organisations have established sophisticated management strategies and execution methodologies in response. Additionally, because of the ground-breaking potential of AI and IoT, organisations keep exploring these technologies despite the added hurdles brought about by their explosive growth, specifically in data confidentiality and safety.

Even though complexity is an issue as evidenced in Table 5.3, it is evident that organisations will continue to innovate regardless of potential challenges. Financial considerations play a significant role in this dynamic due to the substantial costs associated with implementing these technologies, encompassing extensive investments in procurement, installation, and maintenance of new technological infrastructure. However, as demonstrated by Chen et al. (2021), these financial commitments are viewed as necessary investments rather than deterrents. Their research shows that complexity's role in emerging technology adoption contributes positively to firm innovation performance when effectively managed.

Organisations have demonstrated remarkable resilience through understanding and effectively managing these intricacies, including technology integration challenges, comprehensive training provision, and cost management strategies. Instead of letting complexity hinder innovation, advanced methods have been created to enhance the potential of new technologies. This adaptation suggests that technological complexity, whilst significant, serves as a catalyst for organisational development rather than a barrier to adoption.

Therefore, the evidence clearly illustrates that organisational readiness to embrace technological innovation is not adversely affected by the complexity of the new digital technologies under consideration. Instead, organisations have shown remarkable flexibility in overseeing these challenges by viewing them as significant roadblocks to technological innovation. A realisation that has fundamentally altered the approach that organisations use to view the relationship between technological complexity and innovation adoption in contemporary business settings.

5.2.4 H4 Trialability

The trialability of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation. – *Supported*

Organisations facilitating the preliminary testing of emerging technologies before full implementation demonstrate accelerated adoption and growth. According to Jiang et al. (2024), trialability is an important driver of technology adoption, particularly within situations where, in advance of full implementation, organisations must assess both technical functionality and social implications. The potential advantages - including higher productivity, cost reductions and operational efficiencies - can be systematically evaluated through strategic pre-implementation trials. Kruger and Steyn (2024) found that trialability is particularly important for complex emerging technologies, as it allows organisations to assess compatibility with existing systems and verify expected benefits before committing substantial resources. Their research demonstrates that assessment of trialability encompasses multiple dimensions: organisational authorisation for technology testing, confidence in appropriate utilisation, individual willingness to experiment, and perceived benefits of pilot programmes.

Technologies that can be readily tested experience more rapid uptake, as trialability reduces perceived risk and uncertainty (Jiang et al., 2024). This is particularly relevant for emerging technologies that require significant organisational change and investment. Kruger and Steyn (2024) emphasise that trialability has become increasingly important as emerging technologies become more sophisticated and interconnected. Organisations must carefully evaluate integration capabilities and potential disruptions to existing processes. Subsequently, those who implement effective trial programmes demonstrate higher adoption rates and enhanced innovation outcomes. Moreover, positioning trialability as a strategic component builds transformative capabilities for sustained competitive advantage, particularly when supported by strong organisational capabilities and leadership commitment.

Trialability enables organisations to evaluate emerging technologies before comprehensive implementation - particularly relevant for modern innovations requiring integration across multiple platforms. Jiang et al. (2024) emphasise that successful trials can provide evidence of both technical feasibility and social sustainability benefits, vital factors for stakeholder buy-in and successful adoption. This dual validation approach has proven especially valuable in supply chain contexts where multiple stakeholders must coordinate technology adoption efforts.

5.2.5 H5 Perceived Ease of Use

Perceived ease of using emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation. - Supported

Recent research, including studies by Solomovich and Abraham (2024), has demonstrated that perceived ease of use plays a significant role in establishing trust in technological innovations.

This finding suggests that even complex technologies can gain widespread adoption when users perceive them as user-friendly and accessible.

As organisations increasingly recognise the benefits of integrating emerging technologies, the perception of ease of use has become a critical driver of innovation across various sectors, including healthcare, finance, retail, transportation, manufacturing, and creative industries. Studies by Almaiah et al. (2022) highlight the importance of ensuring smooth implementation and integration of these technologies within organisational frameworks. This integration requires employees to develop a comprehensive understanding and proficiency in utilising these new tools effectively.

As discussed within the section on various industries and their usage of emerging technologies, Chapter Two, the (IoT) revolution has particularly exemplified the importance of perceived ease of use in promoting innovation and sustainable development. The transformative potential of Industry 4.0 reaches far beyond manufacturing, influencing sectors such as medicine, agriculture, and energy. The implementation of AI, IoT, and connected devices creates a clear pathway for immersive technology use, facilitating improvements in healthcare and precision farming.

As corroborated by Faqih (2022), organisations prioritising user-friendly solutions and effectively communicating technological accessibility position themselves to better harness transformative potential. Furthermore, organisations that recognise and respond to customer perceptions of technology usability are better positioned to achieve successful implementation and adoption and additionally, this focus naturally leads to reduced resistance to change and increased stakeholder buy-in.

5.3 In answering research question 2: How does the organisation's readiness for emerging digital technologies affect innovation adoption?

In addressing the research question, the study examined the assessment of organisational readiness encompassing multiple factors such as regulatory support, top management support, technology readiness, technology partner and vendor support, and industry pressure from competition aligning with previous research (Al Hadwer et al., 2021; Chen et al., 2021;

Holmstrom, 2022; Malik et al., 2021; Moldabekova et al., 2021; Musyaffi et al., 2021; Premkumar and Roberts, 1999; Stjepić et al., 2021). The findings of the hypotheses illustrated in Table 4.10 in Chapter Four are discussed below:

5.3.1 H6 Top Management Support

Top management support of emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation. - Not Supported

Recent research has fundamentally challenged traditional assumptions about the top management support in technology adoption, moreover, suggesting that a more refined understanding is imperative. Whereas management backing has historically been considered significant as indicated within the several cited references in chapter two and three, emerging evidence increasingly indicates that ground-level technical expertise and implementation capabilities may be significantly more fundamental to technology adoption, especially complex or combined technologies such as those evaluated within this study.

The research findings align with an emerging pattern in technology adoption literature that challenges conventional wisdom about top management support. Furthermore, studies such as Hassan et al. (2017), who discovered that "top management support is not significant in explaining cloud computing adoption among SMEs", this study also revealed that top management support was not a significant predictor of emerging technology adoption. Furthermore, Shahadat et al. (2023) found that environmental conditions and technology resources had a greater impact than leadership support, rejecting their hypothesis regarding management innovativeness. Badghish and Soomro (2024) suggest that organisational support does not significantly influence AI adoption, indicating that practical considerations such as high costs and extended payback periods often overshadow managerial enthusiasm.

Nayal et al. (2023) also found top management to have an insignificant relationship with blockchain technology adoption, suggesting that top management may withhold support due to knowledge gaps. The finding reinforces the discussion regarding the necessity of sufficient internal capabilities, which would enable top management to provide greater support for implementation initiatives. Furthermore, the complexity of modern technological implementations presents a particularly complicated challenge for top management support alone. As Pu et al. (2019, p.2) astutely discussed, "system complexity becomes overwhelming for firms to manage and control," thereby highlighting how technical expertise, rather than management endorsement, often determines implementation success. Consequently, this implies that top management support must be specifically geared toward technological adoption, or it could potentially become a challenge rather than an enabler. Indeed, this understanding suggests that generic management support without a specific technological focus may be not only insufficient but potentially counterproductive.

Notably, this technical knowledge gap appears to be widening progressively. According to Hussain and Papastathopoulos (2022), management's understanding of emerging technologies proves essential for strategic decision-making and future development. Nevertheless, their findings suggest that as technologies emerge more rapidly, it becomes increasingly challenging for top management to maintain pace, creating a problematic lag between strategic intent and implementation capability. The findings of Zhang and Bu (2024) further reinforce this perspective, demonstrating that managers with technological expertise exhibit enhanced capabilities in accepting, interpreting, and encouraging technological implementation compared to those without such technical background. Therefore, implying that technical knowledge combined with management assistance is the most effective combination. The fundamental challenge lies in the operational requirements of modern technology adoption. Research indicates that successful implementation depends heavily on ground-level process redesign and technical alignment capabilities rather than top-down strategic directives (Pu et al., 2019). This becomes especially apparent as organisations cultivate adequate expertise to effectively utilise and customise the technology to harmonise with their relevant operational procedures, inferring that development of managerial skills through “learning-by-using” is important (Zhu et al., 2006 p. 1564).

Nonetheless, management's role cannot be entirely dismissed. Rahman et al. (2023) discuss that management's financial commitment provides necessary resources for implementation while simultaneously signalling the organisation's long-term vision. By extension, effective resource allocation becomes possible through this commitment to funding and supporting technological initiatives. However, this financial support, is also inferred in Table 5. 4 with open-ended comments discussing resources and financial support as elements linked to top management, while undoubtedly necessary, is not sufficient without corresponding technical expertise at the implementation level.

This understanding calls for a comprehensive recalibration of how organisations approach technology adoption. Rather than primarily focusing on securing top management support, organisations might benefit substantially more from investing in building technical capabilities and expertise at the operational level. Such a shift in emphasis could help bridge the growing gap between strategic intent and implementation success in an era of increasingly complex technological adoption. Ultimately, the findings highlight the necessity for a more balanced approach that recognises both the enabling role of management support and the critical nature of technical expertise. However, when prioritising resources and attention, the evidence increasingly suggests that technical competency and implementation capabilities should take precedence over securing management support alone.

5.3.3 H7 Technology Readiness

Technology readiness for emerging digital technologies has a positive influence on the willingness of an organisation to adopt technological innovation. - Supported

Technology readiness has emerged as a prerequisite for organisations adopting advanced technologies such as automation, robotics, and real-time data analytics. This evaluation encompasses the compatibility of existing systems, networks, and data storage capacities with emerging technological requirements. Consequently, Hong and Park (2024) emphasise the importance of conducting thorough research to determine organisational readiness, enabling precise decisions about which technological services or products to implement.Initially, organisations demonstrate increasing technological preparedness, enabling them to harness AI capabilities for analysing customer preferences and delivering personalised experiences. Subsequently, as Capatine et al. (2024) discussed, these capabilities empower organisations to identify new opportunities and develop progressive solutions.

Furthermore, technology readiness manifests through established confidence in AI systems and emerging technologies to perform as expected. Consequently, according to Rahman et al. (2023), this confidence creates an environment where organisations effectively leverage technology to drive innovation and product development, intending to secure competitive advantage. Technology readiness plays a vital role in preparing organisations for emerging technology adoption through a comprehensive assessment of existing infrastructure and capabilities. Subsequently, organisations must evaluate their current systems whilst investing in scalable architectures, system upgrades, and robust data security measures to support IoT devices and AI systems. Furthermore, technological preparedness significantly influences an organisation's ability to exploit new technologies and achieve innovation performance. Consequently, organisations that allocate appropriate resources position themselves to develop long-term client relationships and create sustainable competitive advantages in an increasingly technology-driven marketplace (Durst et al., 2023).

Finally, a comprehensive approach to technology readiness encompasses both technical infrastructure and the organisation's capacity to integrate and utilise new technologies effectively. This integration requires a balanced consideration of technological capabilities and organisational preparedness, thus ensuring that investment in emerging technologies aligns with strategic objectives and operational requirements.

5.3.4 H8 Technology Partners Support

"Technology partner support has a positive influence on the willingness of an organisation to adopt technological innovation."- Not Supported

The research examined the hypothesis that technology partner support significantly influences an organisation's willingness to adopt technological innovation. Contrary to initial expectations, the empirical findings challenge the straightforward assumption of a positive correlation of the hypothesis.

Drawing from Barney's (1991) Resource-Based View (RBV) theory, explored comprehensively in chapter two, organisations exhibit an inclination towards utilising internal knowledge resources before pursuing external support. Zhang et al. (2022) reinforced this organisational trait, asserting that organisations view their internal capabilities as the primary driver of technological innovation. Similar studies have consistently shown that vendor and partner support have weak or insignificant relationships with innovation adoption, especially in technological contexts. Mangula et al. (2014) found that trust in vendors was an insignificant factor in the decision-making process for adopting software-as-a-service technology. Likewise, Bordeleau et al. (2018) noted in their study of Industry 4.0 that vendor-provided frameworks frequently require extensive validation, with limited evidence of their contribution to strategic value creation. Lada et al 2023 found that external support is insignificant for AI adoption.

Kowalkowski et al. (2024) identified partners' capacity to deliver critical solutions during implementation challenges, while Li et al. (2024) emphasised the importance of partners' deep technical expertise in guiding organisational system implementation. Despite these potential benefits, the research findings reveal that organisations fundamentally view themselves as the primary solution providers, relegating external partners to an ancillary support function. This interpretation implies that partner involvement is not the core catalyst for an organisation's innovation preparedness. Consequently, while knowledge transfer and implementation experience provide valuable insights, they are not necessarily seen as the key factor in technological adoption.

Butt et al. (2023) expanded the complexity of the discourse by examining the consequences of insufficient knowledge sharing, demonstrating how restricted information exchange can significantly undermine an external partner's ability to provide substantive support. subsequently, their research revealed that organisations fundamentally prioritise internal knowledge and capabilities, strategically positioning external partners as supplementary resources while maintaining a discerning approach to external technological support. Critically, the findings reveal the necessity of comprehensive knowledge sharing as a prerequisite for meaningful collaborative engagement. The findings indicate that technology partner support cannot be reduced to a straightforward predictor of organisational innovation adoption. Instead, it represents a complex interaction between internal capabilities, strategic orientations, and collaborative dynamics. This investigation fundamentally challenges conventional perspectives, advocating for a more sophisticated comprehension of how organisations evaluate and integrate external technological support, thus moving beyond simplistic interpretations of partner engagement. The research indicates that although external technology partners can offer valuable insights and support, as highlighted in Table 5.4 with open-ended comments on vendor support, they do not appear to be the main driver of organisational innovation. an organisation's internal strategic approach, technical capabilities, and willingness to effectively integrate external knowledge remain major factors.

5.3.2 H9 Regulatory Support

Regulatory policies for emerging technologies have a positive influence on the willingness of an organisation to adopt technological innovation. – Supported

As emerging technologies advance, it is increasingly apparent that they must have well-defined legislative or regulatory frameworks to provide clarity for both technology vendors and organisations (Dudnik et al., 2021). Adopting emerging technologies has become increasingly vital for organisations striving to enhance innovation performance and stay competitive in the digital era. Studies by Bhardwaj et al. (2021) and Shahadat et al. (2023) indicate that emerging economies have the highest level of dependencies regarding regulatory support. Initially, effective policy frameworks must balance innovation enablement with risk management, ensuring regulations act as enablers rather than barriers to technological advancement, as emphasised by Jackson and Allen (2024). Subsequently, organisations must navigate these frameworks to meet data protection, privacy and security standards whilst adhering to legal and ethical considerations. Furthermore, studies by Bag et al. (2023) and Raj and Jeyaraj (2023) revealed that developing countries offer specific technology grants, potentially explaining their high adoption rates. Moreover, as illustrated in Table 5.1 and 5.2, governments and regulatory bodies provide financial benefits, including tax breaks, grants, and subsidies, to encourage technological investment. Subsequently, these economic incentives help reduce the financial burden of adoption whilst creating an environment conducive to innovation government regulation and incentives for technological innovation are particularly prevalent in developing economies, whilst prominent developed nations place more emphasis on privacy and ethical norms.

Therefore, policy consistency emerges as a critical factor in technology adoption, as frequent regulatory changes can create uncertainty and diminish investment confidence. Subsequently, stable policies enable organisations to confidently integrate AI, IoT, and Industry 4.0 solutions through effective long-term planning. Moreover, governments dedicate significant resources to understanding and investing in these technologies whilst devising national strategies. Consequently, this collaborative approach between governments and organisations fosters an environment where emerging technologies drive business growth and societal progress.

Table 5. 1 Technology regulatory policies across developed economies (exemplars of variations or similarities)

	Country	**Regulatory Policy**
North America	**USA**	The United States has also given high importance to budget allocations that are targeted at promoting the development of artificial intelligence and technical progress through legislation (Girasa and Girasa, 2020). The United States adopt diverse programmes that provide subsidies comparable to those of the countries mentioned above. An example of this is the "CHIPS and Science Act" in the United States, which seeks to provide significant financial assistance to promote the growth of American semiconductor I4.0 manufacturing (Ju et al.,2024).
	Canada	The "International Innovation Programme," managed by the "Canadian Trade Commissioner Service," has allocated financing for multiple international collaborations and joint ventures in the field of digital technology, specifically targeting projects centred around the development of artificial intelligence (AI) (Attard-Frost et al., 2023). The "Office of the Privacy Commissioner of Canada" has the responsibility of conducting investigations and studies, as well as increasing public awareness about privacy issues on behalf of the Canadian federal government (Attard-Frost et al., 2023).

European Union	**EU Countries**	The European Commission AI Act proposal presents an innovative risk-based framework for governing AI. This paradigm classifies AI systems according to the potential hazards they pose to safety and fundamental rights. (Almeida et al., 2022).
	Norway	The Norwegian AI strategy, known as the "National Strategy for Artificial Intelligence," aims to facilitate investment and testing of digital technologies like AI. (Van et al., 2023).
	Malta	The Maltese AI policy, as described in "A strategy and vision for artificial intelligence in Malta 2030," aims to improve competency and the application of AI (Van et al., 2023).
UK	**UK**	The UK government has allocated £21 million to Tech City UK over four years. The funding is intended to promote the adoption of digital technologies. There have also been efforts made to strengthen the development of the "UK government's investment in the Compound Semiconductor cluster" in collaboration with IQE, Cardiff University, and both the Welsh and UK governments. ("Industrial strategy: Artificial intelligence sector deal," assets.publishing.service.gov.uk, 2024). The UK AI policy closely resembles the strategy of the EU, placing considerable importance on data privacy, security, and ethical issues (Almeida et al., 2022).

Table 5. 2 Technology regulatory policies across emerging countries (countries within this study)

Africa	**Ghana**	The Science, Technology, and Innovation (STI) programme in Ghana was designed to promote national development by implementing technology in many sectors of the economy (Amoako et al., 2023).
	Nigeria	The "Three Million Technical Talent" (3MTT) programme was launched through regulatory regulations enforced by the "Federal Ministry of Communications, Innovation, and Digital Economy" and the "National Information Technology Development Agency (NITDA)" to promote the acceptance of technological innovation by supporting the creation of "two million digital employment opportunities" by 2025 (Agbeyangi et al., 2024).
	South Africa	The primary objective of the "National Digital and Future Skills Strategy" is to improve digital skills in the education sector to promote digital innovation. In addition, the "National Skills Development Strategy III" implements the "catalytic" fund to provide financial assistance for research and innovation initiatives. Additionally, it cultivates strategic alliances and partnerships to enhance skill acquisition and promote socioeconomic advancement (Habiyaremye et.al., 2022).
	Tanzania	The Tanzanian government is dedicated to leveraging its digital capabilities to improve access to information and communication technology (ICT), and it partners with telecommunications companies to reduce technology expenses and provide affordable connectivity to its population (Mwananziche et al., 2023).

	Country	**Regulatory Policy**
Middle East	**UAE**	The “UAE Council for Artificial Intelligence and Blockchain “initiative aims to develop regulatory frameworks conducive to innovation and digital transformation. Emphasis is placed on fostering collaboration, investment, and strategic AI implementation to enhance government performance (UAE Government, 2024a; UAE Government, 2024b).
	Saudi Arabia	The "Saudi Arabia Vision 2030" program promotes technology adoption and ICT development by removing barriers for foreign-owned firms while ensuring Saudi workforce participation. These policies guarantee equal privileges and incentives for all firms and involve significant investments in ICT infrastructure to attract FDI, foster innovation, and stimulate economic diversification in line with Vision 2030" objectives (Alharbi, 2023).

Asia	**India**	Provides rebates as incentives to encourage technological advancement in manufacturing industries (Jimo et al., 2023)
	South Korean	The government committed to accelerating the process of granting licences for 5G networks to network providers (Massaro and Kim, 2022).
	China	VAT reform includes measures to reduce taxes for organisations, provide relief, and allow resources to be allocated towards research and development projects and technical improvements, which subsequently improve the performance of organisations (Yu and Qi, 2022; He et al., 2023).
	Taiwan	Implemented semiconductor incentives to attract and maintain the forefront manufacturing organisations, such as MediaTek, within its territory (Kamin and Kysar, 2023).
	Pakistan	The objective of the "Digital Pakistan Policy" is to stimulate economic expansion through the improvement of broadband availability, the establishment of technology parks, the generation of fresh employment prospects and the advancement of industries such as robots, (IoT), and (AI). Providing tax benefits for technology startups and establishing incubation centres like "IGNITE" in partnership with international technology organisations (Jamil ,2021).
	Bangladesh	The Bangladesh government implemented the "National ICT Policy (NIP)" as a vital regulatory framework to drive the digital innovation effort throughout the country, with an extensive network of 4500 Union Digital Centres (UDC) being created across the country to advance rural empowerment and technological inclusivity; and provide a comprehensive explanation of the attractive tax benefits available to both startups and international investors (Lewis et al.,2024).

5.3.5 H10 Competitive Industry Pressure

Competitive pressure for emerging technologies has a positive influence on the willingness of an organisation to adopt technological innovation. - Not supported

The findings from this research indicate that the hypothesis - that competitive pressure positively influences an organisation's willingness to adopt technological innovation - is not supported. This outcome challenges conventional assumptions about the drivers of technological adoption in business environments.

The findings emerge from several key areas of investigation. Sjodin et al. (2024) provide evidence that technological transformation creates new employment demands and workforce development needs. However, the research indicates that these transformations occur independently of competitive pressures, driven instead by strategic organisational initiatives and internal capability development goals. Furthermore, Faiz et al. (2024) found that competitive pressure does not significantly influence digital technology adoption. Similarly, Maroufkhani et al. (2020) determined that competitive pressure has an insignificant effect on innovative technology initiatives. Additionally, Horváth and Szabó (2019) identified competitive pressure as a factor showing inconsistent relationships with innovation adoption in their analysis of Industry 4.0 implementation. This aligns with Lada et al. (2023), who found competitive pressure to be insignificant for AI adoption. Bhatia and Kumar (2022) explored stakeholder and competitive pressures on Industry 4.0 technologies and concluded that internal organisational factors are more influential than external pressures. According to Salah and Ayyash (2024), organisations attracting increased investment often display initiative-taking mindsets, however, the correlation appears more strongly linked to internal organisational characteristics rather than responses to competitive pressure. Therefore, suggests that technology adoption decisions stem from strategic vision rather than competitive forces.

Enholm et al. (2021) discuss competitive pressure, describing it as the influence of industry rivals' actions, which helps frame the research context. However, the data indicates that organisations' technological adoption decisions frequently originate from internal strategic planning rather than external competitive forces. Hart and Rodgers (2024) reveal that while emerging technology adoption enables enhanced productivity and automated operations, these implementations typically align with internal efficiency objectives rather than competitive positioning. This suggests that operational improvement goals take precedence over competitive responses in driving technology adoption decisions.

The research concludes that while competitive pressure exists within the technological adoption landscape, it does not demonstrate the hypothesised positive influence on organisational willingness to adopt technological innovation. Instead, successful technology adoption appears to stem from a complex interplay of factors, including organisational readiness, strategic alignment, and internal capability development. These findings contribute to an evolving understanding of technological adoption drivers in contemporary business environments, challenging previous assumptions about the role of competitive pressure in innovation decisions.

5.4 In answering research question 3: What impact does the adoption of a combination of emerging digital technologies have on firm innovation performance?

The measurement of firm innovation performance incorporated three independent variables: organisational, process, and product and service innovativeness, aligning with prior research (Anning-Dorson et al., 2018; Ghosh and Srivastava, 2021; Gunday et al., 2011; Phirouzabadi et al., 2013; Shonubi O, 2023; Tweneboah-Koduah et al., 2020). The findings of the hypotheses illustrated in Table 4.10 in Chapter Four are discussed below:

5.4.1 H11 Organisational Innovativeness

The greater the adoption of organisational innovation, the more the firm's innovation performance improved. – Supported

Organisational innovativeness emerges as a critical factor in achieving successful performance. According to Tripathi and Kalia (2024), organisations must accommodate innovative ideas and practices while fostering a flexible organisational culture that encourages employee contribution and experimentation with novel approaches.

