Emerging Technologies and Public Innovation in the Saudi Public Sector: An Analysis of Adoption and Challenges Amidst Vision 2030

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ABSTRACT

Utilizing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology, this study conducts a comprehensive examination of the adoption and impact of emerging technologies within Saudi public sector operations from 2018 to 2022. This analysis marks a significant advancement in public sector innovation research by providing a detailed empirical overview of technological trends used to enhance Saudi government operations. It reveals a notable increase in studies, indicating a shift towards digital transformation, particularly accelerated by the COVID-19 pandemic. This shift is evident in the growing focus on AI and cloud computing, which have seen their incorporation in pandemic-related studies rise from 10% to 57% in just three years.

The study contributes to public sector innovation literature by identifying key challenges to technology adoption, including security and privacy concerns, skill gaps, infrastructural needs, financial constraints, and the need for robust governance. Additionally, it maps the prevalent technologies and the government sectors actively adopting them, providing insights into how the pandemic has shaped priorities and integration strategies.

The findings underscore the necessity for transparency, accountability, and meticulous planning in the application of emerging technologies to enhance public service operations in Saudi Arabia. This enhancement directly contributes to improving the customer experience and aligns with the ambitious goals and objectives of Saudi Vision 2030, which aims to create a vibrant society, a thriving economy, and an ambitious nation. Furthermore, the findings illuminate the current landscape of technological adoption within the government sector and establish a baseline for future investigations. This study offers a benchmark for continuous inquiry into the strategic implementation of government technology, proposing guidelines for future research and policy formulation in the realm of digital governance.

Key words: Emerging Technologies, Saudi Arabia, Government, Public Innovation, Challenges.

Introduction

In recent years, the global business and societal landscapes have experienced a profound shift, catalyzed by the widespread adoption of emerging technologies. This transformative phenomenon, known as digital transformation, represents a fundamental change in how organizations operate, interact with stakeholders, and generate value in a progressively digitalized world (A. H. Gajo and Akyuz, 2023). The acceleration of digital transformation is closely intertwined with the rapid proliferation of emerging technologies such as Artificial Intelligence (AI), Internet of Things (IoT), Blockchain, Big Data/data analytics, and Cloud Computing (CC). Together, these technologies are driving a paradigm shift that is reshaping industries, governance, and human experiences on a global scale.

Within this context, public sector innovation plays a pivotal role. It is defined as the introduction and implementation of novel ideas, methods, or products within public organizations. These innovations represent significant departures from previous practices, carrying risks and challenges but ultimately aiming for improvement. They bring new approaches to the organization and contribute to enhancing processes or services. This aligns with the broader definition of innovation as a new or improved product or process that differs significantly from previous iterations (Glor, 1997; OECD/Eurostat, 2018). In the context of this paper, innovation is synonymous with the strategic adoption of emerging technologies into government operations, offering a unique opportunity to enhance public services and elevate overall end user satisfaction.

The adoption of emerging technologies has evolved from being an option to becoming an imperative for governments due to the compelling opportunities they offer, such as improving the quality of public services, elevating the overall customer experience (CX), and enhancing human capability while maintaining cost-efficiency. As highlighted by studies such as Cassetta et al. (2020), A. Gajo (2023), and Khan, Imran, and Haleem (2020), cutting-edge technologies such as IoT, AI, big data, and robotics have the potential to enhance productivity and make businesses more competitive. Phuyal, Bista, and Bista (2020) noted that the integration of emerging technologies, including AI, can yield a significant productivity increase of around 20% in manufacturing. Furthermore, AI is expected to add $15.7 trillion to the global economy by 2030 (Kelly, Kaye, and Oviedo-Trespalacios, 2023). Moreover, according to Field, Patel, and Leon (2019), organizations utilizing AI with active human supervision can achieve cost savings of up to 30% and revenue increases of as much as 20%. In line with the global significance and value of emerging technologies, Saudi Arabia also is expected to gain profoundly from adopting these technologies as emphasized by the Saudi government (Digital Government Authority, 2022a). A primary benefit of this technological innovation is the preservation of the environment. It achieves this by reducing carbon emissions through improved energy efficiency and various spillover effects, as outlined by Gao et al. (2022). Additionally, Liang et al. (2022) have identified technological advancements as key drivers in decreasing carbon dioxide emissions, further emphasizing their environmental impact. This aligns with sustainable practices and upholds the broader objectives of preserving the planet for future generations. On the economic front, technologies centered on data analytics are projected to inject at least SAR500 billion into the Saudi economy by 2030, while robotics are anticipated to contribute an

astounding 18.3 trillion Riyals to the Kingdom's financial landscape within the same timeframe by (Digital Government Authority, 2022a).

An additional factor that has propelled the integration of emerging technologies into government operations as a global trend is the unprecedented impact of the COVID-19 pandemic. This unforeseen global disruptor served as a powerful accelerator for technology adoption. In response to the pandemic's challenges, remote work, telemedicine, contactless transactions, and data-driven decision-making emerged as vital components of resilience strategies (Dwivedi et al., 2020). Governments and organizations that proactively embraced digital transformation found themselves better equipped to navigate the storm and respond effectively to the rapidly evolving circumstances.

Within this global landscape of technological advancement, the Saudi Arabian government stands as a unique context for the adoption of emerging technologies. Several compelling factors converge to emphasize the significance of this endeavor. First and foremost, the Saudi economy heavily relies on oil revenues, accounting for approximately 80% of export income and 40% of its gross domestic product (GDP) (Schaer, 2022). Recognizing the need for diversification and modernization, the government has embraced emerging technologies as a strategic means to reduce dependency on oil. Furthermore, the Saudi Arabian government has embarked on an array of ambitious modernization plans, notably Vision 2030, which places a premium on the adoption of emerging technologies to achieve modernization goals and enhance government operational efficiency (Vision 2030, n.d.). This vision is supported by a significant financial commitment, with the Kingdom projected to spend $34.6 billion on Information and Communications Technology in 2023, positioning it as the leading country in the Middle East, Turkey, and Africa region in ICT spending (Cabral, 2023).

Beyond economic and strategic considerations, the adoption of emerging technologies in Saudi Arabia, a country governed by Sharia (Islamic law and principles), is influenced by cultural and social factors, underpinned by Islamic values and practices. Ethical dimensions, particularly regarding AI and its alignment with Islamic principles of justice and fairness, have garnered attention (Alkhiri, 2022a). Alkhiri raises an urgent question about artificial intelligence, considering ethical foundations that determine its appropriateness and the impact of its applications on human activity. Hermansyah et al. (2023) echo this sentiment, highlighting AI's impact on mental abilities and social relations. Their concerns delve into realms of social justice and privacy, including the potential for AI to exhibit human-like mental disabilities. These discussions underscore the necessity of balancing technological advancement with adherence to tenets of Islam, which emphasize mental acuity and strong social connections (Alkhiri, 2022b).

Addressing the unique cultural, economic, and strategic imperatives of the Saudi Arabian government, this study aims to bridge the research gap highlighted by the notable absence of systematic literature reviews on the adoption of emerging technologies in the public sector of Saudi Arabia. This includes addressing gaps in literature pertaining to specific technologies such as 5G and Robotics, as well as gaps in geographic focus, which are critical in understanding the diverse applications and implications of these technologies in different regional contexts. The study provides a comprehensive analysis of the adoption of emerging technologies within the Saudi public sector. It delves into the drivers of technological adoption and pinpoints emerging

technologies that are catalyzing public sector innovation in the Saudi government. Furthermore, it examines the complex challenges faced during and after the implementation of these technologies, offering a nuanced understanding of their integration process. Additionally, the study furnishes a valuable framework for researchers and policymakers examining the adoption of emerging technologies in other governments and regions, thereby contributing to the broader field of public sector innovation research.

Moreover, this research holds potential benefits for end users, including Saudi Arabian citizens, residents, and investors. Echoing the insights of Gaikwad and Jadhav (2021), it emphasizes the pivotal role of Information and Communication Technologies (ICTs) in delivering efficient services. By addressing the challenges that hinder the adoption of emerging technologies, this study indirectly contributes to enhancing the efficiency and effectiveness of government services. Consequently, this translates into tangible benefits for the end users, including improved accessibility and quality of public services.

To achieve the study's objectives, the following research questions are proposed:

RQ1: What emerging technologies are adopted in the Saudi Arabian government entities, and which promising technologies remain underutilized?

RQ2: What challenges does the Saudi government face during and after the implementation of emerging technologies?

Systematic Literature Review

This systematic literature review comprehensively explores various aspects of emerging technologies, their evolution, and their impact in the context of the Saudi Arabian public sector. It delves into the stages of technology adoption, highlighting the most prominent technologies and examining their role in Saudi Arabia's digital transformation journey.

Emerging technologies

The term “emerging technology” first appeared in the 1960s and began to be used widely in scientific journals in the 1990s (Cozzens et al., 2010). According to Millea, Green, and Putland (2005), a technology can be categorized as emerging as long as it has not yet reached the status of a must-have or widely adopted. For instance, in its earlier stages, email was an emerging technology with limited usage and effectiveness. However, as time progressed and technology advanced, email has become a highly effective communication tool in today's digital age. This exemplifies how a technology that was once considered emerging has now become a standard and widely adopted method of communication. The definition of emerging technologies is a matter of contention in the scientific community. The New Oxford American Dictionary defines “emerge” as “the process of coming into being, or of becoming important and prominent” (Rotolo, Hicks, and Matrin, 2015). On the other hand, Porter et al. (2002) defined it as those technologies that are likely to influence the economy positively over the next 15 years or so, whereas Cozzens (2010) described it as a technology that has immense promise but hasn't proven its worth or gained widespread acceptance.

