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"تقييم أثر استخدام النظم الذكية في تطوير الأداء بالقطاع الصحي بالمملكة العربية السعودية "

" دراسة تطبيقية على مستشفيات منطقة جدة "

"Evaluating the Impact of Using Smart Systems in Developing "
Performance in the Health Sector in Saudi Arabia"
" An Applied Study on Hospitals in the Jeddah Region"

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Abstract

The healthcare sector is rapidly evolving with the adoption of smart systems to enhance service quality. This study examines the impact of using these systems on performance development in hospitals within the Jeddah region of Saudi Arabia. This study aims to evaluate the impact of using smart systems on developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia. This study uses a descriptive analytical method to evaluate the impact of smart systems on performance development in hospitals in the Jeddah region, Saudi Arabia. All employees in 11 government hospitals in the Jeddah region, totaling approximately 9,500 staff across medical, nursing, technical, and administrative roles. The sample will be selected from these employees to ensure accurate representation, with size calculated to maintain an estimation error within 5%. The study indicates broad agreement among participants on the positive role of smart systems in Jeddah-region hospitals. Respondents generally recognize the value of smart devices, communication networks, and big data databases in improving healthcare delivery. The sample is predominantly female, mid-career, and well-educated, with many working in frontline technical and clinical roles. Overall, these results suggest strong acceptance of technology's role in enhancing coordination, decision-making, and operational effectiveness in the healthcare sector. From these results, the study recommends that Provide a strong and reliable communication network infrastructure, secure data centers, and continuous technical support to form a robust foundation for adopting smart systems, design and implement continuous, tailored training programs for medical and administrative staff at all levels to ensure their ability to use smart systems effectively and efficiently and establish clear frameworks and policies for big data collection, storage, use, and sharing, with a focus on privacy protection and compliance with international and local standards.

Keywords: Smart Systems - Smart Devices - Communication Network - Artificial Intelligence - Performance Development - Performance Effectiveness - Performance Efficiency - Performance Quality - Innovation in Performance.

1/1: Introduction:

The global healthcare industry is experiencing significant shifts due to the swift pace of technological innovation, prompting the essential adoption of intelligent systems to boost operational efficiency and elevate the standard of patient care. According to the World Health Organization, global healthcare expenditure is projected to reach \$12 trillion by 2025, accompanied by a significant surge in demand for healthcare services due to population growth and the rising prevalence of chronic diseases (Khang, 2024).

In the Kingdom of Saudi Arabia, this transformation is integral to Vision 2030, which aims to elevate the quality of life and foster sustainability within the healthcare sector. Saudi Arabia is actively transforming its healthcare sector by embracing advanced technologies like artificial intelligence, big data analytics, and the Internet of Things. This technological integration presents a valuable opportunity to enhance system performance and achieve cost-efficiency. According to the Ministry of Health's 2024 report, the use of digital solutions in medical institutions has surged by 55% over the last seven years, signaling a nationwide move towards comprehensive digitalization (Uraif, 2024).

Moreover, integrating smart technologies into healthcare systems significantly enhances service quality by streamlining diagnosis and treatment workflows, improving data precision, and optimizing the use of resources. Research has shown that leveraging artificial intelligence in medical diagnostics can boost accuracy rates to as high as 92%, reducing the workload on healthcare professionals and strengthening the system's capacity to efficiently meet growing demands (Rani et al, 2023).

Smart technologies are also transforming the patient journey by offering more personalized and engaging healthcare experiences. By harnessing big data, healthcare providers can tailor recommendations to individual needs, encouraging better adherence to treatment plans and minimizing the likelihood of hospital readmissions. This data-driven model not only elevates the standard of

care but also improves transparency and operational efficiency (Singh, and Chatterjee, 2021).

Nonetheless, Saudi Arabia encounters several obstacles in adopting these technologies, including the urgent need to equip healthcare professionals with the skills to navigate modern systems and to safeguard sensitive data from cyber threats. Hence, thoroughly assessing the influence of smart systems on healthcare performance is essential to uncover their true value, address potential barriers, and formulate practical, evidence-based strategies to advance the Kingdom's healthcare landscape (Al-Saggaf et al, 2024).

This research seeks to explore how smart systems contribute to enhancing performance within Saudi Arabia's healthcare sector, specifically through an applied study conducted in hospitals located in the Jeddah region. Utilizing a combination of research tools—such as structured questionnaires and in-depth interviews with both medical and administrative personnel—the study will evaluate the influence of these technologies on service quality and operational effectiveness. Comparative data will be gathered from periods before and after the adoption of smart systems to identify measurable improvements and uncover any obstacles encountered during implementation.

The practical value of this study lies in its potential to directly enhance hospital performance, ultimately leading to improved healthcare outcomes for the population. By assessing the role of smart technologies, the research will support the development of targeted strategies aimed at maximizing efficiency and elevating the quality of care. Moreover, the study's insights will help inform future healthcare policy decisions and align with the goals of Saudi Vision 2030, playing a key role in building a resilient and sustainable healthcare system tailored to the needs of the community.

2/1: Study Problem:

Global reports indicate that the artificial intelligence market was valued at USD 327.5 billion in 2021 and is expected to grow significantly, reaching approximately USD 1.6 trillion by the year 2028. Investment in artificial intelligence reached USD 77.5 billion in 2022, with key application areas including healthcare, financial services, manufacturing, and retail. Artificial intelligence is most frequently applied through technologies such as machine learning, computer vision, and natural language processing. The number of devices linked through Internet of Things (IoT) networks stood at 12.3 billion in 2021 and is forecast to soar to 27.1 billion by 2025, according to recent data. Among the primary application domains are smart cities, smart homes, manufacturing, and healthcare, where commonly adopted IoT technologies include Wi-Fi, Bluetooth, and cellular networks. Regarding big data, the global market was estimated at USD 229.4 billion in 2021 and is anticipated to grow to USD 1,104 billion by 2028. Key application areas include financial services, healthcare, marketing, and manufacturing, with the most commonly used big data technologies being Hadoop, Spark, and Hive". (Statista, 2023. Grand View Research 2023, International Data Corporation, 2023, McKinsey & Company, 2023).

As stated in the 2021 report released by Saudi Arabia's Ministry of Health, titled "Digital Health Strategy in the Kingdom of Saudi Arabia," investment in health technology in the Kingdom is projected to reach \$2.5 billion by 2023. Additionally, (40% of hospitals in Saudi Arabia utilize EHRs, over 70% of Saudis use health applications on their smartphones, and the adoption of telemedicine has reached 20% of Saudis using telemedicine services, Ministry of Health, Kingdom of Saudi Arabia, 2023).

Nevertheless, the issue of poor performance efficiency and quality of healthcare services in the Saudi Arabian healthcare sector is a critical concern that necessitates in-depth study. According to the Ministry of Health's 2024 report, hospitals in the Jeddah region suffer from high patient waiting times, with an average waiting time of 2 hours and 45 minutes, negatively impacting patient satisfaction and the quality of care provided.

Furthermore, a study conducted by the General Authority for Statistics indicates that 30% of patients in government hospitals experience a lack of accurate information regarding their health conditions, leading to non-adherence to treatment and repeated hospital visits. Amidst these challenges, it has become essential to explore how smart systems, such as artificial intelligence and big data analytics, can be used to improve performance and deliver faster, more accurate healthcare services.

Additionally, statistics show that 40% of medical staff in Jeddah hospitals do not receive adequate training on the use of these modern systems, exacerbating the gap between available technology and its effective utilization. Consequently, these factors clearly indicate a real problem that warrants an evaluation of the impact of smart systems on developing performance in the healthcare sector, thus reinforcing the importance of this study as a step towards enhancing healthcare service quality and achieving higher efficiency in hospital management, Aldosari, (2017)

Therefore, this study aims to analyze the factors hindering the implementation of smart systems and how they affect performance improvement in hospitals within the Jeddah region, thereby contributing to the overall effectiveness of the healthcare system and better meeting the needs of citizens.

3/1: Importance of the Study:

3/1/1: Scientific Importance:

- 1) **Contribution to Existing Literature:** This study will provide valuable insights into the application of smart systems in healthcare, contributing to

the growing body of literature on digital transformation in the medical field.

- 2) **Framework for Future Research:** The findings can serve as a foundation for future research on the impact of technology on healthcare performance, encouraging further investigations in different regions and contexts.
- 3) **Gaining Insight into Barriers:** By exploring the difficulties encountered during the integration of smart technologies, this study will provide deeper insights into the obstacles hindering digital adoption in healthcare environments, laying the groundwork for future research aimed at overcoming these limitations.
- 4) **Advancing Theoretical Frameworks:** This research has the potential to inform the creation of theoretical frameworks that illustrate how smart technologies impact healthcare performance, thereby enriching scholarly discussions and academic inquiry in the field.

3/1/2: Practical Importance:

- 1) **Enhancing Patient Care:** This study seeks to deliver actionable insights for healthcare providers, aiming to elevate the quality of care, improve health outcomes, and boost patient satisfaction.
- 2) **Informing Policy Strategies:** The findings will serve as valuable input for decision-makers, demonstrating the impact of smart technologies and guiding the formulation of policies that foster digital transformation in healthcare institutions.
- 3) **Empowering Medical Personnel:** By emphasizing the importance of training healthcare professionals in smart system usage, the research will support efforts to build digital competencies that drive better service delivery.

4) Strategic Investment Decisions: The results will help healthcare managers allocate resources more effectively, ensuring technological investments are aligned with performance improvement goals.

5) Establishing Performance Standards: The study will offer a reference point for hospitals in Jeddah and elsewhere to measure their progress in adopting smart healthcare technologies, supporting continuous improvement.

6) Boosting Operational Productivity: Through an in-depth analysis of smart system integration, the research will reveal strategies for reducing delays, optimizing workflows, and enhancing hospital operations.

Together, these contributions underscore the study's relevance not only to academic inquiry but also to the practical advancement of healthcare systems across Saudi Arabia.

4/1: Research Objectives:

The researcher aims to achieve the following main objective:

"To evaluate the impact of using smart systems on developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia".

In addition to achieving the following sub-objectives:

- 1) To evaluate the impact of using smart systems on performance effectiveness in hospitals within the Jeddah region, Saudi Arabia.
- 2) To evaluate the impact of using smart systems on performance efficiency in hospitals within the Jeddah region, Saudi Arabia.
- 3) To evaluate the impact of using smart systems on performance quality in hospitals within the Jeddah region, Saudi Arabia.
- 4) To evaluate the impact of using smart systems on innovation in performance in hospitals within the Jeddah region, Saudi Arabia.

1/5: Study Questions:

This study is driven by the need to assess how the implementation of smart systems influences hospital performance in the Jeddah region of Saudi Arabia. In light of this objective, the central research problem is translated into the following key questions:

Main Research Question:

"What is the impact of using smart systems on developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia"

The following sub-questions branch out from this main research question:

- 1) What is the impact of using smart systems on performance effectiveness in hospitals within the Jeddah region, Saudi Arabia?
- 2) What is the impact of using smart systems on performance efficiency in hospitals within the Jeddah region, Saudi Arabia?
- 3) What is the impact of using smart systems on performance quality in hospitals within the Jeddah region, Saudi Arabia?
- 4) What is the impact of using smart systems on innovation in performance in hospitals within the Jeddah region, Saudi Arabia?

- Main Research Question Two:

"Is there a difference between the responses of the research sample regarding the impact of using smart systems on developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to (Gender - Age - Educational Level - Job Level - Years of Experience) ?"

The following sub-questions branch out from this main research question two:

- 1) Is there a difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to gender?

- 2) Is there a difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to age?
- 3) Is there a difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to educational level?
- 4) Is there a difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to job level?
- 5) Is there a difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to years of experience?

1/6: Research Hypotheses:

The researcher can formulate the research hypotheses as follows:

Main Hypothesis One:

- 1) **"There is a statistically significant relationship between the use of smart systems and the development of performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia".**

The following sub-hypotheses branch out from this main hypothesis one:

- 2) **H1:** There is a statistically significant relationship between the use of smart systems and performance effectiveness in hospitals within the Jeddah region, Saudi Arabia.
- 3) **H2:** There is a statistically significant relationship between the use of smart systems and performance efficiency in hospitals within the Jeddah region, Saudi Arabia.

- 4) **H3:** There is a statistically significant relationship between the use of smart systems and performance quality in hospitals within the Jeddah region, Saudi Arabia.
- 5) **H4:** There is a statistically significant relationship between the use of smart systems and innovation in performance in hospitals within the Jeddah region, Saudi Arabia.

Main Hypothesis Two:

"There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to (Gender - Age - Educational Level - Job Level - Years of Experience).

The following sub-hypotheses branch out from this main hypothesis two:

- 1) There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to gender.
- 2) There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to age.
- 3) There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to educational level.
- 4) There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to job level.

- 5) There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to years of experience.