Moreover, the symbiotic relationship between organisational innovativeness and emerging technologies creates a foundation for long-term success. Organisations that effectively balance technological adoption, strategic partnerships, and operational flexibility while maintaining alignment with core values position themselves advantageously in an increasingly competitive business environment. Subsequently, as highlighted by Malakar and Lacey (2024), emerging technologies require innovative approaches for successful implementation. This transformation demands a careful balance between technological integration and maintaining organisational core values.

Furthermore, Mai et al. (2023) demonstrate through their research that the integration of emerging technologies leads to enhanced processes and products, resulting in improved organisational performance. Additionally, Aggarwal et al. (2024) discussed the role of internally maintaining awareness of technological developments and regularly updating operational modalities to drive adaptation. As a result, fostering an innovation-driven environment through these elements helps organisations sustain their competitive edge while adapting to market changes. This approach guarantees the continuous delivery of customer value, as the flow of organisational innovativeness drives transformative outcomes across all operations. Furthermore, the strategic integration of emerging technologies enables organisations to develop unique capabilities and competitive advantages. By balancing technological advancement with core organisational values, companies can achieve sustainable growth while nurturing an environment of continuous innovation.

5.4.2 H12 Process Innovativeness

The greater the adoption of process innovation, the more the firm's innovation performance improved. – Supported

Process innovativeness drives successful technology adoption, enabling organisations to harness emerging technologies in dynamic markets. Indeed, management's swift response to novel business approaches proves vital in cultivating an innovation-conducive environment (Annose et al., 2024). Furthermore, this agile approach to process innovation strengthens an organisational capacity to adapt and thrive in rapidly evolving business landscapes.

Moreover, the ongoing digital transformation of processes and organisational structures highlights the necessity for process innovativeness (Bhattacharya and Pant, 2024). Consequently, this transformation enables organisations to redefine product offerings and explore novel commercial models whilst optimising resource allocation.

Furthermore, customer-centric process enhancement drives innovation as organisations must continuously assess and refine their service processes to align with evolving preferences (Kwok and Tang, 2023). Through this approach, advanced systems like Industry 4.0 enhance core functions and deliver value-added services, from inventory management to insightful pricing strategies. Additionally, successful process innovation requires systematic evaluation of technological capabilities against market demands. Accordingly, organisations must develop frameworks for assessing potential impacts and implementation requirements, ensuring innovations address practical business challenges whilst maintaining adeptness.

Strategic alignment with emerging technology integration necessitates adaptable systems and continuous improvement processes. Nasir et al. (2022) emphasise that organisations fostering this innovative mind-set whilst maintaining agile responses to market changes position themselves to achieve sustainable growth through enhanced technological capabilities.

5.4.3 H13 Products and Service Innovativeness

The greater the adoption of product and service innovations, the more the firm's innovation performance improved. - Supported

An organisation's capacity to swiftly introduce innovative products and services through cutting-edge technologies establishes formidable competitive advantages. Consequently, this market responsiveness enables firms to surge ahead of rivals and seize emerging opportunities (Jamipour et al., 2024), particularly when endeavouring to penetrate new markets with groundbreaking offerings. Furthermore, the facilitation of knowledge exchange within organisations proves essential for enhancing overall performance through data-driven decision-making (Brush et al., 2022). Hence, organisations harnessing emerging technologies for data analysis foster strategic growth through well-informed decision-making processes.

Moreover, AI implementation has markedly reduced product development expenditure, underscoring its profound impact on innovation (Babina et al., 2024). Indeed, the research demonstrates a robust correlation between innovative product introduction and organisational scale, as innovation-centric organisations achieve multinational presence through the efficient utilisation of data and digital tools. As a result, this enables the identification of market trends and unfulfilled demands, thereby nurturing the creation of innovative solutions.

The findings, which align with various scholarly works (Anning-Dorson et al., 2018; Gunday et al., 2011; Nasir et al., 2022), indicate that process innovation—encompassing the implementation of systematic and novel processes through the integration of new tools—can significantly enhance innovation performance. Ultimately, harmonising strategy with the integration of emerging technologies reinforces this notion and highlights the paramount importance of organisations being equipped with adaptable systems that facilitate seamless alignment.

5.4.4 Summary of Research Questions Hypothesis

Conclusively, the research findings revealed significant relationships across all three key dimensions: rapid advancement of technologies, organisational readiness, and firm innovation performance. For rapid advancement, Relative Advantage (H1), Compatibility (H2), Perceived Ease of Use (H5), and Trialability (H4) showed strong support, indicating that the speed and benefits of technological progress significantly influence adoption decisions. In terms of organisational readiness, Technology Readiness (H7), and Regulatory Support (H9), demonstrated significant relationships, highlighting the importance of internal capabilities and external environmental factors in preparing for innovation adoption.

The impact on firm innovation performance was evidenced through the strong support for organisational innovativeness (H11), Process Innovativeness (H12) and Products and Services Innovativeness (H13), suggesting that successful adoption leads to tangible improvements in both operational processes and market offerings. However, some hypothesised relationships were not supported , including Complexity (H3), Top Management Support (H6), Technology Partners Support (H8) and Competitive Pressure (H10).

However, as discussed in Chapter three, each research question and its dependent variable has a minimum of three independent variables. This comprehensive approach allowed for a thorough examination, with each research question being well-addressed as a minimum of two hypotheses linked to each question yielded significant results. These findings with significant hypothesis representation to address the three research questions provide a comprehensive understanding of how organisations navigate the complex interplay between rapid advancement, organisational readiness, and firm innovation performance of continuously evolving technologies whilst challenging some traditional assumptions about innovation adoption drivers.

The presence of both significant and non-significant results, with at least two significant hypotheses per research question, not only substantiates the research findings but also reinforces the objectivity of the experimental design and analysis. Drawing from Platt's (1964) critique of single hypothesis testing and Nickerson's (1998) insights, this study effectively mitigates confirmation bias by avoiding attachment to a single preferred hypothesis. Since each of the three research questions incorporates multiple theoretical hypotheses, the study aligns with Nickerson's (1998, p. 177) assertion that research that "routinely consider multiple possibilities are less likely to show confirmation bias than those who typically consider only a single possibility".

An assertion also highlighted by Platt (1964), discusses that adherence to a single hypothesis can not only lead to confirmation bias, but hinder scientific progress, and weaken experimental rigour. Furthermore, Chamberlin's (1931) advocacy for the method of multiple working hypotheses highlights the importance of considering multiple explanations to enhance objectivity, encourage comprehensive data collection, and acknowledge research complexity. Subsequently, the combination of significant and non-significant hypotheses demonstrates a systematic and unbiased testing of alternative explanations, contributing to an in-depth and reliable scientific understanding of the research questions.

5.5 Text Entry Questions Comments and Inference

This section incorporates open-ended textual responses (comparable to the Likert scale approach) used to augment the survey, drawing on methodological precedents established by Nambisan et al. (1999), Powell and Wright (2008), and Wynekkop and Waltz (2000), as detailed in Chapter Three. These previous studies had fifteen, eleven, and nine participants respectively to enhance their existing research methodologies. The insights derived from this analysis have been incorporated into both the discussion and contributions sections, strengthening the overall research framework."

5.5.1 Rapid Advancement (Diffusion of Innovation Theory (DOI) Rogers E. M (2003), and Technology Acceptance Model (T.A.M.) Davis, (1989).

Table 5. 3 Text entry summary for Rapid Advancement

Independent Variables	**H1: Relative Advantage**
Comments from Text Entry Version	"Helps us know when we need to upgrade our systems and how to repair”." Makes things more efficient”." Makes things work faster and smarter." "We are providers of I4.0, so we help other organisations reduce the cost of mass customisation." "For ourselves, we are deploying AI to improve our chatbots." "We share equipment that has other technology,". "Widens the scope of our business”." Faster production," "Automation of tasks". "Allows us to work faster,". "We can quickly adapt to new situations”." Makes us quicker to respond to changes". "We can change and adapt." "It helps us to understand better how our customers use our devices" "Their pain points". " It enables us to provide smart repairs before breakdowns occur" and "reducing downtime." "Makes us fast to launch”." Automation makes things faster". "Quicker way of working". "Simplify our processes". "Cut down on waste". "Make more money”."We get better results and make more money." "The information allows us to satisfy the customers better". "It enables us to provide more value to our customers at a lower cost". "Faster production helps grow sales."
Inference from Text Entry Comments	Through the implementation of integrated technologies, organisations are gradually updating their operations. Consequently, this has led to a system that is more efficient and performs at a higher level, as it enables a methodical approach to updates and repairs. By implementing I4.0 technologies and integrating AI, organisations not only reduce their costs but also improve their internal processes, as seen by progress in chatbot technology as an example. Through the act of integrating technologies for equipment and broadening the scope of the organisation, they can expedite production and implement automation to adapt to market fluctuations and fulfil the demands promptly. These innovations also revolutionise proactive customer support manufacturing processes, increasing productivity and reducing costs, as evidenced by not just the specific measurement items within the study that focus on this but also from inference and supported by various studies across the chapters. Therefore, supports the indication that organisations are better off with emerging technologies than without them.

Independent Variables	H2: Compatibility
Comments from Text Entry Version	"New products increase our market share and revenue". "We sell different products, so we expand quickly". The new products and services we make help us expand our business." "The products and services are better quality," "and are differentiated so sell faster." "It will be in if the new tech should work with the way we work now." "We make sure they fit in well with what we were already doing. " It fits into what we do and helps us make it better". "We are exploring how AI can make us work smarter". "AI adoption is working in parallel with our digital transformation initiatives." "It is, as we use them to make the production process faster"." It is in line and aligned with our systems". "We are trying to catch up to the changes and merge them with what we had already.". "Should be able to help us reach our business goals." "It should help us do things better and make more profit," "It should help us achieve goals quicker." "They should provide measurable business value," "Either increase revenue, productivity, efficiency, or drive costs down." "It is needed for business growth and should be a focus." "Organisations' objectives are advanced technologies and combination of technologies allows us to do this". "It should contribute fully." "I believe if we can successfully integrate the new technologies," "it will help our business grow." "The organisations' objectives are to make revenue". "New technologies give us an edge which makes this happen.". "If it syncs well, it fits in quickly." "We ensure they can enhance". "They can easily be restructured to work with what we have"." They work together". "They complement each other". "The new one serves as support for the old one." "We check that new technologies can work with the old one to avoid waste." "The new technologies are usually included as an add-on, so we check compatibility before using it on a wider scale". "Due to the high cost of technology". "We always make sure any new technology will fit in with existing equipment as we cannot always replace."
Inference from Text Entry Comments	The successful integration of new technology depends on their compatibility with existing organisational procedures as highlighted by the respondents' insights. New products and services increase market share and revenue development; therefore, compatibility is necessary for expansion. It is imperative as a wider range of products are offered, necessitating quick adaptation and seamless integration of new technologies to support varied offerings. Moreover, various organisations' commitment to delivering superior quality products that differentiate them in the market indicates the importance of compatibility in facilitating faster sales and enhancing customer satisfaction. Therefore, alignment of new technologies with current processes is integral to maximising their potential impact on operations.

Independent Variables	H3: Complexity
Comments from Text Entry Version	"Because new tech is so complicated", "It can be hard to use at first". "It requires new skills which may not always be available". "It takes much effort to get them working as needed." "Any new technology that needs to be deployed has to be secure and robust". "It can be difficult to understand, or it can get damaged quickly," and "Sometimes new technology is hard to understand quickly." "Cost, knowledge, skills, high cost, the expertise required to integrate"." Sometimes, they are hard to understand, so we usually have to outsource the implementation. " "It is hard to understand and use new technologies"." Recruiting top-tier tech talent, licenses, and infrastructure "Takes time and requires learning". "One needs time and effort to understand them". "Keeping up with the pace of innovation in these fields". "Need to learn everything new"."Difficulty to understand how to use or apply"."Learning, training is limited". "At first, it can be pricey to bring in new technology. " "It usually has a high cost, which requires time to recoup". "We had to buy new equipment and spend money on training"." The new equipment using the technology is expensive"."From my understanding, the new technology is expensive."
Inference from Text Entry Comments	Newly developed technologies frequently present substantial complexity obstacles, especially in the early stages of implementation. The complex nature of these technologies can make them challenging to use successfully, necessitating the need to acquire new skills that may not always be readily available inside organisations. Moreover, a significant amount of effort is required to guarantee the proper functioning of these technologies, particularly considering the scope that may be required within the organisation. In addition, the intricacy of emerging technologies is further complicated by variables such as exorbitant expenses, the need for specialised skills to facilitate integration, and the possibility of swift deterioration or becoming outdated. Outsourcing implementation is frequently required because of the challenges in comprehending and effectively utilising new technologies. The learning curves are high, requiring a significant amount of focused time and effort to understand and efficiently apply them thoroughly. The scarcity of training possibilities worsens the difficulty, while the initial cost of implementing new technologies might burden financial resources without immediate benefits. Although these technologies provide advantages, the cost and associated support involved in obtaining and deploying them highlights the significance of thoughtful deliberation and strategic preparation before deciding to use them.

Independent Variables	H4: Trialability
Comments from Text Entry Version	"I get to use it at home and report back on updates." "We usually make sure to try it out well." "We need time to be certain they fit into what we need." "Our organisation has a sandbox for securely and safely testing new technologies before implementing them." "In many ways, we have always to test." "I get to test and use products, and I also am trained." "In many ways, from beginning to the end, I would be given an unfinished product to test and also give feedback." ."To test the product during development and before launch and help provide feedback." "We need some time to try out new technology." "We make sure it will really help us before we decide to invest." "Check how it works and then see how it fits with what we need." "Very strict ways to ensure it will work well." "Training, testing, redevelopment." "We test it well. "We check how it works in other places." "We would ensure it is suitable for our product type". "Take it through the stages of testing”. "Check the feasibility." "Test, understand uses"." Evaluate properly."
Inference from Text Entry Comments	Technological effectiveness requires trialability, and organisations test these technologies for system updates and maintenance to guarantee continuous suitability. Furthermore, conducting trials enables a deeper understanding of consumer usage patterns, areas of concern, and potential chances for intelligent repairs, which, in turn, minimises periods of inactivity and enhances customer contentment. It assists organisations in verifying the potential advantages of novel technologies, guaranteeing compatibility with business objectives, and improving contribution to revenue growth and market expansion. Through comprehensive testing and experimentation of novel technologies, organisations not only reduce potential hazards but also encourage the development of new ideas and ongoing enhancement, positioning themselves for long-term expansion and achievement in a rapidly changing market environment.

Independent Variables	H5: Perceived Ease of use
Comments from Text Entry Version	"We try to make tech methods that are easy to understand". "It helps to get things done faster," and "makes work easier, which is important." "If I am trained before using "." in the way of training to use it and using frequently”." I learn it frequently". I use the manual and training materials." "Most of such are to make the work process easier so we would have been trained on the application beforehand." "I require the knowledge for the work I do, so I make efforts”. “It should be easy to make things with new technology because there is always improvement from the last one." "Technology makes it more seamless to develop products and services". "It is straightforward when we have the right tools or knowledge”. “We use manuals and are used to it." "It's required, so we make sure it works out by adapting as new knowledge comes”." We follow a process and make sure we follow the right steps." "We have processes we follow". We adjust accordingly to produce faster”. “It makes it easier to complete things". "Training the team and making sure they know how to use it."
Inference from Text Entry Comments	The perception of how easy it is to use technology is important in determining its acceptance and fostering creativity inside the organisation. The primary focus is on creating technological approaches that are straightforward and efficient, enabling quicker task execution and streamlining work procedures. Training is essential for improving usability and ensuring that team members have the required skills and expertise to use new technologies effectively. Consistent training sessions and availability of manuals and training materials help familiarity with the technological applications, which, in turn, allows for smooth incorporation into daily operations. In addition, the perceived simplicity of using technology is enhanced by the ongoing enhancement and fine-tuning of technology, which makes it more straightforward to create products and services. Embracing new information and adhering to existing procedures are crucial for guaranteeing the proper utilisation of new technology and their contribution to increased productivity. In summary, user-friendliness and adequate training and support simplify new technology adoption and allow teams to use it to innovate and achieve organisational goals.

5.5.2 Organisational Readiness (Technology Organisation Environment Theory (T.O.E.) Tornatzky and Fleischer, (1990)

Table 5. 4 Text entry summary for Organisational Readiness

Independent Variables	**H6: Technology Readiness**
Comments from Text Entry Version	"In many ways as we need it to succeed, in multiple ways, factory, retail, marketing, production "."We use them in every area." "Multiple ways, we partner, we invest, and we make efforts to learn about new developments". "Computers will do what they are told using commands inside them and outside because we would have tested it to confirm it will work as intended". "They are programmed to do what is asked and will only malfunction if they have a fault". "Machines make it easy”. "We can use them easily with no issues". "Machines are for support and man-made”. "They follow set processes and usually work according to that". "Because machines are programmed, and if the programming is well set, there will be no issues". "It is built on science". " If managed well, works accordingly and can be adjusted". "New technologies make life easier, like smart TVs and customer feedback. ". "They usually save time, which is important to customers and businesses because they are better at understanding intent and are easy to use". "They have different features and USPs. "The features make it easy to use". "They have features that are designed to make them convenient."
Inference from Text Entry Comments	The degree of preparedness for new technologies substantially impacts their acceptance and incorporation into organisational activities. Organisations like to collaborate with pioneers, invest in research, and keep up with the latest advancements. The assurance of technology readiness is derived from meticulous testing and validation procedures, guaranteeing their reliability and intended functionality. In addition, automated machines and computer systems that follow instructions perfectly and provide the necessary assistance for objectives are indicated as an add-on to technology preparedness for developing technologies. Strict protocol and careful programming of the systems for implementation are believed to reduce failures and ensure reliability, and adjustment for evolving requirements with these emerging technologies. There is a focus on using the readiness to meet consumer expectations in the constantly evolving technological landscape. By adopting a proactive approach towards technology and utilising its advantages, organisations could position themselves to consistently innovate and achieve success in a rapidly changing business environment.

Independent Variables	**H7: Top Management Support**
Comments from Text Entry Version	"The people in charge of our company are in favour of new technology." "They like to try new ideas also and be ahead in the industry". "Encouraging staff", "To learn", "Through the purchase of the technologies and implementation”. "Recruitment of the right individuals". "Buying equipment, investing in new technology and ensuring we have the right partners"." "Key technology projects have an executive sponsor who speaks and ensures all necessary resources for the project are available"." In a major way, by investing and using and making sure we also use." "They are involved in selection and making the decision". "They promote it and support the investment." "Executives want people to use new methods". Top-level managers know how technology can help us". "They understand the importance". " To improve things." "Managers are trained on the strategy and priorities of the organisation". "They ensure that the same knowledge is passed down the ranks". "They test". "They use and make it better. "They train and learn daily". "They self-teach”. Are also trained and implement in their job". "Decision makers who support are at the top level". "Executive level". "C-Level executives". "MD/CEO". "Highest level" "Senior management". " Highest level". " Senior".
Inference from Text Entry Comments	The involvement of top management is vital in promoting the use of new technologies and cultivating knowledge within the organisations. At the highest level of leadership, there is an endorsement of embracing technology advancements for the purpose of maintaining a competitive edge in the applicable industry. The support is demonstrated through a range of measures, including promoting staff development and the acquisition of new skills, investing in the procurement and implementation of technology, and ensuring the recruitment of persons with the appropriate experience. Executive sponsors champion key technological projects, advocating for their importance and ensuring the provision of essential resources. High-ranking executives play an active role in the selection and decision-making processes concerning new technologies, actively encourage the adoption of these technologies and provide support to ensure a return on the technological investments. Managers possess a comprehensive knowledge of how technology may boost the operation of an organisation and consistently prioritise enhancing procedures through the implementation of technical solutions.

Independent Variables	H8: Technological Partner Support
Comments from Text Entry Version	"We need partners who are experts in the field". "We need them when we switch to new tech," "They make it easier to combine the system". "It saves time". " Reduces the chance of making common mistakes." "We work closely with our suppliers who handle issues we may not be able to handle". "To help make things better." "Partners can provide support not available within". "Partners sometimes know about new technology more". "Have used it for another company so they can share". "Partners sometimes have skills or technology our internal teams do not have, so we rely on." "Our providers and we work together a lot". "Our partners can help fix any new tech issues"."They can easily troubleshoot and fix problems." "Some partners have extra knowledge". "They provide support". "They have different knowledge we combine with ours". "We have retainers for tech partners and sometimes have them on-site". "We cannot cover all technical areas, so using partners does this."
Inference from Text Entry Comments	External technology partners act as accelerators for internal innovation within the organisation. By using the knowledge and skills of industry partners, organisations depend on them to facilitate the adoption of new technologies. This allows them to take advantage of their proficiency in optimising system integration and minimising the likelihood of mistakes. Constant communication and collaboration with technological experts allow organisations to tap into their specialised expertise and resources that are not easily accessible within the organisation, and by closely collaborating with suppliers and external partners, organisations can tackle difficulties that go beyond what they can handle internally. These partners know of emerging technologies acquired from their previous collaborations with other organisations, enabling them to offer significant expertise and exemplary methods. In addition, they may provide talents or technology that enhance internal capabilities, allowing them to utilise their strengths to accomplish innovation objectives. To overcome internal expertise limitations, we partner with technology-focused collaborators who help advance solutions and resolve deployment challenges. These partners enhance our technical capabilities with complementary knowledge and resources. By maintaining an on-site partner presence for immediate support, we address diverse technological areas and strengthen innovation. This collaborative approach demonstrates our commitment to embracing new technologies and ensures seamless implementation.

Independent Variables	H9: Regulatory Policies
Comments from Text Entry Version	"Organisations that use new technology or make devices need help from the government". "Rules from the government guide us on how far to go with the use". "Provide guidelines and support". "Provide the law and support with tax or building new projects". "Providing a good atmosphere for technology"." Offering support for business to grow"." They are important because of the laws." "The government provides licenses and personnel to support the implementation". "Provides funding more easily". "The rules give us ideas for new tech". " Encouraging companies to invest in new tech and the country". " Helps grow the market with good laws"."Providing benefits to technology companies and supporting them". "When businesses expand, the economy grows". " Our government partners with companies on technology projects". "Makes it feasible for them to do business". "Makes it easier and safer". " Helps us try out new ideas and make them work if needed". "Providing opportunities to grow and invest". "Growing the market to ensure continuity"," Providing regulatory support like incentives through government projects"," Helps us know what is allowed or not". "Important so we do not break the law". "Helps to avoid issues or law-breaking". " Makes it easy to operate ". "It makes it easy to not get sanctions or fines due to non-compliance".
Inference from Text Entry Comments	Regulatory policies exercise valuable influence over organisations' technological adoption strategies. Crafted and enforced by governmental bodies, these policies provide essential frameworks establishing parameters for exploring and integrating new technologies. By ensuring compliance with legal requirements and industry standards, these regulations guide organisations through innovation complexities, mitigating potential legal and reputational risks. Moreover, compliance extends beyond legal obligations, significantly influencing interactions with stakeholders, enhancing credibility, and complying with regulatory standards, demonstrating the organisation's commitment to ethical business practices. Additionally, these policies shape the competitive landscape and market dynamics surrounding technological adoption, with incentives driving swift technology uptake while stringent regulations may impede progress. Adapting to regulatory changes is essential for compliance and growth in fast-evolving tech environments. Non-compliance risks damaging relationships and deterring investors and partners. Aligning tech adoption with regulations builds stakeholder trust and ensures long-term sustainability in today's increasingly regulated business landscape.