Other researchers have expanded on the characteristics of emerging technologies. For instance, Rotolo, Hicks, and Matrin (2015) emphasized that they have a significant impact on socio-economic domains, are not a "static property" but rather a "label for a process", and are consistently surrounded by "uncertainty and ambiguity". Veletsianos (2016) noted that the context of these technologies changes and evolves over time. Further, these technologies promote new industries and modernize existing ones, as highlighted by Cozzens (2010), while also influencing organizations in the foreseeable future (Johnson et al., 2014). Millea (2005) mentioned that they are not yet a "must-have". Adding to these, Digital Government Authority (2022) introduced the aspects of 'Novelty', indicating that they bring newness and originality, and 'Coherence', suggesting a harmonized alignment with current technologies or paradigms.

Technology Evolution Stages

Understanding the adoption and evolution of these technologies also means acknowledging their lifecycle. Cozzens (2010) identifies five distinct stages that a technology undergoes through during its evolution. The first stage is where the technology represents a great opportunity and potential. Yet, it hasn't proven much value and hasn't "settled down into any kind of consensus." This stage is called the emerging technology stage. The second stage of the cycle is the "leading edge," where technology shows value in the market, but still faces challenges in marketing it. Technology then moves to the next stage, the "prevalent technology stage," where the market and the majority of customers believe that this technology is the best fit their needs. After a while of using the prevalent technology, a new "leading technology" starts to be marketed and used by customers who are excited about the features and products, making the prevalent technology a "dated technology". The fifth and final stage is the "Obsolete technology stage," where the technology becomes rarely used.

Prominent emerging technologies

According to Likens (2021), among more than 250 emerging technologies, the following have been identified to potentially have the greatest business impact across various industries: 1) Artificial Intelligence, which uses techniques such as natural language processing and machine learning to improve the decision-making process for computers by simulating human cognition. 2) Blockchain, which is a shared, immutable digital ledger for recording transactions and verifying them across multiple participants. The ledger can be used to securely store and access data that is cryptographically encrypted, and the transactions stored within it are mathematically verifiable and unchangeable (Berryhill, Bourgery, and Hanson, 2018). 3) Internet of Things (IoT), which is a network of devices that are fitted with sensors, software, connectivity, and computing power that allows for data collection, exchange, and automated action without the need for human intervention (Holdowsky et al., 2014). 4) Robotics, self-governed robots capable of completing specific tasks autonomously from planning to execution, with artificial intelligence managing their movements in real-time interactions with physical environment elements.

In addition to these technologies, big data/data analytics and cloud computing have emerged as transformative forces and considered the core muscle of emerging technologies. Data is now available faster, has greater coverage and scope, and includes new types of observations and measurements that previously were not available (Prüfer and Chottmüller, 2021). According to Hariri, Fredericks, and bowers (2019), the rapid availability of data, characterized by the five

V's of big data (high volume, low veracity, high velocity, high variety, and high value) presents both an opportunity and a challenge for organizations and companies. Utilizing advanced data analysis techniques can transform big data into smart data, enabling the extraction of critical insights from large datasets. Consequently, smart data furnishes actionable intelligence, enhancing decision-making capacities for organizations and companies.

On the other hand, cloud computing, a model now prominent in modern business landscapes, encapsulates the delivery of traditional IT infrastructure and software services such as storage, CPU, network, applications, and services in a consolidated manner. This model facilitates on-demand network access to a shared pool of configurable computing resources including networks, servers, storage, applications, and services. These resources can be swiftly provisioned and relinquished with minimal management effort or interaction with the service provider (Columbia University, 2021; Microsoft, 2020).While cloud computing has matured in developed regions, it remains a burgeoning concept in many developing countries, including Saudi Arabia (Al Mudawi, Beloff, and White, 2020).

That said, Stevens and Zimmerman (2021) conducted a survey to examine the most crucial emerging technologies in 2020, respondents ranked big data/data analytics as the leading technology receiving 69% of the votes. The internet of things followed closely with 66% of the votes, while artificial intelligence/machine learning and robotics process automation secured the third and fourth positions with 66% and 53% of the votes, respectively. Moreover, in a related study by Scheibenreif (2022) focusing on the "Top 10 Customer Experience Technology Investment Priorities," Artificial intelligence emerged as the leading technology investment. Data management and analysis secured the second and fifth positions, respectively, emphasizing their significant roles in managing the customer experience.

Beyond the private sector, emerging technologies are also reshaping the public sector, influencing government operations and public services. According to Tech Trends 2022: A Government Perspective (2022), automation, blockchain, data-sharing, AI, and cybersecurity stand out as the most significant technology trends for governments. These technologies are pivotal in enhancing the efficiency, transparency, and security of government operations. Sorvino (2023) echoes this sentiment, highlighting Digital Identity, AI and Automation, Cyber Security, and National Cryptocurrencies (based on blockchain technology) as crucial trends in the public sector. These technologies are not only optimizing internal processes but also revolutionizing how citizens interact with government services, enhancing accessibility and trust in public institutions. Furthermore, the Ubaldi et al. (2019) report that AI and blockchain hold considerable potential for making the public sector smarter - more agile, efficient, user-friendly, and consequently, more trustworthy. These technologies can streamline bureaucratic processes, reduce redundancy, and improve the delivery of public services, aligning government operations with the needs and expectations of the 21st-century citizen.

Saudi Arabia and digital transformation

In recent years, Saudi Arabia has been one of the most active countries in the world when it comes to embracing new technologies and utilizing them in the public sector, which consists of 292 entities (ministries, councils, presidents, diwans (government body or office), universities, forces, funds, municipalities, governorates, colleges, corporations, directorates, centers,

hospitals, authorities, and other entities) (Digital Government Authority, 2021) . This movement is spurred by the ambitious national strategy called "Vision 2030," which was launched in 2016 with the theme "Transform or be left behind," aiming to make positive radical changes across multiple sectors including urban development, tourism, energy, healthcare, education, environment, housing, communication, and others (An Ambitious Vision for an Ambitious Nation, 2016). One of the main objectives of the vision is to strengthen the experience economy. This involves enhancing the government's effectiveness, not just by offering digital services but also by ensuring personalized customer experience (CXO Insight Middle East, 2019). To emphasize the importance of digital transformation's role in the vision, the government announced: "In technology, we will increase our investments in, and lead, the digital economy" (Sarirete et al., 2022).

The vision is based on three main pillars: Ambitious Nation, Thriving Economy, and Vibrant Society, which are cascaded into 96 strategic objectives achieved through a set of programs and initiatives. Among these programs is The National Transformation Program (NTP) that intends to enhance the government operations, and boost digital transformation, enabling all sectors (private, public, and non-profit) to achieve the vision's goals (Vision 2030, n.d.). Currently, Saudi Arabia has a strong focus on emerging technologies like artificial intelligence, big data/data analytics, internet of things, robotics, machine learning, 5G, blockchain, and 3D printing. These technologies are revolutionizing almost all aspects of life—from tourism to healthcare and education (Digital Government Authority, 2022b). To emphasize the importance of these technologies, the Saudi Arabia Crown Prince and Deputy of the Prime Minister said:

"We are living in a time of scientific innovation, unprecedented technology, and unlimited growth prospects. These new technologies, such as artificial intelligence and IoT, if used optimally, can spare the world from many disadvantages and can bring enormous benefits to the world" (Saudi Data and AI Authority, 2018).

Furthermore, he approved the launch of the National Strategy for Data and AI (NSDAI) to support the national plan for Data & AI, aiming to position the Kingdom among the world's most advanced data-driven economies by innovating sustainable and ethical artificial intelligence applications based on data and emerging technologies (Saudi Data and AI Authority, 2020).

Related Studies

Many researchers have studied emerging technologies and their effects on several aspects, such as transportation, healthcare, education, and security. For instance, in the transportation sector, Lachapelle et al. (1992) studied the use of emerging technologies in the Canadian transportation sector across three modes (marine, air, and road). Thai and Huh (2022) investigated how big data and cloud computing could increase the efficiency of patients' transportation in the Republic of Korea. Additionally, Camacho, Cárdenas, and Muñoz (2018) presented an overview of the role of 5G architecture in enhancing the intelligence of transportation systems (ITS). On the other hand, in the healthcare sector, Nazli et al. (2018) investigated the impact of big data and cloud computing in the Iranian healthcare industry. In their endeavor to develop an advanced healthcare system, Minopoulos et al. (2022) used a mix of emerging technologies such as Artificial Intelligence, Internet of Things, Big Data/Data Analytics, Augmented Reality (AR), Mixed Reality (MR), and Cloud Computing (CC) to empower medical personnel with speedy and precise information, aiding in accurate patient

diagnosis and treatment. Regarding the education sector, Foronda et al. (2017) studied the role of augmented reality (AR) and virtual simulation in nursing education and showcased six products that could enhance nursing education. Vries (2022) explored several concerns related to emerging technologies in engineering education. Moreover, Wang (2022), Xiaohong(2017), and Wang (2021) studied different applications and aspects of emerging technologies in distance learning. Further research, such as Elgelany et al.(2017), Abdullahi et al.(2022), and Adnan, Akbar, and Wang (2021), reviewed emerging technologies like cloud computing, AI, and big data in various domains like education, cybersecurity, and engineering, respectively.