1/7: Variables and Research Model:

1/7/1: Study Variables

Based on the hypotheses that the research will address, the research variables are as follows:

- **Independent Variable: Smart Systems.**

The researcher will rely on the following dimensions of the independent variable:

- Smart Devices
- Communication Network (Infrastructure)
- Big Data Databases
- Artificial Intelligence

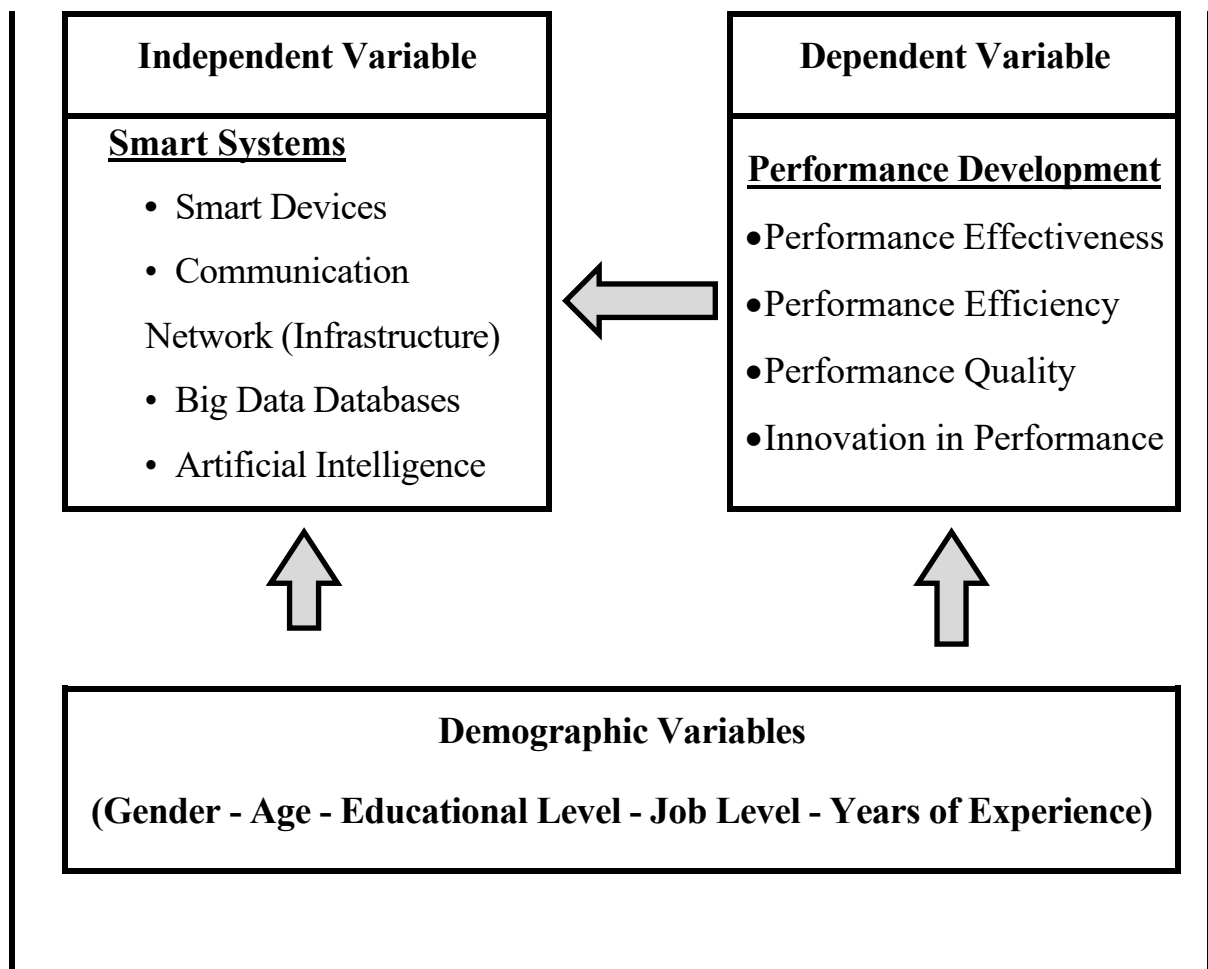
- **Dependent Variable: Performance Development.**

The researcher will rely on the following dimensions of the dependent variable:

- Performance Effectiveness
- Performance Efficiency
- Performance Quality
- Innovation in Performance

1/7/2: Research Model:

The research model can be presented as follows:



Source: Prepared by the Researcher.

1/8: Research Terms:

The researcher will address the terms used in this research, as follows:

- **Smart Systems:** Refers to systems that use smart technology and artificial intelligence to learn and make autonomous decisions. These systems can be programmed to perform specific tasks or be capable of learning and adapting to the environment and making independent decisions (Romero,. et al, 2020)
- **Smart Devices:** Means technical devices that are equipped with smart features or capable of communicating with a communication network and exchanging data with other systems. Smart devices include smartphones, tablets, smart home devices, smart cars, and so on (Silverio-Fernández,. et al, 2018)

- **Communication Network:** Refers to the infrastructure and technologies used for seamless communication and data exchange between different devices. These networks can be wired (such as internet networks) or wireless (such as 4G and 5G networks) Jiang, (2022)
- **Big Data Databases:** Means a massive collection of structured data stored in specific data structures that allow efficient data access and analysis. Big data database systems use techniques such as data distribution, data fragmentation, and advanced query analysis (Berisha,. et al, 2022).
- **Artificial Intelligence:** Refers to the ability to develop systems and programs. Artificial intelligence (AI) is a field concerned with developing systems and programs that have the ability to simulate human intelligence. Artificial intelligence works on designing and developing systems that can extract knowledge from data, make intelligent decisions, solve problems, learn from experience, and perform tasks autonomously Zhang, and Lu, (2021)
- **Performance Development:** Refers to the efforts made to improve the performance of organizations and individuals. This includes implementing new strategies and techniques to achieve better goals and improve efficiency, effectiveness, and quality. Advancing performance may involve optimizing internal operations, enhancing the quality of services and offerings, strengthening team effectiveness, and promoting overall organizational excellence (Budworth, and Chummar, 2022).
- **Performance Effectiveness:** Refers to the capacity of an individual or organization to accomplish targeted objectives efficiently and with meaningful outcomes (Limna et al, 2022).
- **Performance Efficiency:** Refers to the capability to optimize the use of available resources to attain intended outcomes. It involves maximizing

output, minimizing inefficiencies, and enhancing the effectiveness of resource deployment (Cai, 2023).

- **Performance Quality:** Refers to the capacity of an individual or organization to deliver high-quality products or services that align with and fulfill the expectations and requirements of clients or end users (Rizqulloh et al, 2024).
- **Innovation in Performance:** Represents the ability to generate and apply innovative ideas that lead to improved performance, process enhancement, and a sustainable competitive advantage (O'Dwyer, (2021).

1/9: Previous Studies:

Study by Elhoseny, et al., (2017) titled "Intelligent systems based on cloud computing for healthcare services: a survey"

This study set out to explore the influence of cloud-based intelligent systems on enhancing the performance of healthcare services. It aimed to examine how the integration of such technologies supports efficiency, cost reduction, and overall service improvement in the healthcare sector. Central to the research was the role of cloud computing in facilitating swift and efficient access to patient data and aiding in accurate disease diagnosis at a lower operational cost. The study further investigated the application of artificial intelligence techniques—specifically Genetic Algorithms (GA) and Particle Swarm Optimization (PSO)—within cloud environments to optimize task scheduling, minimize execution times, and improve the utilization of computing resources. Employing a descriptive-analytical approach, the research drew on an extensive review and analysis of existing scholarly literature. Findings from the reviewed studies revealed a strong correlation between the implementation of intelligent systems and improvements in healthcare performance. Notably, the adoption of smart scheduling algorithms significantly reduced patient wait times and enhanced

workflow efficiency, thereby accelerating service delivery. Moreover, the application of AI technologies led to quicker processing of stakeholder requests, improving the patient experience and easing the burden on healthcare professionals. The integration of cloud computing with intelligent solutions also proved effective in maximizing resource efficiency, lowering operational costs, and boosting institutional productivity. In light of these findings, the study recommended the widespread implementation of cloud-based intelligent systems in healthcare, emphasizing the need for robust technological infrastructure and targeted staff training to ensure successful adoption and sustained impact.

Study by Tian, et al., (2019) titled "Smart healthcare: making medical care more intelligent"

This study set out to deliver an in-depth exploration of the concept of smart healthcare, emphasizing how modern information technologies can be harnessed to enhance the intelligence and responsiveness of medical care. It examined the evolution of smart healthcare as a direct result of rapid advancements in digital technologies, such as the Internet of Things (IoT), big data, cloud computing, and artificial intelligence. These innovations are reshaping conventional healthcare systems by promoting greater efficiency, convenience, and personalized care delivery. Adopting a descriptive analytical approach, the study conducted a qualitative content analysis of existing academic literature, focusing on core technologies driving smart healthcare, their real-world applications, current challenges, proposed solutions, and future directions. The findings revealed that IoT technologies enable continuous remote patient monitoring and real-time tracking of vital signs, which support more effective management of chronic illnesses and reduce unnecessary hospital visits. Big data was shown to play a crucial role in processing large volumes of medical information, allowing for improved diagnostic accuracy, better disease forecasting, and the personalization of treatment strategies. Cloud computing provides a dynamic and scalable

infrastructure for storing and managing health data, enhancing accessibility while also lowering operational costs. Additionally, artificial intelligence contributes significantly through the development of smart diagnostic tools, virtual assistants, and medication management systems—leading to streamlined workflows, reduced human error, and enhanced patient-centered care. The integration of these technologies has resulted in noticeable improvements in operational efficiency, reduced wait times, and enhanced service quality within healthcare institutions. In light of these outcomes, the study recommended accelerating the adoption of smart healthcare practices, prioritizing the resolution of key issues such as data privacy and cybersecurity, the provision of adequate training for healthcare professionals, and the establishment of ethical frameworks and standardized protocols for the responsible use of emerging technologies.

Study by Owais, (2019) titled "Development of Intelligent Systems to Optimize Training and Real-World Performance Amongst Health Care Professionals"

This study aimed to design and implement intelligent systems to enhance both training effectiveness and on-the-job performance among healthcare professionals, with a particular emphasis on improving procedural efficiency and minimizing clinical errors. It explored the critical need for equipping healthcare workers with the necessary competencies, highlighting the role of simulation-based medical education (SBME) as a foundational approach to delivering practical, hands-on training. The research utilized a descriptive analytical methodology, incorporating a review of existing scholarly literature alongside developmental investigations into intelligent system design. Data collection involved the analysis of previous studies focused on SBME and artificial intelligence applications, with qualitative content analysis employed to examine how intelligent systems can assess skill acquisition and provide insights into future training needs. The findings demonstrated that the integration of intelligent

systems significantly enhanced real-world clinical performance, reduced the incidence of errors, and improved the efficiency of medical interventions. These systems also made training more personalized and effective by tailoring programs to individual learner needs, resulting in higher training quality and greater satisfaction among trainees. Furthermore, the development of intelligent systems capable of deeply analyzing simulation outputs allowed for the precise identification of trainee strengths and weaknesses, enabling the creation of customized learning pathways. Based on these outcomes, the study recommended incorporating intelligent systems into simulation-based medical education, with a focus on creating objective performance evaluation tools, delivering detailed feedback, and designing adaptive training programs aligned with each trainee's unique development requirements.

Study by Kaur, et al., (2022) titled "Intelligent Systems for Sustainable Development of Healthcare Industry. In Decision Analytics for Sustainable Development in Smart Society 5.0: Issues, Challenges and Opportunities"

This study set out to investigate the contribution of intelligent systems to the sustainable development of the healthcare sector, with a focus on the influence of emerging technologies on both economic performance and overall quality of life. It examined the critical link between healthcare standards and a nation's economic vitality and social well-being, highlighting how technological innovation and smart services play a central role in enhancing satisfaction among both patients and healthcare providers. The research delved into various intelligent technologies currently utilized in the sector—such as robotics and artificial intelligence, augmented reality, blockchain, the Internet of Things (IoT), and 3D printing—framing sustainable healthcare development as the core outcome variable. A descriptive analytical approach was adopted, relying on an extensive review of published scientific literature. The data, derived from existing studies, were examined using qualitative content analysis to identify key

objectives, practical applications, and barriers to implementation. The findings revealed that robotics and AI technologies significantly enhanced surgical precision, minimized medical errors, and accelerated diagnostic procedures, collectively improving care quality while reducing associated costs. Augmented reality was found to support advanced clinical training and help practitioners better visualize complex medical conditions, thereby elevating the standard of care. Blockchain technology offered secure and transparent handling of medical records and facilitated efficient data sharing across institutions, reducing fraud and streamlining operations. Meanwhile, IoT technologies enabled continuous remote monitoring, improved adherence to medication regimens, and provided real-time health data—contributing to higher care quality and fewer in-person visits. Based on these insights, the study recommended the strategic adoption of intelligent systems as a pathway to sustainable healthcare development, emphasizing the need to overcome challenges related to data privacy, financial investment, and the upskilling of healthcare professionals to ensure effective implementation.

Study by Akila, et al, (2023) titled "Intelligent Information Systems in Healthcare Sector: Review Study"

This study aimed to deliver an in-depth examination of recent advancements and practical implementations of intelligent information systems within the healthcare domain. It explored the transformative capabilities of these systems in elevating patient care standards, supporting more accurate and timely clinical decision-making, and streamlining operational processes in medical institutions. The research investigated core components of intelligent information systems—such as electronic health records, machine learning models, natural language processing, and computer vision—and analyzed their integration with Internet of Things (IoT) frameworks and telemedicine platforms. The study considered "intelligent information systems" as the independent variable, comprising

dimensions such as enhancing patient care, optimizing clinical decisions, improving operational workflows, and integrating with IoT and remote care technologies. The dependent variable was identified as the overall improvement of healthcare sector performance. Using a descriptive analytical methodology, the study drew upon a wide range of academic sources, including peer-reviewed journals and scholarly databases, with data analyzed through qualitative content analysis. Findings revealed a clear positive correlation between the deployment of intelligent information systems and performance enhancement in healthcare settings. The results emphasized the significant role these systems play in advancing the quality and efficiency of healthcare services and underlined the added value of their integration with IoT devices and telemedicine solutions. Based on these conclusions, the study recommended addressing key barriers to implementation—particularly concerns related to data privacy and system security—while also encouraging further research to explore future innovations and applications in this evolving field.