Independent Variables	H10: Competitive Pressure
Comments from Text Entry Version	"The way our competitors use technology affects how we use it ourselves". "We know other companies are using new tech, and we also do, through constant market updates". "We follow the market". We check their products". " Aware based on knowing what products they offer". " We analyse them." "We use competitor analysis and monitor their products". " We follow market trends and do market investigations to know". "We keep an eye on new technologies that are important to our work". " We use them to have a market advantage ". To maintain and enhance our products and services." "We are developing AI computers that we expect would propel us ahead of the competition". " Using them in new products by monitoring and following up with competitors". "We use newer components in the products". " We have built apps and added digital tools to our distribution network". " To make products and services," We have to incorporate technologies from partners." "We support relationships that are good for everyone." "What other companies do influences what we do". "Makes us vigilant". "Makes us want to do more every day". " It makes us want to be better to keep customers and get new ones". "It makes us push to launch newer products with better features." "We keep our ways for innovation up to date". "Seeing product launches pushes us to want to do more and helps us strictly follow industry standards." "When we lose business"." When we see a new product by the competitor". " It makes us want to understand the technology and use it more". It makes us want to be sure we are using the right technology." "To increase market share". " We always want to be ahead of the trends ". "To not lose market share to competitors". "We keep trying to retain the customers".
Inference from Text Entry Comments	Competitive pressures drive technology adoption and innovation. Organisations monitor competitors' tech use, recognising its impact on their approach. Regular market monitoring and competitor analysis keep them informed about the latest developments, maintaining industry competitiveness. Organisations commit to innovation for competitive advantage by proactively developing and integrating new technologies like AI and digital tools to meet evolving client needs. They track competitor activities and industry standards to introduce improved products with better features, ensuring innovation aligns with market trends. Competition catalyses continuous improvement, demanding deeper technological understanding and more efficient implementation. The strategic goal is adopting appropriate technology to expand market presence and maintain client loyalty, preventing customer loss to competitors. Strong competition fosters an innovation culture that drives excellence in technology adoption and consistent product development.

5.5.3 Firm Innovation Performance (Anning-Dorson et al., 2018; Ghosh and Srivastava, 2021; Gunday et al., 2011)

Table 5. 5 Text entry summary for Firm Innovation Performance

Independent Variables	**H11: Organisational Innovativeness**
Comments from Text Entry Version	"Management backs up new ways of working". "We keep learning through networking and staying connected"." We focus on the market and customers through market research and partners,". "We investigate the market weekly, research, staff, partners". "To better serve our customers, we have added new strategies"." Through constant changes to ensure we improve"." makes it necessary to involve partners in projects". "We are always undergoing digital changes through the interaction of various departments". "We have partner managers. "We keep in touch with all our partners"." Updated to include digital teams and more product testing teams". " We have teams that work together on projects". "We focus on researching competitive information"."Changes to include new ideas to grow more"." Following processes, changing systems". " Training and updating products and service processes according to the segment". "We use updated equipment and also check on new technology regularly". "We check to ensure we have the right equipment and is it the right technology". "Bi-annual checks and yearly upgrades are done."
Inference from Text Entry Comments	Organisations pursue innovation through technology adoption and continuous improvement. Management champions innovative work methods and fosters learning by encouraging networking and monitoring industry trends and customer needs.Their approach is informed by market research, partnerships, and analysis of market dynamics to improve customer service and adaptability. Digital transformation is driven through partner collaboration and cross-departmental initiatives.Partner managers maintain communication with collaborators to ensure alignment on innovation efforts. Teams conduct competitive research and implement innovative ideas, focusing on process improvements, technology integration, and equipment upgrades. Semi-annual audits and annual updates keep technological infrastructure current and aligned with organisational goals, enabling effective leverage of new technologies for success and customer satisfaction.

Independent Variables	H12: Process Innovativeness
Comments from Text Entry Version	"By asking us to think outside the box"." By setting KPIs". "By encouraging digital mode of working". "They push teams to develop themselves and bring information and new ideas". "Encouraging ideas." "We have increased our reach of customer service". "We have found new ways to make things easier and more accessible, such as smart retail stores, virtual online services, digital communication". "We expanded the team,". "Partnered with other companies". "Trained staff, more training"."More interest in new technologies". "Adjustment of service processes by being more digital". "We offer special processes for different customers as they need". "We constantly seek to change by getting feedback". "Through using digital tools like integrated CRM". "Update applications and ensure customer feedback is included in technology use". "We check processes daily and change if necessary or change technology if one is not working well". "Reviewing the current procedures and updating them"." We listen to the customers and improve".
Inference from Text Entry Comments	Organisations respond to process innovation by fostering a culture of creativity and continuous improvement. They encourage thinking outside the box and set key performance indicators to drive innovation forward. Digital working modes motivate team development and idea generation, creating an innovation-friendly environment. Organisations establish channels for confident idea sharing, bringing innovative solutions forward. In response to process innovation, organisations have expanded their reach in customer service by leveraging new technologies and implementing innovative solutions, and this includes the establishment of smart retail stores, virtual online services, and digital communication platforms to make interactions more straightforward and more accessible for customers. Furthermore, organisations tailor their processes to meet the unique needs of different customers, constantly seeking feedback to become more digitally oriented and drive innovation. They use digital tools like customer relationship management (CRM) systems, regularly updating applications and incorporating customer feedback to improve technology use. Continuous process monitoring enables timely adjustments and technology changes, maintaining effectiveness and customer focus. Organisations implement improvements based on customer feedback, showing commitment to innovation and satisfaction.

Independent Variables	H13: Products and Services Innovativeness
Comments from Text Entry Version	"We add new features by going above and launching innovative products". "We use new hardware materials and also new components". "We make changes based on user feedback". "We use features to differentiate our goods from those of our rivals." "We have to change our approach since COVID and come up with new ideas more frequently". "Changed product line to more sustainable material". "Leading in the deployment of AI PCs and developing cutting-edge technology in ink and toner". "We created customised products that are different for different purposes". "Ways of creating new products in the market, upgrading existing products to be better, advanced products". "Creating a distribution service portal that has an integrated chatbot". "By being market-sensitive and partnering with other companies".
Inference from Text Entry Comments	The organisations are committed to innovation and integrating emerging technologies to elevate products and services. Continuous enhancement involves pushing boundaries and setting new benchmarks in the market using state-of-the-art hardware materials. Customer feedback guides targeted modifications to address demands and preferences directly. Strategically differentiating products ensures unique value propositions for clientele, and organisations have intensified efforts to generate novel concepts and solutions more frequently. Transitioning and pioneering the use of AI-driven systems maintains leadership in technical innovation. The focus on customisation provides personalised solutions that meet diverse demands and objectives and enhance competitiveness. Continuously seeking innovative methods, organisations introduce new products or enhance existing ones to improve efficiency and effectiveness, which includes developing a distribution service portal featuring a chatbot to enhance the overall client experience. Responsiveness to market trends and strategic alliances with other companies are prioritised to remain competitive. In summary, dedication to innovation in both products and services ensures the organisations' position as industry leaders.

5.7 Text Entry Summary

The rapid growth of emerging technologies has significantly impacted innovation adoption. The relative advantage, compatibility, perceived ease of use, complexity management, and trialability of technology are identified as vital factors that have shaped adoption. Addressing ethical concerns and channelling technological potential will benefit society while upholding ethical standards and societal values. Harnessing the potential of technology-focused research centres on creating a future characterised by enhanced connectivity and growth, with the ability to change organisational operations and drive innovation across various dimensions. Subsequently, this comprehensive discussion dives into the impact of technology adoption on organisational, process, and product and service innovativeness, shedding light on its transformative potential and implications for firm innovation performance.

Considering organisation readiness, with variables such as top management support, technological infrastructure readiness, support from technology partners, regulatory compliance, and awareness of competitive industry pressures, organisations can unlock the benefits of emerging digital technologies, positioning themselves for success in the digital era. Understanding the variables and the insights can enable organisations to enhance their readiness for emerging technology. Organisations can unlock the benefits of advanced technologies by positioning themselves for success in the digital era and being at the forefront of radical and disruptive growth elements associated with the new technologies, as discussed in previous chapters.

Regarding firm innovation performance, organisations increasingly realise the significance of incorporating AI to drive innovation and improve performance. Technological adoption significantly benefits organisational, process, and product and service innovativeness. By harnessing this power, firms can revolutionise their operations and achieve substantial growth. By strategically embracing technologies and aligning them with specific requirements and core values, organisations can unlock new avenues of innovation and drive competitive advantage. The findings highlight the importance of assessing unique organisational needs, developing robust strategies, and ensuring effective integration and implementation. Researchers and practitioners can fully leverage the potential to propel innovation to enhance firm innovation performance.

Chapter 6 Conclusion

6.1 Introduction

This concluding section of the research study highlights its primary accomplishments while providing practical suggestions, constraints, and avenues for further investigation. Based on available information and studies, this study seems to be one of the pioneering investigations undertaken to integrate the three specific emerging technologies **(Artificial Intelligence, Internet of things, Industry 4.0)** that carry global relevance and are currently undergoing rapid development and focus on larger enterprises and multinational respondents from three combined emerging economies **(Middle East, Africa, and Asia).** The responses from the survey participants were explicitly based on business perspectives as they were managers and above who have either operational or decision-making knowledge of technological innovations within their respective organisations. The primary aim of this research study was to generate valuable contributions to the existing knowledge through an extensive investigation and a well-informed response to the designated research question:

R.Q. 1: What impact does the rapid advancement of a combination of emerging digital technologies have on the adoption of innovation?

RQ2: How does the organisation's readiness for a combination of emerging digital technologies affect innovation adoption?

RQ3: What impact does the adoption of a combination of emerging digital technologies have on firm innovation performance?

6.2 Summary of Alignment Between Research Elements (Research Gaps → Research Questions → Research Objectives → Research Contributions)

As illustrated in Table 6.1, the research's contributions lie within its multifaceted approach, whereby individual contributions often address multiple gaps simultaneously, forming a comprehensive web of knowledge (Bibri, 2018; Brock and Von Wangenheim, 2019; Grover et al., 2022). Moreover, the interconnected nature of the contributions ensures that each research gap receives attention from various angles, providing a more detailed and comprehensive understanding of the research problems (Frank et al., 2019; Sebastian et al., 2020; Vial, 2021). Furthermore, the overlapping nature of these contributions reinforces the validity of the findings, as similar conclusions are reached through different analytical paths (Bibri, 2018; Zhong et al., 2017). Therefore, this comprehensive coverage, supported by multiple perspectives and approaches, demonstrates the thorough nature of the research and its significant contribution to the field of digital technology adoption and innovation performance (Davenport and Ronanki, 2018; Lee et al., 2019; Warner and Wäger, 2019).

Table 6. 1 Summary of Alignment Between Research Elements

Research Gap	Research Question	Related Contributions	Direction of alignment
• **Gap 1:** Limited research on emerging digital technologies and innovation adoption framework (within emerging economies)	• **RQ1:** Rapid Advancement of combined emerging digital technologies on innovation adoption	• **Contribution 1**: Integration of three theoretical models (DOI, TAM, TOE) • **Contribution 2:** Integration of new and old technologies • **Contribution 6:** Simplifying integration of diverse emerging technologies.	• Theoretical framework is well established. • Technology integration is comprehensively addressed. • Complexity Barrier’s perspective in adoption are highlighted within solutions offered.

Research Gap	Research Question	Related Contributions	Direction of alignment
• **Gap 2**: Evolution of technological innovation ecosystem and organisational readiness	• **RQ2:** Organisational readiness for combined emerging digital technologies	• **Contribution 3:** Augmenting organisational readiness. • **Contribution 4:** Combining technologies for emerging economies. • **Contribution 7:** Gender-differentiated interests in product and service innovationess • **Contribution 2:** Integration of new and old technologies	• Ecosystem perspective is covered through the focus on various emerging economies and collaboration of technologies • Gender perspective adds valuable organisational and futuristic dynamics insight. • Technology integration supports ecosystem evolution
Research Gap	**Research Question**	**Related Contributions**	**Direction of alignment**
• **Gap 3: Understanding** the impact of emerging digital technologies on firm innovation performance	• **RQ3:** Impact of combined emerging digital technologies on firm innovation performance	• **Contribution 4**: Impact on firm innovation performance in emerging economies • **Contribution 5:** Data-driven insights for performance • **Contribution 6:** Simplifying integration and addressing complexity barriers. • **Contribution 7**: Gender-differentiated interests in product and service innovation	• Areas of difficulty is addressed through multiple perspectives. • Technical complexity challenges are tackled through simplification strategies for product, process and organisational innovativeness. • Gender-based challenges in driving innovation performance is addressed.

6.3 Research Contributions to Knowledge

Contribution 1: Combination of Measurement Items from Three Technological Innovation Models:

This research study contributes to the existing literature by integrating three theoretical models: DOI (Rogers, 2003), TAM (Davis, 1989), and TOE (Tornatzky and Fleischer, 1990) and using various measurement items from the respective models in a quantitative study to assess innovation adoption of the combination of three specific emerging digital technologies.

Contribution 2: Using the Integration of New and Old Technologies to Achieve Maximum Rapid Progress in Technology:

Implementing digital technologies requires flexibility, enabling manufacturers to have a quicker time-to-market and shortened research and development cycles because of the implementation of technologically enhanced processes (Keskar, 2024; Nambisan et al., 2019). Therefore, organisations can refocus their resources on combined focused innovation to strengthen their competitive edge as more digital technologies, particularly AI-based solutions, are being introduced into various industries (Davenport and Ronanki, 2018; Lee et al., 2019). These technologies improve automation and job accuracy, time management, productivity, and invariably, other improvements that further drive the growth of an organisation (Frank et al., 2019; Sarcea et al.,2024).

Contribution 3: Augmenting Organisational Readiness for the Integration of Emerging Technologies to Sustain the Long-term Growth of Organisations:

Organisational preparedness for incorporating evolving technology affects innovation performance, enabling companies to distinguish themselves (Li et al., 2018; Warner and Wäger, 2019). Indeed, improving performance proves vital to foster the creation of cutting-edge products and services (Attaran et al., 2024; Cheng et al., 2024). Furthermore, the readiness of digital technology enhances operational capabilities by streamlining processes, facilitating product innovation, and aligning services with consumer expectations (Vial, 2021).

Subsequently, combining evolving technology promotes agility and innovation (Sebastian et al., 2020). Additionally, aligning innovation with business goals preserves growth momentum through product and service enhancement, substantiating the integration of developing technologies (Aldoseri et al.,2024; Hossain et al., 2024). Employee readiness becomes essential as an organisation becomes increasingly digitally focused (Mutambik and Almuqrin, 2024); Therefore, employee education must be prioritised to improve competencies, especially as technical expertise is increasingly required for various emerging technologies (Olsson et al., 2025). Additionally, a comprehensive digital technology strategy promoting innovation and decision-making is essential for organisational growth (Hamadaqa et al., 2024). Therefore, these findings deepen the understanding of organisational readiness for various emerging technologies and provide insights applicable to future studies, especially in developing economies (Alam et al., 2024; Bhuiyan et al., 2024; Felemban et al., 2024).

Contribution 4: Combining Emerging Technologies can Significantly Elevate a Firm's Innovation Performance by Capitalising on the Demand and Enthusiasm for Continuous Technological Access in Emerging Economies, both on a continent level and on a regional level:

Implementing IoT and I4.0 technologies provides the infrastructure and tools required to connect remote areas and leverage digital advancements, empowering large enterprises in emerging economies to access pioneering and innovative solutions (Amin et al., 2024; Jabeen and Ishaq , 2024). By increasing technological reach in emerging economies, multinational organisations can tap into new markets and customer segments, thereby enhancing their performance and growing exponentially (Parida et al., 2019). However, although access to emerging economies opens opportunities for growth, diversification, and innovation, organisations must be prepared and adaptable to leverage emerging technologies for increased technological reach in emerging economies (Castelo-Branco et al., 2019). Such adequate preparation involves understanding the specific needs and challenges of these markets, developing localised strategies, and adapting products or services to cater to the unique requirements of emerging economies (Agbeyangi et al. 2024; Alharbi, 2023; He et al., 2023; Jimo et al., 2023). Organisations in developing economies require adaptable infrastructure and concepts to prioritise flexibility and expansion, facilitating greater access to technology. As indicated in Table 5.2, this process is ongoing.

Furthermore, adhering to the definition by Geraci (1991) in the IEEE Standard Computer Dictionary, interoperability is described as the proficiency of multiple systems or elements to share and effectively utilise the data exchange. The combination of emerging technologies enables organisations to increase their technological reach from their initial domicile to emerging economies (Frank et al., 2019). Such subsequent geographical growth facilitates the exploration of new markets, improves firm innovation performance, and promotes innovation through the utilisation of real-time data, adaptation to local requirements, and the cultivation of collaborative efforts (Bag et al., 2021). Embracing technologies enables organisations to bridge the technological divide, drive inclusive innovation, and tap into the vast potential of emerging economies (Kiel et al., 2017). Therefore, a comprehensive understanding of this study's insights from emerging economies is fertile ground for applying emerging technologies, highlighting the ability to generate increased revenue for large enterprises and multinational corporations.

Contribution 5: Incorporating AI and Other Cutting-Edge Technologies can revolutionise Decision-Making by Harnessing the Potential of Data-Driven Insights to enhance Firm Innovation Performance.

AI algorithms and advanced analytics reveal trends and behaviours, enabling intelligent decision-making to fuel growth and allowing organisations to employ real-time product performance and user feedback data (Li et al., 2024; Raji et al., 2024), as discussed in Chapter Two. Organisations may increase output and simplify operations with automated processes (AI), machinery (I4.0), and connectivity (IoT) (Frank et al., 2019; Xu et al., 2018). These technologies identify bottlenecks, reduce redundancies, and manage resource distribution, improving performance and cost (Lasi et al., 2018). Such integration facilitates innovations for organisations, enabling them to focus on research, new products, and developing markets (Fang and Liu ,2024;Vărzaru, and Bocean, 2024). Integration and adoption of these technologies allow organisations to adjust their operational modalities and strategic strategy, invariably facilitating their advancement in competitiveness and progress (Bhatia et al., 2024).

Contribution 6: Simplifying the Integration of Diverse Emerging Technologies by Addressing Complexity Barriers will Increase Technological Adoption.

The complexity inherent in artificial intelligence (AI) presents significant challenges for organisations adopting emerging technologies (Brock and Von Wangenheim, 2019). Indeed, this sophisticated technology demands extensive resources and expertise for successful implementation. Furthermore, the nature of AI algorithms, machine learning models, and data processing frameworks often deters the adoption of these technologies (Grover et al., 2022). As Chapter Two highlights, numerous studies have emphasised complexity as a significant hindrance, and this was further validated by the insights from the respondents, as stated in Chapter Four and the subsequent sections.

Moreover, organisations encounter difficulties understanding the inner workings of AI systems, implementing them effectively, and ensuring transparency and accountability. Therefore, a vital contribution to integrating emerging technologies involves the process of reducing the complex nature of AI by offering straightforward user interfaces, thorough documentation, and accessible tools. Consequently, these approaches are likely to offer organisations a quicker chance to take advantage of the potential of AI without being burdened by its complexities.

Additionally, IoT-enabled organisations face growing complexity (Bibri, 2018), whilst IoT ecosystems encounter integration, security, and data management issues due to device and sensor interaction (Ng and Wakenshaw, 2017). Subsequently, simplified frameworks are needed for quick device connection, strong security, and effective data management for greater integration. By improving linked devices and delivering data-driven insights, IoT implementation accelerates its disruptive potential.

Industry 4.0 offers significant potential for production enhancement through the seamless integration of digital technology with conventional manufacturing approaches (Xu et al., 2018). Nevertheless, the inherent complexity of these advanced systems can impede widespread adoption and organisational development. Key challenges encompass the successful navigation of sophisticated cyber-physical systems and the effective utilisation of diverse technological solutions.

Organisations must implement scalable solutions whilst providing comprehensive training programmes and robust support mechanisms for their workforce to overcome these obstacles. Furthermore, research conducted by Vetrivel et al. (2024) demonstrates that simplifying interfaces, refining dashboard designs, and enhancing documentation substantially improves comprehension and reduces the barriers to technological adoption. Consequently, various technologies can be complex for organisations due to the wide range of platforms and protocols available (Zhong et al., 2017); it is important to prioritise consistency and integration in emerging technologies such as AI, IoT, and I4.0. Simplification can be achieved by promoting industry standards, open protocols, and shared data formats, which allows for straightforward communication and data exchange between different technologies, components, and systems, ultimately reducing complexity. By adopting these practices, organisations can take advantage of a more expansive range of compatible technologies, recognising that one technology can compensate for the limitations of another. Therefore, in line with previous studies outlined in Chapter Two, the results from this study further highlight the consistent deterrent effect of complexity.

Contribution 7: Advancement of Gender-Differentiated Interests and Skills in Product and Service Innovation:

Based on the demographic to-variable analysis (illustrated in Appendix 6), product and service innovation and gender were the only factors that had a statistically significant difference among thirteen variables indicating the need for more synchronised viewpoints and interests between males and females concerning product and service innovation, which is predominantly technical-oriented (Agnete Alsos et al., 2013). Such engagement may reduce male dominance in innovative product and service areas (established across the studies mentioned within Chapter Five) and also bring diverse viewpoints that provide comprehensive product and service features (Dai et al., 2019; Pecis, 2016), which could increase uptake or open up new segments and further influence the adoption of innovation of emerging technologies for firm innovation performance (Ruiz-Jiménez et al., 2016).

6.4 Practical Recommendations for Knowledge

The digital revolution has brought about remarkable advancements but poses significant challenges. This discussion explores the challenges and opportunities the digital revolution presents, focusing on areas such as privacy, security, the digital divide, and ethical considerations. Organisations can successfully adopt and leverage digital technologies for improved performance, growth, and financial gains by addressing these challenges and harnessing opportunities. Due to the complicated nature of the technologies and information systems that develop and manage evolving technologies like I4.0, AI and IoT, it is increasingly difficult for organisations to create and effectively utilise them independently.