While the current literature offers valuable insights into the adoption of emerging technologies such as AI, blockchain, IoT, and big data in the public sector, it also reveals significant gaps. Firstly, there's a noticeable lack of comprehensive coverage of critical technologies like 5G and robotics, suggesting an incomplete exploration of the entire technology spectrum. Secondly, the geographical focus of existing studies is predominantly either too generic or overly specific to countries like the UK and Poland. This is a notable omission, as the unique socio-economic and regulatory fabric of different regions, especially in the Middle East, likely influences the adoption and impact of these technologies in distinct ways. In particular, the scarcity of research specifically targeting Middle Eastern countries, and Saudi Arabia in particular, is stark. This gap is especially pronounced when considering the ambitious objectives of Saudi Arabia's Vision 2030, which is poised to significantly reshape the country's socio-economic landscape. The absence of focused research on how emerging technologies can be leveraged within the Saudi public sector, in alignment with Vision 2030, highlights a critical research gap.

In response to these deficiencies, this study aims to bridge these gaps by offering a comprehensive exploration of emerging technologies within the unique socio-economic context of Saudi Arabia. Table 1 provides a detailed synopsis of the extant literature pertinent to the adoption of emerging technologies in the public sector, emphasizing the need for research that takes into account the unique characteristics of different geographical regions.

Methodology

A Systematic Literature Review (SLR) was undertaken to thoroughly explore the most relevant and current literature on emerging technologies and their implementation within the public sector of Saudi Arabia. This approach was chosen for its rigor and systematic nature, allowing for the synthesis and evaluation of a large volume of literature in an objective and comprehensive manner (Tranfield, Denyer, and Smart). It increases the trustworthiness of the findings and decreases bias (Liberati et al., 2009), and it offers concise summaries of the current studies and limitations related to a subject area allowing for the identification of future research (Page et al., 2021). Through conducting an SLR, a thorough understanding of the current state of emerging technologies utilized by the Saudi Arabian government to improve public services was obtained, as well as an in-depth analysis of the challenges faced during and after implementation.

Table 1: Overview of Research on Emerging Technologies in the Public Sector

Study/Authors	Scope	Method	Limitations	Findings
Whether AI adoption challenges matter for public managers? The case of Polish cities. (Sienkiewicz-Małyjurek, 2023)	Identify challenges in AI adoption by public organizations	SLR and survey research	Geographically limited to Polish Cities; Solely focused on AI	Identified 15 distinct challenges hindering AI adoption within public organizations
Unveiling Roadblocks and Mapping Solutions for Blockchain Adoption by Governments: A Systematic Literature Review. (Setiawan Wibowo and Yazid, 2023)	Identify and analyze barriers and solutions in blockchain adoption by governments	SLR combined with the tollgate method	Time frame from 2019 to 2023; Sole focus on Blockchain technology	Unveiled 40 distinct adoption challenges and proposed corresponding solutions for blockchain technology
Challenges of blockchain technology adoption for e-government: a systematic literature review. (Batubara, Ubacht, and Janssen, 2018)	Review challenges and future directions of blockchain adoption in e-Government	SLR and TOE framework	Narrowly focused on Blockchain technology	Highlighted the limited adoption and identified 23 specific challenges; Emphasized the lack of empirical evidence
Systematic Literature Review on Opinion Mining of Big Data for Government Intelligence. (Kumar and Sharma, 2017)	Review opinion mining applications and challenges in big data for government intelligence	SLR	Time frame from 2011 to 2017; Limited to Big Data technology	Classified application areas into six broad domains, offering a comprehensive view of the field's scope and potential
Artificial Intelligence in Government Services: A Systematic Literature Review. (Reis, Santo, and Melão, 2019)	Provide an overview of AI's role in policy making and government services	SLR, bibliometric analysis, content analysis	Exclusively focused on AI	Suggested the need for more in-depth research in public administration, governmental law, and business economics to fully leverage AI in digital transformation
Algorithmic Government: Automating Public Services and Supporting Civil Servants in using Data Science Technologies. (Engin and Treleaven, 2019)	Propose a technology framework for utilizing emerging technologies in the public sector	SLR	Limited to the UK; Covers multiple technologies (AI, Blockchain, IoT, Big Data)	Provided a comprehensive technology framework illustrating how emerging technologies can be effectively utilized in the public sector
The Challenges and Opportunities in Adopting AI, IoT, and Blockchain Technology in E-	Identify challenges and opportunities of AI, IoT, and	SLR	Time frame from 2016 to 2021; Focused on AI, IoT, and Blockchain	Addressed challenges related to technical infrastructure, cost-benefit considerations, and legal foundations;

Government: A Systematic Literature Review. (Ivic et al., 2022)	blockchain in e-government			underscored the potential benefits and risks of adopting these technologies in e-government
Assessing behavioral data science privacy issues in government artificial intelligence deployment. (Saura et al., 2022)	Classify risks to citizens' privacy in government AI deployment	SLR	Singularly focused on AI	Revealed 11 AI strategies employed by governments, highlighting implications for citizen interaction, service provision, and economy; Identified 8 critical privacy-related issues arising from government use of AI
Understanding the Use of Emerging Technologies in the Public Sector: A Review of Horizon 2020 Projects. (Kalampokis et al., 2023)	Understand the utilization and deployment of emerging technologies in the public sector	SLR and concept-centric analysis	Time frame from 2018 to 2021; Limited to Horizon 2020 funded projects; Covers multiple technologies (AI, Cloud Computing, Blockchain, Semantic Technologies, NLP)	AI, Cloud Computing, Blockchain, Semantic Technologies, and NLP were identified as the top five emerging technologies explicitly mentioned in the objectives of Horizon 2020 projects

For quality assurance purposes, the study's structure will strictly follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method, which is used "as a basis for reporting systematic reviews" (Moher et al., 2009). The PRISMA flow diagram consists of four phases: "Identification, screening, eligibility, and inclusion." Through them, the appropriate research will be selected, filtered, and analyzed to achieve the study's objectives (Liberati et al., 2009). Figure 1 depicts the four phases of the systematic literature review following PRISMA.

Figure 1: PRISMA Phases

Phase 1: Identification

Reputable databases such as Scopus and Web of Science (WoS) were utilized to identify studies pertinent to the current research. The selection of these two databases was predicated on their credibility, quality, and cross-disciplinary coverage. Additionally, WoS and Scopus are primary sources for citations as noted by Mongeon and Paul-Hus (2016). The articles included were sourced from high-ranked journals.

Two sets of search keywords were employed to search within the articles' titles in the two databases; the first set comprises "Government*" OR "Public sector*". The terms "public

sector" and "government" were utilized in the search keywords as they are used interchangeably to refer to non-private sector service providers. The second set comprises "Emerg* technolog*" OR "AI" OR "Big Data" OR "Cloud Computing*" OR "IOT" OR "Internet of Things" OR "Artificial Intelligence" OR "Machine Learning." The detailing of technologies in the search keywords was executed for two reasons. First, some researchers employ abbreviations when referring to specific technologies (e.g., AI for Artificial Intelligence, ML for Machine Learning, etc.). Second, certain researchers utilize the term "emerging technology" in their titles without explicitly enumerating the technologies involved, and conversely.

While numerous emerging technologies like augmented reality and virtual reality are gaining traction globally, this analysis strategically focuses on AI, cloud computing, IoT, big data, robotics, and blockchain due to their impact on public sector operations as noted by Phuyal, Bista, and Bista (2020). AI, being a cornerstone, has been instrumental in fostering innovations across a multitude of sectors, ranging from healthcare to education (Berryhill et al., 2019). It has paved the way for the development of novel tools for fraud detection, customer service, and policy analysis within governmental frameworks. On the other hand, cloud computing has significantly augmented the efficiency and scalability of government IT systems (Alanezi, 2018), while IoT has emerged at the forefront of smart city applications, including intelligent traffic management systems and energy-efficient buildings. Big data continues to play a pivotal role in enhancing the delivery of public services, notably in healthcare and education. robotics and blockchain are also gaining momentum; robotics is revolutionizing public service delivery (Digital Government Authority, 2022), and blockchain is fostering transparency and trust in government transactions (Berryhill, Bourgery, and Hanson, 2018). This technological focus aligns with the Saudi government's vision as clearly articulated in the Guidelines for Emerging Technology Adoption by the Digital Government Authority in Saudi Arabia. The guideline underscores the Saudi government's keen interest and substantial investments in these technologies to bolster operational efficacy in the public domain, echoing broader global trends in leveraging emerging technologies for enhanced governance and public service delivery (Digital Government Authority, 2022).

Table 2 shows the search keywords and queries used for each database. The search resulted in 290 studies from all sources, with 105 studies found in the Web of Science and 185 studies found in Scopus.