Study by Ala, et al., (2024) titled "Enhancing patient information performance in internet of things-based smart healthcare system: Hybrid artificial intelligence and optimization approaches"

This study set out to design a novel model aimed at enhancing the performance of patient information management within Internet of Things (IoT)-enabled smart healthcare systems by leveraging a combination of artificial intelligence and optimization techniques. It explored how the integration of advanced technologies can revolutionize the handling of medical records and support more effective patient care, with a particular focus on the role of artificial intelligence in strengthening healthcare delivery. Adopting an analytical experimental approach, the study involved the development and evaluation of a new model using real-world patient data. The data were processed using Particle Swarm Optimization (PSO) and a hybrid PSO-Long Short-Term Memory (PSO-

LSTM) algorithm, with the primary goal of improving data processing efficiency in smart healthcare environments. The findings indicated that the PSO-LSTM model significantly outperformed the standalone PSO algorithm in classifying patient medical data, achieving an impressive 92.5% accuracy rate in predicting potential health risks. This high level of predictive accuracy demonstrated the algorithm's potential to deliver precise and dependable assessments, contributing to a safer and more satisfying experience for patients. The implementation of the PSO-LSTM approach also enhanced the overall performance of data handling in smart healthcare centers, ultimately leading to better care quality. Based on these outcomes, the study recommended the integration of the PSO-LSTM algorithm into IoT-driven smart healthcare systems, with a particular emphasis on improving data security and elevating the patient experience.

1/9/1: Researcher's Commentary on Previous Studies:

A wide body of previous research has demonstrated the positive influence of smart technologies on advancing healthcare performance and improving service quality. These studies consistently emphasize the value of integrating cutting-edge innovations—such as artificial intelligence, the Internet of Things (IoT), cloud computing, and big data analytics—into healthcare systems to enhance both clinical and administrative efficiency. Smart systems have been shown to contribute significantly to more accurate diagnostics, reduced medical errors, faster treatment delivery, and an overall better patient experience. Despite these benefits, several studies also identify key obstacles to implementation, including concerns about data security and patient privacy, insufficient training among medical staff, and the lack of robust technological infrastructure to support these systems. A review of notable findings includes the work of Akila et al. (2023), who underscored the transformative role of intelligent information systems in improving patient care and supporting clinical decision-making

processes. Their conclusions align closely with those of Tian et al. (2019), who highlighted the importance of adopting smart technologies to increase the intelligence and efficiency of healthcare delivery. In contrast, the study by Owais (2019) adopted a more specialized approach, focusing specifically on developing intelligent systems to enhance the training and real-world performance of healthcare professionals, rather than exploring broader applications of smart technologies across the sector.

Moreover, Elhoseny et al. (2017) emphasized the significant contribution of cloud computing in optimizing healthcare operations, particularly in enhancing task scheduling and minimizing processing time. These findings align with the research conducted by Ala et al. (2024), which highlighted the effectiveness of integrating hybrid artificial intelligence and optimization methods to improve the management of patient information. In contrast, Kaur et al. (2022) adopted a broader perspective by examining how smart technologies contribute to the sustainable development of the healthcare sector. While the first two studies concentrated on the technical and implementation-driven dimensions of intelligent systems, the latter focused on their long-term strategic impact and developmental role.

Kaur et al. (2022) underscored the critical role of smart system adoption in driving sustainable development within the healthcare sector. This aligns with the conclusions drawn by Tian et al. (2019), who emphasized the urgency of advancing smart healthcare technologies to enhance service delivery. In contrast, Owais (2019) concentrated on a more specialized dimension, focusing on the development of intelligent systems aimed at improving the training and on-the-ground performance of healthcare professionals. Unlike the broader technological and systemic perspectives adopted by Kaur and Tian, Owais's work narrowed in on a specific functional application of smart technologies within professional development contexts.

✓ Relationship Between Previous Studies and the Current Study

A common thread among previous studies and the present research lies in their shared emphasis on the transformative role of smart and intelligent technologies in advancing healthcare sector performance. Across the board, these studies—including the current one—highlight the beneficial effects of innovations such as artificial intelligence, the Internet of Things, big data analytics, and cloud-based platforms in enhancing service quality, operational efficiency, and informed decision-making. Methodologically, a descriptive-analytical lens is consistently applied, drawing on literature reviews or survey-based research to assess the effectiveness of technological adoption. All works converge on the argument that smart systems can revolutionize healthcare delivery by minimizing medical errors, improving diagnostics, and streamlining resource utilization. They also share common recommendations that call for investment in digital infrastructure, workforce development, and structured implementation frameworks.

However, the current study stands apart from prior research in several significant aspects. While earlier studies often approach the topic from a global or theoretical viewpoint, this study is more localized in its focus—concentrating specifically on public hospitals within the Jeddah region of Saudi Arabia. It adopts a field-based methodology by conducting a descriptive analytical survey among healthcare professionals, diverging from the reliance on secondary data or simulation models found in other research. The study's target population is distinct as well, involving a sample of around 9,500 employees across 11 governmental hospitals, offering context-rich insights rooted in empirical data. Moreover, unlike previous work that primarily centers on the technological dimension, this research extends its contribution by providing actionable, region-specific recommendations. These include enhancing digital infrastructure within

hospitals, offering tailored staff training, and establishing governance protocols to support the secure and effective use of smart healthcare technologies.

1/9/2: Theoretical Framework of the Study:

▪ **Smart Systems in Healthcare**

The integration of smart healthcare technologies presents a compelling opportunity to address persistent challenges in the medical field. By utilizing Internet of Things (IoT) innovations, the conventional model of hospital-based care can be transformed into a more decentralized, home-centered approach. IoT-driven systems offer notable improvements in treatment quality by enabling continuous, remote monitoring of patients, regardless of the severity of their conditions. These technologies not only enhance patient oversight but also allow healthcare professionals to allocate more time to urgent and complex care tasks, minimizing the need for routine in-person visits and consultations. As the strain on medical staff continues to grow due to increased patient demands, this study seeks to explore how smart healthcare solutions can alleviate that pressure and contribute to more efficient healthcare delivery (Akpojaro & Bello, 2019).

Tian et al (2019) describe smart healthcare as a transformative, multi-layered progression fueled by modern advancements in information technology. Rather than adhering to traditional, illness-centered models, this new paradigm places the individual patient at the core of care. It moves away from isolated clinical frameworks and embraces widespread regional integration, replacing standardized care with tailored, personalized solutions. The emphasis also shifts from reactive treatment to preventive strategies. These developments aim to improve care quality and operational efficiency simultaneously, offering a blueprint for the next generation of medical practice. Central to this evolution are technologies such as IoT devices, wearable sensors, and mobile internet

platforms, which enable continuous data sharing and create a connected, responsive healthcare environment. This intelligent infrastructure fosters collaboration, streamlines decision-making, ensures equitable access to services, and optimizes the allocation of healthcare resources. Ultimately, smart healthcare represents a sophisticated, forward-looking stage in the development of medical information systems.

According to Akila et al. (2024), the integration of intelligent information systems (IIS) into healthcare traces back to the formative years of artificial intelligence, where early initiatives primarily revolved around expert systems and rule-based tools designed to support clinical decisions. Over the past two decades, the landscape has significantly evolved, driven by the proliferation of electronic health records (EHRs), advancements in computing power, and the rise of sophisticated data analytics techniques. The surge in healthcare-related big data—from diagnostic imaging and genetic sequencing to user-generated data from wearable devices—has accelerated the deployment of intelligent technologies across various medical fields. As a result, the sector has witnessed the emergence of highly effective solutions for a range of functions, including interpreting diagnostic images, forecasting health risks, crafting individualized treatment protocols, and overseeing public health trends. Notable smart healthcare innovations encompass deep learning for image diagnostics, predictive modeling through machine learning, natural language processing to analyze clinical documentation, virtual care platforms for remote treatment, AI-assisted pharmaceutical research, and genomic-driven precision healthcare. Collectively, these systems are reshaping modern healthcare by enhancing service quality, increasing operational efficiency, and supporting more precise, data-centric clinical decisions.

- The Healthcare Sector in Saudi Arabia

Launched in 2022 as a strategic pillar of Saudi Arabia's Vision 2030, the Health Sector Transformation Program aims to reshape the healthcare landscape by establishing a fully integrated, patient-focused, and high-performing system. Its core philosophy revolves around value-based care—promoting transparency, financial efficiency, and a shift toward preventative health practices and community well-being. The program is committed to expanding access by ensuring equitable geographic distribution of services, scaling up digital health technologies, and improving service quality across the board. By 2025, the initiative aspires to provide inclusive healthcare coverage to 88% of the population and ensure all citizens are enrolled in a centralized digital health record system. In today's increasingly digital healthcare environment, technologies like the Internet of Things (IoT) and 5G are revolutionizing healthcare delivery in Saudi Arabia. They enable real-time patient monitoring in remote locations and support early interventions, helping healthcare providers enhance efficiency and reduce costs. Emerging trends in the healthcare landscape include virtual hospitals, wearable devices, and telehealth services. 5G technology, in particular, will power new use cases such as augmented reality—assisted surgeries, robotic surgery, connected ambulances, post-operative care, and continuous remote patient monitoring. A prime example is the virtual hospital “Sehha,” which is connected to over 130 hospitals nationwide. It leverages cutting-edge treatment technologies, promotes the use of medical robotics to save time and effort, reduces the need for travel—especially for critical cases requiring specialized, fast, and precise consultations—and facilitates the delivery of healthcare services directly to patients' homes (Global Health Exhibition, 2022).

Saudi Arabia's healthcare sector is undergoing major transformation driven by demographic pressures and Vision 2030. Spending reached SAR196 billion (\$52.2 billion) in 2021 (about 6% of GDP) and is expected to grow as the

government works to expand access, improve quality, and promote cost-efficiency through private sector participation. The Health Sector Transformation Program (HSTP) aims to build a globally competitive, patient-centered system, supported by policy reforms encouraging private investment and diversified funding. Progress includes increased life expectancy (77.6 years in 2023), advances in telemedicine, and digital health infrastructure. However, challenges remain: rapid population growth and aging increase demand, while chronic diseases like diabetes and cardiovascular conditions strain resources. Vision 2030 addresses this by prioritizing public-private partnerships (PPPs), with goals to privatize hospitals, outsource services, and grow the private sector's share of healthcare provision to 65% by 2030. Risks persist, including the rising burden of non-communicable diseases, the need for specialized geriatric and long-term care, and workforce shortages. Expatriates make up most of the private healthcare workforce, and as Saudization policies aim to boost local employment, the sector may face transitional challenges in maintaining workforce quality and capacity (I.U.S.-Saudi Business Council, 2024).

▪ **Smart Initiatives and Performance Development in Healthcare Institutions in the Kingdom of Saudi Arabia**

Mani & Goniewicz (2024) assert that Saudi Arabia has embraced digital health as a central pillar of its Vision 2030 plan to transform healthcare. This commitment is evident in the Kingdom's efforts to integrate advanced technologies throughout its healthcare system, aiming to improve access, efficiency, and personalization of care for all its residents:

- ✓ Saudi Arabia has made digital health a priority within Vision 2030 by adopting telemedicine, electronic health records (EHRs), and artificial intelligence (AI) to improve the delivery of medical services.

- ✓ Virtual care is helping overcome geographical barriers across the Kingdom, giving people in remote areas easy access to consultations and follow-up visits, which supports continuous and timely care.
- ✓ Training programs for healthcare workers are being updated to include digital health skills, making sure the workforce is ready to use new technologies effectively at all levels of care.
- ✓ These wide-ranging digital health initiatives are helping Saudi Arabia set new standards for healthcare innovation, serving as a model for how countries can modernize their health systems through strategic technology integration.
- ✓ Nationwide implementation of electronic health records (EHR) is enabling healthcare providers to exchange patient information securely and efficiently, enhancing collaboration, minimizing redundant testing, and improving overall patient care.
- ✓ AI-driven technologies are now integral to modern healthcare systems, supporting accurate diagnostics, forecasting medical conditions, and crafting tailored treatment strategies that increase efficiency and precision.
- ✓ Comprehensive legal and cybersecurity frameworks have been established to safeguard sensitive health information, fostering public and professional confidence in digital medical platforms.
- ✓ Health-focused mobile applications and smart wearables empower users to take proactive roles in their well-being by tracking vital signs, managing long-term illnesses, and maintaining healthier lifestyles.
- ✓ Increased funding for digital health ventures and scientific research is nurturing a robust innovation environment aimed at generating homegrown solutions to national healthcare needs.

In addition, Ministry of Foreign Affairs, Republic of Estonia (n.d) announced that Saudi Arabia's healthcare sector is undergoing a significant

transformation as part of Vision 2030, with strong government support and investment driving growth across multiple areas. From dental care and medical devices to biotechnology and digital health, these initiatives aim to modernize healthcare delivery, improve access and quality, and promote innovation to meet the needs of a growing and increasingly health-conscious population:

- ✓ **Dental Services:** the dental sector is set to grow thanks to higher spending, better insurance, and new technologies like digital imaging and 3D printing. Major investments and rising demand in specialized treatments support this trend, with the market for devices and clinic services expected to expand steadily.
- ✓ **Digital Health:** backed by major government funding, Saudi Arabia's digital health market is rapidly expanding through EMRs, telemedicine, AI diagnostics, and predictive analytics, with strong projected growth through 2028.
- ✓ **Health Insurance:** growth in health insurance is driven by regulatory requirements, more insured residents, and mandatory coverage for expats, private workers, and tourists.
- ✓ **Medical Devices:** the sector is growing quickly, supported by incentives for local production, rising chronic diseases, and demand for wearables, with strong growth expected by 2032.
- ✓ **Pharma and Biosciences:** privatization is increasing demand for medicines, encouraging local production, technology transfer, clinical trials, and a greater focus on R&D.
- ✓ **Specialty Clinics and Ambulatory Care Centres:** investments in wellness and preventive care are rising, with PPP models supporting non-hospital settings.
- ✓ **Biotechnology:** government support and international partnerships are driving significant growth in the biotech sector to meet Vision 2030 goals.