6.4.1 Opportunities for the adoption of emerging technologies and their impact on firm innovation performance:

a) **New Models of Growth**: Emerging markets are experiencing transformative changes driven by digitalisation and business model innovation. Research demonstrates that organisations in these markets can develop innovative growth models despite resource constraints by strategically integrating digital capabilities with local market understanding (Saqib and Satar, 2021). Success in emerging markets requires adapting business models to local contexts rather than simply replicating approaches from developed markets. Evidence from emerging economies suggests that hybrid models - which blend technological capabilities with local market requirements - often prove most effective (Solomon and Van Klyton, 2020). These models enable firms to overcome infrastructure limitations whilst building technological capabilities progressively. Organisations can achieve sustainable competitive advantages by developing business models that emphasise personalised service delivery, collaborative ecosystems, and swift adaptation to market conditions (Saqib and Satar, 2021). Such a strategic approach to growth allows emerging market firms to build sustainable advantages whilst developing more sophisticated capabilities over time. Rather than attempting to immediately replicate advanced technologies, organisations benefit from focusing first on foundational capabilities whilst leveraging partnerships strategically (Solomon and van Klyton, 2020) as highlighted in chapter five (section on technological partner support).

b) **Evaluation of Societal Impact:** Organisations confront a critical challenge in embracing emerging technologies while simultaneously maintaining a commitment to societal well-being and ethical considerations (Keith, 2024). Consequently, this requires a comprehensive approach that carefully balances innovative potential with responsible governance. Moreover, a sophisticated technological evaluation necessitates multi-dimensional analysis. Organisations must conduct nuanced feasibility studies that extend beyond technical parameters to assess social, ethical, and environmental implications (Arnaldi et al., 2015). Furthermore, this process involves robust stakeholder engagement, inclusive dialogue platforms, and transparent consultation processes. For instance, India's Science for Equity Empowerment and Development (SEED) programme exemplifies an approach explicitly aligning technological innovation with social development objectives (Arnaldi et al., 2015). Indeed, such models demonstrate how technological advancement can be purposefully directed to serve broader societal needs. Fundamentally, responsible technological innovation is about intentional progress. By systematically integrating comprehensive impact assessment, stakeholder engagement, and adaptive governance mechanisms, organisations can effectively transform technology into a powerful tool for sustainable development. Ultimately, the overarching goal is to create a symbiotic relationship between technological advancement and societal well-being, thereby shifting from a narrow, performance-driven perspective to a holistic understanding of technology's transformative potential as highlighted in chapter five (section on regulatory support within emerging economies).

c) **Investment in Training Initiatives and Capability-Building Programmes**: Implementing human skill development programmes is an integral part of empowering the workforce with the skills and knowledge needed to embrace evolving technologies effectively. Consequently, human participation in technological integration can significantly enhance an organisation's overall expansion, fostering superior capacities for innovation and attaining an elevated state of technological preparedness. The research study of Chen et al. (2021) highlights a shortage of professionals possessing the requisite technical expertise, time, and financial resources for technology development which could also affect the top management support. Consequently, such insight, combined with the mounting urgency presented by evolving technologies, as discussed in the study of Olan et al.(2022), shows the importance of organisations investing in continuous training initiatives while emphasising cross-collaboration and knowledge sharing; such training can also include diversity-oriented training to encourage more knowledge transfer from male technological experts to female and a more robust integration of specialist skills as highlighted in chapter five (section on Asia as a region).

d) **Implement Partner Diversity and Industry Sector Initiatives:** Implement Partner Diversity and Industry Sector Initiatives: organisations and governmental bodies are progressively developing diversity initiatives to support women-owned enterprises within supply chains. Furthermore, research highlights the importance of sector-specific support, recognising that female leaders' innovation capabilities vary across different industries (Ackah et al., 2024). Consequently, the development of tailored programmes must consider the diverse innovative contributions of female leaders across various sectors. Moreover, empirical evidence suggests that female chief executives can enhance product and process innovations (Ackah et al., 2024). Nevertheless, addressing systemic challenges requires a comprehensive approach. This includes mitigating glass ceiling barriers, streamlining administrative procedures for business registration, and promoting gender-inclusive policies that foster more equitable entrepreneurial environments (Hemmert et al., 2024). Additionally, such interventions aim to create more supportive frameworks for women's professional advancement. Therefore, organisations can develop a more inclusive entrepreneurial ecosystem. Indeed, recognising women's distinctive contributions to innovation demands a nuanced, sector-specific approach that acknowledges their unique capabilities. Therefore, the potential for transformation lies in creating supportive infrastructures that empower women entrepreneurs, ultimately unlocking new opportunities for economic innovation and growth as highlighted in chapter five (section on gender as a demographic factor).

e) **Mitigating Competitive Pressures Through Intergenerational learning:** Organisations must proactively address technological adoption challenges by cultivating an environment of mutual understanding and collaborative learning. Drawing from Ramírez-Herrero et al. (2024), generational technological perspectives vary significantly, with each generation bringing unique capabilities to technological innovation. By creating structured knowledge-sharing platforms that allow older generations to appreciate younger managers' digital fluency and younger managers to understand established strategic insights, companies can mitigate competitive pressures. The proposed intergenerational leadership approach offers a strategic framework for technological integration, emphasising mutual respect and complementary skill sets. Generations like Millennials and Generation X can drive technological transformation, with their combined technological understanding and professional experience serving as a bridge between traditional and emerging technological paradigms (Ramírez-Herrero et al., 2024). By reducing competitive tensions and fostering a culture of continuous learning, organisations can effectively navigate technological disruptions while leveraging the multifaceted strengths of cross-generational workforces, as highlighted in chapter five (section on age as a demographic factor) as highlighted in chapter five (section on age as a demographic factor).

6.4.2 Challenges impeding the adoption of emerging technologies and their impact on firm innovation performance:

a) **Workforce adaptation through Technological Integration**: Organisational readiness for technological transformation necessitates a strategic and comprehensive approach to change management. Indeed, drawing from research on digital organisational preparedness, enterprises must establish robust frameworks that not only facilitate technological integration but also simultaneously develop workforce capabilities (Machado et al., 2021). Moreover, this involves creating cross-functional governance structures, cultivating digital leadership, and promoting a culture of continuous learning and adaptation. Consequently, the implementation of emerging technologies requires more than technical infrastructure; in fact, it demands a holistic organisational transformation. Therefore, companies must assess their digital maturity, align technological investments with strategic objectives, and develop mechanisms for knowledge management and stakeholder engagement (Kane et al., 2018). Additionally, critical success factors include establishing clear communication channels, defining a compelling digital vision, and empowering employees to navigate technological transitions effectively., further supported by discussions on technological readiness and organisational innovativeness in chapter five, further supported by discussions on technological readiness and organisational innovativeness in chapter five.

b) **Cross-Platform Functionality and Interchangeability:** The integration of emerging technologies within cross-platform environments presents a formidable challenge for contemporary organisations (Segun-Falade et al., 2024). Effective implementation necessitates strategic partnerships that facilitate seamless data exchange and platform collaboration. As Cenamor and Frishammar (2021) observe, platform ecosystems increasingly rely on collaborative approaches where sponsors share activities while maintaining strategic partnerships emerge as a vital mechanism for addressing cross-platform challenges, enabling organisations to overcome technological barriers and create adaptive infrastructures (Segun-Falade et al., 2024). By developing frameworks that emphasise compatibility and shared resources, organisations can mitigate risks associated with isolated technological solutions. This approach not only enhances organisation capacity but also creates opportunities for innovative cross-domain applications leveraging collective platform capabilities. further supported by compatibility, compatibility, perceived ease of use, and technological partner support discussions in chapter five.

c) **Navigating the Web of Regulation for Technology Development**: Organisations engaged in technological innovation must maintain a dynamic approach to regulatory assessment and strategic refinement. As highlighted by research on international technology transfer, successful technological development requires a nuanced understanding of policy landscapes and collaborative engagement across multiple stakeholders (Pandey et al., 2021). The process involves proactively aligning technological advancements with sustainable development goals, while simultaneously addressing potential regulatory challenges. Emerging economies, such as China, demonstrate that technological progress is most effective when organisations develop strategies that balance innovation with structured regulatory frameworks (Zhou et al., 2021). This approach necessitates continuous interaction between governmental bodies, research institutions, and private sector entities to create an ecosystem that supports technological advancement while maintaining appropriate governance mechanisms. By prioritising interdisciplinary collaboration and maintaining flexibility in policy interpretation, organisations can more effectively navigate the complex terrain of technological regulation and development further supported by technology readiness and regulatory support discussions in chapter five.

In summary, organisations must fully grasp the opportunities and effectively manage the obstacles that come with developing technologies to utilise their potential for innovation and organisational expansion. Embracing these technologies enables firms to enhance innovation, explore new business models around AI, adopt I4.0 principles, invest in IoT technological integration training, and facilitate the process of transforming the workforce, ultimately opening growth opportunities.

6.4 Limitations of the Study

The study is not exempt from limitations, which present avenues for future research studies and are outlined below.

- **Sample Size:** The response rate for the present study comprised 153 respondents, which accounted for approximately 43% of the targeted sample. While this was an acceptable rate based on several comparable studies in the field, Schwing (2025) with 148 respondents and Samsor (2021) with 150 respondents, a higher response rate could have provided more comprehensive and detailed information.

- **Research Method**: While the primary focus of this study is quantitative analysis with the rationale outlined in chapter three, the literature review incorporates secondary data from case studies conducted in articles that have examined innovation adoption and different technologies across various countries (Chou et al., 2018; Da Silva, 2023;

DeVass et al., 2021). The research also incorporated a text version of the questionnaire (Nambisan et al., 1999; Wynekkop and Waltz, 2000; Powell and Wright, 2008) and used the actual comments from the respondents to create an inference in the discussion section.

- **Confidentiality**: Given the nature of emerging technologies, concerns regarding privacy and confidentiality are prominent, mainly due to the fear of exposing organisational trade secrets. The limitations of this study include the inability to involve organisations directly from an institutional perspective, which could facilitate a more thorough understanding while highlighting the potential benefits of research studies.

- **Financial resources:** A significant constraint encountered in research studies focusing on emerging economies is the limitation of financial resources. Conducting research within these economies and gathering data from multiple countries can be expensive, particularly when accessing participants through platforms or other avenues, creating a challenge that could be surmounted within a funded study with an enlarged scope.

6.5 Recommendations for Future Academic Research

- It is essential for forthcoming studies to explore diverse combinations of emerging technologies, actively engaging industry experts to facilitate cross-industry and cross-continent comparison.
- Further research can explore how innovation ecosystems across continents can facilitate the creation of global standards for emerging technological solutions.
- Future research could examine the relationship between the compatibility and complexity of emerging technologies related to organisational readiness to adopt such technologies.
- Future research could monitor the development and results of women-led innovations Brush et al. (2022) over an extended period through longitudinal studies. It can offer significant insights into the different obstacles encountered by female technology executives, thereby contributing to the formulation of specific support initiatives and

policies that create more knowledge and encourage the interest of female employees in product and service innovativeness associated with new and upcoming technologies.

6.6 Summary

This section briefly summarises the key findings, suggestions, constraints, and potential directions for future investigations presented in the research. The application of advanced technologies has already showcased its significant transformative influence across various sectors. Empirical data from practical instances exemplifies how combining different types of technology offers benefits, including decreased expenses and flexibility while enhancing operational effectiveness and facilitating well-informed decision-making. Additionally, it emphasises the significance of prioritising emerging economies due to the potential for growth and the eagerness to accept, adopt and expand technological advancements, as was evidenced within the study.

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Appendixes

Appendix 1: Ethics approval

University of Brighton

Cross-School Research Ethics Committee C

424 Watts Building
Lewes Road
Brighton
BN1 4GJ

25/07/2022

Ref: 2022-9362-Shonubi ADOPTION OF INNOVATION AND THE IMPACT OF EMERGING DIGITAL TECHNOLOGY – (INTERNET OF THINGS, INDUSTRY 4.0 AND ARTIFICIAL INTELLIGENCE) ON FIRM PERFORMANCE

Dear Ololade

Thank you for your submission to the Cross-School Research Ethics Committee C at the University of Brighton.

The committee are happy to offer a favourable ethical opinion for this study on the condition all materials are also checked by your supervisor before you begin data collection.

Favourable ethical opinion is given on the basis of a project end date of 01/09/2024. If you need to request an extension, please complete a change request form. Please note that the decisions of the committee are made on the basis of the information provided in your application. The CREC must be informed of any changes to the research process after a favourable ethical opinion has been given. Research that is conducted without having been reviewed by the committee is not covered by the University research insurance cover. If you need to make changes to your proposal please complete and submit a change request form in order that the CREC can determine whether the changes will necessitate any further ethical review.

Once your research has been completed, please could you fill in a brief end of project report form. Finally please could I ask that you flag up any unexpected ethical issues, and report immediately any serious adverse events that arise during the conduct of this study.

We wish you all the best with your research and hope that your research study is successful. If the CREC can be of further assistance with your study please contact us again.

Best wishes

Dr Nichola Khan

Chair, Cross-School Research Ethics Committee C

Appendix 2a: Questionaire (Likert scale versions) used for the survey

<u>Doctoral Research Questionnaire for Managers / Senior Management Participants</u>

Adoption of Innovation Ecosystem and the Impact of Emerging Digital Technologies – (Internet of Things, Industry 4.0, and Artificial Intelligence)

Dear Sir/ Ma'am, I would like to thank you for your time. Please assist with answering the questions below about your organisation. Please be assured of the anonymity associated with your response.

What is your industry in Manufacturing?

(Devices, Hardware and Equipment, Consumer Electronics, FMCG, Telecommunications, Others (Financial Services, Construction, Logistics, Supply Chain Paint Manufacturing)

Gender Female ☐ Male ☐ Non-Binary ☐ Prefer Not to Say. ☐

Others ☐

What is your designation/ Title?

(Manager, Senior Manager, Head of Dept, GM, C-Level, Director)

Age 30 – 40 years ☐ 41 -50 years ☐ 51 and above years ☐

Country

Please specify which of the emerging digital technologies listed below that your organisation uses in its commercial processes. (You may choose more than 1):

☐

- Internet of Things (IoT) (Connected appliances, devices, and equipment)
- Artificial Intelligence (Chatbots, Facial Detection and Recognition, voice assistants, algorithms)
- Industry 4.0(3D printing, robotics, Technology Manufacturing, Virtual and Augmented Reality)

Please specify which of the emerging digital technologies your organisation is most prepared to implement in its commercial processes from the options provided below. (You may choose more than 1):

- Internet of Things (IoT) (Connected appliances, devices, and equipment)
- Artificial Intelligence (Chatbots, Facial Detection and Recognition, voice assistants, algorithms)
- Industry 4.0(3D printing, robotics, Technology Manufacturing, Virtual and Augmented Reality)

Please specify which of the emerging digital technologies has contributed to the rapid advancement or growth of your business (You may choose more than 1):

- Internet of Things (IoT) (Connected appliances, devices, and equipment)
- Artificial Intelligence (Chatbots, Facial Detection and Recognition, voice assistants, algorithms)
- Industry 4.0(3D printing, robotics, Technology Manufacturing, Virtual and Augmented Reality)

	RQ1 Rapid Advancement						
	Relative advantage (HYPOTHESIS 1)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	Holmstrom, J. (2021), (Chen et al., 2021)
1	Adopting AI, IoT, and I4.0 enables our organisation to decrease expenditures.						Modified and Adapted
2	Adopting AI, IoT, and I4.0 empowers our organisation to provide bespoke offerings.						Modified and Adapted
3	Adopting AI, IoT, and I4.0 will improve the versatility and agility of our organisation.						Modified and Adapted
4	Adopting AI, IoT, and I4.0 can enhance financial gains and favourable business outcomes.						Modified and Adapted
	Compatibility (HYPOTHESIS 2)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Stjepić et al., 2021). Holmstrom, (2021)
1	CPB1: The adoption of AI, IoT and I4.0 in my organisation is in line with our current business practises, systems and routines.						Modified and Adapted
2	The integration of emerging technologies like AI, IoT and I4.0 ought to be compatible with current organisational objectives, and the functions executed by these technologies should actively contribute to the achievement of the organisation's objectives.						Modified and Adapted
3	Emerging technologies such as AI, IoT, and I4.0 should have compatibility capability with the existing technology structure and framework within my organisation.						Modified and Adapted

	Complexity (HYPOTHESIS 3)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Stjepić et al.,2021). (Chen et al., 2021)
1	Implementing AI, IoT, and I4.0 technologies in my organisation is complicated and comes with complexity.						Modified and adapted
2	Mastering the complexities of emerging technologies such as IoT, I4.0, and AI can be difficult.						Modified and adapted
3	Adopting and migrating to AI, IoT, and I4.0 in my organisation has incurred significant expenses.						Modified and adapted
	Trialability (HYPOTHESIS 4)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Ullah et al., 2021)
1	I would be granted access to experiment with emerging technologies on a trial basis for a sufficient duration to assess their capabilities.						Modified and Adapted
2	Our company would carefully evaluate any newly developed" technology before making a decision to adopt it".						Modified and Adapted
3	I would appreciate the opportunity to thoroughly test new technology before deciding to use it.						Modified and Adapted
4	Having the ability to explore emerging technologies prior to making a decision could make it less challenging to understand.						Modified and Adapted
	Perceived Ease of use (QUESTIONS FOR HYPOTHESIS 5)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Yuen et al.,2021).

1	The process of using an emerging technology-driven work set-up or functional process is easily understandable to me.						Modified and adapted
2	I will be able to make use of the emerging technology-driven work model or functional approach in our organisation.						Modified and adapted
3	The development of products and services using emerging technologies is a straightforward process for our organisation.						Modified and adapted

	RQ 2 Organisational Readiness						
	Technology Readiness (QUESTIONS FOR HYPOTHESIS 6)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Oliveira et al., 2019).
	Top management support (TOE) (QUESTIONS FOR HYPOTHESIS 6)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Stjepić et al., 2021). Holmstrom, J. (2021), (Chen et al.,2021)
1	The senior leadership endorses the implementation and adoption of AI, IoT and I4.0 innovation.						Modified and Adapted
2	There is an executive in my organisation that exhibits a high level of dedication in pioneering the implementation of AI, IoT or I4.0 Innovation and actively encourages the use of these systems.						Modified and Adapted
3	Managers in our organisation show an in-depth understanding of AI, IoT or I4.0 technologies that may be deployed to improve organisational outcomes.						Modified and Adapted
4	The highest levels of our management are likely to allocating financial resources towards investments in AI, IoT or I4.0.						

	Regulatory Policies Support (QUESTIONS FOR HYPOTHESIS 7)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Malik et al., 2021), (Chen et al., 2021)
1	Regulatory policies facilitate the adoption and implementation of emerging technologies.						Modified and adapted
2	Regulatory Policies provide economic benefits and gains for the adoption of emerging technologies.						Modified and adapted
3	Government is crucial for our organisation to foster innovation.						Modified and adapted
4	The clarity and uniformity of regulatory regulations are advantageous for us to embrace emerging technologies.	.					Modified and adapted
	Technology Readiness (QUESTIONS FOR HYPOTHESIS 8)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Oliveira et al., 2019).
1	In general, my organisation is inclined to adopt and utilise emerging technology in order to accomplish work objectives.						Modified and adapted
2	"I feel confident" that machines will carry out the commands given to them.						Modified and adapted
3	Products and services that include advanced technologies offer significantly greater convenience.						Modified and adapted
	Technological Partner support (QUESTIONS FOR HYPOTHESIS 9)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Chen et al.,2021) Holmstrom, J. (2021),
1	I believe that having technology partner assistance is crucial when transitioning						Modified and adapted

	from a pre-existing system to an AI, IoT, and I4.0-enabled platform.						
2	We have experienced no challenges in acquiring support or dependable services from our vendors/partners.						Modified and adapted
3	Having the support of a technological partner is crucial for solving any technical operational problems.	.					Modified and adapted
4	We maintain particularly close interactions with our suppliers and partners.						Modified and adapted
	Competitive Pressure (QUESTIONS FOR HYPOTHESIS 10)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Chen et al., 2021), (Stjepić et al., 2021). Holmstrom, J. (2021),
1	I am aware of the fact that competitors in the market have already implemented AI, IoT, and I4.0 technologies within their organisations.						Modified and Adapted
2	Our organisation had to adopt AI, IoT, and I4.0 technologies in order to sustain and retain its edge over industry competitors.						Modified and Adapted
3	The presence of competitors within our organisation has exerted pressure, hence influencing the choice to adopt and implement new technological innovations.						Modified and Adapted
4	The adoption of AI, IoT, and I4.0 within the industry will apply pressure on my organisation to follow similar practices.						Modified and Adapted
	RQ3 Firm Innovation Performance						

	Organisational Innovativeness (TOE) (QUESTIONS FOR HYPOTHESIS 11)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Gunday et al.,2011: Ghosh and Srivastava 2021; Phirouzabadi, et al., 2013)
1	Our organisation stays updated on the most recent technological innovations in all relevant aspects.						Modified and adapted
2	The organisational structure is being updated to encourage mutually beneficial collaborations, collaborative projects, and sustained alliances.						Modified and adapted
3	Our organisation regularly updates the "procedures, methods and mode of operations" used to carry out business activities in an innovative way.						Modified and adapted
	Process Innovativeness (TOE) **(QUESTIONS FOR HYPOTHESIS 12)**	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Anning-Dorson et al., 2018; Thomas Anning-Dorson et al.,2018; Tweneboah-Koduah et al.,2020)
1	Management expedites and encourages new ways of accomplishing tasks.						Modified and adapted
2	Within the “past five years”, our company has established a lot of new management strategies for faster and more efficient ways to serve customers.						Modified and adapted
3	We modify our service procedures to meet the demands of our customers.						Modified and adapted
	Products and Services Innovativeness (QUESTIONS FOR HYPOTHESIS 13)	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**	(Anning-Dorson, et al., 2018: Thomas Anning-Dorson, et al.,2018)

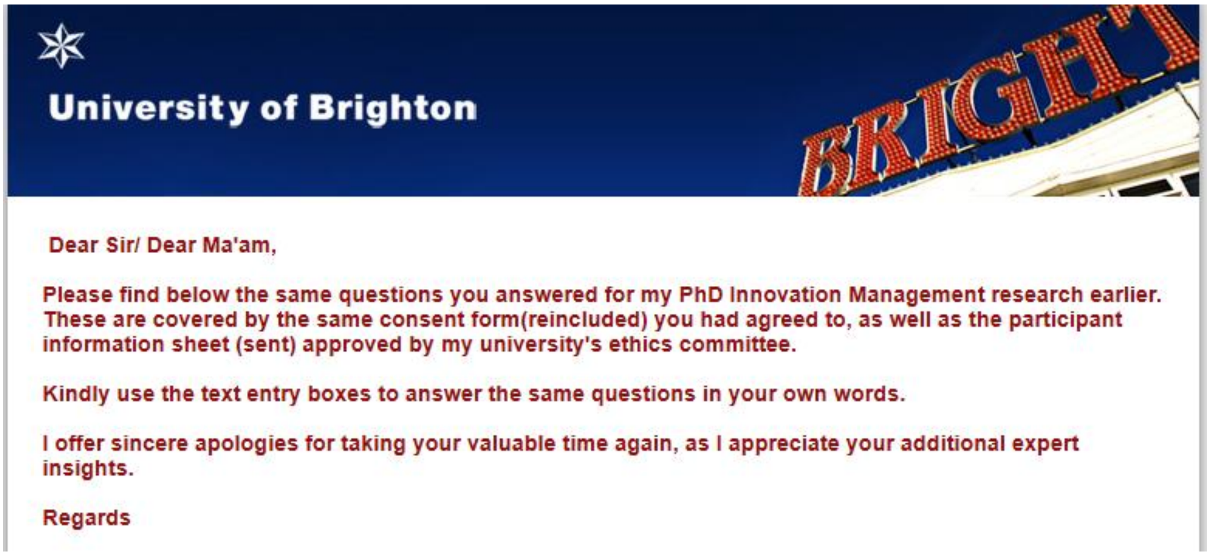
1	Our organisation is ahead of the industry regarding the introduction of products and services in the market.						Modified and adapted
2	Our organisation consistently differentiates our products and services from industry rivals.						Modified and adapted
3	Over the “past five years”, our organisation has introduced a more significant number of innovative products and services than any other.						Modified and adapted

Please tick this box to confirm that you understand that filling out and submitting this questionnaire indicates your consent to participate in the research.

☐

Thank you for your time.

Appendix 2b: Questionaire (Text entry versions) used for the survey.



University of Brighton

Dear Sir/ Dear Ma'am,

Please find below the same questions you answered for my PhD Innovation Management research earlier. These are covered by the same consent form(reincluded) you had agreed to, as well as the participant information sheet (sent) approved by my university's ethics committee.

Kindly use the text entry boxes to answer the same questions in your own words.

I offer sincere apologies for taking your valuable time again, as I appreciate your additional expert insights.