Phase 2: Screening

The initial step in the screening process involved delineating and implementing a set of stringent inclusion and exclusion criteria, which were methodically established to identify articles pertinent to this systematic review. For efficiency and to save on translation efforts, articles written in languages other than English were excluded. Regarding the publication date, only articles published between 2018 and 2022 were included. This time frame was chosen because it spans the last five years, a period during which technologies have rapidly evolved. The aim of this research is to cover the latest studies about the use of emerging technologies in government. In terms of document type, the focus was primarily limited to articles. To ensure the quality of the publications reviewed, conference proceedings were systematically excluded (Mingers, Macri, and Petrovici, 2012). Additionally, all journals that were not of final review were omitted, and articles from irrelevant subject areas such as energy, nursing, mathematics,

fuel, physics, urban studies, and medicine were excluded. With regard to accessibility, only open-access studies were retained.

Table 2: **Search queries.** Query Date February 5, 2023

Database	Queries
Scopus	(TITLE((“Government*” OR “Public sector*”)) AND TITLE(“Emerg* technolog*” OR “AI” OR “Big Data” OR “Cloud Computing*” OR “Blockchain” OR “Data Analyt*” OR “Robotic*” OR “RPA” OR “IOT“ OR “Internet of Things” OR “Artificial Intelligence ” OR “Machine Learning”)) AND PUBYEAR > 2017 AND PUBYEAR < 2023 AND (LIMIT-TO (SRCTYPE,” j”)) AND (LIMIT-TO (OA,” all”) OR LIMIT-TO (OA,” publisherfullgold”) OR LIMIT-TO (OA,” publisherhybridgold”) OR LIMIT-TO (OA,” repository”)) AND (LIMIT-TO (PUBSTAGE,” final”)) AND (LIMIT-TO (SUBJAREA,” COMP“) OR LIMIT-TO (SUBJAREA,” SOCI“) OR LIMIT-TO (SUBJAREA,” BUSI”)) AND (LIMIT-TO (DOCTYPE,” ar”)) AND (LIMIT-TO (LANGUAGE,” English”))
Web of Science (WoS)	Results for (“Government*” OR “Public sector*”) (Title) AND “Emerg* technolog*” OR “AI” OR “Big Data” OR “Cloud Computing*” OR “Blockchain” OR “Data Analyt*” OR “Robotic*” OR “RPA” OR “IOT” OR “Internet of Things” OR “Artificial Intelligence ” OR “Machine Learning” (Title) and 2022 or 2021 or 2020 or 2018 or 2019 (Publication Years) and Article (Document Types) and English (Languages) and Green Accepted or Green Published or Free to Read or Gold-Hybrid or Gold or All Open Access (Open Access)

The researchers then initiated the process of eliminating duplicates to identify and remove any repetitive studies. For this task, Microsoft Excel was utilized, leading to the exclusion of 48 studies. This resulted in a total of 95 unique studies remaining for analysis. Table 3 presents the criteria used for inclusion and exclusion in the study.

Phase 3: Eligibility

After the screening phase, 95 articles were selected for the third round, which involved evaluating their eligibility and relevance to answering the research questions. To be considered eligible, articles had to meet the following criteria:

1) The research purpose had to be related to Saudi Arabia.
2) The target population had to be the general public (citizens and residents) rather than specific groups.
3) The research had to be related to the Saudi government or have implications for government policies.

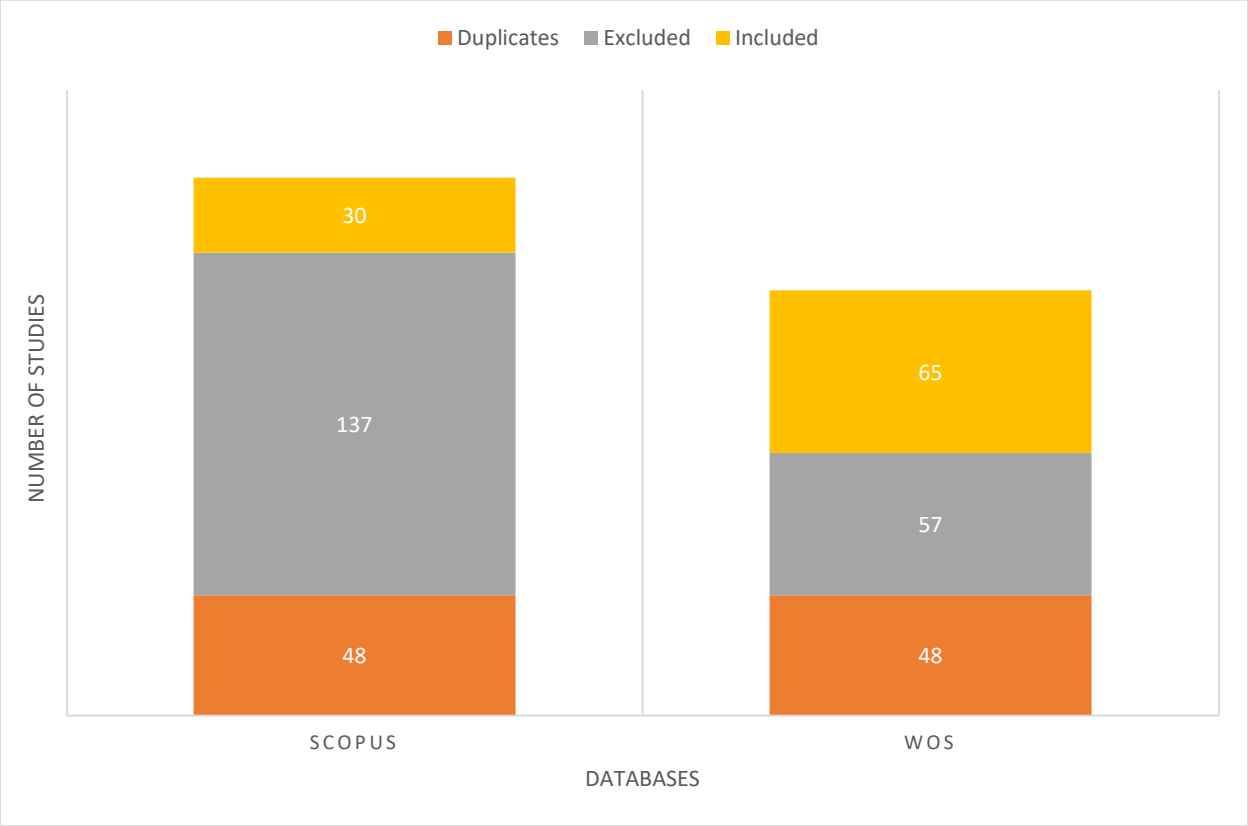
Each article was meticulously reviewed to ensure it met these criteria. Articles that did not fulfill all three criteria were omitted from the review. Moreover, to ensure the accuracy and validity of the selection process, consultation with an expert in the field occurred, where they reviewed the list of articles and provided feedback. The expert's comments were carefully considered, and necessary adjustments were made to the selection process. This enhanced the rigor of the review and ensured that only the most pertinent and high-quality articles were included in the study.

Table 3: Inclusion and Exclusion Criteria

Criteria	Inclusion		Exclusion
Language	English		All other languages
Period	2018-2022		
Document Type	Article		Book chapters, Conference proceedings, and Book series
Publication Stage	Final		Peer Reviews and Articles in Press
Open Access	All open access, Green, Gold, and Hybrid gold	Scopus	Green Submitted
	Gold, Gold-Hybrid, Free to read, Green, published, and Green accepted	WoS	
Source Type	Journal		

The selection process led to the exclusion of 42 journal articles and retained 53 articles for further analysis to extract relevant data and insights. These articles provided the basis to address the research questions. Figure 2 presents the results of the search and screening process for each database