- ✓ **Healthcare IT and Telemedicine:** vision 2030 investments and a tech-savvy population are boosting healthcare IT and telemedicine, with 5G and IoT enabling remote care and treatment.
- ✓ **Healthcare Infrastructure:** over EUR 61 billion is allocated to build and upgrade healthcare facilities as part of Vision 2030.
- ✓ **Mobile Health (mHealth):** mHealth is expanding with apps offering preventive care, remote consultations, and healthcare information to improve accessibility and efficiency.
- ✓ **Virtual Clinics and Robotics:** virtual clinics and robotics are enhancing healthcare delivery, offering precise and efficient services from consultations to surgeries.
- ✓ **Electronic Medical Records (EMRs) and Mobile Health Technologies:** the rollout of EMRs and mobile tech reflects Saudi Arabia's commitment to integrated digital healthcare and better preventive services.
- ✓ **Widespread Use of Forecasting Tools:** By 2022, close to 50% of healthcare providers had integrated predictive analytics into their operations, reflecting a growing reliance on data insights to guide decisions, with continued market expansion anticipated through 2032.
- ✓ **Investment in Digital Healthcare Infrastructure:** vision 2030's National Transformation Program is heavily investing in digital healthcare infrastructure to improve service quality and efficiency.
- ✓ **Innovations in Telemedicine and Remote Monitoring Technologies:** Telemedicine and remote monitoring have advanced quickly, with institutions like the Ministry of Health and King Faisal Hospital leading in tele-ICUs and chronic care monitoring.
- **Impact of Smart Systems on Healthcare Performance**

Smart healthcare is reshaping the delivery of medical services by incorporating advanced tools such as Internet of Things (IoT) devices, smart

wearables, and intelligent data networks. These technologies enable the continuous collection and management of health information from both individuals and medical facilities. As a result, they support key functions like remote patient monitoring, automated medical record creation, proactive treatment strategies, early identification of health issues, and real-time tracking of patient status. By connecting patients, medical staff, institutions, and caregivers within a unified digital network, Smart Healthcare Systems (SHS) promote seamless remote support and service delivery. SHS encompasses various domains such as disease prevention and diagnosis, virtual assistance, decision-making tools, drug development, and health center management. The benefits extend to all stakeholders—patients can monitor their health using wearable devices, access test results, and receive continuous care remotely, while doctors gain access to advanced diagnostic tools and patient data to support accurate decision-making and effective monitoring. Overall, SHS ensures that all healthcare participants receive timely and essential services, enhancing the performance and responsiveness of healthcare delivery (Raoof & Durai, 2022).

Srihith (2024) sees that improving healthcare performance requires more than advanced technology; it needs aligning the priorities of patients, staff, and administrators. As AI and smart tools grow more common, a coordinated approach is essential for better decision-making and overall care quality:

- ✓ **The Need for Integrated Healthcare Strategies:** a coordinated approach is essential to unify diverse healthcare priorities and practices, ensuring smooth collaboration among all stakeholders for better patient and professional outcomes.
- ✓ **The Role and Limitations of Intelligent Agents in Healthcare:** intelligent agents hold promise for improving medical care but must be integrated carefully to support, not replace, healthcare professionals and maintain high-quality patient care.

- ✓ **Exploring Drug Discovery through Machine Learning:** by organizing and analyzing large datasets, systems like Saperi provide doctors with personalized recommendations, helping tailor treatments to individual needs and supporting more precise, data-driven medical decisions.
- ✓ **Exploring Precision Medicine through AI:** precision medicine uses AI to personalize treatments, improve drug therapies, and reduce side effects by analyzing genetic differences, with tools like Cure Match offering oncologists advanced, customized treatment options.
- ✓ **Exploring the Optimization of Clinical Workflow through AI:** AI streamlines hospital workflows by automating tasks, predicting bottlenecks, and improving resource allocation, ultimately enhancing efficiency and ensuring better patient care, especially in high-demand settings like emergency services.
- ✓ **Exploring the Impact of AI on Clinical Decision Support Systems:** AI accelerates drug discovery by analyzing complex data, tailoring treatments to genetic profiles, cutting production costs, and improving access, supporting more personalized, affordable, and effective healthcare solutions.

▪ **ROLE OF BIG DATA ANALYTICS IN HEALTHCARE**

In healthcare, big data depends on sophisticated information technologies to enable improved policy-making by analyzing massive and complex datasets. Data sources span clinical notes, electronic medical records (EMRs), hospital databases, biomedical imaging, device-generated readings, genomic information, and biomedical signals. The widespread computerization of medical tests and patient histories has become standard practice. Genomic data analysis offers deeper insights into genetic markers and disease relationships, although translating these findings into personalized treatments presents ongoing challenges. Methods like clinical text mining, information retrieval, and NLP

transform unstructured clinical notes into actionable information. Given that much healthcare data is unstructured and extremely large in volume, specialized tools are essential for uncovering patterns and trends. Apache Hadoop is a cornerstone technology in many healthcare analytics platforms because it effectively handles vast and complex data while keeping costs manageable. It lowers data warehouse expenses, increases accessibility, and allows clinicians and researchers to uncover insights that were once inaccessible. With its ability to store and process large-scale data, Hadoop supports all stages of analysis, helping researchers detect trends and patterns with numerous variables. This makes Hadoop an ideal solution for analyzing healthcare big data (MALAVIKA & BABU, 2022).

- **Digital Transformation Strategy in Saudi Vision 2030 and Its Relevance to Healthcare**

Saudi Arabia has undergone significant socioeconomic transformation, resulting in major changes to public health priorities and prompting comprehensive healthcare reforms. As part of its Vision 2030 agenda, the Kingdom introduced the National Transformation Program (NTP) in 2015. The initiative seeks to overhaul the healthcare system by embedding innovation and technology at its core. Establishing a strong digital health foundation is considered a key step toward achieving the Vision 2030 objective of delivering accessible, cost-effective, and high-quality care to every citizen. Despite these ambitions, the National Transformation Program (NTP) has flagged a critical challenge: the lack of an integrated IT infrastructure within the Ministry of Health (MoH) to support large-scale digital progress. In response, the MoH has rolled out a range of focused efforts, such as digitizing patient care workflows, introducing electronic health records and automated billing platforms, unifying regulatory frameworks to enhance data reliability and interoperability, and

creating the National Health Observatory to support informed decision-making (Al-Kahtani et al, 2022).

In addition, Saudi Arabia's Vision 2030 emphasizes elevating citizens' quality of life and overall well-being, identifying digital transformation as a fundamental enabler of this objective. Through the modernization of essential sectors like healthcare, education, and government services, digital tools—ranging from telehealth systems and online learning platforms to smart city infrastructure—are playing a pivotal role in improving access to medical care, supporting distance education, and streamlining public sector operations nationwide. Aligned with the broader goals of Vision 2030, digital innovation is seen as a key pillar for promoting sustainable development, enhancing economic resilience, and advancing social progress. This shift is helping build a knowledge-driven economy by encouraging technological innovation, startup growth, and global investment—reflected in programs such as the National Transformation Program and major projects like NEOM. Additionally, Saudi Arabia's swift socioeconomic evolution has brought new public health challenges to the forefront, accelerating the pace of reform within the healthcare system. To meet Vision 2030's objective of delivering equitable, affordable, and high-quality healthcare, the National Transformation Program launched in 2015 aims to modernize healthcare delivery through technology and innovation. Building a robust digital health infrastructure is central to this vision. However, challenges remain, including the need for an integrated IT system within the Ministry of Health. To address this, the Ministry is implementing several solutions: automating patient care, adopting electronic health records and billing systems, standardizing information exchange procedures, and establishing the National Health Observatory (Alnasser et al 2024).

- **Theoretical Models Related to the Adoption of Smart Systems in Healthcare**

Martinez et al (2024) assert that health systems around the world are under growing pressure to deliver efficient, high-quality care. Integration has emerged as a key strategy to align resources, services, and visions across sectors. However, integrating diverse components of health systems remains complex and requires clear theories, models, and frameworks to guide effective implementation and avoid fragmented approaches:

- ✓ **International Use of Integration for Efficiency:** globally, integrating health systems is a major strategy for boosting efficiency. It aims to create shared goals, streamline resources and services, and prevent siloed working practices. Despite these goals, many integration efforts remain challenging for policymakers, researchers, health managers, and practitioners due to the inherent complexity of the process.
- ✓ **Challenges from Ambiguity in Definitions and Strategies:** a significant barrier to successful integration is the lack of clear, consistent definitions and practical strategies. Terms like “integration,” “integrated care,” “integrated delivery systems,” “systems integration,” and “interdisciplinary communication” are often used interchangeably, leading to confusion. Integration must be approached as a continuous effort focused on achieving goals like streamlined service delivery, enhanced healthcare system efficiency, and improved patient outcomes.

- ✓ **Nilsen’s Classification of Theories, Models, and Frameworks:**

- **Theory:** A comprehensive explanation built on systematic principles that clarify how variables interact and influence one another to provide deeper insight into complex issues.

- **Model:** A simplified and illustrative construct designed to represent specific aspects of a phenomenon, usually with limited generalizability.
- **Framework:** A conceptual layout that organizes and maps components or variables and their interrelations, without offering explanations for causal mechanisms.
- ✓ **Core Differences Between These Constructs:** Theories offer the most robust explanations by identifying and justifying the causes behind specific outcomes. Models, though more straightforward, provide visual or descriptive representations of real-world dynamics. Frameworks, meanwhile, function as organizational maps that help conceptualize systems without delving into underlying causes.
- ✓ **Literature Gap in Integration Methodologies:** Research on the theoretical and conceptual foundations of health system integration has been limited since 2013. While earlier literature provided high-level summaries, this study addresses the gap by re-examining and refining existing theoretical tools—deconstructing integration into fundamental elements to guide the creation of more precise strategies and enable better measurement of their effectiveness.

The decision to implement intelligent healthcare technologies within medical organizations involves a nuanced and multi-layered process shaped by numerous internal and external factors. Scholars have explored this complexity by analyzing elements such as technological intricacy, workforce training requirements, and sector-specific risks. A widely adopted analytical tool for this purpose is the Technology-Organization-Environment (TOE) framework, which provides a structured lens to assess how institutions embrace AI-driven healthcare innovations. This model categorizes influential factors into three domains: technological (e.g., cybersecurity issues and system sophistication), organizational (e.g., internal capabilities and infrastructure), and environmental

(e.g., regulatory and market pressures). Through this classification, the TOE framework facilitates a clearer understanding of the dynamics at play in AI adoption and offers a strategic foundation for its successful implementation in healthcare settings (Yang et al., 2022).

- **Patient Acceptance and Satisfaction with Smart Healthcare Systems**

Ensuring intuitive and accessible interaction between users and digital technologies is fundamental to shaping public perception and acceptance of smart healthcare solutions. Insights from the 2020 Outpatient Experience Survey conducted at Taipei Veterans General Hospital indicated that, even with significant promotional efforts, the hospital's mobile application saw limited usage—only 6.9% used it for appointment booking and a scant 0.8% for making payments. These statistics reflect how overly complex or poorly designed technologies can act as barriers to adoption. Evidence from behavioral studies confirms that user attitudes are strong predictors of intended behavior, which subsequently affects actual usage patterns. In this light, patients' views and attitudes toward outpatient care are instrumental in determining their willingness to adopt intelligent healthcare platforms. Hospitals that integrate streamlined, user-centric digital systems can enhance operational efficiency, ease the burden on both patients and medical staff, and increase the overall effectiveness of services. Moreover, a satisfying healthcare experience contributes significantly to building patient trust and encouraging long-term loyalty. Delivering high-quality, patient-centered care has become a cornerstone for strengthening institutional reputation and driving patient retention. To gain deeper insights into these factors, the current study utilized a mixed-methods approach—combining statistical data analysis with in-depth, semi-structured interviews with professionals from both academic and healthcare sectors—to uncover key influences on patients' readiness to adopt smart hospital technologies. The survey component, based on the Technology Acceptance Model (TAM) and refined

through expert insights, aimed to assess outpatients' attitudes and willingness to use smart systems in clinics. By gathering patient feedback, the study sought to uncover key pain points and needs within the existing service system and identify strategies to improve patient willingness and maximize the benefits of smart healthcare services (Tu et al, 2022).

Hsieh et al (2021) added that Smart hospitals are expected to substantially influence patient satisfaction and operational effectiveness, making patient acceptance and support crucial, particularly in Taiwan. While existing research has largely emphasized clinical outcomes and the operational aspects of smart health services, there is limited exploration of patients' actual adoption behaviors toward smart hospital services. Unlike conventional services, smart hospitals involve dynamic interactions between patients and healthcare providers, which traditional technology acceptance models may not fully capture. Prior studies have highlighted the need to integrate additional health-related behavioral factors to enhance these models' explanatory power. To gain a thorough understanding of the drivers behind patients' intentions to use smart hospitals, this study suggests these intentions are shaped by two contrasting forces: facilitating and inhibiting perceptions. Enablers of adoption include favorable user perceptions, such as recognizing the benefits, ease of use, and having adequate health knowledge. On the other hand, barriers often stem from concerns about potential risks and drawbacks tied to engaging with smart hospital technologies.

In recent years, enhancing patient satisfaction has become a key priority within the smart healthcare sector. While traditional methods—such as paper or digital surveys—have been widely used to measure satisfaction, they often suffer from low response rates, making the results less dependable. To overcome these challenges, modern smart healthcare solutions now utilize advanced technologies that analyze facial expressions, body language, vocal cues, and emotional signals to gain deeper insights into patient satisfaction. This study presents an innovative

smart healthcare model that includes a system for classifying patient satisfaction. By integrating multimodal data inputs and employing sophisticated processing of facial imagery and speech patterns, the system effectively determines satisfaction levels and shares this data with healthcare providers. These insights enable practitioners to interpret patient experiences and implement targeted improvements (ALELAIWI, 2019).