Regards

How does adopting AI, IoT and I4.0 enables your organisation to decrease expenditure.(Please type in your own words)

How does Adopting AI, IoT and I4.0 empower your organisation to provide bespoke offerings. (Please type in your own words)

How does Adopting AI, IoT and I4.0 improve the versatility and agility of your organisation.((Please type in your own words)

How does Adopting AI, IoT and I4.0 enhance financial gains and favourable business outcomes in your organisation.(Please type in your own words)

→

University of Brighton

How is or isn't the adoption of AI, IoT and I4.0 in your organisation in line with your current business practises, systems and routines? (Please type in your own words)

How should the integration of emerging technologies like AI, IoT and I4.0 be compatible with current organisational objectives, and the functions executed by these technologies should actively contribute to the achievement of the organisation's objectives?(Please type in your own words)

In what ways do emerging technologies such as AI, IoT, and I4.0 have compatibility capability with the existing technology structure and framework within your organisation.(Please type in your own words)

What makes the Implementing AI, IoT, and I4.0 of technologies in your organisation complicated and complex.(Please type in your own words)

What makes mastering the complexities of emerging technologies such as IoT, I4.0, and AI difficult.(Please type in your own words)

How has adopting and migrating to AI, IoT, and I4.0 in your organisation incurred significant expenses? (Please type in your own words)

In what ways would you be granted access to experiment with emerging technologies on a trial basis for a sufficient duration to assess their capabilities.(Please type in your own words)

In what ways would your company carefully evaluate any newly developed technology before making a decision to adopt it.(Please type in your own words)

Why would you appreciate the opportunity to thoroughly test new technology before deciding to use it. (Please type in your own words

Why would having the ability to explore emerging technologies prior to making a decision make it less challenging to understand.(Please type in your own words)

In what way is the process of using an emerging technology-driven work set-up or functional process easily understandable to you.(Please type in your own words)

How will you be able to make use of the emerging technology-driven work model or functional approach in your organisation.(Please type in your own words)

How is the development of products and services using emerging technologies a straightforward process for your organisation.(Please type in your own words)

In whats ways are your organisation is inclined to adopt and utilise emerging technology in order to accomplish work objectives.(Please type in your own words)

Why do " you feel confident" that machines will carry out the commands given to them.(Please type in your own words)

Why do you think that Products and services that include advanced technologies offer significantly greater convenience.(Please type in your own words)

In what ways do the senior leadership endorses the implementation and adoption of AI,IoT and I4.0 innovation.(Please type in your own words)

What level is the executive in your organisation that exhibits a high level of dedication in pioneering the implementation of AI,IoT or I4.0 Innovation, and actively encourages the use of these systems.(Please type in your own words)

How do managers in your organisation show an in-depth understanding of AI,IoT or I4.0 technologies may be deployed to improve organisational outcomes.(Please type in your own words)

In what ways are the highest levels of your management likely to allocate financial resources towards investments in AI, IoT or I4.0?(Please type in your own words

If you believe so , why is having technology partner assistance crucial when transitioning from a pre existing system to an AI, IoT, and I4.0-enabled platform ,(Please type in your own words)

In what ways has your organisation experienced no challenges in acquiring support or dependable services from our vendors/partners? (Please type in your own words)

In what way does having the support of a technological partner crucial for solving any technical operational problems.(Please type in your own words

How does your organisation maintain particularly close interactions with their suppliers and partners. (Please type in your own words)

In what ways do regulatory policies facilitate the adoption and implementation of emerging technologies? (AI, IoT and Industry 4.0).(Please type in your own words)

In what ways do regulatory Policies provide economic benefits and gains for the adoption of emerging technologies. (AI,IoT,I4.0).(Please type in your own words)

In what ways are government cooperation and support crucial for your organisation to foster innovation. (Please type in your own words)

In what ways is the clarity and uniformity of regulatory regulations advantageous for your organisation to embrace emerging technologies?(Please type in your own words)

In what ways are you aware of the fact that competitors in the market have already implemented AI, IoT, I4.0 technologies within their organisations.(Please type in your own words)

In what ways has your organisation had to adopt AI, IoT, I4.0 technologies in order to sustain and retain its edge over industry competitors .(Please type in your own words)

In what ways does the presence of competitors within your organisation exert pressure, hence influencing the choice to adopt and implement new technological innovations.(Please type in your own words)

In what ways does the adoption of AI, IoT, I4.0 within the industry apply pressure on your organisation to follow similar practise.(Please type in your own words)

How does your organisation stays updated of the most recent technological innovations in all relevant aspects. (Please type in your own words)

How is your organisational structure being updated to encourage mutually beneficial collaborations, collaborative projects, and sustained alliances. (Please type in your own words)

How is your organisation regularly updating the "procedures, methods and mode of operations" used to carry out business activities in an innovative way.(Please type in your own words)

In what ways does the management of your organisation expedite and encourage new ways of accomplishing tasks?(Please type in your own words)

Please mention ways that within the "past five years", your company has established a lot of new management strategies for faster and more efficient ways to serve customers.(Please type in your own words)

In what ways does your organisation modify service procedures to meet the demands of our customers. (Please type in your own words)

In what ways is your organisation ahead of industry rivals regarding the introduction of products and services in the market. (Please type in your own words)

In what ways is your organisation ahead of industry rivals regarding the introduction of products and services in the market. (Please type in your own words)

In what ways do your organisation consistently differentiates our products and services from Industry rivals.(Please type in your own words)

Over the past five years, in what ways has your organisation introduced a greater number of innovative products and services than any other.(Please type in your own words)

Please tick this box to confirm that you kindly understand that filling and submitting this questionnaire indicates your consent to participate inthe research.

	YES
YES	○

→

Appendix 3: Consent form used for the research.

University of Brighton

<u>CONSENT FOR DOCTORAL RESEARCH SURVEY</u>

STUDY TITLE: Adoption of Innovation Ecosystem and the Impact of emerging digital technologies -(Internet of things, Industry 4.0, and Artificial Intelligence) on firm innovation performance

Dear Sir/ Dear Ma'am,

Thank you for agreeing to participate in my Innovation Management doctoral research.

1) Please confirm that you have read and understood the information sheet for the study and have had the opportunity to consider the information and ask questions.

   Yes **No**

2) Please confirm that you agree that I have clearly explained the study's purpose, principles and procedures and any risks involved.

Yes **No**

3) Please confirm that you are kindly aware that the study will involve filling out a questionnaire or answering the questions via an interview format at your convenience.

Yes **No**

4) Please confirm that you kindly understand that your participation is voluntary and that you are free to withdraw from the study via email without giving a reason.

Yes **No**

5) Please confirm that you understand how the data collected will be recorded, used, and stored and who will have access to it.

Yes **No**

The data will be collated in a password-protected file and used for analysis for the study.

6) Please confirm that you agree to take part in the study.

Yes **No**

7) Please confirm that you know you can withdraw by refusing to fill out the questionnaire via email.

Yes **No**

8) Please confirm that I have your agreement to use the data collected up to that point should you want to withdraw from the project (via email)

Yes **No**

9) Please confirm that I am authorized to use the data and analysis from the interview for my research with a cover of anonymity for you.
(except where agreed otherwise in writing and by mutual consent)

Yes **No**

The information shared will be anonymous in accordance with the data protection laws. If you have any questions about this study, please contact o.shonubi@brighton.ac.uk

Appendix 4: Participant Information Sheet used for the survey.

University of Brighton

Participation Information Sheet

Title of Study: Adoption of Innovation Ecosystem and the Impact of Emerging Digital Technologies (Internet of things, Industry 4.0, and Artificial Intelligence) on firm performance

My name is Ms Ololade Shonubi. I am enrolled in a PhD in Innovation Management, focusing on service innovation and new-age digital technology like Industry 4.0, Artificial Intelligence, and the Internet of Things with the Brighton Business School. I kindly seek an opportunity to research innovation management and digital technology with innovative brands. This contact is based on your esteemed profile and your reputable organisation's focus on Innovation.

I wondered if there would be areas, I could partner with on my research that will also benefit your organisation in Innovation and the impact of digital technologies. I will be available at your earliest convenience to review the questionnaire and answer all your questions. You were specially invited to participate because you are a manager, senior management, or executive of an innovative brand. The selection was made across various industries to understand digital technology's rapid and evolving changes.

Your participation in the research is appreciated. However, please be informed that your involvement is voluntary; there is no obligation to participate, and there will be no payment in the study. Your valuable time will be required to participate, including completing a questionnaire and an interview if you do not have time for the questionnaire.

The potential benefits of taking part in the research include but are not limited to product and service innovation and novel digital technologies and are as follows:

1) Partnering with your organisation will allow evaluation of the growth of Innovation in your company and enable your organisation to be part of new-age research

2) More knowledge of how new digital technologies can impact Innovation will help establish a framework or model that can impact both academia and industry

3) Innovation has an impact on the local and global stage, and more knowledge adds to the impact and performance

Your participation will be confidential and anonymous. The data will be used for my PhD thesis. ***A consent form/link is attached to this email /letter.*** *You have the right to withdraw* *from participation at any time during the period via email or the consent box on the questionnaire. The data will be password-protected on a secure drive. Please see below the link to the University's Research* *__Privacy Notice__* *for further information on data protection.*

My contact details are o.shonubi@brighton.ac.uk. If you have a question or concern, please contact the University of Brighton Cross School Research Ethics Committee (CREC). The relevant Research Ethics Committee or Panel has reviewed the study and given a favourable ethical opinion.

Appendix 5: Tables and Figures for Data Analysis

Figures and Tables for Hypothesis H1: Relative Advantage

Appendix Table H1a Adopting AI, IoT, and I4.0 enables our organisation to decrease expenditures.

Appendix Figure H1a Adopting AI, IoT and I4.0 enables our organisation to decrease expenditure.

Appendix Table H1b Adopting AI, IoT and I4.0 empowers our organisation to provide bespoke offerings.

Appendix Figure H1b Adopting AI, IoT and I4.0 empowers our organisation to provide bespoke offerings.

Appendix Table H1c Adopting AI, IoT and I4.0 will improve the versatility and agility of our organisation.

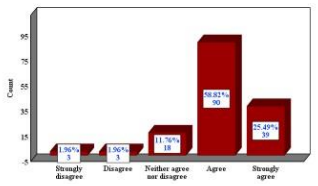
Appendix Figure H1c Adopting AI, IoT and I4.0 will improve the versatility and agility of our organisation.

Appendix Table H1d Adopting AI, IoT, and I4.0 can enhance financial gains and favourable business outcomes.

Appendix Figure H1d Adopting AI, IoT and I4.0 can enhance financial gains and favourable business outcomes.

Adopting AI, IoT and I4.0 enables our organisation to decrease expenditure

RADV1-Q10- Adopting AI, IoT and I4.0 enables our organisation to decrease expenditure

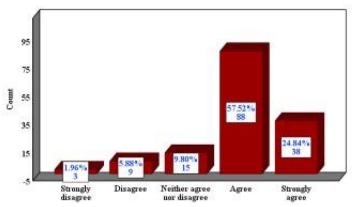


Adopting AI, IoT and I4.0 enables our organisation to decrease expenditure

	Frequency	Percent	Percent	Cumulative Percentage
Strongly disagree	3	2.0	2.0	2.0
Disagree	3	2.0	2.0	3.9
Neither agree nor disagree	18	11.8	11.8	15.7
Agree	90	58.8	58.8	74.5
Strongly agree	39	25.5	25.5	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	172.588			
df	4			
P-Value	<.001			

Adopting AI, IoT and I4.0 empowers our organisation to provide bespoke offerings.

RADV2-Q11- Adopting AI, IoT and I4.0 empowers our organisation to provide bespoke offerings.

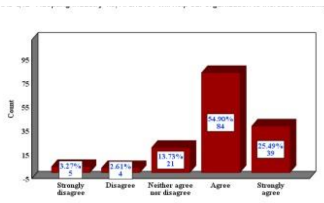


Adopting AI, IoT and I4.0 empowers our organisation to provide bespoke offerings.

	Frequency	Percent	Percent	Cumulative Percentage
Strongly disagree	3	2.0	2.0	2.0
Disagree	9	5.9	5.9	7.8
Neither agree nor disagree	15	9.8	9.8	17.6
Agree	88	57.5	57.5	75.2
Strongly agree	38	24.8	24.8	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	157.556			
df	4			
P-Value	<.001			

Adopting AI, IoT and I4.0 will improve the versatility and agilityof our organisation.

RADV3-Q12- Adopting AI, IoT and I4.0 will improve the versatility and agility of our organisation.

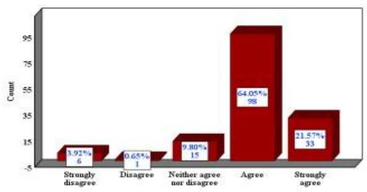


Adopting AI, IoT and I4.0 will improve the versatility and agilityof our organisation.

	Frequency	Per cent	Percent	Cumulative Percent
Strongly disagree	5	3.3	3.3	3.3
Disagree	4	2.6	2.6	5.9
Neither agree nor disagree	21	13.7	13.7	19.6
Agree	84	54.9	54.9	74.5
Strongly agree	39	25.5	25.5	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	143.046			
df	3			
P-Value	<.001			

Adopting AI, IoT and I4.0 can enhance financial gains and favourable business outcomes

RADV4-Q13- Adopting Industry 4.0, AI and IoT can increase revenues and profitability.



Adopting AI, IoT and I4.0 can enhance financial gains and favourable business outcomes

	Frequency	Percent	Percent	Cumulative Percent
Strongly disagree	6	3.9	3.9	3.9
Disagree	1	.7	.7	4.6
Neither agree nor disagree	15	9.8	9.8	14.4
Agree	98	64.1	64.1	78.4
Strongly agree	33	21.6	21.6	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	205.007			
df	4			
P-Value	<.001			

Figures and Tables for Hypothesis H2: Compatibility

Appendix Table H2a: The adoption of AI, IoT, and I4.0 in my organisation is in line with our current business practises, systems, and routines.

Appendix Figure H2a: The adoption of AI, IoT and I4.0 in my organisation is in line with our current business practises, systems and routines.

Appendix Table H2b: The integration of emerging technologies like AI, IoT and I4.0 ought to be compatible with current organisational objectives, and the functions executed by these technologies should actively contribute to the achievement of the organisation's objective

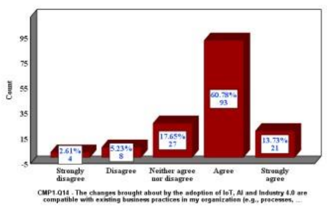
Appendix Figure H2b: The integration of emerging technologies like AI, IoT and I4.0 ought to be compatible with current organisational objectives, and the functions executed by these technologies should actively contribute to the achievement of the organisation's objective

Appendix Table H2c: Emerging Technologies like AI, IoT, and I4.0 AI, IoT, and I4.0 should have compatibility capability with the existing technology structure and framework within my organisation.

Appendix Figure H2c: Emerging Technologies like AI, IoT, and I4.0 AI, IoT, and I4.0 should have compatibility capability with the existing technology structure and framework within my organisation.

The adoption of AI, IoT and I4.0 in my organisation is in line with our current business practises, systems and routines.

CMP1-Q14- The adoption of AI, IoT and I4.0 in my organisation is in line with our current business practises, systems and routines.



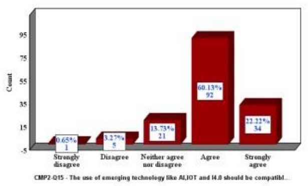
CMP1-Q14 - The changes brought about by the adoption of IoT, AI and Industry 4.0 are compatible with existing business practices in my organization (e.g., processes, ...

The adoption of AI, IoT and I4.0 in my organisation is in line with our current business practises, systems and routines.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	4	2.6	2.6	2.6
	Disagree	8	5.2	5.2	7.8
	Neither agree nor disagree	27	17.6	17.6	25.5
	Agree	93	60.8	60.8	86.3
	Strongly agree	21	13.7	13.7	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		170.497			
df		4			
P-Value		<.001			

The integration of emerging technologies like AI, IoT and I4.0 ought to be compatible with current organisational objectives, and the functions executed by these technologies should actively contribute to the achievement of the organisation's objectives.

CMP2-Q15- The integration of emerging technologies like AI, IoT and I4.0 ought to be compatible with current organisational objectives and the functions executed by these technologies should actively contribute to the achievement of the organisation's objectives.

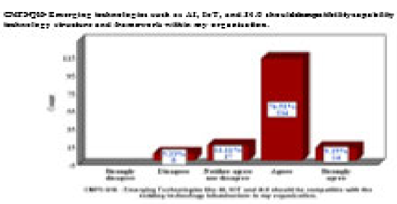


CMP2-Q15 - The use of emerging technology like AI,IOT and I4.0 should be compatibl...

The integration of emerging technologies like AI, IoT and I4.0 ought to be compatible with current organisational objectives, and the functions executed by these technologies should actively contribute to the achievement of the organisation's objectives.

		Frequency	Percent	Per cent	Cumulative Percent
	Strongly disagree	1	.7	.7	.7
	Disagree	5	3.3	3.3	3.9
	Neither agree nor disagree	21	13.7	13.7	17.6
	Agree	92	60.1	60.1	77.8
	Strongly agree	34	22.2	22.2	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		176.641			
df		4			
P-Value		<.001			

Emerging technologies such as AI, IoT, and I4.0 should havecompatibility capability with the existing technology structure and framework within my organization.



Emerging technologies such as AI, IoT, and I4.0 should havecompatibility capability with the existing technology structure and framework within my organization.

		Frequency	Percent	Percent	Cumulative Percent
	Disagree	8	5.2	5.2	5.2
	Neither agree nor disagree	17	11.1	11.1	16.3
	Agree	114	74.5	74.5	90.8
	Strongly agree	14	9.2	9.2	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		200.118			
df		3			
P-Value		<.001			

Figures and Tables for Hypothesis H3: Complexity

Appendix Table H3a: Implementing AI, IoT, and I4.0 technologies in my organisation is complicated and comes with complexity.

Appendix Figure H3a: Implementing AI, IoT, and I4.0 technologies in my organisation is complicated and comes with complexity.

Appendix Table H3b: Mastering the complexities of emerging technologies such as IoT, I4.0, and AI can be difficult.

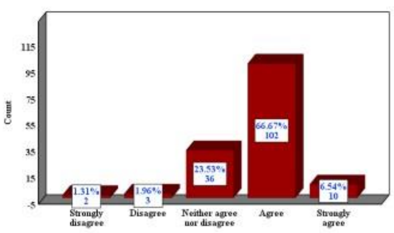
Appendix Figure H3b: Mastering the complexities of emerging technologies such as IoT, I4.0, and AI can be difficult.

Appendix Table H3c: Adopting and migrating to AI, IoT, and I4.0 in my organisation has incurred significant expenses.

Appendix Figure H3c: Adopting and migrating to AI, IoT, and I4.0 in my organisation has incurred significant expenses.

Implementing AI, IoT, and I4.0 technologies in my organisation is complicated and comes with complexity.

CPX1-Q17- IntroducingAI, IoT and Industry 4.0 into my organisation is complex.

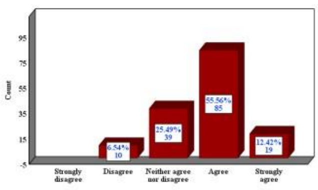


Implementing AI, IoT, and I4.0 technologies in my organisation is complicated and comes with complexity.

		Frequency	Per cent	Percent	Cumulative Percent
	Strongly disagree	2	1.3	1.3	1.3
	Disagree	3	2.0	2.0	3.3
	Neither agree nor disagree	36	23.5	23.5	26.8
	Agree	102	66.7	66.7	93.5
	Strongly agree	10	6.5	6.5	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		233.046			
df		4			
P-Value		<.001			

Mastering the complexities of emerging technologies such as IoT, I4.0, and AI can be difficult

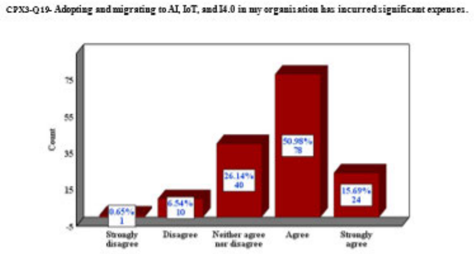
CPX2-Q18- Mastering the complexities of emerging technologies such as IoT, I4.0, and AI can be difficult



Mastering the complexities of emerging technologies such as IoT, I4.0, and AI can be difficult

		Frequency	Percent	Per cent	Cumulative Percent
	Disagree	10	6.5	6.5	6.5
	Neither agree nor disagree	39	25.5	25.5	32.0
	Agree	85	55.6	55.6	87.6
	Strongly agree	19	12.4	12.4	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		87.706			
df		3			
P-Value		<.001			

Adopting and migrating to AI, IoT, and I4.0 in my organisation has incurred significant expenses.



Adopting and migrating to AI, IoT, and I4.0 in my organisation has incurred significant expenses.

	Frequency	Percent	Percent	Cumulative Percent
Strongly disagree	1	.7	.7	.7
Disagree	10	6.5	6.5	7.2
Neither agree nor disagree	40	26.1	26.1	33.3
Agree	78	51.0	51.0	84.3
Strongly agree	24	15.7	15.7	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	120.235			
df	4			
P-Value	<.001			

Figures and Tables for Hypothesis H4: Trialability

Appendix Table H4a: I would be granted access to experiment with emerging technologies on a trial basis for a sufficient duration to assess their capabilities.

Appendix Figure H4a: I would be granted access to experiment with emerging technologies on a trial basis for a sufficient duration to assess their capabilities.

Appendix Table H4b: Our company would carefully evaluate any newly developed" technology before making a decision to adopt it".

Appendix Figure H4b: Our company would carefully evaluate any newly developed "technology before making a decision to adopt it".

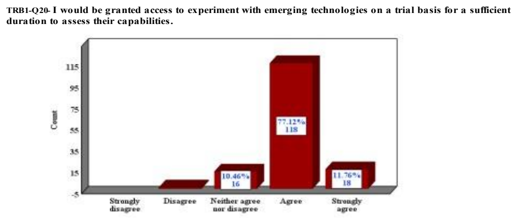
Appendix Table H4c: I would appreciate the opportunity to thoroughly test new technology before deciding to use it.

Appendix Figure H4c: I would appreciate the opportunity to thoroughly test new technology before deciding to use it.

Appendix Table H4d: Having the ability to explore emerging technologies prior to making a decision could make it less challenging to understand.

Appendix Figure H4d: Having the ability to explore emerging technologies prior to making a decision could make it less challenging to understand.

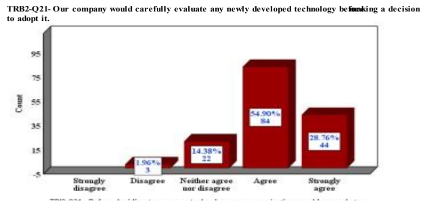
I would be granted access to experiment with emerging technologies on a trial basis for a sufficient duration to assess their capabilities.



I would be granted access to experiment with emerging technologies on a trial basis for a sufficient duration to assess their capabilities.

	Frequency	Percent	Percent	Cumulative Percent
Disagree	1	.7	.7	.7
Neither agree nor disagree	16	10.5	10.5	11.1
Agree	118	77.1	77.1	88.2
Strongly agree	18	11.8	11.8	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	226.216			
df	3			
P-Value	<.001			

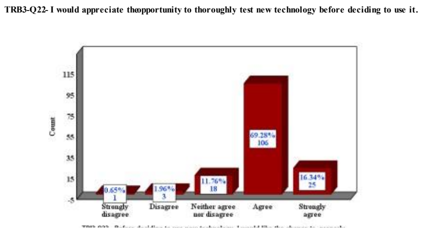
Our company would carefully evaluate any newly developed technology before making a decision to adopt it.



Our company would carefully evaluate any newly developed technology before making a decision to adopt it.

	Frequency	Percent	Percent	Cumulative Percent
Disagree	3	2.0	2.0	2.0
Neither agree nor disagree	22	14.4	14.4	16.3
Agree	84	54.9	54.9	71.2
Strongly agree	44	28.8	28.8	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	94.974			
df	3			
P-Value	<.001			

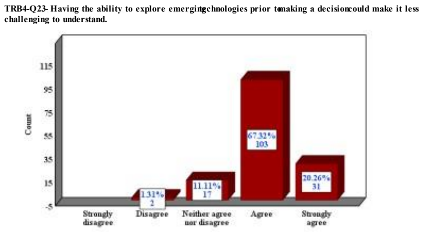
I would appreciate the opportunity to thoroughly test new technology before deciding to use it.



I would appreciate the opportunity to thoroughly test new technology before deciding to use it.

	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly disagree	1	.7	.7	.7
Disagree	3	2.0	2.0	2.6
Neither agree nor disagree	18	11.8	11.8	14.4
Agree	106	69.3	69.3	83.7
Strongly agree	25	16.3	16.3	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	245.529			
df	4			
P-Value	<.001			

Having the ability to explore emerging technologies prior to making a decision could make it less challenging to understand.



Having the ability to explore emerging technologies prior to making a decision could make it less challenging to understand.