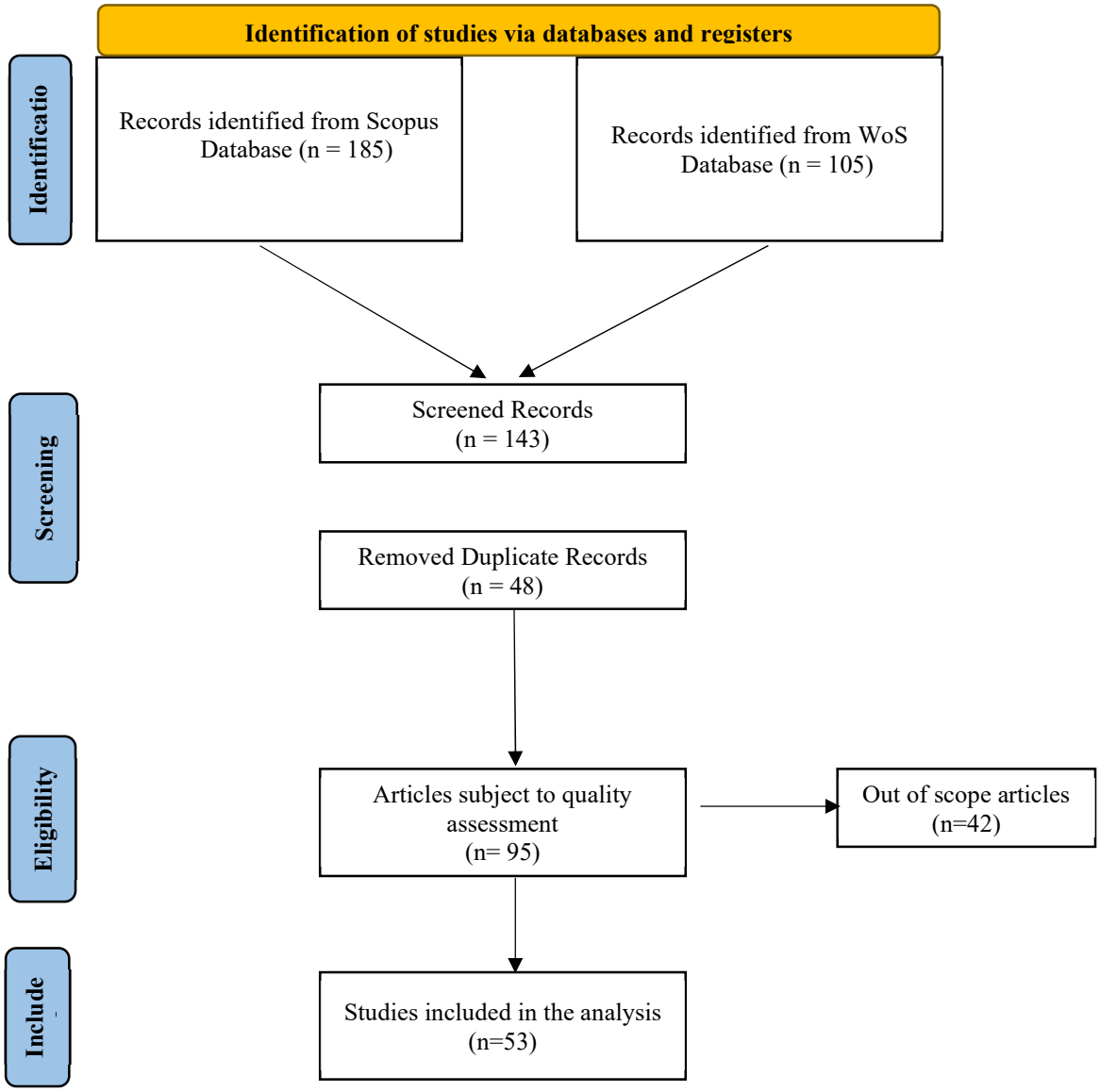
Figure 2: Comparative Analysis of Search and Screening Results in Scopus and WoS



Phase 4: Inclusion

Following a meticulous review, 53 journal papers were retained for an in-depth assessment and analysis. The selected studies were categorized based on the primary emerging technologies they employed. Since machine learning is regarded as a subset of artificial intelligence, as elucidated in several sources (Columbia University, 2021; Microsoft, 2020), all research pertaining to either Machine Learning or AI was collectively grouped under the umbrella term of artificial intelligence (refer to Table 4). Finally, to provide a visual representation of the systematic review process applied in this analysis, Figure 3 presents the PRISMA Flow Chart.

Figure 3: PRISMA Flow Chart

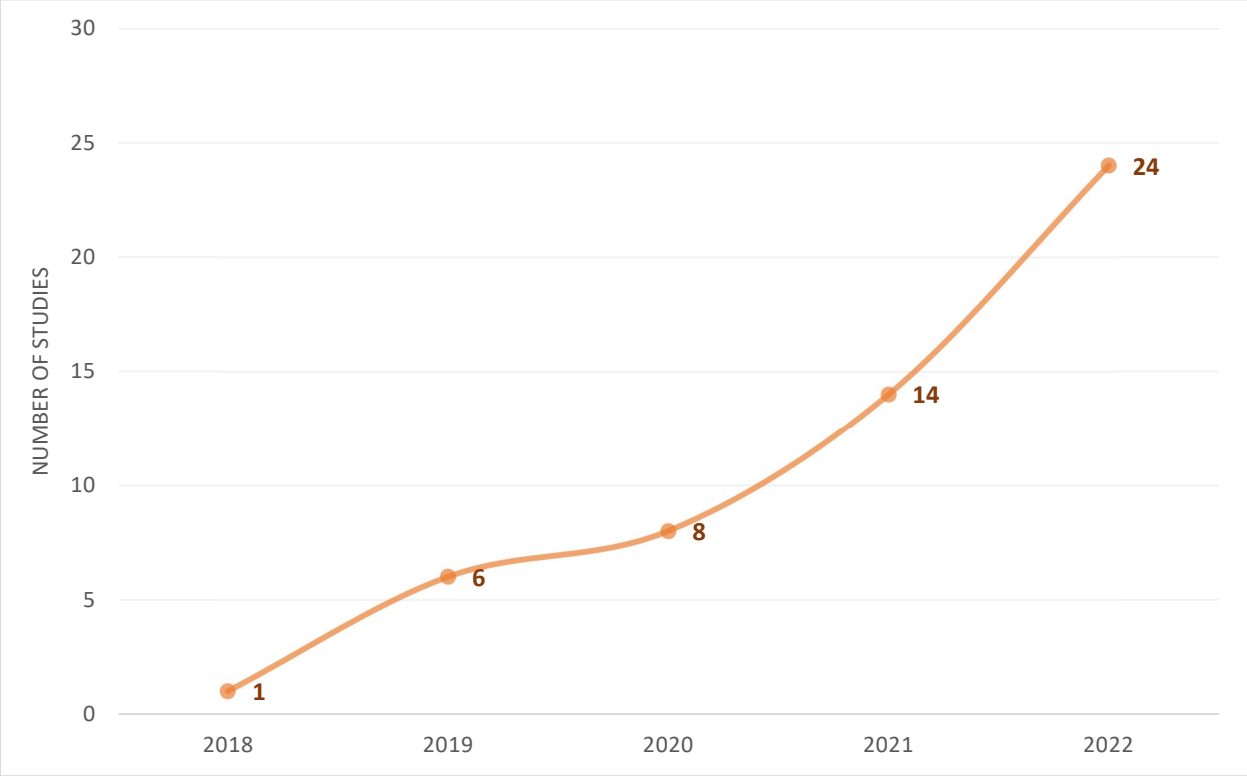


Analysis and Results

The analysis indicates a notable increase in emerging technology studies related to the Saudi government from one in 2018 to 24 in 2022, as illustrated in Figure 4. This upward trend can be attributed to several factors, including the Saudi government's strong commitment to digital transformation and innovation. The government has demonstrated this commitment through various initiatives aimed at facilitating the adoption of emerging technologies across different sectors, such as healthcare, transportation, and finance. Furthermore, significant resources have been invested in developing the necessary infrastructure and essential resources

to support the seamless implementation of emerging technologies in various government domains (Digital Transformation, 2021; The National Transformation Program, 2021). However, to gain a more comprehensive understanding of the underlying reasons behind this increase and to accurately predict the future trajectory of technology trends, it is imperative to conduct further research and analysis. Such a research inquiry could help to identify the precise factors driving the observed increase in technology adoption.

Figure 4: Trend in the number of Published Studies on Emerging Technologies in the Saudi Public Sector



In addressing the research questions, the findings, based on extensive analysis, are as follows.

Addressing RQ1: Adoption of Emerging Technology in the Saudi Arabian Government

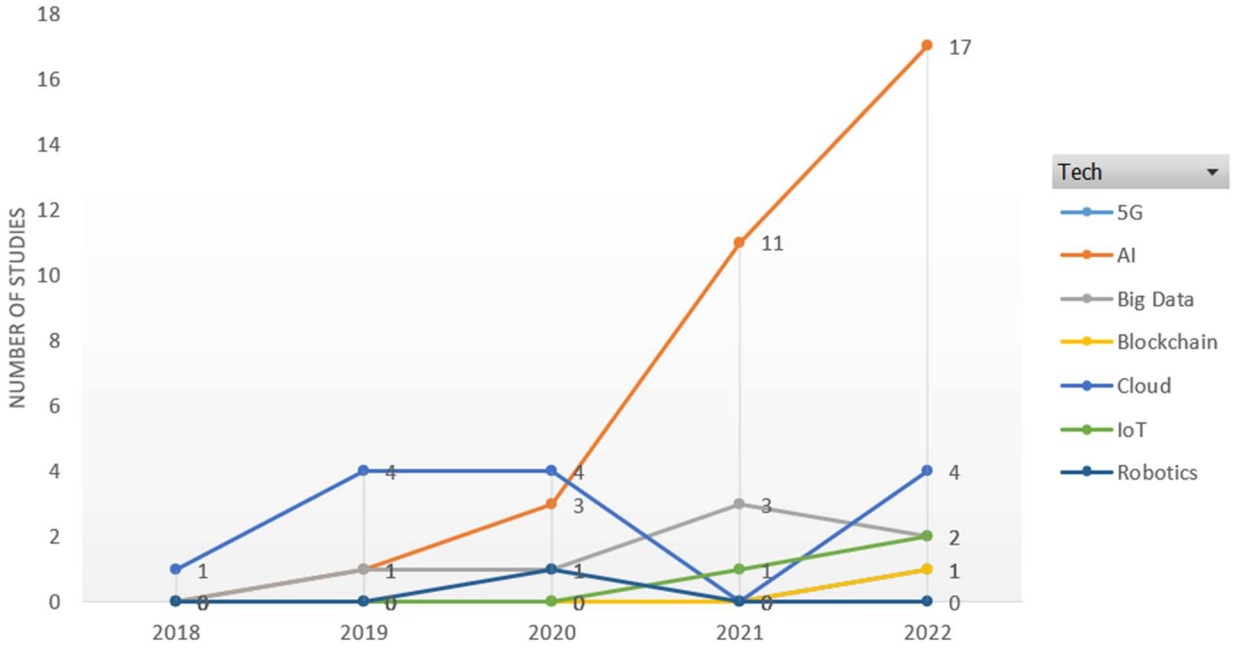
The analysis reveals distinctive trends in research attention directed toward various emerging technologies. Notably, the number of studies focusing on AI has exhibited significant growth over the years, with a jump from three studies in 2020 to 11 studies in 2021 and 17 studies in 2022 (see Figure 5). This upward trajectory aligns seamlessly with the global trend of harnessing AI for driving digital innovation and resonates with the Saudi government's dedication to this technology (Saudi Data and AI Authority, 2018).