▪ **Challenges of Implementing Smart Systems in Hospitals**

As highlighted by Anyadiegwu et al (2023), the global shift toward smart healthcare technologies is accompanied by a range of substantial barriers that can impede effective deployment. These challenges span across technological, organizational, economic, and human dimensions, all of which must be addressed to achieve secure, efficient, and patient-focused healthcare services.

- ✓ **System Expansion and Compatibility:** Many institutions struggle to scale up digital solutions and ensure integration with legacy systems.
- ✓ **High Energy Demands:** Cutting-edge devices often consume large amounts of power, posing sustainability concerns.
- ✓ **Strict Real-Time Requirements:** Many medical applications rely on instantaneous data transmission and cannot tolerate delays.
- ✓ **Ease of Use:** For successful adoption, both healthcare workers and patients need access to intuitive, user-friendly technologies.
- ✓ **Data Security and Privacy:** The transmission and storage of confidential patient information raise major concerns regarding data breaches and cybersecurity threats.
- ✓ **Processing Demands:** Intelligent healthcare systems require powerful computing resources, which may be unavailable in some settings.
- ✓ **Resistance to Change:** Healthcare professionals may be hesitant or resistant to embrace unfamiliar digital tools.

- ✓ **Technological Infrastructure Gaps:** Particularly in underserved or economically disadvantaged areas, the foundational digital infrastructure is often lacking.
- ✓ **Budgetary Limitations:** Financial challenges hinder the acquisition and maintenance of smart technologies in many healthcare systems.
- ✓ **Regulatory Ambiguity:** The absence of comprehensive policies and standardized regulations creates uncertainty in system adoption and implementation.
- ✓ **Talent Shortages:** There is an ongoing need for skilled personnel capable of managing and supporting smart healthcare technologies.
- ✓ **Data Integrity and Standardization Issues:** ensuring accurate, consistent data across departments remains challenging.
- ✓ **Compatibility Between Systems:** different devices and software may not work well together, hindering integration.
- ✓ **Patient Concerns:** worries about personal information breaches and difficulty using new technologies reduce acceptance.

While Hamza & Akbar (n.d) Smart healthcare systems hold great promise as a way to modernize traditional healthcare delivery, improve patient outcomes, and reduce costs. However, rolling out these technologies in hospital environments comes with a range of challenges. These challenges span technical, organizational, operational, and ethical areas, posing risks to the security, dependability, and overall success of smart healthcare if left unaddressed:

- ✓ **Insufficient Verification of Medical Practitioners:** the absence of robust systems to authenticate doctors' credentials, expertise, and experience erodes patient confidence and safety.
- ✓ **Lack of Standardized Smart Device Training:** many healthcare professionals have no formal training or certification in using advanced smart devices, resulting in misuse and resistance to new technologies

- ✓ **Interoperability Issues Across Diverse Platforms and Standards:** devices built by different manufacturers often rely on proprietary protocols, making it difficult to ensure smooth, secure communication and data sharing.
- ✓ **Limitations of Compact Hardware:** Small-scale devices often suffer from restrictions in processing capacity, memory storage, and battery endurance, making it difficult to incorporate robust security mechanisms.
- ✓ **Lack of Update Functionality:** Many smart medical devices are not designed to support regular software or firmware updates, exposing them to emerging cyber threats and hindering the integration of updated clinical standards.
- ✓ **Absence of Scalable IoT Management Frameworks:** With the rapid increase in connected healthcare devices, the industry faces a critical shortage of unified and expandable systems to handle device onboarding, authentication, and lifecycle management.
- ✓ **Absence of Autonomous Learning and Enhancement Capabilities in Devices:** many smart healthcare tools cannot independently process data or suggest treatments, creating delays and adding to the burden on hospital staff.
- ✓ **Ethical Gaps in System Design:** inadequate attention to ethical design results in privacy breaches and undermines user trust, particularly in how patient data is collected and shared.
- **Human Capital and Training Needs for Smart Healthcare Adoption**

The healthcare industry is in a state of constant evolution, propelled by breakthroughs in modern technology. To remain competitive and responsive, healthcare organizations must invest in enhancing their workforce's capabilities—especially in technological competencies that support innovation and efficiency. This calls for a long-term commitment to education and training

programs that drive digital adoption and streamline operations. Strengthening knowledge-sharing practices, supporting professional growth, and implementing structured learning systems are essential components for building resilient institutions. Many healthcare providers have adopted detailed frameworks and strategies to promote continuous employee development across critical operational areas. A skilled and knowledgeable workforce remains a cornerstone of institutional competitiveness, making staff development a strategic priority in navigating the shifting demands of the healthcare environment. Effective training initiatives not only boost workforce performance but also play a key role in improving the patient experience throughout the service continuum. To properly address skill gaps, training assessments must be strategically aligned with organizational priorities. Analytical tools such as SWOT evaluations, gap assessments, and risk analyses can help healthcare organizations identify specific areas that require targeted investment and system improvements. This study aims to examine effective models for advancing workforce development in healthcare management, particularly in light of the disruptions caused by the COVID-19 pandemic. The global crisis has significantly redefined operational realities, necessitating adaptive leadership and innovative training solution. The study aims to examine the complex challenges facing healthcare management professionals, emphasizing the importance of customized solutions to address these evolving issues effectively and thoroughly assess specific training needs in healthcare administration (Willie, 2025).

Furthermore, given the new responsibilities and demographic shifts facing the healthcare sector, there is a clear need to strengthen competencies and advance research within municipal services. Integrating such technologies is envisioned as a fundamental component of future healthcare delivery, as emphasized in Norwegian government policy documents. The role of super-users" is particularly crucial, as they support system implementation, upgrades,

troubleshooting, and overall problem-solving. Research consistently highlights that successful deployment of electronic support tools depends on maintaining quality standards across all levels of operation. It is also argued that achieving a balance between human expertise and technological tools is vital for sustaining employee motivation and fostering ongoing learning. Moreover, the adoption of innovations is not a straightforward or linear journey; instead, users often adapt, reinterpret, and reshape these solutions to fit their needs. Ultimately, studies on innovation uptake highlight the critical role of tailored implementation strategies that integrate proven, research-backed practices into daily clinical workflows, with the overarching goal of improving healthcare service quality and efficiency (Rawden et al., 2017).

- **Data Privacy and Cybersecurity in Smart Healthcare Systems**

Although smart healthcare technologies offer the potential for highly individualized care and better clinical outcomes, they simultaneously pose serious risks concerning cybersecurity and the protection of sensitive health data. Alarming figures reveal that almost 92% of healthcare institutions have experienced security breaches over the last three years, emphasizing the sector's heightened exposure to cyber threats. In 2023 alone, cyber incidents targeting the healthcare industry rose by 55%, compromising more than 93 million patient records and incurring an average financial burden of \$10.1 million per attack. Modern smart healthcare ecosystems are increasingly prone to a broad spectrum of cyber threats, including ransomware that disrupts clinical services, phishing attacks that deceive staff into leaking credentials, and distributed denial-of-service (DDoS) attacks that bring down entire systems. Additional risks involve malware infiltration, SQL injection vulnerabilities, insider threats, Advanced Persistent Threats (APTs), and weaknesses within Internet of Medical Things (IoMT) devices. These growing concerns underscore the urgent demand for comprehensive cybersecurity policies to ensure data safety and preserve the

operational integrity of health services. Research has found that 72% of individuals fear their health information might be exploited, especially when data is collected without clear or informed consent. The widespread use of cloud computing, electronic health records, and connected medical devices has resulted in an unprecedented volume of sensitive data, increasingly attractive to cybercriminals. The consequences of breaches extend beyond financial loss, often leading to identity theft and disruptions in patient care. For this reason, healthcare organizations are ethically and legally obligated to establish robust systems that uphold data privacy, accuracy, and system uptime. At the same time, patients must play an active role by adopting personal cybersecurity practices to protect their digital health profiles in today's highly interconnected digital health landscape (Otorkpa et al., 2024).

Data Analysis and results

Methodology

Overview

In this part, the participants of the study and the instruments employed are introduced. Moreover, the procedure of the research, the design and data analysis are presented in detail where This study aims to evaluate the Impact of Using Smart Systems in Developing Performance in the Health Sector in Saudi Arabia.

Research Design:

To achieve the research objectives and test the validity of the hypotheses, the descriptive analytical method was adopted. This method provides an accurate and detailed description of the social phenomenon under study, in either qualitative or quantitative numerical form. It does not stop at collecting information to describe the phenomenon but also analyzes the phenomenon and reveals the relationships between its various dimensions to interpret it and reach conclusions that contribute to improving and developing reality (Gharaibeh et al., 2015). In this research, it is used to evaluate the impact of using smart systems on developing performance in hospitals within the Jeddah region, Saudi Arabia.

Participants

Research Population:

The study population is the group of elements or individuals that are the focus of interest in a particular study. In other words, it is all the elements related to the research problem. The study population consists of employees in hospitals within the Jeddah region, Saudi Arabia, which includes (11) government hospitals, comprising approximately (9500) employees, according to the Saudi Ministry of Health. These employees are distributed across various medical and administrative specialties, including (medical staff, nursing staff, technical and

administrative staff). The researcher will select the sample from the employees of the hospitals under study.

Research Sample:

The population size is estimated to be approximately (9500) employees according to the annual statistical book issued by the Saudi Ministry of Health. The research sample size can be determined from a finite population according to the sample size determination formula, ensuring complete representation of this population and that the estimation error does not exceed 5%. The researcher relied on the following formula to determine the sample size.

$$n = (Np(1 - p))/((N - 1)((d^2) / (z^2)) + p(1 - p))$$

Population size N = 9500

- Expected proportion (p): The expected proportion of the characteristic we want to measure in the population, assumed to be approximately 0.5 (i.e., 50%). Therefore, $p = 0.5$.
- Margin of error (d): The permissible margin of error is $\pm 3\%$. Therefore, $d = 0.03$.
- The critical value of z at a 95% confidence level is 1.96.

Equation:

$$n = (Np(1 - p))/((N - 1)((d^2) / (z^2)) + p(1 - p))$$

We substitute the values into the equation : $n = (9500 * 0.5 * 0.4) / ((9500 - 1)((0.03^2) / (1.96^2)) + 0.5 * 0.4)$

Thus, the value of n = 350

Based on this, a sample of 350 individuals will be taken to evaluate the impact

of using smart systems on developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia.

Data Types:

Data will be collected from the following sources:

1-Primary Data:

This is the data obtained through the field study related to the research, which will be collected using a questionnaire. This includes surveys and employee questionnaires in hospitals within the Jeddah region. Questionnaires will be designed to evaluate the impact of using smart systems on developing performance in the hospitals under study in the Jeddah region. The questionnaires will be distributed to a random sample of hospital employees, and the data extracted from the questionnaires will be analyzed.

2-Secondary Data:

This is the data obtained through research in books, journals, studies, and conferences related to the study variables, which include:

- Published Reports and Studies: Previous reports and studies discussing smart systems and performance development will be reviewed. Academic databases and scientific journals will be searched for relevant research

Data Collection Methods:

Data will be collected using "questionnaire forms," which will be distributed to the research sample in hospitals within the Jeddah region. In addition, personal interviews will be conducted, and official reports issued by the hospitals under study will be reviewed, to collect data on the extent of using smart systems in developing performance

The study tool:

The questionnaire was developed by the researcher based on a thorough review of the theoretical background and existing literature; the questionnaire consisted of two main sections as follows:

- **The first section** included the demographic data of participants.
- **The second section** consists of two main axes
 - **The first axis: Smart Systems** consisting of 16 items divided into 4 domains
 - **The second axis: Performance Development** consisting of 16 items divided into 4 domains

The validity of tool:

Face validity

To ensure the instrument's validity, the researcher enlisted the help of a panel of experts whose involvement was required to determine the questionnaire's content validity. The jurors were instructed to review the questionnaire items for language, applicability, and consistency. Some suggestions and comments were received, and minor changes to the questionnaire were made as a result.

The internal consistency:

Internal consistency was calculated by Pearson correlation coefficient between each item and the axis that belonged to, and the results shown as the following:

Table (1) internal correlation between phrases and the axis belonged to it

Smart Systems				Performance Development			
N	correlation coefficient	N	correlation coefficient	N	correlation coefficient	N	correlation coefficient
1	.537**	9	.739**	1	.821**	9	.693**

2	.616**	10	.555**	2	.710**	10	.771**
3	.694**	11	.593**	3	.738**	11	.691**
4	.627**	12	.694**	4	.629**	12	.729**
5	.655**	13	.703**	5	.720**	13	.578**
6	.669**	14	.582**	6	.715**	14	.722**
7	.582**	15	.632**	7	.688**	15	.698**
8	.726**	16	.687**	8	.704**	16	.725**

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

From the above table we conclude that all Pearson correlation coefficients between each item and the axis that belonged to it come with high degree and significant (where significant value less than 0.05) Which indicates a high degree of validity of the internal consistency of the terms of the questionnaire.

The reliability of Instrument:

The reliability of the study tool means that the tool will give approximately the same results when applied multiple times to the same sample. The reliability of the questionnaire was checked through Cronbach's alpha Coefficient, as shown in the following table.

Table (2) Cronbach's Alpha coefficients

Axis	N of Items	Cronbach's Alpha
Smart Systems	16	.801
Performance Development	16	.814
Total degree	32	.897

From the above table we conclude that the reliability coefficients value of all axes of questionnaire were all high scores approaching the correct one and the total degree of reliability was (.897) which is high value and approaching the correct one and it refers to the reality of the questionnaire for the application.

Data Analysis

After the collection of data, the variables will be checked and entered a computer, and statistical analyses will be conducted by appropriate methods using Statistical Package for Social Sciences (SPSS) version (24.0).

relying on the following methods:

- The Frequency and percentage will be counted for categorical variables
- Calculation of means and standard deviations
- One-sample T-test
- Multiple regression analysis

Ethical concerns

The researcher will obtain informed consent from all participants, clearly explaining the purpose of the study and ensuring confidentiality. Also, he will seek ethical approval from relevant institutional review boards to ensure the research adheres to ethical guidelines.