	Frequency	Percent	Valid Percent	Cumulative Percent
Disagree	2	1.3	1.3	1.3
Neither agree nor disagree	17	11.1	11.1	12.4
Agree	103	67.3	67.3	79.7
Strongly agree	31	20.3	20.3	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	157.144			
df	3			
P-Value	<.001			

Figures and Tables for Hypothesis H5: Perceived ease of use

Appendix Table H5a: The process of using an emerging technology-driven work set-up or functional process is easily understandable to me.

Appendix Figure H5a: The process of using an emerging technology-driven work set-up or functional process is easily understandable to me.

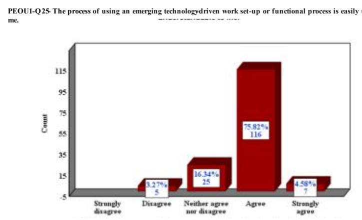
Appendix Table H5b: I will be able to use the emerging technology-driven work model or functional approach in our organisation.

Appendix Figure H5b: I will be able to use the emerging technology-driven work model or functional approach in our organisation.

Appendix Table H5c: The development of products and services using emerging technologies is a straightforward process for our organisation.

Appendix Figure H5c: The development of products and services using emerging technologies is a straightforward process for our organisation.

The process of using an emerging technology -driven work set-up or functional process is easily understandable to me.



The process of using an emerging technology -driven work set-up or functional process is easily understandable to me.

		Frequency	Percent	Percent	Cumulative Percent
	Disagree	5	3.3	3.3	3.3
	Neither agree nor disagree	25	16.3	16.3	19.6
	Agree	116	75.8	75.8	95.4
	Strongly agree	7	4.6	4.6	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		217.065			
df		3			
P-Value		<.001			

I will be able to make use of the emerging technology -driven work model or functional approach in our organisation.

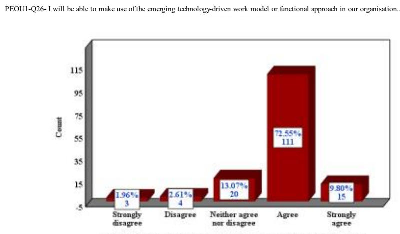
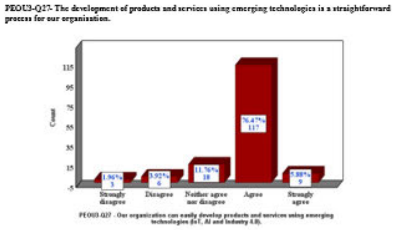


Table 4.26: I will be able to make use of the emerging technology -driven work model or functional approach in our organisation.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	3	2.0	2.0	2.0
	Disagree	4	2.6	2.6	4.6
	Neither agree nor disagree	20	13.1	13.1	17.6
	Agree	111	72.5	72.5	90.2
	Strongly agree	15	9.8	9.8	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		270.889			
df		4			
P-Value		<.001			

The development of products and services using emerging technologies is a straightforward process for our organisation.



The development of products and services using emerging technologies is a straightforward process for our organisation.

	Frequency	Percent	Percent	Cumulative Percent
Strongly disagree	3	2.0	2.0	2.0
Disagree	6	3.9	3.9	5.9
Neither agree nor disagree	18	11.8	11.8	17.6
Agree	117	76.5	76.5	94.1
Strongly agree	9	5.9	5.9	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	309.059			
df	4			
P-Value	<.001			

Figures and Tables for Hypothesis H6: Technology Readiness

Appendix Table H6a: In general, my organisation is inclined to adopt and utilise emerging technology in order to accomplish work objectives.

Appendix Figure H6a: In general, my organisation is inclined to adopt and utilise emerging technology in order to accomplish work objectives.

Appendix Table H6b: “I feel confident” that machines will carry out the commands given to them.

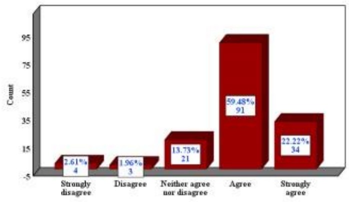
Appendix Figure H6b: “I feel confident” that machines will carry out the commands given to them.

Appendix Table H6c: “Products and services that include advanced technologies offer significantly greater convenience”.

Appendix Figure H6c: “Products and services that include advanced technologies offer significantly greater convenience.”.

In general, my organisation is inclined to adopt and utilise emerging technology in order to accomplish work objective

TER1-Q28:In general, my organisation is inclined to adopt and utilise emerging technology in order to accomplish work objective

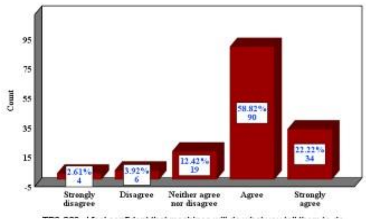


In general, my organisation is inclined to adopt and utilise emerging technologyin order to accomplish work objective

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	4	2.6	2.6	2.6
	Disagree	3	2.0	2.0	4.6
	Neither agree nor disagree	21	13.7	13.7	18.3
	Agree	91	59.5	59.5	77.8
	Strongly agree	34	22.2	22.2	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		170.627			
df		4			
P-Value		<.001			

"I feel confident" that machines will carry out the commands given to them.

TER2-Q29:"I feel confident" that machines will carry out the commands given to them.

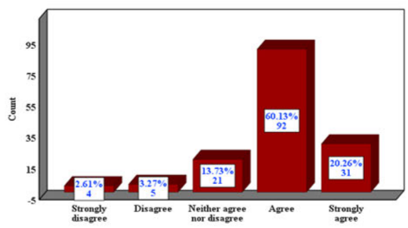


"I feel confident" that machines will carry out the commands given to them.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	4	2.6	2.6	2.6
	Disagree	6	3.9	3.9	6.5
	Neither agree nor disagree	19	12.4	12.4	19.0
	Agree	90	58.8	58.8	77.8
	Strongly agree	34	22.2	22.2	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		162.98			
df		4			
P-Value		<.001			

Products and services that include advanced technologies offer significantly greater convenience.

TER3-Q30: Products and services that include advanced technologies offer significantly greater convenience.



Products and services that include advanced technologies offer significantly greater convenience.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	4	2.6	2.6	2.6
	Disagree	5	3.3	3.3	5.9
	Neither agree nor disagree	21	13.7	13.7	19.6
	Agree	92	60.1	60.1	79.7
	Strongly agree	31	20.3	20.3	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		170.758			
df		4			
P-Value		<.001			

Figures and Tables for Hypothesis H7: Top Management Support

Appendix Table H7a: The senior leadership endorses the implementation and adoption of AI, IoT and I4.0 innovation.

Appendix Figure H7a: The senior leadership endorses the implementation and adoption of AI, IoT and I4.0 innovation.

Appendix Table H7b: There is an executive in my organisation that exhibits a high level of dedication in pioneering the implementation of AI, IoT or I4.0 Innovation and actively encourages the use of these systems.

Appendix Figure H7b: There is an executive in my organisation that exhibits a high level of dedication in pioneering the implementation of AI, IoT or I4.0 Innovation and actively encourages the use of these systems.

Appendix Table H7c: Managers in our organisation show an in-depth understanding of AI, IoT or I4.0 technologies that may be deployed to improve organisational outcomes.

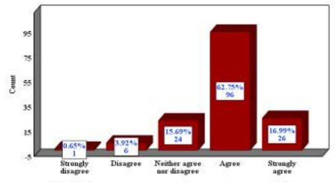
Appendix Figure H7c: Managers in our organisation show an in-depth understanding of AI, IoT or I4.0 technologies that may be deployed to improve organisational outcomes.

Appendix Table H7d: The highest levels of our management are likely to allocate financial resources towards investments in AI, IoT or I4.0.

Appendix Figure H7d: The highest levels of our management are likely to allocate financial resources towards investments in AI, IoT or I4.0.

The senior leadership endorses the implementation and adoption of AI,IoT and I4.0 innovation.

TMGS1-Q31: The senior leadership endorses the implementation and adoption of AI,IoT and I4.0 innovation.

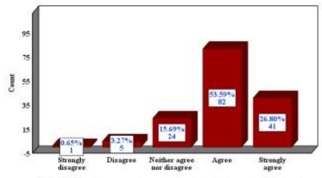


The senior leadership endorses the implementation and adoption of AI,IoT and I4.0 innovation.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	1	.7	.7	.7
	Disagree	6	3.9	3.9	4.6
	Neither agree nor disagree	24	15.7	15.7	20.3
	Agree	96	62.7	62.7	83.0
	Strongly agree	26	17.0	17.0	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		190.301			
df		4			
P-Value		<.001			

There is an executive in my organisation that exhibits a high level of dedication in pioneering the implementation of AI,IoT or I4.0 Innovation, and actively encourages the use of these system

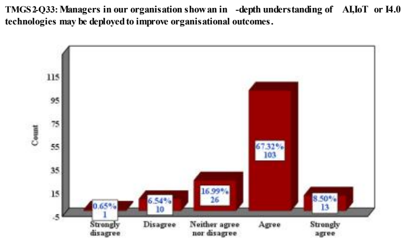
TMGS2-Q32: There is an executive in my organisation that exhibits a high level of dedication in pioneering the implementation of AI,IoT or I4.0 Innovation, and actively encourages the use of these system



There is an executive in my organisation that exhibits a high level of dedication in pioneering the implementation of AI,IoT or I4.0 Innovation, and actively encourages the use of these system

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	1	.7	.7	.7
	Disagree	5	3.3	3.3	3.9
	Neither agree nor disagree	24	15.7	15.7	19.6
	Agree	82	53.6	53.6	73.2
	Strongly agree	41	26.8	26.8	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		141.346			
df		4			
P-Value		<.001			

Managers in our organisation show an in -depth understanding of AI,IoT or I4.0 technologies may be deployed to improve organisational outcomes.



Managers in our organisation show an in -depth understanding of AI,IoT or I4.0 technologies may be deployed to improve organisational outcomes.

	Frequency	Percent	Percent	Cumulative Percent
Strongly disagree	1	.7	.7	.7
Disagree	10	6.5	6.5	7.2
Neither agree nor disagree	26	17.0	17.0	24.2
Agree	103	67.3	67.3	91.5
Strongly agree	13	8.5	8.5	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	224.614			
df	4			
P-Value	<.001			

The highest levels of our management are likely to allocate financial resources towards investments in AI,IoT or I4.0.

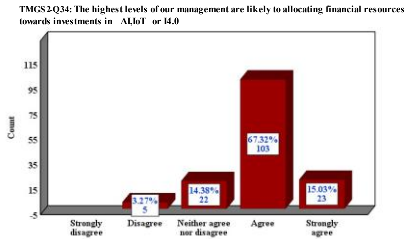


Table 4.34 The highest levels of our management are likely to allocating financial resources towards investments in AI,IoT or I4.0

	Frequency	Percent	Percent	Cumulative Percent
Disagree	5	3.3	3.3	3.3
Neither agree nor disagree	22	14.4	14.4	17.6
Agree	103	67.3	67.3	85.0
Strongly agree	23	15.0	15.0	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	151.497			
df	3			
P-Value	<.001			

Figures and Tables for Hypothesis H8: Technological Support

Appendix Table H8a: I believe that having technology partner assistance is crucial when transitioning from a pre-existing system to an AI, IoT, and I4.0-enabled platform

Appendix Figure H8a: I believe that having technology partner assistance is crucial when transitioning from a pre-existing system to an AI, IoT, and I4.0-enabled platform.

Appendix Table H8b: We have experienced no challenges in acquiring support or dependable services from our vendors/partners.

Appendix Figure H8b: We have experienced no challenges in acquiring support or dependable services from our vendors/partners.

Appendix Table H8c: Having the support of a technological partner is crucial for solving any technical operational problems.

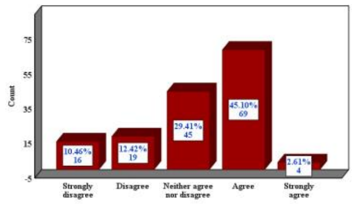
Appendix Figure H8c: Having the support of a technological partner is crucial for solving any technical operational problems.

Appendix Table H8d: We maintain particularly close interactions with our suppliers and partners.

Appendix Figure H8d: We maintain particularly close interactions with our suppliers and partners.

I believe that having technology partner assistance is crucial when transitioning from an existing legacy system to an AI, IoT, and I4.0 -enabled system.

TEPS1 -Q35: I believe that having technology partner assistance is crucial when transitioning from an existing legacy system to an AI, IoT, and I4.0 -enabled system.

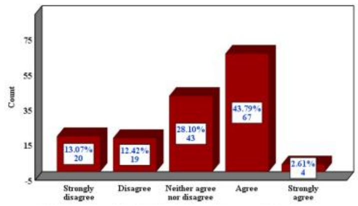


I believe that having technology partner assistance is crucial when transitioning from an existing legacy system to an AI, IoT, and I4.0 -enabled system.

	Frequency	Percent	Percent	Cumulative Percent
Strongly disagree	16	10.5	10.5	10.5
Disagree	19	12.4	12.4	22.9
Neither agree nor disagree	45	29.4	29.4	52.3
Agree	69	45.1	45.1	97.4
Strongly agree	4	2.6	2.6	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	92.039			
df	3			
P-Value	<.001			

We have experienced no challenges in acquiring support or dependable services from our vendors/partners.

TEPS2 -Q36: We have experienced no challenges in acquiring support or dependable services from our vendors/partners.

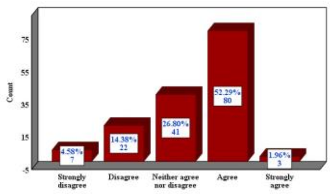


We have experienced no challenges in acquiring support or dependable services from our vendors/partners.

	Frequency	Percent	Percent	Cumulative Percent
Strongly disagree	20	13.1	13.1	13.1
Disagree	19	12.4	12.4	25.5
Neither agree nor disagree	43	28.1	28.1	53.6
Agree	67	43.8	43.8	97.4
Strongly agree	4	2.6	2.6	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	89.451			
df	4			
P-Value	<.001			

Having the support of a technological partner is crucial for solving any technical operational problems.

TEPS3 -Q37: Having the support of a technological partner is crucial for solving any technical operational problems.

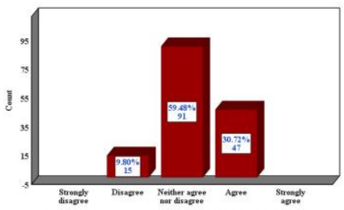


Having the support of a technological partner is crucial for solving any technical operational problems.

	Frequency	Percent	Percent	Cumulative Percent
Strongly disagree	7	4.6	4.6	4.6
Disagree	22	14.4	14.4	19.0
Neither agree nor disagree	41	26.8	26.8	45.8
Agree	80	52.3	52.3	98.0
Strongly agree	3	2.0	2.0	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	128.797			
df	4			
P-Value	<.001			

We maintain particularly close interactions with our suppliers and partners.

TEPS4 -Q38: We maintain particularly close interactions with our suppliers and partners.



We maintain particularly close interactions with our suppliers and partners.

	Frequency	Percent	Percent	Cumulative Percent
Disagree	15	9.8	9.8	9.8
Neither agree nor disagree	91	59.5	59.5	69.3
Agree	47	30.7	30.7	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	57.098			
df	2			
P-Value	<.001			

Figures and Tables for Hypothesis H9: Regulatory Policies

Appendix Table H9a: Regulatory policies facilitate the adoption and implementation of emerging technologies.

Appendix Figure H9a: Regulatory policies facilitate the adoption and implementation of emerging technologies.

Appendix Table H9b: Regulatory Policies provide economic benefits and gains for the adoption of emerging technologies.

Appendix Figure H9b: Regulatory Policies provide economic benefits and gains for the adoption of emerging technologies

Appendix Table H9c: Government cooperation and support are critical for organisations to innovate.

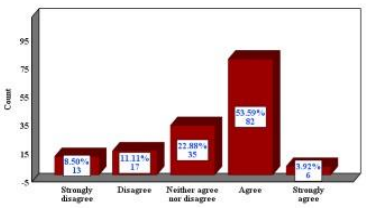
Appendix Figure H9c: Government cooperation and support are critical for organisations to innovate.

Appendix Table H9d: The clarity and uniformity of regulatory regulations are advantageous for us to embrace emerging technologies.

Appendix Figure H9d: The clarity and uniformity of regulatory regulations are advantageous for us to embrace emerging technologies.

Regulatory policies facilitate the adoption and implementation of emerging technologies

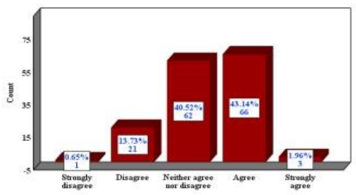
RG1-Q39:Regulatory policies facilitate the adoption and implementation of emerging technologies.



RG1-Q39 . Regulatory Policies support the adoption of emerging technology (AI,IoT and Industry 4.0).

Regulatory Policies provide economic benefits and gains for the adoption of emerging technologies.

RG2-Q40:Regulatory Policies provide economic benefits and gains for the adoption of emerging technologies



RG2-Q40 . Regulatory Policies provide economic incentives for the adoption of emerging technology (AI, IoT and Industry 4.0).

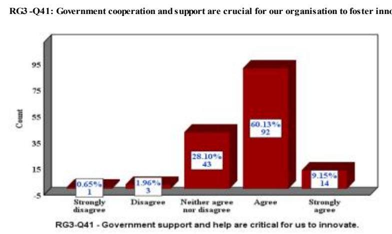
Regulatory policies facilitate the adoption and implementation of emerging technologies

	Frequency	Percent	Percent	Cumulative Percent
Strongly disagree	13	8.5	8.5	8.5
Disagree	17	11.1	11.1	19.6
Neither agree nor disagree	35	22.9	22.9	42.5
Agree	82	53.6	53.6	96.1
Strongly agree	6	3.9	3.9	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	122.915			
df	4			
P-Value	<.001			

Regulatory policies provide economic incentives for the adoption of emergingtechnologies

	Frequency	Percent	Percent	Cumulative Percent
Strongly disagree	1	.7	.7	.7
Disagree	21	13.7	13.7	14.4
Neither agree nor disagree	62	40.5	40.5	54.9
Agree	66	43.1	43.1	98.0
Strongly agree	3	2.0	2.0	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	129.712			
df	4			
P-Value	<.001			

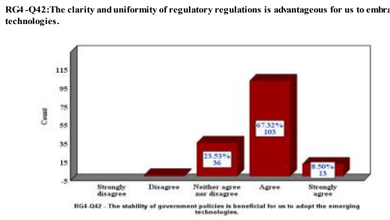
Government cooperation and support are crucial for our organisation to foster innovation



Government cooperation and support are crucial for our organisation to foster innovation.

	Frequency	Percent	Percent	Cumulative Percent
Strongly disagree	1	.7	.7	.7
Disagree	3	2.0	2.0	2.6
Neither agree nor disagree	43	28.1	28.1	30.7
Agree	92	60.1	60.1	90.8
Strongly agree	14	9.2	9.2	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	190.758			
df	4			
P-Value	<.001			

The clarity and uniformity of regulatory regulations is advantageous for us to embrace emerging technologies.



The clarity and uniformity of regulatory regulations is advantageous for us to embrace emerging technologies.

	Frequency	Percent	Percent	Cumulative Percent
Disagree	1	.7	.7	.7
Neither agree nor disagree	36	23.5	23.5	24.2
Agree	103	67.3	67.3	91.5
Strongly agree	13	8.5	8.5	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	162.686			
df	3			
P-Value	<.001			

Figures and Tables for Hypothesis H10: Competitive Pressure

Table 4.40: I am aware that competitors in the market are already implementing AI, IoT, and I4.0 within their organisations.

Figure 4.41: I am aware that competitors in the market are already implementing AI, IoT, and I4.0 within their organisations.

Table 4.41: Our organisation had to adopt AI, IoT, and I4.0 technologies in order to sustain and retain its edge over industry competitors.

Figure 4.42: Our organisation had to adopt AI, IoT, and I4.0 technologies in order to sustain and retain its edge over industry competitors.

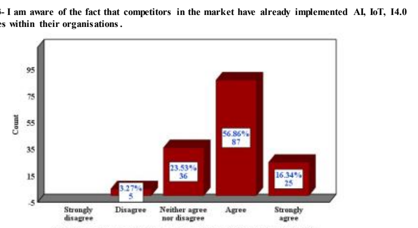
Table 4.42: The presence of competitors within our organisation has exerted pressure, hence influencing the choice to adopt and implement new technological innovations.

Figure 4.43: The presence of competitors within our organisation has exerted pressure, hence influencing the choice to adopt and implement new technological innovations.

Table 4.43: The adoption of AI, IoT, and I4.0 within the industry will apply pressure on my organisation to follow similar practices.

Figure 4.44: The adoption of AI, IoT, and I4.0 within the industry will apply pressure on my organisation to follow similar practices.

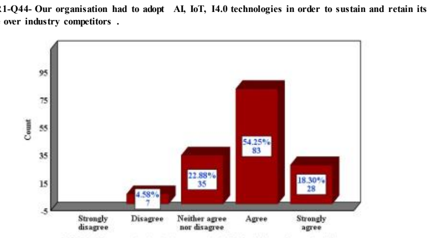
I am aware of the fact that competitors in the market have already implemented AI, IoT, I4.0 technologies within their organisations.



I am aware of the fact that competitors in the market have already implemented AI, IoT, I4.0 technologies within their organisations.

	Frequency	Percent	Percent	Cumulative Percent
Disagree	5	3.3	3.3	3.3
Neither agree nor disagree	36	23.5	23.5	26.8
Agree	87	56.9	56.9	83.7
Strongly agree	25	16.3	16.3	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	95.758			
df	3			
P-Value	<.001			

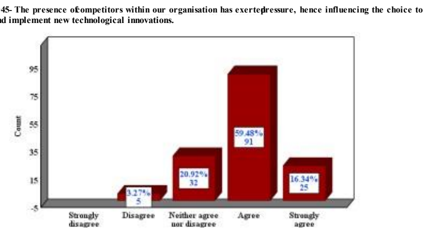
Our organisation had to adopt AI, IoT, I4.0 technologies in order to sustain and retain its edge over industry competitors .



Our organisation had to adopt AI, IoT, I4.0 technologies in order to sustain and retain its edge over industry competitors .

	Frequency	Percent	Percent	Cumulative Percent
Disagree	7	4.6	4.6	4.6
Neither agree nor disagree	35	22.9	22.9	27.5
Agree	83	54.2	54.2	81.7
Strongly agree	28	18.3	18.3	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	80.908			
df	3			
P-Value	<.001			

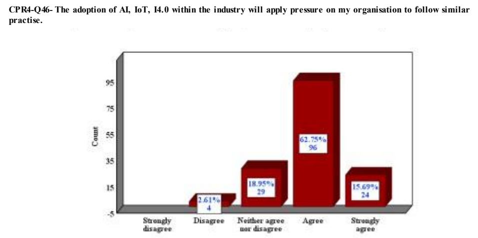
The presence of competitors within our organisation has exerted pressure, hence influencing the choice to adopt and implement new technological innovations.



The presence of competitors within our organisation has exerted pressure, hence influencing the choice to adopt and implement new technological innovations.

	Frequency	Percent	Percent	Cumulative Percent
Disagree	5	3.3	3.3	3.3
Neither agree nor disagree	32	20.9	20.9	24.2
Agree	91	59.5	59.5	83.7
Strongly agree	25	16.3	16.3	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	107.261			
Df	3			
P-Value	<.001			

The adoption of AI, IoT, I4.0 within the industry will apply pressure on my organisation to follow similar practise.



The adoption of AI, IoT, I4.0 within the industry will apply pressure on my organisation to follow similar practise.

	Frequency	Percent	Percent	Cumulative Percent
Disagree	4	2.6	2.6	2.6
Neither agree nor disagree	29	19.0	19.0	21.6
Agree	96	62.7	62.7	84.3
Strongly agree	24	15.7	15.7	100.0
Total	153	100.0	100.0	
Test Statistics				
Chi-Square	125.405			
df	3			
P-Value	<.001			

Figures and Tables for Hypothesis H11: Organisational Innovativeness

Appendix Table H11a: Our organisation stays updated on the most recent technological innovations in all relevant aspects

Appendix Figure H11a: Our organisation stays updated on the most recent technological innovations in all relevant aspects

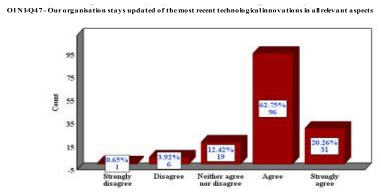
Appendix Table H11b: The organisational structure is being updated to encourage mutually beneficial collaborations, collaborative projects, and sustained alliances.