These findings underscore the vast potential of AI to improve public services in Saudi Arabia, spanning applications that encompass personalized healthcare services, educational

enhancements, and the overall enhancement of government efficiency. In contrast, other technologies like cloud computing have also received notable attention, with a total of 13 studies. Big data/data analytics accounted for seven studies, indicating considerable interest and exploration. On the other hand, the research landscape also reveals contrasting patterns. Some emerging technologies, such as robotics, blockchain, and 5G, have received limited research attention, featuring only one study each (Table 3). This observation hints at a potential research gap within the Saudi context, particularly concerning transformative technologies that have previously garnered recognition in the literature (Cassetta et al. (2020), A. Gajo (2023), and Khan, Imran, and Haleem, 2020).

It is noteworthy that five of the studies incorporated more than one emerging technology in their research (demonstrated in Table 5), reflecting a multifaceted approach to addressing technological challenges. Additionally, two studies highlighted in this review demonstrate the expansive applicability of emerging technologies across multiple government entities, indicating promising potential for cross-sectoral collaboration in the Saudi Arabian government sector. The study by Alzain et al. (2022) involved an analysis across three distinct entities: the Ministry of Municipal, Rural Affairs and Housing (MOMRAH), the Ministry of Justice (MOJ), and the Ministry of Commerce (MOC). This collaborative investigation underscores the multidisciplinary nature of emerging technologies and their potential to bridge integrated solutions across diverse government domains. Similarly, the study conducted by Alharbi et al. (2019) focused on the synergy between the Ministry of Health (MOH) and the Ministry of Haj and Umrah (MOHU), highlighting how the integration of technology can streamline operations. This synergy showcases a cohesive approach to addressing challenges and optimizing service delivery in disparate, yet interconnected, governmental sectors. Notably, the Haj refers to the pilgrimage, while Umrah denotes a non-compulsory pilgrimage. Through these studies, it is evident that exploring cross-sectoral collaboration through the lens of emerging technologies opens avenues for more integrated and efficient governmental operations.

Figure 5: Trends in Studies on Emerging Technologies by Technology Type in the Saudi Government



Addressing RQ1: The Impact of COVID-19 on Emerging Technology Adoption

Analysis of the 53 studies provides intriguing insights into how the COVID-19 pandemic has shaped research priorities and the adoption of emerging technologies in Saudi Arabia. Notably, 36% of the analyzed studies focused on the pandemic, highlighting its profound influence on both research directions and the use of emerging technologies in addressing its challenges. Figures 4 and 5 illustrate this evolving trend over the past three years.

Furthermore, the use of emerging technologies in COVID-19-related research has steadily increased. In 2020, only 10% of the eligible studies incorporated these technologies in the pandemic investigation, but this percentage rose to 31% in 2021 and further to 57% in 2022. This upsurge signifies the accelerated adoption of emerging technologies, driven by the urgent demands posed by the pandemic.

Moreover, a closer examination of the studies targeting the Ministry of Health (MoH) revealed that out of the 29 studies, 21 leveraged AI and big data, highlighting the immense potential of these technologies in the healthcare. Notably, Kola, Veena, and Guntoju (2022) employed machine-learning algorithms to forecast infection rates 60 days in advance. Additionally, Atlam et al. (2022) applied statistical and machine-learning methods to examine the pandemic's impact on education systems, specifically focusing on the psychological well-being of university students. While Alabbad et al. (2022) developed a machine learning model to identify COVID-19 patients requiring intensive care and predict their expected duration of stay.

Table 4: Studies Categorized by Primary Emerging Technology

Emerging Technology	Studies	Number of Studies
Artificial Intelligence (AI)	Kuppuswamy et al.(2022) Abalkhail and Al Amri (2022) Alzain et al.(2022) Humayun and Alsayat (2022) Alkhammash, Al Otaibi, and Ullah (2021) Sayed Al Mnhrawi and Alreshidi (2022) Areef et al. (2021) Alzahrani et al. (2021) Osman et al. (2021) Ahmad et al.(2022) Kola, Veena, and Guntoju (2022) Mukhtar and Al Azwari (2021) Alhazmi et al. (2021) Alqurashi (2022) Aljabri et al. (2021) Alkhelaiwi et al.(2021) Alghamdi et al. (2021) Shahin and Almotairi (2021) Noor et al. (2022) Islam et al. (2022) Daghistani and Alshammari (2020) Hadwan et al. (2022) Alanazi et al. (2020) Khan et al. (2022) Olatunji et al. (2022) John and Shaiba (2019) Atlam et al. (2022) Noor et al. (2022) Alswedani et al. (2022) Alswedani, Mehmood, and Katib (2022) Alabbad et al. (2022)	32
Cloud Computing	Al Mudawi, Beloff, and White (2020) Ali (2020) Alanazi et al. (2020) Alanazi, Gay, and Alturki (2022) Karim(2022) Sharaf et al. (2019) Alenezi (2019) Alassafi et al. (2019) Al-Ruithe et al.(2020) Alanezi (2018) Alkhlewi et al. (2019) Alrebdi and Khan (2022) Alassafi et al. (2022)	13
Big Data/Data Analytics	Alswedani et al. (2022) Kuppuswamy et al.(2022) Qaffas, Hoque, and Almazmomi (2021) Alharbi et al. (2019) Bali et al. (2021) Alfaifi and Khan (2022) Alkraiji (2022)	7
Internet of Things	Almalki (2022) Humayun, Jhanjhi, and Almotilag (2022) Qaffas, Hoque, and Almazmomi (2021)	3
Blockchain	Alzahrani, Alhomoud, and Wills (2022)	1
Robotics	AlGosaibi et al. (2020)	1
5G	Humayun, Jhanjhi, and Almotilag (2022)	1

Table 5: Research Spanning Several Emerging Technologies

Study	Emerging Technologies
Humayun, Jhanjhi, and Almotilag (2022)	IoT, 5G
Kuppuswamy et al. (2022)	AI, Big Data
Alanazi et al. (2020)	AI, Cloud Computing
Alswedani et al. (2022)	AI, Big Data
Qaffas, Hoque, and Almazmomi (2021)	IoT, Big Data

Addressing RQ1: Primary Government Sectors Targeted by Emerging Technologies Studies in Saudi Arabia

Our analysis underscores the pivotal role of emerging technologies across various Saudi governmental sectors. While 15 studies revealed potential benefits for all Saudi government sectors, specific ministries were more prominently featured. The Ministry of Health (MOH) stood out with 29 studies, underscoring the significant implications of emerging technologies within the healthcare sector. Following closely, the Ministry of Education (MOE) had ten studies, pinpointing the transformative potential of these technologies in educational system enhancements.

Besides that, emerging technologies were often used in conjunction with each other to enhance their capabilities and provide more comprehensive solutions. For instance, IoT devices require high-speed internet connectivity, provided by 5G networks, to communicate and transmit data, facilitating real-time data communication with low latency. Likewise, AI algorithms require large amounts of data (Big Data) for training and learning, while cloud computing is utilized for storing and processing extensive datasets, providing the scalability and flexibility required for AI and big data applications.

In relation to RQ1, this analysis highlights that emerging technologies can benefit various government sectors in Saudi Arabia. The Ministry of Health and the Ministry of Education have shown the most potential for utilizing emerging technologies to enhance their services. However, some government sectors might not prioritize the implementation and research on emerging technologies as heavily as others, indicating a need for further exploration of potential technology applications across all government sectors. Table 6 provides further insights into the specific Saudi government entities that were the focal point of research studies related to emerging technologies. This encompasses the Ministry of Commerce (MOC), Ministry of Hajj and Umrah (MOHU), Ministry of Interior (MOI), Ministry of Justice (MOJ), Ministry of Municipal and Rural Affairs and Housing (MOMRAH), Ministry of Social Affairs (MOSA), and Ministry of Transportation (MOT).