Results and Recommendations

Study demographic data

The frequencies and percentages of the sample were calculated according to the following:

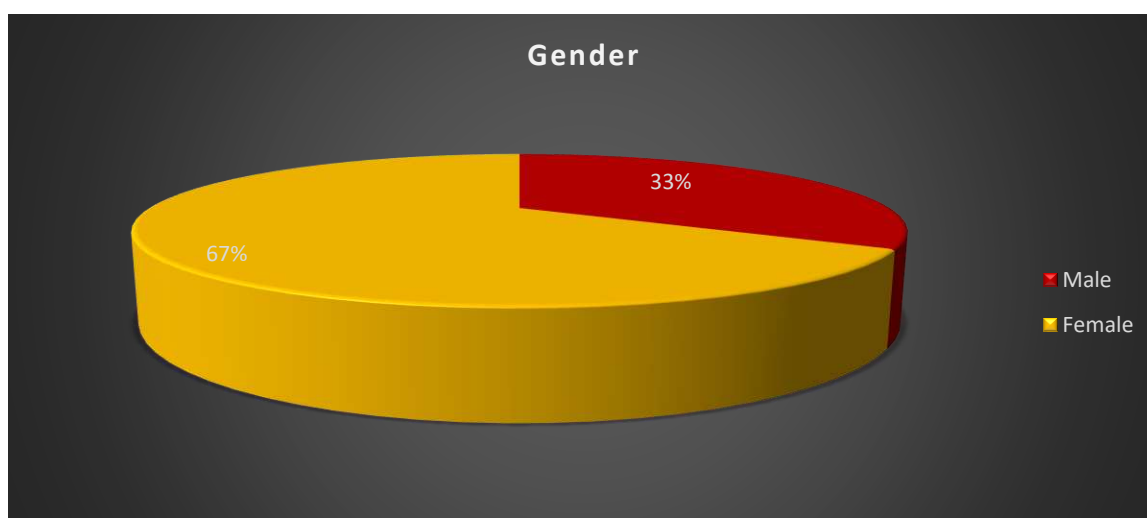
1- Gender

Table (1) the gender of the sample

Gender	Frequency	Percent
Male	117	33.4
Female	233	66.6
Total	350	100%

From the above table, we conclude that (66.6%) of the participants are females, (33.4%) of the participants are males.

This result indicates that the study sample is predominantly female, suggesting that women were more represented or possibly more willing to participate in the survey than men. This gender imbalance should be considered when interpreting the findings, as it may influence the generalizability of the results to the broader population.



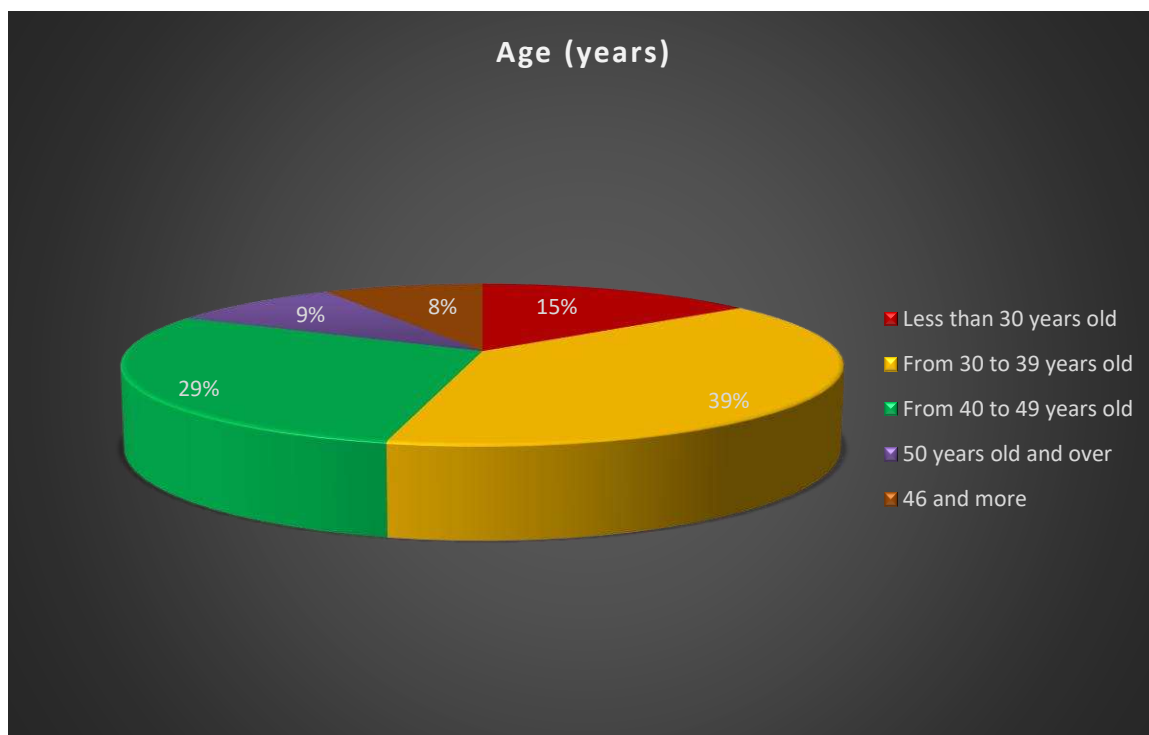
2- Age (years)

Table (2) Age (years) of the sample

Age (years)	Frequency	Percent
Less than 30 years old	56	16.0
From 30 to 39 years old	149	42.6
From 40 to 49 years old	110	31.4
50 years old and over	35	10.0
46 and more	32	30.8
Total	350	100%

From the above table, we conclude that (42.6 %) of the participants aged from 30 to 39 years old, (31.4%) of the participants aged from 40 to 49 years old, and (16 %) of the participants aged Less than 30 years old

This result indicates that the majority of participants are in the 30–39 age group, followed by those aged 40–49, while younger participants under 30 are less represented. This age distribution suggests that the sample is largely composed of early- to mid-career adults, which may influence the perspectives captured in the study and should be considered when analyzing and generalizing the findings.



3-Education Level

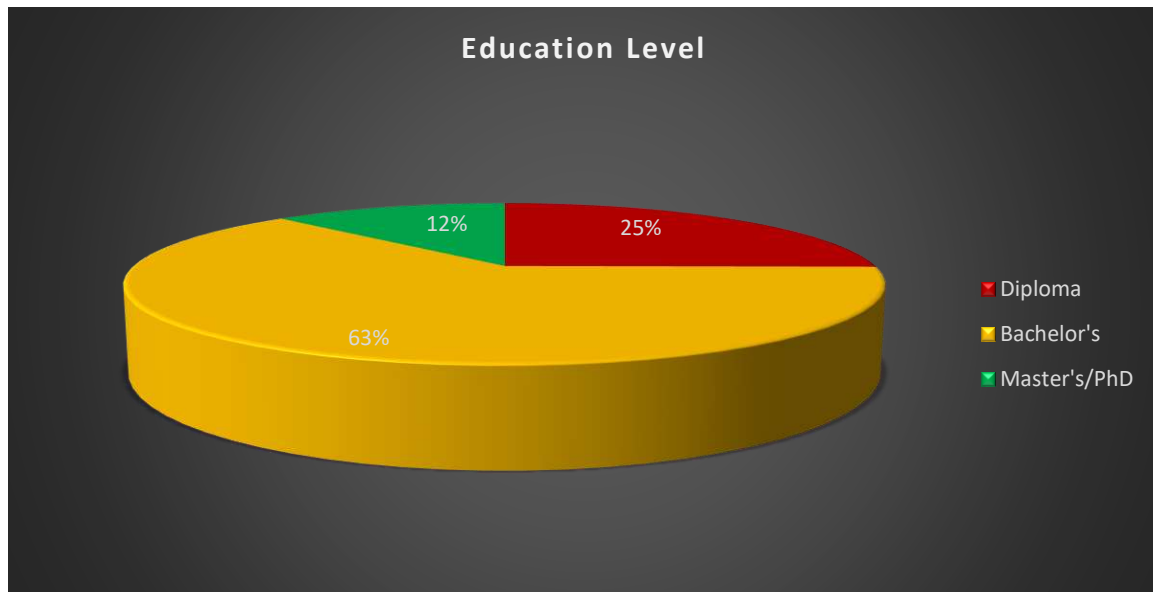
Table (3) Education Level of the sample

Education Level	Frequency	Percent
Diploma	88	25.1
Bachelor's	219	62.6
Master's/PhD	43	12.3
Total	350	100%

From the above table, we conclude that (62.6%) of the participants have bachelor's degree, (25.1%) of the participants have Diploma degree, (12.3%) of the participants have Master's/PhD.

This result indicates that most participants hold a bachelor's degree, with fewer holding a diploma and an even smaller proportion having a master's or PhD. This educational profile suggests that the sample is predominantly made up of individuals with undergraduate-level qualifications, which may reflect the

general educational background of the target population and could influence their perspectives and responses in the study.



4- Job Level

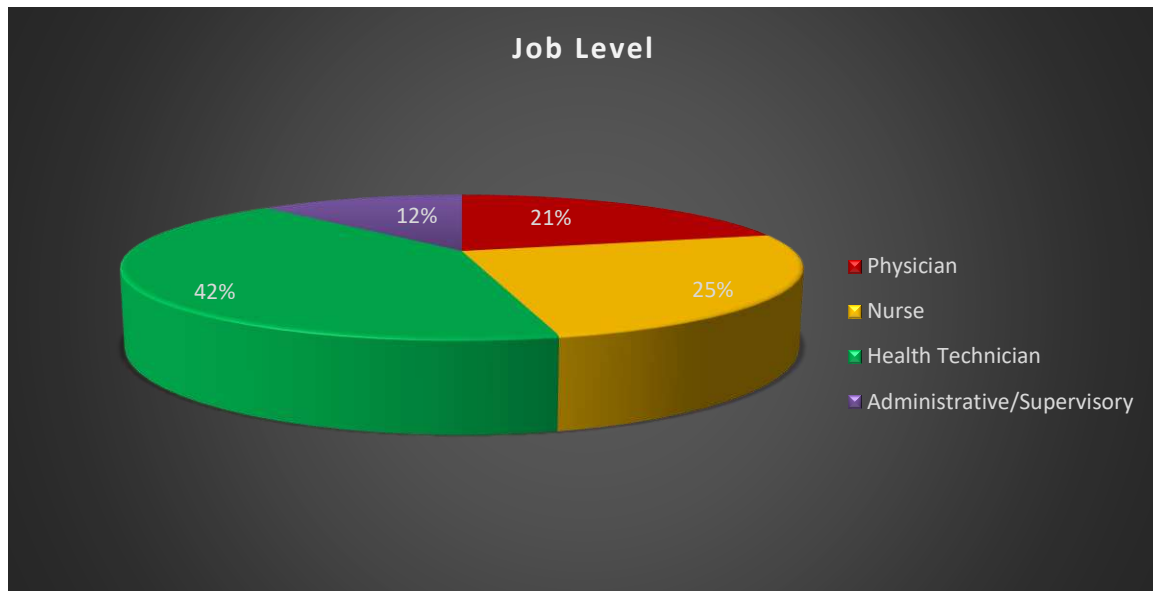
Table (4) Job Level of the sample

Job Level	Frequency	Percent
Physician	74	21.1
Nurse	88	25.1
Health Technician	146	41.7
Administrative/Supervisory	42	12.0
Total	350	100%

From the above table, we conclude that (41.7%) of the participants are Health Technicians, (25.1%) of the participants work as Nurses, (21.1%) of the participants are Physicians, and (12%) of the participants are Administrative /Supervisory.

This result indicates that health technicians make up the largest share of participants, followed by nurses and physicians, with administrative or supervisory staff representing the smallest group. This distribution suggests that

the sample is heavily weighted toward frontline clinical and technical roles, which may provide valuable insights into the practical, hands-on aspects of healthcare delivery while offering relatively fewer perspectives from managerial or administrative viewpoints.



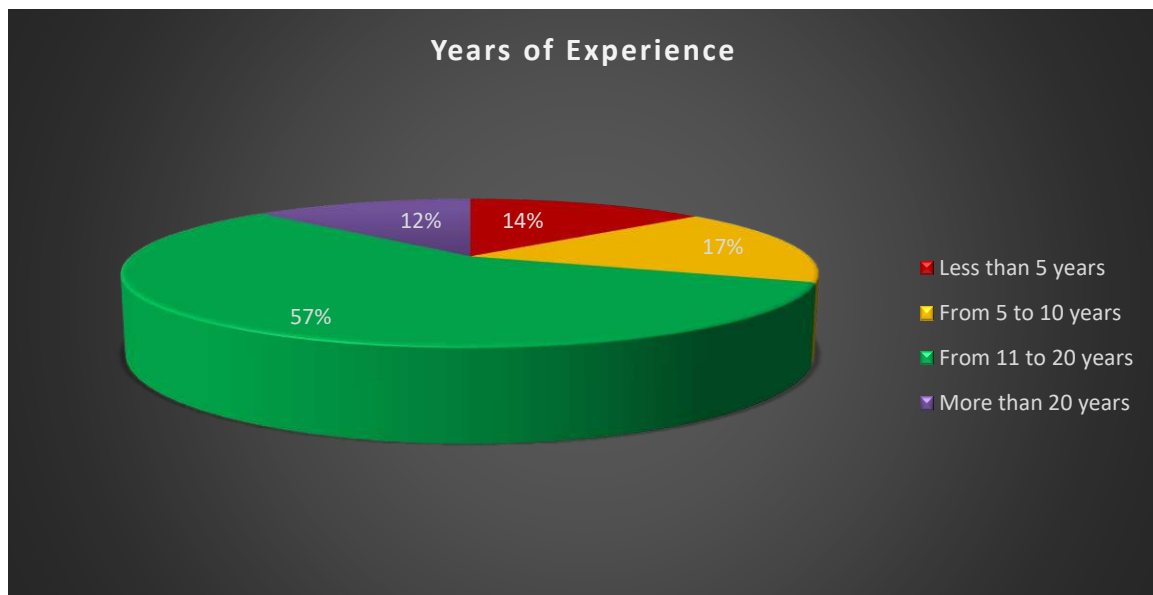
5- Years of Experience

Table (5) Years of Experience of the sample

Years of Experience	Frequency	Percent
Less than 5 years	48	13.7
From 5 to 10 years	59	16.9
From 11 to 20 years	199	56.9
More than 20 years	44	12.6
Total	350	100%

From the above table, we conclude that (56.7%) of the participants have from 11 to 20 years of experience, (16.9%) of the participants have from 5 to 10 years of experience, (13.7%) of the participants have Less than 5 years of experience, and (12%) of the participants have more than 20 years of experience.