Appendix Figure H11b: The organisational structure is being updated to encourage mutually beneficial collaborations, collaborative projects, and sustained alliances.

Appendix Table H11c: Our organisation regularly updates the "procedures, methods and mode of operations" used to carry out business activities in an innovative way.

Appendix Figure H11c: Our organisation regularly updates the "procedures, methods and mode of operations" used to carry out business activities in an innovative way.

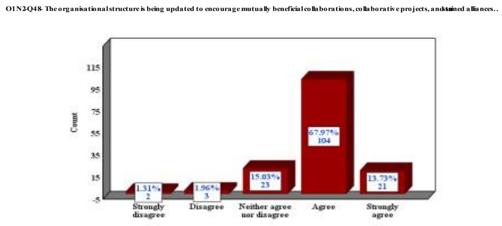
Our organisation stays updated of the most recent technological innovations in all relevant aspects.



Our organisation stays updated of the most recent technological innovations in all relevant aspects.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	1	.7	.7	.7
	Disagree	6	3.9	3.9	4.6
	Neither agree nor disagree	19	12.4	12.4	17.0
	Agree	96	62.7	62.7	79.7
	Strongly agree	31	20.3	20.3	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		192.588			
df		4			
P-Value		<.001			

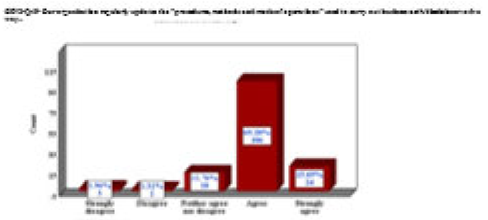
The organisational structure is being updated to encourage mutually beneficial collaborations, collaborative projects, and sustained alliances.



The organisational structure is being updated to encourage mutually beneficial collaborations, collaborative projects, and sustained alliances.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	2	1.3	1.3	1.3
	Disagree	3	2.0	2.0	3.3
	Neither agree nor disagree	23	15.0	15.0	18.3
	Agree	104	68.0	68.0	86.3
	Strongly agree	21	13.7	13.7	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		232.588			
df		4			
P-Value		<.001			

Our organisation regularly updates the "procedures, methods and mode of operations" used to carry out business activities in an innovative way.



Our organisation regularly updates the "procedures, methods and mode of operations" used to carry out business activities in an innovative way.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	3	2.0	2.0	2.0
	Disagree	2	1.3	1.3	3.3
	Neither agree nor disagree	18	11.8	11.8	15.0
	Agree	106	69.3	69.3	84.3
	Strongly agree	24	15.7	15.7	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		244.026			
		4			
P-Value		<.001			

Figures and Tables for Hypothesis H12: Process Innovativeness

Appendix Table H12a: Management expedites and encourages new ways of accomplishing tasks.

Appendix Figure H12a: Management expedites and encourages new ways of accomplishing tasks.

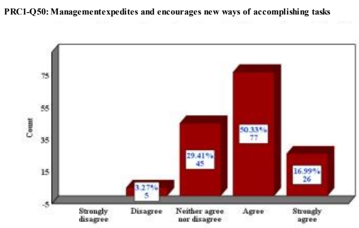
Appendix Table H12b: Within the “past five years”, our company has established a lot of new management strategies for faster and more efficient ways to serve customers.

Appendix Figure H12b: Within the “past five years”, our company has established a lot of new management strategies for faster and more efficient ways to serve customers.

Appendix Table H12c: We modify our service procedures to meet the demands of our customers.

Appendix Figure H12c: We modify our service procedures to meet the demands of our customers.

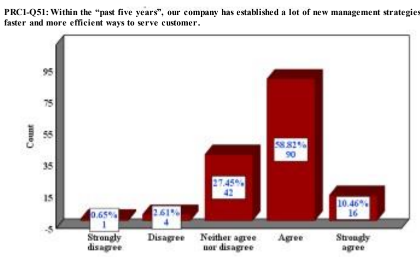
Management expedites and encourages new ways of accomplishing tasks



Management expedites and encourages new ways of accomplishing tasks

		Frequency	Percent	Percent	Cumulative Percent
	Disagree	5	3.3	3.3	3.3
	Neither agree nor disagree	45	29.4	29.4	32.7
	Agree	77	50.3	50.3	83.0
	Strongly agree	26	17.0	17.0	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		73.275			
df		3			
P-Value		<.001			

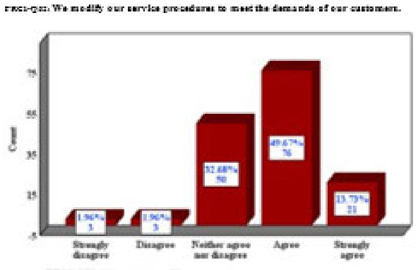
Within the “past five years”, our company has established a lot of new management strategies for faster and more efficient ways to serve customers.



Within the “past five years”, our company has established a lot of new management strategies for faster and more efficient ways to serve customers.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	1	.7	.7	.7
	Disagree	4	2.6	2.6	3.3
	Neither agree nor disagree	42	27.5	27.5	30.7
	Agree	90	58.8	58.8	89.5
	Strongly agree	16	10.5	10.5	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		178.275			
df		4			
P-Value		<.001			

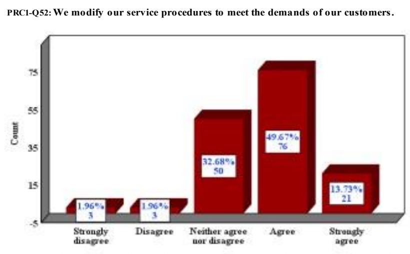
We modify our service procedures to meet the demands of our customers.



We modify our service procedures to meet the demands of our customers.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	3	2.0	2.0	2.0
	Disagree	3	2.0	2.0	3.9
	Neither agree nor disagree	50	32.7	32.7	36.6
	Agree	76	49.7	49.7	86.3
	Strongly agree	21	13.7	13.7	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		132.458			
df		4			
P-Value		<.001			

We modify our service procedures to meet the demands of our customers.



We modify our service procedures to meet the demands of our customers.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	3	2.0	2.0	2.0
	Disagree	3	2.0	2.0	3.9
	Neither agree nor disagree	50	32.7	32.7	36.6
	Agree	76	49.7	49.7	86.3
	Strongly agree	21	13.7	13.7	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		132.458			
df		4			
P-Value		<.001			

Figures and Tables for Hypothesis H13: Products and Services Innovativeness

Appendix Table H13a: Our organisation is ahead of industry rivals regarding the" introduction of products and services in the market".

Appendix Figure H13a: Our organisation is ahead of industry rivals regarding the" introduction of products and services in the market".

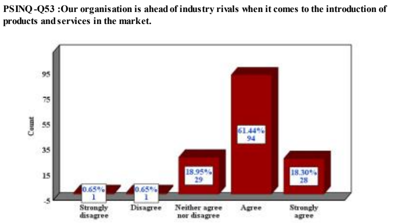
Appendix Table H13b: Our organisation consistently differentiates our products and services from Industry rivals.

Appendix Figure H13b: Our organisation consistently differentiates our products and services from Industry rivals.

Appendix Table H13c: Over the "past five years", our organisation has introduced a greater number of innovative products and services than any other.

Appendix Figure H13c: Over the “past five years”, our organisation has introduced a greater number of innovative products and services than any other.

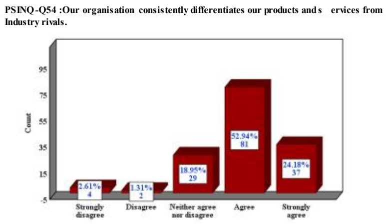
Our organisation is ahead of industry rivals when it comes to the introduction of products and services in the market.



Our organisation is ahead of industry rivals when it comes to the introduction of products and services in the market.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	1	.7	.7	.7
	Disagree	1	.7	.7	1.3
	Neither agree nor disagree	29	19.0	19.0	20.3
	Agree	94	61.4	61.4	81.7
	Strongly agree	28	18.3	18.3	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		188.928			
df		4			
P-Value		<.001			

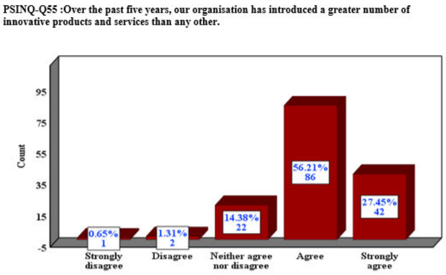
Our organisation consistently differentiates our products and s ervices from industry rivals.



Our organisation consistently differentiates our products and s ervices from industry rivals.

		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	4	2.6	2.6	2.6
	Disagree	2	1.3	1.3	3.9
	Neither agree nor disagree	29	19.0	19.0	22.9
	Agree	81	52.9	52.9	75.8
	Strongly agree	37	24.2	24.2	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		134.288			
df		4			
P-Value		<.001			

Over the past five years, our organisation has introduced a greater number of innovative products and services than any other.

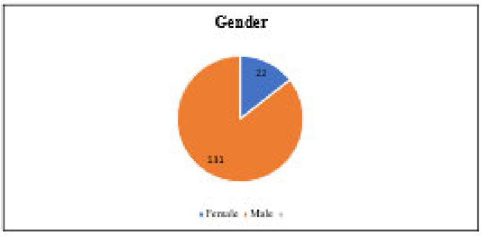


Over the past five years, our organisation has introduced a greater number of innovative products and services than any other.

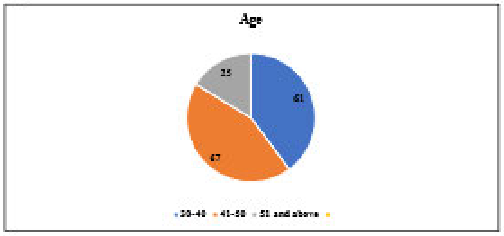
		Frequency	Percent	Percent	Cumulative Percent
	Strongly disagree	1	.7	.7	.7
	Disagree	2	1.3	1.3	2.0
	Neither agree nor disagree	22	14.4	14.4	16.3
	Agree	86	56.2	56.2	72.5
	Strongly agree	42	27.5	27.5	100.0
	Total	153	100.0	100.0	
Test Statistics					
Chi-Square		162.327			
df		4			
P-Value		<.001			

Figures and table for Demographics (Gender, Age, Designation, Industry, Country of location)

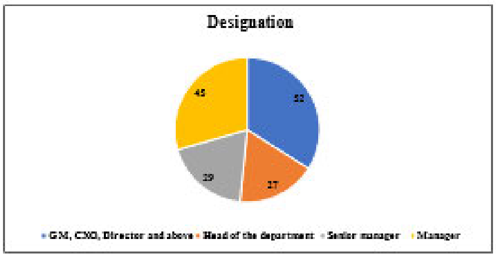
Gender Distribution



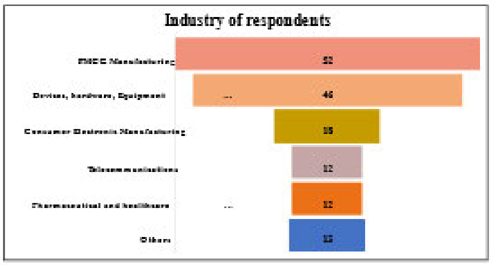
Age Distribution



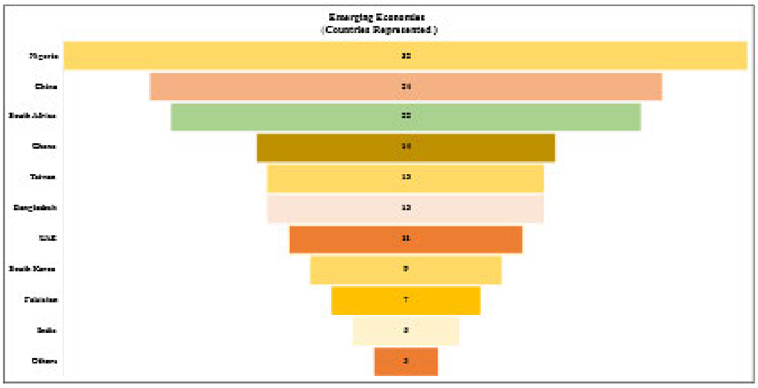
Designation



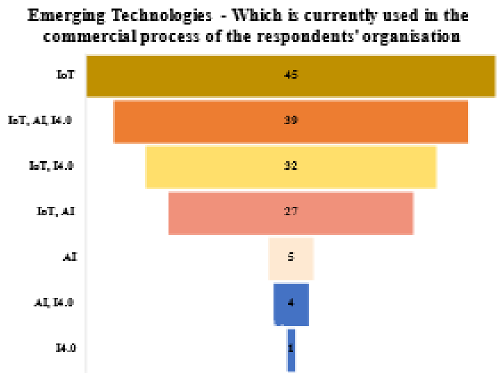
Industry



Country of Residence



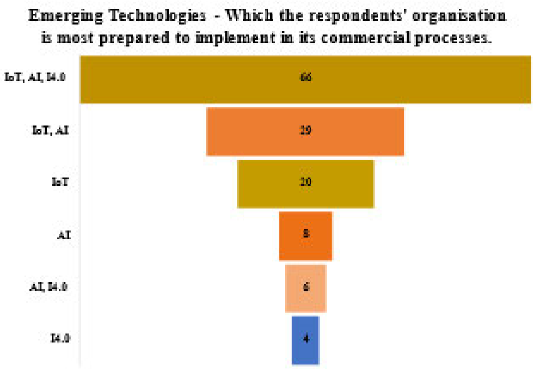
Figures and table for emerging digital technologies that the respondents' organisation uses in its commercial processes.



	Frequency	Percentage
AI	5	3.3
AI, I4.0	4	2.6
I4.0	1	.7
IoT	45	29.4
IoT, AI	27	17.6
IoT, AI, I4.0	39	25.5
IoT, I4.0	32	20.9
Total	153	100.0

Figure and Tables for emerging digital technologies your organisation is most prepared to implement in its commercial processes from the options provided below (You may choose more than 1):

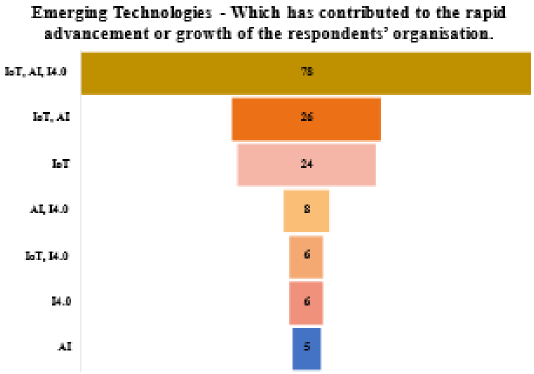
Figure and table for The emerging digital technologies your organisation is most prepared to implement in its commercial processes.



	Frequency	Percentage
AI	8	5.2
AI, I4.0	6	3.9
I4.0	4	2.6
IoT	20	13.1
IoT, AI	29	19.0
IoT, AI, I4.0	66	43.1
IoT, I4.0	20	13.1
Total	153	100.0

Figure and Tables for emerging digital technologies has contributed to the rapid advancement or growth of your organisation (You may choose more than 1):

Figure and Tables for Emerging digital technologies that have contributed to the rapid advancement or growth of your organisation.



	Frequency	Percentage
AI	5	3.3
AI, I4.0	8	5.2
I4.0	6	3.9
IoT	24	15.7
IoT, AI	26	17.0
IoT, AI, I4.0	78	51.0
IoT, I4.0	6	3.9
Total	153	100.0

Appendix 6 : Chi Square analysis and discussions on demographics and descriptives

Analysis and Discussions on Demographics (Gender)

All the respondents provided information about their gender, which was split predominantly between females and males with no allocation for other genders, although the three options were given in the questionnaire. Regarding gender, most participants are men (85.6%) compared to women (14.4%).

With respect to more in-depth analysis into specific variables and gender, there were no significant gender-based differences for relative advantage ($\chi^2 = 0.241$, df = 2, p = 0.886) and perception of complexity between genders ($\chi^2 = 6.165$, df = 3, p = 0.104), Both males and females showed comparable perceptions of compatibility ($\chi^2 = 0.359$, df = 3, p = 0.949). Both male and female respondents demonstrated similar attitudes towards technology experimentation without any noticeable gender-based differences in perceptions of trialability ($\chi^2 = 0.358$, df = 3, p = 0.949). The analysis did not uncover any gender disparity in perceived ease of use ($\chi^2 = 4.626$, df = 4, p = 0.328), indicating similar perceptions of the user-friendliness of new technologies among males and females. The findings revealed no significant gender-based discrepancy in technology readiness perceptions ($\chi^2 = 2.705$, df = 4, p = 0.608), suggesting identical viewpoints on the integration of technology among different genders. Both male and female respondents exhibited comparable attitudes towards regulatory policies, with no significant difference in perceptions between genders ($\chi^2 = 0.28$, df = 3, p = 0.964). Results indicated no notable gender-based differences in perceptions of top management support ($\chi^2 = 1.361$, df = 4, p = 0.851). An individual independent variable analysis of respondents' perspectives regarding products and services innovativeness showed the Chi-square test revealed a statistically non-significant difference ($\chi^2 = 7.058$, df = 3, p = 0.070), based on the level of significance ($\alpha = 0.05$) which was the sole variable with a statistical difference, and this has been incorporated into the discussion section in chapter five.

However, for the entire set of dependent variables upon which the study relies. Firstly, Rapid Advancement reveals no significant difference between genders ($\chi^2 = 1.844$, $df = 2$, $p = 0.40$). Furthermore, suggests a generally consistent perception of the rate of technological progress among both males and females, indicating that gender does not significantly influence perceptions of the pace of technological change. Secondly, Organisational Readiness, which measures the preparedness of organisations to adapt to technological changes, demonstrates no significant gender disparities ($\chi^2 = 0.446$, $df = 2$, $p = 0.80$), indicating similar perceptions of organisational readiness across genders. Thirdly, firm innovation performance, which evaluates the impact of technological factors on overall organisational performance, exhibits no significant differences in perspectives between males and females ($\chi^2 = 1.194$, $df = 3$, $p = 0.754$).

There is an indication of the connection between technology and innovation performance, regardless of gender. It highlights a recognition of the significance of technology in promoting organisational performance.

Gender and dependent variables cumulative analysis

Dependent Variables (consisting of all independent variables)	**Gender**	χ^2		
		Value	**df**	**P Value**
Rapid Advancement	Female			
	Male	1.844	2	0.40
	Total			
Organisational Readiness	Female			
	Male	0.446	2	0.80
	Total			
Firm Performance	Female			
	Male	1.194	3	0.75
	Total			

Gender and independent variables only analysis

	Independent Variables	Gender	χ^2 Value	df	P Value
Rapid Advancement	Relative Advantage	Female	0.241	2	0.886
		Male			
	Compatibility	Female	0.359	3	0.949
		Male			
	Complexity	Female	6.165	3	0.104
		Male			
	Trialability	Female	0.358	3	0.949
		Male			
	Perceived ease of use	Female	4.626	4	0.328
		Male			

	Independent Variables	Gender	χ^2 Value	df	P Value
Organisational Readiness	Technology Readiness	Female	2.705	4	0.608
		Male			
	Top Management Support	Female	1.361	4	0.851
		Male			
	Technological Partner Support	Female	7.717	4	0.103
		Male			

	Regulatory Policies	Female	0.28	3	0.964
		Male			
	Competitive Pressure	Female	4.421	3	0.219
		Male			

	Independent Variables	**Gender**	χ^2 **Value**	**df**	**P Value**
Firm Innovation Performance	Organisational Innovativeness	Female	2.901	4	0.574
		Male			
	Process Innovativeness	Female	2.82	3	0.42
		Male			
	Products and Services Innovativeness	Female	7.058	3	0.07
		Male			

Analysis and Discussions on Demographics (Age)

The analysis uncovered a statistically significant difference between age groups regarding independent variables perceived ease of use and competitive pressure. In providing a possible rationale, such difference might be explained by the fact that younger individuals often hold lower-level management positions, leading to less awareness of the higher-level competitive pressures that necessitate technology adoption. The perspective is supported by the study by Wang (2023), who discusses the intensity of pressure faced by senior managers and higher levels which could be an indication of external pressure also. Subsequently, the studies of (Kitole et al.,2024; Ünver et al.2023) both found a direct correlation between age and technology adoption, indicating that younger age groups are more inclined to adopt technology, which explains the perceived ease of use difference in age.

However, within this study, age did not show significant effects on the three dependent variables in the study, and there were no visible differences among the other eleven independent variables, which studies by Aithal et al. (2023) and Rodic et al. (2023), also did not find age to have a significant influence as demographic factors on technology adoption.

Demographics (Age)

Table 4.1 presents a profile of the respondents' ages. Of the 153 responses, 67% of the respondents belonged to the 41-50 age group, forming the largest category. However, the 30-40 age group was slightly below this figure at 39.9 %. The lowest category was fifty-one and above years at 16.3 %.

With respect to a more in-depth analysis of specific variables and age in Tables 4.4 and 4.5, the analysis of perceived ease of use across different age groups revealed varying responses among participants. The Chi-square test indicated a statistically significant difference (χ^2 = 16.968, df = 8, p = 0.03), indicating that there are significant variations in how different age groups perceive the level of ease in using something. Similarly, the Chi-square test revealed a statistically significant difference (χ^2 = 13.647, df = 6, p = 0.034), indicating significant variations in perceptions of competitive pressure among participants belonging to different age groups. No statistically significant differences were observed among the age groups. In terms of Relative advantage. (χ^2 = 4.1, df = 4, p = 0.393). Compatibility shows a similar trend, with no significant disparity observed among age groups (χ^2 = 6.332, df = 6, p = 0.387). Complexity, representing perceptions of the challenges associated with adopting new technologies, does not show any apparent differences among different age groups. (χ^2 = 5.048, df = 6, p = 0.538). Trialability, assessing the ease of experimentation with new technologies, reflects relatively consistent perceptions across age groups (χ^2 = 6.088, df = 6, p = 0.413). The other independent variables, such as technology Readiness, Top Management Support, Technological Partner Support, Regulatory Policies, Organisational Innovativeness, Process Innovativeness, and Products and Services Innovativeness, show no significant variations in perceptions related to age, as evidenced by the chi-square tests associated with each variable.

However, for the entire set of dependent variables upon which the study relies, with respect to the age categories, Rapid Advancement displays no significant differences across age groups (χ^2 = 2.626, df = 4, p = 0.622). Similarly, Organisational Readiness exhibits no significant disparities in each age category ($\chi^2 = 2.769$, df = 4, p = 0.597). Furthermore, Firm innovation Performance, evaluating the impact of technological factors on overall organisational performance, demonstrated no significant variation within each age group ($\chi^2 = 7.154$, df = 6, p = 0.307).