Table 6: Comparative Analysis of Emerging Technology Studies Related to Saudi Government Ministries

Gov. Entities	5G	AI	Big Data	Blockchain	Cloud	Cloud Computing	IoT	Robotics	Grand Total
MOC		1							1
MOE		6	2		2				10
MOH	1	18	3	1	2	1	3		29
MOHU		1	1						2
MOI	1	1					1		3
MOJ		1							1
MOMRAH		1							1
MOSA		1							1
MOT	1	1					1		3
Saudi Gov		4	2		8			1	15
Grand Total	**3**	**35**	**8**	**1**	**12**	**1**	**5**	**1**	**66**

Addressing RQ2: Challenges in Adopting Emerging Technologies in the Saudi Arabian government

Despite the crucial role that emerging technology plays in the digital transformation process, bringing numerous benefits such as cost reduction (Field, Patel, and Leon , 2019) and enhanced performance (Kelly, Kaye, and Oviedo-Trespalacios, 2023; Parviainen et al., 2017), its adoption within the Saudi Arabian government sector remains confronted by several significant challenges. Comprehensive analysis of the eligible studies has identified nine key challenges commonly encountered.

Security and Privacy Concerns

Robust security measures are imperative to safeguard government data against cyber threats, a challenge that gains urgency in an era of increasingly sophisticated and frequent cyberattacks. The Shamoon malware attacks in 2012 and 2016, which targeted Saudi government organizations and oil companies, serve as a poignant example of the persistent and evolving threats (Alelyani and Kumar, 2018). In light of this, Humayun, Jhanjhi, and Almotilag (2022) raised concerns about the security of interconnected devices (IoT) in government operations. Vulnerabilities within IoT ecosystems can potentially expose critical infrastructure to cyber threats, posing a considerable challenge to government cybersecurity efforts.

Furthermore, the adoption of cloud computing solutions introduces a distinct set of security considerations. For instance, Al Mudawi, Beloff, and White (2020) and Ali (2020) underscore the lack of control and ownership of data. This issue stems from the fact that in cloud computing, data and information are not stored on government premises; instead, they are accessed through the internet, with third-party providers offering these services. Consequently, it becomes the responsibility of the government to ensure the implementation of all necessary security features to safeguard data and information against unauthorized access, modification, or destruction. Another notable challenge associated with cloud computing adoption in the government sector is the issue of unsatisfactory financial benefit. As highlighted by Alrebdi and Khan (2022), there can be instances where the anticipated cost savings and financial benefits of migrating to cloud-based solutions do not materialize as expected. Government agencies may invest significant resources in transitioning to cloud environments, including the procurement of cloud services, training, and infrastructure upgrades. However, the actual return on investment (ROI) may fall short of initial expectations due to various factors such as unexpected migration costs, ongoing subscription fees, and the need for additional security measures. Lastly, Al Mudawi, Beloff, and White (2020) draw attention to significant privacy risks.

Balancing the protection of sensitive citizen data with the advantages of cloud technology poses a complex challenge in safeguarding citizens' privacy rights. To address these concerns, the Saudi government has taken significant steps, including the enactment of the Personal Data Protection Law in 2021 (Personal Data Protection Law, 2021). This law represents a crucial milestone in the country's commitment to data privacy, establishing a legal framework that mandates the protection of personal data collected, processed, or stored by any entity operating within the Kingdom. The Personal Data Protection Law introduces several key provisions aimed at enhancing data security and privacy. For instance, it requires explicit consent from individuals before their personal data can be processed, ensuring that citizens have control over their information. Furthermore, the law stipulates strict guidelines for data processing and storage, obliging organizations to implement robust security measures to prevent data breaches and unauthorized access. These measures are crucial in the context of cloud technology, where data is often stored and managed externally, raising concerns about vulnerability to cyber threats (Personal Data Protection Law, 2021).

However, the effective implementation of this legal framework remains an ongoing challenge, requiring further attention and effort (Alrebdi and Khan, 2022; Al Mudawi, Beloff, and White, 2020; Ali, 2020; Humayun, Jhanjhi, and Almotilag , 2022). Ensuring compliance among all entities, particularly in a rapidly evolving digital landscape, and fostering a culture of

data privacy awareness are essential steps towards the successful realization of the law's objectives. Continuous monitoring, regular updates to the legislation in response to technological advancements, and comprehensive training programs for stakeholders are necessary to ensure the law achieves its intended impact in protecting citizens' data privacy in the age of cloud technology.

Lack of Expertise

The rapid evolution of technologies such as AI, IoT, and blockchain necessitates a workforce with specialized skills and knowledge. Several studies have emphasized the shortage of such expertise within the government sector. Alrebdi and Khan (2022) and Al Mudawi, Beloff, and White (2020), along with Ali (2020), observed that government agencies often struggle to attract and retain talent with the requisite technical proficiencies. The shortage of skilled personnel poses a substantial barrier to effectively harnessing the potential of emerging technologies. Furthermore, according to Ali (2020), the lack of training opportunities for government staff makes the challenge more difficult. For instance, a study on cloud computing adoption at higher educational institutions in Saudi Arabia highlighted that inadequate training can result in the improper utilization of cloud resources, leading to increased costs, regardless of actual usage.

Infrastructure Upgrades

One of the significant challenges faced by the Saudi Arabian government in the adoption of emerging technologies is the need for substantial infrastructure upgrades. Several key areas require attention and investment. According to Al Mudawi, Beloff, and White (2020), IT infrastructure, internet availability, internet coverage, and communication tools represent a major challenge in the developing countries, including Saudi Arabia. This has a negative impact on adopting technologies such as IoT, which requires seamless high-speed data transmission, as noted by Humayun, Jhanjhi, and Almotilag (2022). Moreover, the large amount of data generated from technologies such as IoT and blockchain necessitate high computational power in addition to scalable and high-performance data storage and processing capabilities (Humayun, Jhanjhi, and Almotilag, 2022; Alzahrani et al., 2022). Therefore, the government must invest in data centers and cloud infrastructure to accommodate the growing data volumes and analytical demands. Lastly, cybersecurity infrastructure must be continuously updated and aligned with international best practices to safeguard sensitive government data from breaches and cyberattacks (Alghamdi et al., 2022). Inadequate cybersecurity measures could expose the government to significant risks, including data breaches, financial losses, and damage to its reputation (Aljumah and Ahanger, 2020).

Cost

While emerging technologies offer substantial benefits, it's crucial to address the associated expenses. According to Alzahrani, Alhomoud, and Wills (2022), acquiring and implementing emerging technologies come with significant upfront costs, including hardware, software, and infrastructure upgrades. For instance, high-performance servers, computing clusters for AI and big data, and specialized software tools can be capital-intensive. Moreover, the generation and management of vast amounts of data by emerging technologies incur expenses related to data storage and processing (Alrebdi and Khan, 2022). Extensive training

programs are also essential to equip government personnel with the necessary skills to operate and maintain these technologies effectively (Ali, 2020).

Cost considerations extend to the potential for vendor lock-in. Government agencies may become dependent on specific technology providers, limiting their flexibility and bargaining power in cost negotiations (Ali, 2020). Breaking free from such lock-in scenarios can be costly and disruptive. Therefore, establishing strategies to mitigate vendor lock-in risks and promoting healthy competition among technology providers is vital (Alrebdi and Khan, 2022).

Return on investment (ROI) must be considered when adopting emerging technologies. While these technologies can lead to significant cost savings and revenue increases, quantifying these benefits accurately can be challenging (Mannix, 2018). A thorough cost-benefit analysis is necessary to evaluate the long-term financial impact of these technologies on government operations.

Dependency on Third-Party Providers

The adoption of emerging technologies in the Saudi Arabian government sector often involves reliance on third-party providers for various services, infrastructure, and software solutions. While this reliance can offer cost-effective and efficient solutions, it also poses significant challenges and risks. One primary challenge associated with this dependency is the potential loss of control and ownership (Ali, 2020). Government agencies may find themselves relying on external entities for critical services, data storage, or software applications, limiting their ability to customize solutions to specific government needs. This reliance may lead to a potential decrease in the government's ability to make independent decisions or exercise control over essential services (Alrebdi and Khan, 2022). Furthermore, there's a potential for misalignment between the goals of third-party providers and government objectives. Private entities may prioritize profitability over public service requirements, leading to potential conflicts of interest or challenges in ensuring the delivery of essential public services at expected quality levels.

To mitigate the challenges linked to third-party dependency, government agencies should develop robust vendor management and contract negotiation strategies (Alrebdi and Khan, 2022). These strategies should prioritize data security, service level agreements, and contingency plans for service interruptions. Additionally, promoting competition among providers and considering open-source alternatives can help reduce vendor lock-in risks (Ali, 2020).

Governance and Regulation

Effective governance and regulation play a pivotal role in ensuring the responsible and secure adoption of emerging technologies within the Saudi Arabian government sector. The absence of clear and comprehensive regulatory frameworks can pose significant challenges (Alrebdi and Khan, 2022). Without well-defined guidelines and oversight, there is a risk of unchecked deployment of technologies that may not align with government objectives or ethical standards (Alzahrani et al., 2022).

One of the key areas where governance and regulation are crucial is in the realm of data privacy and protection (Alrebdi and Khan, 2022). Government agencies handle vast amounts of

sensitive data, making it imperative to establish robust data protection measures and compliance frameworks. The European Union's General Data Protection Regulation (GDPR) serves as a notable example of comprehensive data privacy legislation, and similar regulatory models could be explored within the Saudi context. Furthermore, the absence of clear regulatory guidelines for blockchain technology presents a notable challenge (Alzahrani, Alhomoud, and Wilss, 2022). This regulatory gap adds complexity to the governance landscape. Although the Saudi government introduced the Personal Data Protection Law (Personal Data Protection Law, 2021), concerns raised by Alrebdi and Khan (2022) and Alzahrani et al. (2022) emphasize the need for more specific regulations and privacy measures in certain areas.