This result indicates that the majority of participants have between 11 and 20 years of experience, suggesting a highly experienced workforce overall. The relatively smaller proportions of participants with less than 5 years or more than 20 years of experience point to a balanced but predominantly mid-career sample. This distribution may reflect a strong base of seasoned professionals who can provide informed and practical perspectives on workplace practices and challenges.



Second study the variables

1- Independent Variable: Smart Systems

To study Smart Systems, mean and standard deviation was calculated the first axis as the following.

1- Smart Devices

Table (4) means standard deviation to Smart Devices

No	Item	Mean	Standard Deviation	Rank	Degree
1	Our institution uses smart devices (e.g., tablets, smartphones,	4.13	.681	4	Agree

	wearables) to support clinical and administrative tasks.				
2	Medical and auxiliary staff are provided with smart devices that facilitate access to patient information.	4.16	.792	3	Agree
3	We utilize smart sensors for remote monitoring of patient conditions (e.g., vital signs monitors).	4.23	.900	1	Strongly Agree
4	We have virtual reality/augmented reality technologies available to support training or medical procedures.	4.21	.832	2	Strongly Agree
General mean		4.18	0.80	Agree	

From the above table we conclude that the use of Smart Devices in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Agree), mean (4.18) and standard deviation (0.80) low value, indicating the homogeneity of opinions of the study sample on the items of this dimension

In the first order (We utilize smart sensors for remote monitoring of patient conditions (e.g., vital signs monitors).), with a mean (4.23), a standard deviation of (0.90) and a degree of (Strongly Agree)

While in the last order (Our institution uses smart devices (e.g., tablets, smartphones, wearables) to support clinical and administrative tasks.) with a mean of (4.13) and a standard deviation (0.681) with a degree of (Agree)

So, we conclude that the use of Smart Devices in the healthcare sector in hospitals within the Jeddah region with a high degree

This result indicates that participants generally agree on the use of smart devices in the healthcare sector in hospitals within the Jeddah region, with a high mean score of 4.18. The relatively low standard deviation (0.80) suggests a strong consistency and homogeneity in their views. This reflects broad acceptance and alignment among the sample regarding the integration and value of smart devices in enhancing healthcare delivery.

2- Communication Network (Infrastructure)

Table (5) means and standard deviation to Communication Network (Infrastructure)

No	Item	Mean	Standard Deviation	Rank	Degree
5	We have a strong and reliable internet network infrastructure within the institution.	4.11	.723	3	Agree
6	Our network enables seamless and instant communication between different departments and staff.	4.19	.810	1	Agree
7	Our communication network is regularly updated to keep pace with technological advancements.	4.15	.876	2	Agree
8	Our network has robust security measures to protect patient data and sensitive information.	3.98	.858	4	Agree
General mean		4.11	0.82	Agree	

From the above table we conclude that the use of Communication Network (Infrastructure) in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Agree), mean (4.11) and standard deviation (0.82) low value, indicating the homogeny opinions of the study sample on the items of this dimension

In the first order (Our network enables seamless and instant communication between different departments and staff.), with a mean (4.19), a standard deviation of (0.81) and a degree of (Agree)

While in the last order (Our network has robust security measures to protect patient data and sensitive information.) with a mean of (3.98) and a standard deviation (0.858) with a degree of (Agree)

So, we conclude that the use of Communication Network (Infrastructure) in the healthcare sector in hospitals within the Jeddah region with a high degree

These results indicate that overall, participants agree strongly on the effective use of communication network infrastructure in hospitals within the Jeddah region. The high mean score (4.11) with a low standard deviation (0.82) reflects consistent and homogeneous views across the sample. The highest-rated aspect—seamless and instant communication between departments and staff (mean = 4.19)—suggests that the network is highly valued for improving internal coordination. Meanwhile, the slightly lower mean for security measures (3.98) indicates that although security is seen positively, there may be room for further enhancement. Overall, these findings suggest that communication infrastructure is well-developed and widely appreciated for supporting hospital operations in the region.

3- Big Data Databases

Table (6) means and standard deviation to Big Data Databases

No	Item	Mean	Standard Deviation	Rank	Degree
9	We have effective systems for collecting and storing large volumes of patient data (records, images, test results).	4.21	.788	2	Strongly Agree

10	We can easily access historical clinical and administrative data for trend analysis.	4.32	.871	1	Strongly Agree
11	Big data is used to support clinical and administrative decision-making in our institution.	4.02	.775	4	Agree
12	We possess the necessary resources (human and technical) to effectively analyze and interpret big data.	4.13	.750	3	Agree
General mean		4.17	0.80	Agree	

From the above table we conclude that the use of Big Data Databases in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Agree), mean (4.17) and standard deviation (0.80) low value, indicating the homogeny opinions of the study sample on the items of this dimension

In the first order (We can easily access historical clinical and administrative data for trend analysis.), with a mean (4.32), a standard deviation of (0.871) and a degree of (Strongly Agree)

While in the last order (Big data is used to support clinical and administrative decision-making in our institution.) with a mean of (4.02) and a standard deviation (0.775) with a degree of (Agree)

So, we conclude that the use of Big Data Databases in the healthcare sector in hospitals within the Jeddah region with a high degree

These results suggest that participants view the use of big data databases in Jeddah hospitals positively. It indicates that staff generally agree on the value of big data for improving operations, supporting analysis, and aiding decision-making, highlighting its important role in enhancing healthcare services.

4- Artificial Intelligence

Table (7) means and standard deviation to Artificial Intelligence

No	Item	Mean	Standard Deviation	Rank	Degree
13	We use Artificial Intelligence/Machine Learning systems for disease diagnosis or prediction.	4.20	.822	1	Agree
14	AI is utilized in our institution to improve appointment scheduling and waiting list management.	4.12	.663	3	Agree
15	We have AI-powered systems to assist physicians in making treatment decisions.	3.96	.735	4	Agree
16	We leverage AI to analyze big data for pattern identification and healthcare improvement.	4.17	.804	2	Agree
General mean		4.11	0.76	Agree	

From the above table we conclude that the use of Artificial Intelligence in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Agree), mean (4.11) and standard deviation (0.76) low value, indicating the homogeny opinions of the study sample on the items of this dimension

In the first order (We use Artificial Intelligence/Machine Learning systems for disease diagnosis or prediction.), with a mean (4.2), a standard deviation of (0.822) and a degree of (Agree)

While in the last order (We have AI-powered systems to assist physicians in making treatment decisions.) with a mean of (3.96) and a standard deviation (0.735) with a degree of (Agree)

So, we conclude that the use of Artificial Intelligence in the healthcare sector in hospitals within the Jeddah region with a high degree

These results suggest that participants generally view the use of Artificial Intelligence in Jeddah hospitals positively. Staff agree that AI is being effectively used to support diagnosis and assist in treatment decisions, indicating its growing role as an important tool to enhance healthcare quality and clinical decision-making.

From the above results we conclude that Smart Systems variable was as follows

Table (7) means and standard deviation to first axis

N o	Dimension	Mean	Standard Deviation	Rank	Degree
1	Smart Devices	4.18	0.8	1	Agree
2	Communication Network (Infrastructure)	4.11	0.82	3	Agree
3	Big Data Databases	4.17	0.8	2	Agree
4	Artificial Intelligence	4.11	0.76	3	Agree
General mean		4.14	0.80	Agree	

From the above table we conclude that the use of Smart Systems in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Agree), mean (4.14) and standard deviation (0.80) So, we conclude that the use of Smart Systems in the healthcare sector in hospitals within the Jeddah region with a high degree

These results indicate that participants have a positive perception of the use of smart systems in hospitals in the Jeddah region. This suggests that smart

systems are seen as valuable tools that support efficiency, improve service delivery, and enhance overall healthcare operations.

2- Dependent Variable: Performance Development

To study Performance Development, mean and standard deviation was calculated the items of the second axis as the following.

1- Performance Effectiveness

Table (4) means standard deviation to Performance Effectiveness

No	Item	Mean	Standard Deviation	Rank	Degree
1	The use of smart systems has contributed to improving the accuracy of medical diagnoses.	4.06	.823	4	Agree
2	Smart systems have led to an increased success rate for treatments provided to patients.	4.18	.946	3	Agree
3	Smart systems have enhanced our ability to achieve the institution's strategic goals.	4.26	.831	1	Strongly agree
4	Smart systems have helped in improving compliance with health standards and protocols.	4.19	.754	2	Agree
General mean		4.17	0.84	Agree	

From the above table we conclude that the level of Performance Effectiveness in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Agree), mean (4.17) and standard deviation (0.84) low value, indicating the homogeny opinions of the study sample on the items of this dimension

In the first order (Smart systems have enhanced our ability to achieve the institution's strategic goals.), with a mean (4.26), a standard deviation of (0.831) and a degree of (Strongly Agree)

While in the last order (The use of smart systems has contributed to improving the accuracy of medical diagnoses.) with a mean of (4.06) and a standard deviation (0.823) with a degree of (Agree)

So, we conclude that the level of Performance Effectiveness in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with a high degree

These findings suggest that participants view performance effectiveness in Jeddah-region hospitals positively. Smart systems are perceived as important contributors to achieving strategic goals and improving the quality of medical care, highlighting their role in enhancing overall healthcare performance.

2- Performance Efficiency

Table (5) means and standard deviation to Performance Efficiency

No	Item	Mean	Standard Deviation	Rank	Degree
5	Smart systems have reduced the time required to complete administrative and clinical tasks.	4.22	.796	1	Strongly Agree
6	Smart systems have contributed to decreasing human errors and duplicated processes.	3.87	.790	4	Agree
7	Smart systems have led to improved utilization of available resources (e.g., equipment, staff).	4.17	.740	2	Agree
8	Smart systems have accelerated the process of information exchange between departments and staff.	4.14	.759	3	Agree

General mean	4.10	0.77	Agree
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From the above table we conclude that the level of Performance Efficiency in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Agree), mean (4.10) and standard deviation (0.77) low value, indicating the homogeny opinions of the study sample on the items of this dimension

In the first order (Smart systems have reduced the time required to complete administrative and clinical tasks), with a mean (4.22), a standard deviation of (0.796) and a degree of (Strongly Agree)

While in the last order (Smart systems have contributed to decreasing human errors and duplicated processes.) with a mean of (3.87) and a standard deviation (0.79) with a degree of (Agree)

So, we conclude that the level of Performance Efficiency in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with a high degree

These results indicate that participants generally perceive smart systems as effective tools for improving efficiency in hospitals. They are seen as helping to streamline workflows, reduce task completion time, and minimize errors, supporting smoother and more reliable healthcare operations in the Jeddah region.

3- Quality Performance

Table (6) means and standard deviation to Quality Performance

No	Item	Mean	Standard Deviation	Rank	Degree
9	Smart systems have contributed to improving the overall quality of healthcare services provided to patients.	4.29	.884	1	Strongly Agree
10	Smart systems have enhanced patient experience and their satisfaction with the care received.	4.18	.847	3	Agree

11	Smart systems have helped in providing safer healthcare for patients.	4.14	.829	4	Agree
12	Smart systems have enabled the provision of personalized healthcare tailored to each patient's needs.	4.23	.823	2	Strongly Agree
General mean		4.21	0.85	Strongly Agree	

From the above table we conclude that the level of Quality Performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Strongly Agree), mean (4.21) and standard deviation (0.85) low value, indicating the homogeny opinions of the study sample on the items of this dimension

In the first order (Smart systems have contributed to improving the overall quality of healthcare services provided to patients.), with a mean (4.29), a standard deviation of (0.884) and a degree of (Strongly Agree)

While in the last order (Smart systems have helped in providing safer healthcare for patients.) with a mean of (4.14) and a standard deviation (0.829) with a degree of (Agree)

So, we conclude that the level of Quality Performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with a high degree

These findings suggest that participants view smart systems as making a strong and positive contribution to the overall quality of healthcare services. They are perceived as important in enhancing service standards and ensuring safer, more reliable care for patients in hospitals across the Jeddah region.

4- Innovation in Performance

Table (7) means and standard deviation to Innovation in Performance

No	Item	Mean	Standard Deviation	Rank	Degree
13	Smart systems have encouraged the development of new and innovative working methods within the institution.	3.75	.804	3	Agree
14	Smart systems have contributed to the provision of new healthcare services that were not previously possible.	4.25	.764	1	Strongly Agree
15	Smart systems have enhanced the ability to adapt quickly to emerging health challenges.	3.66	.703	4	Agree
16	Smart systems have played a role in motivating staff to adopt innovative ideas and solutions.	4.17	.613	2	Agree
General mean		3.96	0.72	Agree	

From the above table we conclude that the level of Innovation in Performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Agree), mean (3.96) and standard deviation (0.72) low value, indicating the homogeny opinions of the study sample on the items of this dimension

In the first order (Smart systems have contributed to the provision of new healthcare services that were not previously possible), with a mean (4.25), a standard deviation of (0.764) and a degree of (Strongly Agree)

While in the last order (Smart systems have enhanced the ability to adapt quickly to emerging health challenges.) with a mean of (3.66) and a standard deviation (0.703) with a degree of (Agree)

So, we conclude that the level of Innovation in Performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with a high degree

These results suggest that smart systems are seen as valuable drivers of innovation in healthcare performance. Participants perceive them as enabling new types of services and supporting hospitals in responding effectively to emerging health challenges across the Jeddah region.