Age and dependent and dependent variables cumulative analysis

Dependent Variables (consisting of all independent variables)	**Age**	**χ^2**		
		Value	**df**	**P Value**
Rapid Advancement	30-40	2.626	4	0.622
	41-50			
	51 and above			
	Total			
Organisational Readiness	30-40	2.769	4	0.597
	41-50			
	51 and above			
	Total			
Firm Performance	30-40	7.154	6	0.307
	41-50			
	51 and above			
	Total			

Age and independent variables

	Independent Variables	**Age**	**χ^2**		
			Value	**df**	**P Value**
	Relative Advantage	30-40	4.1	4	0.393
		41-50			
		≥51			

Rapid Advancement	Compatibility	30-40 41-50 ≥51	6.332	6	0.387
	Complexity	30-40 41-50 ≥51	5.048	6	0.538
	Trialability	30-40 41-50 ≥51	6.088	6	0.413
	Perceived ease of use	30-40 41-50 ≥51	16.968	8	0.03

	Independent Variables	**Age**	χ^2		
			Value	**df**	**P Value**
Organisational Readiness	Technology Readiness	30-40 41-50 ≥51	6.806	8	0.558
	Top Management Support	30-40 41-50 ≥51	10.655	8	0.222
	Technological Partner Support	30-40 41-50 ≥51	8.124	8	0.421
	Regulatory Policies	30-40	6.018	6	0.421

		41-50			
		≥51			
	Competitive Pressure	30-40	13.647	6	0.034
		41-50			
		≥51			

	Independent Variables	**Age**	**χ^2**		
			Value	**df**	**P Value**
Firm Innovation Performance	Organisational Innovativeness	30-40	11.375	8	0.181
		41-50			
		≥51			
	Process Innovativeness	30-40	4.346	6	0.63
		41-50			
		≥51			
	Products and Services Innovativeness	30-40	2.897	6	0.822

Analysis and Discussions on Descriptives (Continents)

Discussions on Continents (Middle East)

In addition to the managerial responses within this study, in which additional analysis of specifically the Middle Eastern region and the variables showed no statistically significant difference, the study by Nadeem et al. (2024), which focused on digital nations, including the UAE, emphasised that the region has been giving priority to technological advancement. The respondents found the discussion on many aspects of technological progress, such as organisational changes and procedures, presented within this study to be highly relevant as it supports their strategic goals of maintaining competitiveness. In addition, linked to the UAE government's collaborations with technical businesses, the findings of Bahlooq et al. (2020) support the reason for the lack of statistical difference. Moreover, the portrayal of the UAE, particularly Dubai, as a "revolutionary hub for experimentation" by De Felice and Petrillo (2024) seems to strengthen the conviction of the managerial respondents in the region's dedication to adopting and spearheading technological progress. Therefore, this creates a motivation that could have led managers to investigate and embrace state-of-the-art technology for the purpose of maintaining their organisations' significance and competitiveness in the rapidly changing business environment.

Furthermore, the UAE's drive towards technological progress is supported by the government's strategic plans to refine digitalisation. Recent studies highlight the joint efforts of GCC nations, including the UAE and Saudi Arabia, to promote digitisation initiatives, and the studies by Aidrous et al. (2021) emphasise this collaborative focus. This fact could have added to the positive approach to technology heralded by the managerial responses. Additionally, Arif et al. (2020) provide a compelling example of the UAE's dedication to technological innovation by implementing smart technology in the oil field and integrating AI, IoT, and I4.0. Consequently, this indicates that managers view the agreements as opportunities to capitalise on external expertise and resources to stimulate innovation within the respective organisations.

No statistically significant difference was observed between the Middle East region as a separate entity and the dependent variable and the independent variables within this study.

Discussions on Continents (Asia)

For the management responses studied in this study, regional and multiple variable analysis showed no statistically significant difference and supported by the studies by Miah et al.(2024); even with challenges, it is expected that the Asian region will see an overall increase in job opportunities due to the progress in the implementation of Industry 4.0 technologies, According to Bra (2023) and the "Global Innovation Index," India and Bangladesh face the need to acquire skills in technology outputs across different sectors. Therefore, this highlights the growing need for enhanced training capabilities to facilitate the smooth integration of traditional and emergent technology, an observation that has been highlighted in chapter six of this study as a recommendation. In a similar vein, Hossain et al. (2023) highlight the absence of specialised knowledge and skills in the manufacturing industry as a significant barrier to the adoption of Industry 4.0.

The research conducted by Ali and Xie (2021) in Pakistan highlights the substantial influence of using I4.0 technologies on performance despite encountering obstacles. Research conducted in South Asian countries such as Pakistan and India indicate that multiple factors influence the implementation of technologies, which subsequently impact economic performance and social dynamics. In addition, Smolka and Papulova (2023) suggest that efficiency acts as a catalyst for greater acceptance and implementation of innovation in India. Based on these findings and the data collected and analysed for this research, it is evident that some aspects of the (TOE) framework used within this study, such as partner support, technical preparedness, and top management endorsement, are crucial for promoting ongoing progress in developing nations in the region.

A statistically significant disparity was not found between the Asian region as a distinct entity and the dependent variable and the independent variables in this investigation.

Discussions on Continents (Africa)

Further analysis of the African region specifically and variables showed no statistically significant difference, supporting this study's managerial responses. Given that the African countries within this study are primarily in the Sub-Saharan African region, (Kakeu et al.,2024, p.2) highlight Sub-Saharan Africa's distinction as a region with a notable presence of "innovation learners," highlighting the potential of technological advancements to not only address poverty but also catalyse economic development. Such a perspective aligns with broader academic discussions emphasising the transformative power of technology in emerging economies, which lends credence to the recommendation for new models of growth discussed in chapter six. In a comprehensive examination by Dzator et al. (2023) covering forty-four Sub-Saharan African countries, findings revealed the pivotal role of technological integration across various services in ameliorating poverty levels across diverse demographics. This empirical evidence adds depth to the academic discourse on the intersection of technology and socio-economic development within the region. Furthermore, Myovella et al. (2020)

contribute to this discourse by explaining the critical role of emerging technologies as drivers of growth within Sub-Saharan Africa. Their insights offer valuable perspectives from an academic standpoint, shedding light on the potential pathways for sustainable development through technological innovation.

Moreover, (Deganis et al.,2021; Galperin and Fernanda Viecens 2017) provide analyses of the challenges and opportunities associated with technological adoption in Sub-Saharan Africa. Their studies discuss the importance of addressing barriers such as digital skills gaps and low awareness of technological benefits while highlighting the transformative potential of technologies like the Internet of Things (IoT) in enhancing innovation performance within the region. These insights enrich the discussion within this research. They are supported by the various responses to the need for stronger, focused, technology-driven development strategies tailored to the unique context of Sub-Saharan Africa, which could provide benefits for organisational performance.

A difference in statistical significance was not found between the African region as a distinct entity and the dependent variable, as well as the independent variables in this study.

Descriptives (Continents)

The respondents for the study came from the Middle East, Africa, and Asian continents, with respondents from various countries such as China, South Africa, Nigeria, South Korea, Ghana, Bangladesh, UAE, and Taiwan.

With respect to a more in-depth analysis of specific variables and specific regions within the multi-continent approach, there were no statistically significant differences. Furthermore, for the entire set of dependent variables upon which the study relies, there were no statistically significant differences, and this has been incorporated further into the discussion section in chapter five.

Continents and dependent variables cumulative analysis

Dependent Variables	**Continent**	**χ^2**

(consisting of all independent variables)		Value	df	P Value
Rapid Advancement	Africa	3.001	4	0.558
	Asia			
	Middle East			
	Total			
Organisational Readiness	Africa	1.077	4	0.898
	Asia			
	Middle East			
	Total			
Firm Innovation Performance	Africa	3.97	6	0.680
	Asia			
	Middle East			
	Total			

Continents and independent variables only analysis

	Independent Variables	Continent	χ^2		
			Value	**df**	**P Value**
	Relative Advantage	Africa	2.807	4	0.591
		Asia			
		Middle East			
		Total			
	Compatibility	Africa	4.591	6	0.597

Rapid Advancement		Asia			
		Middle East			
		Total			
	Complexity	Africa	9.635	6	0.141
		Asia			
		Middle East			
		Total			
	Trialability	Africa	6.858	6	0.334
		Asia			
		Middle East			
		Total			
	Perceived ease of use	Africa	13.188	8	0.106
		Asia			
		Middle East			
		Total			

	Independent Variables	**Continent**	χ^2		
			Value	**df**	**P Value**
	Technology Readiness	Africa	2.789	8	0.947
		Asia			
		Middle East			

Organisational Readiness	Top Management Support	Africa	4.52	8	0.807
		Asia			
		Middle East			
	Technological Partner Support	Africa	10.1	8	0.258
		Asia			
		Middle East			
	Regulatory Policies	Africa	5.322	6	0.503
		Asia			
		Middle East			
	Competitive Pressure	Africa	3.162	6	0.788
		Asia			
		Middle East			

Firm Innovation Performance	**Independent Variables**	**Continent**	χ^2		
			Value	**df**	**P Value**
	Organisational Innovativeness	Africa	2.554	8	0.959
		Asia			
		Middle East			
		Total			
	Process Innovativeness	Africa	2.306	6	0.89
		Asia			

		Middle East			
		Total			
	Products and Services Innovativeness	Africa	1.44	6	0.963
		Asia			
		Middle East			
		Total			

Analysis and Discussions on Descriptives (Industries)

This section discussed the relevance of the top five industries featured in this research study, which supports the findings of prior research. The study's data analysis demonstrates a significant statistical difference between industry support and assistance from technology partners, which is one of the indicators that indicate organisational readiness. Nevertheless, there was no observable statistical variation in any of the remaining twelve independent variables. Technological partner support is essential for fostering innovation and sustaining competitiveness in industries including Fast-Moving Consumer Goods (FMCG), Telecommunications, Consumer Electronics, Pharmaceuticals, and the devices, hardware, and equipment sector. The operational landscape of these businesses has undergone substantial changes as a result of the use of modern technologies (Tripathi et al., 2022), and the managerial responses based on adapted theoretical measurement items could be further explained by technological improvements in the FMCG business that have completely transformed manufacturing and distribution operations. As a result, continual assistance from technology partners is crucial to adapt to these changes successfully. In the field of Telecommunications, managers must have a strong understanding of technologies such as IoT in order to make well-informed judgements about adopting new technology (Alarefi, 2023; Raman et al., 2023).

Consumer Electronics firms heavily depend on market research and managerial knowledge to assess external elements and frameworks, allowing them to promote innovation and achieve a competitive advantage (Lutfi et al., 2023). Organisational structures in the pharmaceutical business are crucial for driving technical progress, and managers must have a deep awareness of technological advancements to be relevant and competitive (Tasnim et al., 2023; Nuryanto et al., 2024). Similarly, within the devices, hardware, and equipment industry, successful incorporation and implementation of hardware innovations necessitate a comprehensive understanding of management principles (Cummings et al., 2023; Wenzel, 2023). Therefore, the assistance of technology partners has become essential in several sectors to effectively traverse and exploit technological breakthroughs, ensuring a competitive advantage in the market.

The disparity in degrees of partner assistance can be ascribed to the distinct difficulties, priorities, and affiliations with technology partners within each industry as relates to the technology. For example, the FMCG industry places a high importance on rapid innovation and effective distribution, whereas pharmaceutical companies may place greater emphasis on partnerships for research and development. In order to maintain competitiveness, consumer electronics and hardware producers may need ongoing technical support and customised adjustments. Additionally, the variations in support levels indicate the differing requirements and objectives of different sectors, underscoring the significance of considering industry-specific subtleties when assessing organisational readiness. In order to successfully achieve industry-specific goals and overcome problems, organisations require continual guidance from technology partners of different levels and as applicable to their industry.

Additionally, process innovation as an independent factor within innovation adoption is continuously being studied across various industries, as discussed in chapters one and two. While there was a marginal statistically significant difference observed between industries and process innovativeness, studies such as Lugovoi et al. (2022) delve into process innovation within the pharmaceutical industry, emphasising the role of technologically driven R and D to maintain competitiveness in a rapidly evolving sector that requires similar evolving technological use. In manufacturing industries, including FMCG and consumer electronics, Huang and Tong (2024) discuss the necessity of differentiation within the marketplace for growth, which also adds to the discussion of the need for process innovation across various industries. In addition, manufacturing industries may be particularly susceptible to variations in process innovation due to their incessant requirement for digital technologies Chin et al. (2023). Moreover, due to the necessity of remaining afloat economically, the studies by Vendrell-Herrero et al. (2023) discuss the use of several strategies to combine multiple types of innovation and explore emerging technologies while simultaneously providing products and services, as highlighted by Bustinza et al. (2020) all which collectively provides insights into the slight statistically significance difference.

Descriptives (Industry)

In the study, 34% of participants came from the manufacturing of FMCG products, followed closely by 30% within the manufacturing of devices, hardware, and equipment, 7.8% from telecommunications, 11% from consumer electronics, and the remaining was a breakdown of other industries within the manufacturing sectors.

With respect to a more in-depth analysis of specific variables, Relative Advantage analysis did not yield statistically significant differences between industries ($\chi^2 = 6.08$, df = 10, $p = 0.809$). Compatibility follows a similar trend, with no significant disparity observed among industries ($\chi^2 = 17.113$, df = 15, $p = 0.312$). Complexity analysis indicates no statistically significant differences between industries ($\chi^2 = 15.593$, df = 15, $p = 0.410$) and process innovativeness ($\chi^2 = 25.396$, df = 15, $p = 0.05$) also. Trialability reflects relatively consistent perceptions across industries ($\chi^2 = 20.596$, df = 15, $p = 0.150$). Technology Readiness, Top Management Support, Regulatory Policies, Organisational Innovativeness, and Products and Services Innovativeness exhibit no significant difference across industries, as evidenced by the chi-square tests associated with each variable. The analysis of respondents' perspectives on technological partner support ($\chi^2 = 40.383$, df = 20, $p = 0.004$) and process innovativeness ($\chi^2 = 25.396$, df = 15, $p = 0.045$) revealed a statistically significant difference across different industry sectors and the outcome had been included in the discussion section of chapter five.

However, for the entire set of dependent variables upon which the study, Rapid Advancement reveals no significant disparities among industries ($\chi^2 = 5.64$, df = 10, $p = 0.845$); however, organisational readiness demonstrates slightly significant differences among industries ($\chi^2 = 20.428$, df = 10, $p = 0.025$). While there were no statistical differences found ($\chi^2 = 22.867$, df = 15, $p = 0.087$) for firm innovation Performance.

Industry and dependent variables cumulative analysis

<table>
<tr><th rowspan="2">Dependent Variables (consisting of all independent variables)</th><th rowspan="2">Industry</th><th colspan="3">χ^2</th></tr>
<tr><th>Value</th><th>df</th><th>P Value</th></tr>
<tr><td rowspan="6">Rapid Advancement</td><td>FMCG Manufacturing</td><td rowspan="6">5.64</td><td rowspan="6">10</td><td rowspan="6">0.845</td></tr>
<tr><td>Devices, hardware, and Equipment</td></tr>
<tr><td>Consumer Electronics</td></tr>
<tr><td>Telecommunications</td></tr>
<tr><td>Pharmaceutical</td></tr>
<tr><td>Others</td></tr>
<tr><td rowspan="6">Organisational Readiness</td><td>FMCG Manufacturing</td><td rowspan="6">20.428</td><td rowspan="6">10</td><td rowspan="6">0.025</td></tr>
<tr><td>Devices, hardware, and Equipment</td></tr>
<tr><td>Consumer Electronics</td></tr>
<tr><td>Telecommunications</td></tr>
<tr><td>Pharmaceutical</td></tr>
<tr><td>Others</td></tr>
<tr><td rowspan="6">Firm Performance</td><td>FMCG Manufacturing</td><td rowspan="6">22.867</td><td rowspan="6">15</td><td rowspan="6">0.087</td></tr>
<tr><td>Devices, hardware, and Equipment</td></tr>
<tr><td>Consumer Electronics</td></tr>
<tr><td>Telecommunications</td></tr>
<tr><td>Pharmaceutical</td></tr>
<tr><td>Others</td></tr>
</table>

Industry and independent variables only analysis

<table>
<tr><th rowspan="2"></th><th rowspan="2">Independent Variables</th><th rowspan="2">Industry</th><th colspan="3">χ^2</th></tr>
<tr><th>Value</th><th>df</th><th>P Value</th></tr>
<tr><td rowspan="18">Rapid Advancement</td><td rowspan="6">Relative Advantage</td><td>FMCG Manufacturing</td><td rowspan="6">6.08</td><td rowspan="6">10</td><td rowspan="6">0.809</td></tr>
<tr><td>Devices, hardware, and Equipment</td></tr>
<tr><td>Consumer Electronics</td></tr>
<tr><td>Telecommunications</td></tr>
<tr><td>Pharmaceutical</td></tr>
<tr><td>Others</td></tr>
<tr><td rowspan="6">Compatibility</td><td>FMCG Manufacturing</td><td rowspan="6">17.113</td><td rowspan="6">15</td><td rowspan="6">0.312</td></tr>
<tr><td>Devices, hardware, and Equipment</td></tr>
<tr><td>Consumer Electronics</td></tr>
<tr><td>Telecommunications</td></tr>
<tr><td>Pharmaceutical</td></tr>
<tr><td>Others</td></tr>
<tr><td rowspan="6">Complexity</td><td>FMCG Manufacturing</td><td rowspan="6">15.593</td><td rowspan="6">15</td><td rowspan="6">0.410</td></tr>
<tr><td>Devices, hardware, and Equipment</td></tr>
<tr><td>Consumer Electronics</td></tr>
<tr><td>Telecommunications</td></tr>
<tr><td>Pharmaceutical</td></tr>
<tr><td>Others</td></tr>
</table>

	Trialability	FMCG Manufacturing	20.596	15	0.150
		Devices, hardware, and Equipment			
		Consumer Electronics			
		Telecommunications			
		Pharmaceutical			
		Others			
	Perceived ease of use	FMCG Manufacturing	9.126	20	0.981
		Devices, hardware, and Equipment			
		Consumer Electronics			
		Telecommunications			
		Pharmaceutical			
		Others			

	Independent Variables	**Industry**	χ^2		
			Value	**df**	**P Value**
	Technology Readiness	FMCG Manufacturing	30.231	20	0.066
		Devices, hardware and Equipment			
		Consumer Electronics			
		Telecommunications			
		Pharmaceutical			

Organisational Readiness		Others			
	Top Management Support	FMCG Manufacturing	16.914	20	0.659
		Devices, hardware and Equipment			
		Consumer Electronics			
		Telecommunications			
		Pharmaceutical			
		Others			
	Technological Partner Support	FMCG Manufacturing	40.383	20	0.004
		Devices, hardware and Equipment			
		Consumer Electronics			
		Telecommunications			
		Pharmaceutical			
		Others			
	Regulatory Policies	FMCG Manufacturing	12.049	15	0.675
		Devices, hardware and Equipment			
		Consumer Electronics			
		Telecommunications			
		Pharmaceutical			
		Others			
		FMCG Manufacturing	9.268	15	0.863

	Competitive Pressure	Devices, hardware, and Equipment			
		Consumer Electronics			
		Telecommunications			
		Pharmaceutical			
		Others			

	Independent Variables	Industry	χ^2		
			Value	df	P Value
Firm Innovation Performance	Organisational Innovativeness	FMCG Manufacturing	18.5	20	0.555
		Devices, hardware, and Equipment			
		Consumer Electronics			
		Telecommunications			
		Pharmaceutical			
		Others			
	Process Innovativeness	FMCG Manufacturing	25.396	15	0.045
		Devices, hardware, and Equipment			

		Consumer Electronics			
		Telecommunications			
		Pharmaceutical			
		Others			
	Products and Services Innovativeness	FMCG Manufacturing	12.809	15	0.617
		Devices, hardware, and Equipment			
		Consumer Electronics			
		Telecommunications			
		Pharmaceutical			
		Others			

Analysis and Discussions on Descriptives (Designation)

This section discussed the relevance of organisational designations featured in this research study, which supports the findings of prior research. There are no statistical differences between any of the industries and the variables within this study.

The result reinforces the importance of the managerial-level respondents who were used for this study since managers are tasked with evaluating the impact of innovation adoption and ensuring the smooth integration of technological advancements into their operations. Additionally, imperative for staying competitive in the rapidly evolving market (Tripathi et al., 2022) is the fact that managers play a vital role in adoption decisions, particularly concerning technologies like IoT, which have significant implications within their organisations (Alarefi, 2023; Raman et al., 2023). Furthermore, managers are positioned as frontrunners and must possess extensive knowledge of market dynamics and external factors to drive innovation and maintain competitiveness (Lutfi et al., 2023). As evidenced by this research study, a managerial-level understanding of technological progress is essential for leveraging organisational structures to promote innovation and competitiveness (Tasnim et al., 2023;

Nuryanto et al., 2024). Managers must comprehend the integration of hardware devices with various technologies to drive adoption, working closely with partners who understand hardware functionalities to facilitate technological uptake (Cummings et al., 2023; Wenzel, 2023). Overall, managers' understanding of innovation's impact, internal dynamics, and market influences are necessary for successful technology integration across industries, shaping the modern industrial landscape (Tripathi et al., 2022; Alarefi, 2023; Raman et al., 2023; Lutfi et al., 2023; Tasnim et al., 2023; Nuryanto et al., 2024; Cummings et al., 2023; Wenzel, 2023).

Descriptives (Designation)

Regarding organisational designation or title held, the total breakdown of the GM, C-level and director categories was fifty-two respondents or 34%. Head of the department was 17.6 %, while senior managers were 19%, with the highest category being managers at 29.4 %, as illustrated below.

With respect to a more in-depth analysis of specific variables and designation shown in Table 4.6 and 4.7, there were no statistically significant differences. Additionally, for the entire set of dependent variables upon which the study relies (Table 4.4), rapid advancement exhibits no significant differences across designations (χ^2 = 10.804, df = 6, p = 0.095), suggesting a relatively uniform perception among individuals occupying various organisational roles. Similarly, organisational readiness reveals no significant differences across designations (χ^2 = 8.945, df = 6, p = 0.177); moreover, firm innovation performance, assessing the impact of technological factors on overall organisational performance, demonstrates no significant variation across designations (χ^2 = 6.261, df = 9, p = 0.714),

Designation and dependent variables cumulative analysis

Dependent Variables (consisting of all independent variables)	**Designation**	**χ^2**		
		Value	**df**	**P Value**
Rapid Advancement	GM, CXO, Director Head of the department Manager	10.804	6	0.095

	Senior manager			
	Total			
Organisational Readiness	GM, CXO, Director	8.945	6	0.177
	Head of department			
	Manager			
	Senior manager			
	Total			
Firm Performance	GM, CXO, Director	6.261	9	0.714
	Head of department			
	Manager			
	Senior manager			
	Total			

Designation and independent variables only analysis

	Independent Variables	**Designation**	χ^2		
			Value	**Df**	**P Value**
Rapid Advancement	Relative Advantage	GM, CXO, Director	5.107	6	0.530
		Head of department			
		Manager			
		Senior manager			
	Compatibility	GM, CXO, Director	5.598	9	0.779
		Head of department			
		Manager			
		Senior manager			
	Complexity	GM, CXO, Director	9.946	9	0.355
		Head of department			
		Manager			
		Senior manager			
	Trialability	GM, CXO, Director	5.171	9	0.819

		Head of department			
		Manager			
		Senior manager			
	Perceived ease of use	GM, CXO, Director	15.475	12	0.217
		Head of department			
		Manager			
		Senior manager			

	Independent Variables	**Designation**	χ^2		
			Value	**Df**	**P Value**
Organisational Readiness	Technology Readiness	GM, CXO, Director	10.102	12	0.607
		Head of department			
		Manager			
		Senior manager			
	Top Management Support	GM, CXO, Director	14.508	12	0.269
		Head of department			
		Manager			
		Senior manager			

	Technological Partner Support	GM, CXO, Director	14.035	12	0.298
		Head of department			
		Manager			
		Senior manager			
	Regulatory Policies	GM, CXO, Director	4.303	9	0.890

		Head of department			
		Manager			
		Senior manager			
	Competitive Pressure	GM, CXO, Director	10.263	9	0.330
		Head of department			
		Manager			
		Senior manager			

Firm Innovation Performance	**Independent Variables**	**Designation**	χ^2		
			Value	**Df**	**P Value**
	Organisational Innovativeness	GM, CXO, Director	15.896	12	0.196
		Head of department			
		Manager			
		Senior manager			
	Process Innovativeness	GM, CXO, Director	13.452	9	0.143
		Head of department			
		Manager			
		Senior manager			
	Products and Services Innovativeness	GM, CXO, Director	11.181	9	0.263
		Head of department			

		Manager			
		Senior manager			