To address these governance and regulatory challenges, Saudi Arabia can draw lessons from international best practices and adapt them to its unique context. Collaborative efforts involving government agencies, technology experts, and legal scholars are essential to crafting effective regulations that promote innovation while safeguarding public interests.

Lack of Standardization

The adoption of emerging technologies in government operations often reveals a lack of standardization across various technological domains. This absence of standardized practices and protocols can pose significant challenges (Alzahrani, Alhomoud, and Wills, 2022). In the context of emerging technologies like blockchain, which rely on decentralized ledgers and smart contracts, the absence of standardized frameworks can hinder interoperability and data sharing among entities and prevent them from achieving the necessary information security audits (König et al., 2020).

Additionally, the lack of standardized security protocols and authentication mechanisms can introduce vulnerabilities and increase cybersecurity risks (Alrebdi and Khan, 2022). To address these challenges, the Saudi Arabian government should consider initiatives aimed at developing and implementing standardized frameworks and best practices for emerging technology adoption. This approach facilitates seamless integration and ensures data integrity and cybersecurity across government sectors. Moreover, it's important to highlight that data sharing, while beneficial, is accompanied by perceived risks and barriers, such as potential data breaches and privacy concerns (Kim and Stanton, 2016). These considerations are vital for bolstering national economic prosperity while adhering to the standards established by the Personal Data Protection Law (Personal Data Protection Law, 2021).

Data Consistency

Data consistency emerges as a significant challenge, especially in the context of big data analytics (Alkhiri, 2022a). The extensive collection and storage of data from diverse sources can result in inconsistencies in data formats, structures, and values. These inconsistencies can impede the generation of meaningful insights and hinder data-driven decision-making processes (N. Khan et al., 2014; Alnofal, Alrwisan, and Alshammari, 2020). It is essential for the Saudi government to invest in data governance frameworks that emphasize data quality, consistency, and integration. This includes establishing data standards, data cleansing processes, and data validation protocols (Alrebdi and Khan, 2022). Furthermore, the implementation of data management tools can aid in ensuring data consistency (Humayun and Alsayat, 2022). By

addressing data consistency challenges, the government can maximize the value of its data assets and enhance the effectiveness of emerging technology applications across various sectors.

Corruption and Cronyism

The potential for the abuse of power is a challenge not unique to Saudi Arabia but one that persists in many developing countries (Al Mudawi, Beloff, and White, 2020). In the context of emerging technology adoption in the government sector, the misuse of power for personal gain can manifest in various forms. This includes corruption, favoritism, and unethical practices related to technology procurement and project implementation (Al Mudawi, Beloff, and White, 2020). The lack of transparency and accountability can exacerbate these issues, allowing individuals in positions of authority to manipulate technology-related decisions to their advantage. Such abuses can result in inefficient resource allocation, misappropriation of funds, and compromised technology projects.

To mitigate the risk of the abuse of power in the context of emerging technology adoption, the Saudi Arabian government must prioritize transparency, accountability, and ethical conduct in its operations (Alkhiri, 2022a). Implementing robust governance frameworks, whistleblower protection mechanisms, and regular audits can help detect and prevent abuse of power (Alrebdi and Khan, 2022). Additionally, fostering a culture of integrity and ethics within government institutions is essential to promote responsible decision-making and ensure that emerging technologies are used for the benefit of the public.

Moreover, leveraging Artificial Intelligence (AI) strategically can amplify efforts to combat corruption and cronyism in public organizations. Caruso et al. (2023) emphasize how Business Intelligence combined with AI can effectively detect fraud, corruption, and policy misalignments. Neves, Da Silva, and Carvalho (2019) highlight AI's role in advancing the anti-corruption agenda through cybercrime, fraud, and corruption detection, prevention, and analysis. Additionally, Gallego, Prem, and Vargas (2022) point to AI's predictive power in anticipating and mitigating corruption, suggesting the use of machine learning models to forecast municipality-level corruption. These AI-driven initiatives can significantly contribute to creating a more transparent, accountable, and ethical governance landscape in Saudi Arabia.

Limitations and Future Agenda

This study about the usage of emerging technology in the Saudi Arabian government sector has some limitations that should be considered when interpreting its results. Only five emerging technologies were discussed based on the eligible studies: AI, cloud computing, blockchain, IoT, and big data. This does not imply that these are the only emerging technologies available but rather that these are the technologies that were included in the eligible studies. Additionally, the study's range only covers the period from 2018 to 2022, so other periods could produce different results. Furthermore, the research is about the government sector in Saudi Arabia, so results may not be generalizable to other countries, regions, or sectors. While this study has presented valuable solutions to address the challenges encountered by the public sector in Saudi Arabia during the adoption and implementation of emerging technologies, it is essential to emphasize that further analysis and in-depth research are imperative.

Adding to these limitations are the inherent constraints of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach used in the study. While PRISMA provides a robust methodological framework for the identification, selection, and appraisal of research studies, it is not without its limitations. These include potential biases in study selection, the possibility of overlooking relevant studies not included in the databases searched, and the challenge of synthesizing findings from studies of varying quality and context (Page et al., 2021).

Despite these limitations, the study provides insights into the usage of emerging technologies in the public sector in Saudi Arabia, which can serve as a starting point for further research in this area.

Conclusion

This research, conducted through a rigorous systematic literature review employing the PRISMA methodology, has provided comprehensive insights into the role of emerging technologies in the Saudi Arabian government sector. The research specifically aimed to answer two key questions:

In relation to Research Question 1, findings indicate a growing trend in the adoption of technologies such as artificial intelligence, cloud computing, and the Internet of Things (IoT). These technologies are increasingly being leveraged to enhance public services, streamline government operations, and foster innovation in public administration. The analysis of literature from 2018 to 2022, with a notable increase in studies in 2022, reflects a significant shift towards embracing these technologies. Moreover, the COVID-19 pandemic has acted as a catalyst, intensifying the focus on digital solutions to address public health challenges and maintain service delivery.

However, technologies like blockchain and 5G, while recognized for their potential, are still in the early stages of exploration and adoption within the Saudi government sector. This suggests an opportunity for further development and integration in the coming years.

In the case of Research Question 2, the analysis revealed that security and privacy concerns are top-tier, as evidenced by vulnerabilities in IoT and cloud ecosystems. The data underscores a significant skills gap in the government sector, which is amplified by the rapid progression in areas like AI, IoT, and blockchain. Infrastructure demands further focus, especially with the increasing adoption of interconnected devices. Additionally, the cost implications, both immediate and long-term, present hurdles for smooth integration. There is a palpable tension between the benefits of third-party collaborations and the associated risks, particularly in terms of control and data security. Furthermore, the need for a robust regulatory framework is evident, with current governance structures showing gaps. Inherent challenges, such as corruption, add another layer to the complexity. As the government accelerates its tech-forward journey, addressing these challenges becomes paramount for sustainable and secure growth.

Although the challenges are formidable, they are not insurmountable. The Saudi Arabian government's endeavors, such as the enactment of the Personal Data Protection Law in 2021, signify a determined step towards addressing some of these issues. Effective governance, consistent data management, standardized practices, and a relentless focus on transparency and accountability will be paramount in overcoming these hurdles.

While the primary focus of this study is the Saudi Arabian context, the insights gleaned here have broader implications. The universality of challenges like data security, the skills gap, and the need for robust regulatory frameworks transcends national boundaries. Similarly, the strategies and legislative initiatives such as the Personal Data Protection Law can offer valuable lessons to other nations embarking on similar digital transformation journeys. Therefore, this research charts a path for the Saudi government and contributes to a global discourse on leveraging technology for public sector innovation and governance.

In terms of public sector innovation, this research has shown that the Saudi government is actively pursuing technological advancements to modernize its services and operations. The enactment of the Personal Data Protection Law in 2021 is a testament to the government's commitment to addressing emerging challenges associated with digital transformation. This indicates a forward-thinking approach, emphasizing the need for transparent, accountable, and ethical governance in the digital age.

In addition, the utilization of emerging technologies in the energy sector is a significant aspect of this innovation. Technologies like AI and IoT are being leveraged to optimize energy consumption, enhance renewable energy solutions, and support Saudi Arabia's sustainability objectives. This integration in the energy sector is a clear indication of the government's dedication to fostering a greener, more sustainable future, demonstrating how technological advancements are not only modernizing public services but also contributing to environmental sustainability.

The shift towards a more tech-driven public sector in Saudi Arabia is marked by both enthusiasm for innovation and caution in navigating its challenges. This balanced approach is crucial for sustainable and secure growth in the public sector, ensuring that technological advancements align with national interests and public welfare.

Last but not least, although the findings of this research are contextualized within the Saudi framework, the insights, strategies, challenges, and legislative measures delineated here hold significant value for a global audience. They can serve as references or benchmarks for other nations aiming to harness technology for public sector innovation and governance enhancement. Consequently, this research acts as a catalyst for cross-national dialogue and collaborative exploration, extending an invitation to delve into a broader spectrum of technologies and their implications across various governmental contexts. It sets a foundation for future academic inquiry and practical application, charting paths for innovation and digital governance in the public sector on a global scale.

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