From the above results we conclude that the Performance Development variable was as follows

Table (7) means and standard deviation to second axis

N o	Domain	Mean	Standard Deviation	Rank	Degree
1	Performance Effectiveness	4.17	0.84	2	Agree
2	Performance Efficiency	4.10	0.77	3	Agree
3	Quality Performance	4.21	0.85	1	Strongly Agree
4	Innovation in Performance	3.96	0.72	4	Agree
General mean		4.11	0.80	Agree	

From the above table we conclude that the level of Performance Development in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Agree), mean (4.11) and standard deviation (0.80) low value, So, we conclude that the level of Performance Development in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with a high degree

This result indicates that there is a strong perception among participants that smart systems have positively contributed to the development of performance in

healthcare. It reflects a shared belief that these technologies support continuous improvement and progress in hospital operations across the Jeddah region.

Study Questions:

Main Research Question: "What is the impact of using smart systems on developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia"

To study the impact of using smart systems on developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia (Multiple regression test) was used, and the results was as following

Independent variable	B	T -value	Sig.
(Constant)	.150	1.310	.191
Smart Devices	.214	.084	.003
Communication Network (Infrastructure)	.477	11.062	.000
Big Data Databases	.283	5.256	.000
Artificial Intelligence	.186	3.606	.000
R=0.897		Adjusted R Square=0.703	
F=356.701		Sig.=0.00	

From the table we conclude that (R=0.897) more than (0.7) means that with increase of using the dimensions of smart systems, developing performance increased,(Adjusted R Square=0.703) means that using the dimensions of smart systems interpret (70.3%) of developing performance , (F=356.701) with significant value (Sig.=0.00) less than (0.05) which means that there is a positive significant impact of using smart systems on developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia

The following sub-questions branch out from this main research question:

1-What is the impact of using smart systems on performance effectiveness in hospitals within the Jeddah region, Saudi Arabia?

To study the impact of using smart systems on performance effectiveness in hospitals within the Jeddah region, Saudi Arabia (Multiple regression test) was used, and the results was as following

Independent variable	B	T -value	Sig.
(Constant)	-.045	-.328	.743
Smart Devices	.271	4.758	.000
Communication Network (Infrastructure)	.439	8.463	.000
Big Data Databases	.379	1.227	.002
Artificial Intelligence	.205	3.307	.001
R=0.871		Adjusted R Square=0.655	
F=270.314		Sig.=0.00	

From the table we conclude that (R=0.871) more than (0.7) means that with increase of using the dimensions of smart systems, performance effectiveness increased,(Adjusted R Square=0.655) means that using the dimensions of smart systems interpret (65.5%) of performance effectiveness, (F=270.314) with significant value (Sig.=0.00) less than (0.05) which means that there is a positive significant impact of using smart systems on performance effectiveness in hospitals within the Jeddah region, Saudi Arabia

2- What is the impact of using smart systems on performance efficiency in hospitals within the Jeddah region, Saudi Arabia?

To study the impact of using smart systems on performance efficiency in hospitals within the Jeddah region, Saudi Arabia (Multiple regression test) was used, and the results was as following:

Independent variable	B	T -value	Sig.
(Constant)	.662	4.348	.000
Smart Devices	.324	-.386	.007
Communication Network (Infrastructure)	.566	9.888	.000
Big Data Databases	.320	4.475	.000
Artificial Intelligence	.318	-.268	.009
R=0.819		Adjusted R Square=0.667	
F=176.089		Sig.=0.00	

From the table we conclude that (R=0.819) more than (0.7) means that with increase of using the dimensions of smart systems, performance efficiency increased,(Adjusted R Square=0.667) means that using the dimensions of smart systems interpret (66.7%) of performance efficiency, (F=176.089) with significant value (Sig.=0.00) less than (0.05) which means that there is a positive significant impact of using smart systems on performance efficiency in hospitals within the Jeddah region, Saudi Arabia

3- What is the impact of using smart systems on performance quality in hospitals within the Jeddah region, Saudi Arabia?

To study the impact of using smart systems on performance quality in hospitals within the Jeddah region, Saudi Arabia (Multiple regression test) was used, and the results was as following

Independent variable	B	T -value	Sig.
(Constant)	-.479	-3.334	.001
Smart Devices	-.096	-1.624	.005
Communication Network (Infrastructure)	.595	11.002	.000
Big Data Databases	.343	5.091	.000
Artificial Intelligence	.238	3.685	.000
R=0.880		Adjusted R Square=0.772	
F=295.942		Sig.=0.00	

From the table we conclude that (R=0.880) more than (0.7) means that with increase of using the dimensions of smart systems, performance quality increased,(Adjusted R Square=0.772) means that using the dimensions of smart systems interpret (77.2%) of performance quality, (F=295.942) with significant value (Sig.=0.00) less than (0.05) which means that there is a positive significant impact of using smart systems on performance quality in hospitals within the Jeddah region, Saudi Arabia

4- What is the impact of using smart systems on innovation in performance in hospitals within the Jeddah region, Saudi Arabia?

To study the impact of using smart systems on innovation in performance in hospitals within the Jeddah region, Saudi Arabia (Multiple regression test) was used, and the results was as following

Independent variable	B	T -value	Sig.
(Constant)	.464	3.313	.001
Smart Devices	-.134	-2.324	.021
Communication Network (Infrastructure)	.309	5.876	.000
Big Data Databases	.389	5.928	.000
Artificial Intelligence	.319	5.071	.000
R=0.837		Adjusted R Square=0.697	
F=201.789		Sig.=0.00	

From the table we conclude that (R=0.837) more than (0.7) means that with increase of using the dimensions of smart systems, innovation in performance increased,(Adjusted R Square=0.697) means that using the dimensions of smart systems interpret (69.7%) of innovation in performance, (F=201.789) with significant value (Sig.=0.00) less than (0.05) which means that there is a positive significant impact of using smart systems on innovation in performance in hospitals within the Jeddah region, Saudi Arabia

Main Research Question Two: "Is there a difference between the responses of the research sample regarding the impact of using smart systems on developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to (Gender - Age - Educational Level - Job Level - Years of Experience)?"

To answer this question, the following sub-questions were answered as follows:

1-Is there a difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to gender?

To study the difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to gender (independent Sample T-test) used and the results as follows

Gender	N	Mean	Std. Deviation	T	Sig
Male	117	4.3835	.68745	.902	.368
Female	233	4.3205	.57812		

From the table we conclude that there is no significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to gender where significant value (sig=0.368) more than (0.05)

2- Is there a difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to age?

To study the difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to age (One Way Anova -test) used and the results as follows:

Age	N	Mean	Std. Deviation	F	Sig
Less than 30 years old	56	4.2835	.54224	2.717	.079
From 30 to 39 years old	149	4.4841	.49454		

From 40 to 49 years old	110	4.2602	.73213		
50 years old and over	35	4.0839	.67756		

From the table we conclude that there is no significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to Age where significant value (sig=0.079) more than (0.05)

3-Is there a difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to educational level?

To study the difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to educational level (One Way Anova -test) used and the results as follows:

Educational level	N	Mean	Std. Deviation	F	Sig
Diploma	88	4.3111	.81020	5.176	.009
Bachelor's	219	4.8562	.55613		
Master's/PhD	43	5.3299	.43651		

From the table we conclude that there is a significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to educational level where significant value (sig=0.009) less than (0.05) and these differences were to the responses of the category of Master's/PhD with mean (5.3299) then the category of Bachelor's with mean (4.8562)

4- Is there a difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to job level?

To study the difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to job level (One Way Anova -test) used and the results as follows:

job level	N	Mean	Std. Deviation	F	Sig
Physician	74	4.4561	.49090	2.191	.089
Nurse	88	4.3232	.62652		
Health Technician	146	4.3485	.61605		
Administrative/Supervisory	42	4.1548	.75585		

From the table we conclude that there is no significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to job level where significant value (sig=0.089) more than (0.05)

5-Is there a difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to years of experience?

To study the difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in

hospitals within the Jeddah region, Saudi Arabia, attributable to years of experience (One Way Anova -test) used and the results as follows:

years of experience	N	Mean	Std. Deviation	F	Sig
Less than 5 years	48	4.2148	.59024	6.007	.000
From 5 to 10 years	59	4.5030	.60561		
From 11 to 20 years	199	4.8769	.61311		
More than 20 years	44	5.4321	.67246		

From the table we conclude that there is a significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to years of experience where significant value (sig=0.00) less than (0.05) and these differences were to the responses of the category of More than 20 years with mean (5.4321) then the category of From 11 to 20 years with mean (4.8769)

Research Hypotheses

Main Hypothesis One : "There is a statistically significant relationship between the use of smart systems and the development of performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia"

To study the relationship between the use of smart systems and the development of performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia (Pearson correlation test) used, and the results as follows:

	The development of performance	
The use of smart systems	Pearson Correlation	.897**
	Sig. (2-tailed)	.000
	N	350

From the table we conclude that there is a statistically significant relationship between the use of smart systems and the development of performance in the

healthcare sector in hospitals within the Jeddah region, Saudi Arabia where significant value(sig=0.00) less than (0.05) and Pearson Correlation coefficient (0.897) with a positive value more than (0.7) means that there is a positive strong statistically significant relationship between the use of smart systems and the development of performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia

The following sub-hypotheses branch out from this main hypothesis one :

H1: There is a statistically significant relationship between the use of smart systems and performance effectiveness in hospitals within the Jeddah region, Saudi Arabia

To study the relationship between the use of smart systems and performance effectiveness in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia (Pearson correlation test) used, and the results as follows

	performance effectiveness	
The use of smart systems	Pearson Correlation	.871**
	Sig. (2-tailed)	.002
	N	350

From the table we conclude that there is a statistically significant relationship between the use of smart systems and performance effectiveness in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia where significant value(sig=0.002) less than (0.05) and Pearson Correlation coefficient (0.871) with a positive value more than (0.7) means that there is a positive strong statistically significant relationship between the use of smart systems and performance effectiveness in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia.

H2: There is a statistically significant relationship between the use of smart systems and performance efficiency in hospitals within the Jeddah region, Saudi Arabia.

To study the relationship between the use of smart systems and performance efficiency in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia (Pearson correlation test) used, and the results as follows:

	performance efficiency	
The use of smart systems	Pearson Correlation	.819**
	Sig. (2-tailed)	.000
	N	350

From the table we conclude that there is a statistically significant relationship between the use of smart systems and performance efficiency in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia where significant value(sig=0.00) less than (0.05) and Pearson Correlation coefficient (0.819) with a positive value more than (0.7) means that there is a positive strong statistically significant relationship between the use of smart systems and performance efficiency in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia.

H3: There is a statistically significant relationship between the use of smart systems and performance quality in hospitals within the Jeddah region, Saudi Arabia.

To study the relationship between the use of smart systems and performance quality in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia (Pearson correlation test) used, and the results as follows:

	performance quality	
The use of smart systems	Pearson Correlation	.880**
	Sig. (2-tailed)	.000
	N	350

From the table we conclude that there is a statistically significant relationship between the use of smart systems and performance quality in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia where significant value(sig=0.00) less than (0.05) and Pearson Correlation coefficient (0.880) with

a positive value more than (0.7) means that there is a positive strong statistically significant relationship between the use of smart systems and performance quality in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia

H4: There is a statistically significant relationship between the use of smart systems and innovation in performance in hospitals within the Jeddah region, Saudi Arabia.

To study the relationship between the use of smart systems and innovation in performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia (Pearson correlation test) used, and the results as follows

	innovation in performance	
The use of smart systems	Pearson Correlation	.837**
	Sig. (2-tailed)	.005
	N	350

From the table we conclude that there is a statistically significant relationship between the use of smart systems and innovation in performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia where significant value(sig=0.005) less than (0.05) and Pearson Correlation coefficient (0.837) with a positive value more than (0.7) means that there is a positive strong statistically significant relationship between the use of smart systems and innovation in performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia

Main Hypothesis Two:

"There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to (Gender - Age - Educational Level - Job Level - Years of Experience). "

To study the hypothesis, the following sub-hypotheses were studied as follows:

1- There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to gender

To study the difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to gender (independent Sample T-test) used and the results as follows:

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2- There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to age.

To study the difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to age (One Way Anova -test) used and the results as follows

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3- There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to educational level

To study the difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to educational level (One Way Anova -test) used and the results as follows

Educational level	N	Mean	Std. Deviation	F	Sig
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From the table we conclude that there is a significant difference between the responses of the research sample regarding the use of smart systems in developing

performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to educational level where significant value (sig=0.009) less than (0.05) and these differences were to the responses of the category of Master's/PhD with mean (5.3299) then the category of Bachelor's with mean (4.8562)

4- There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to job level

To study the difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to job level (One Way Anova -test) used and the results as follows:

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From the table we conclude that there is no significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to job level where significant value (sig=0.089) more than (0.05)

5- There is a statistically significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to years of experience.

To study the difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to years of experience (One Way Anova -test) used and the results as follows

years of experience	N	Mean	Std. Deviation	F	Sig
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From the table we conclude that there is a significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to years of experience where significant value (sig=0.00) less than (0.05) and these differences were to the responses of the category of More than 20 years with mean (5.4321) then the category of From 11 to 20 years with mean (4.8769)

Conclusions

- The use of Smart Systems in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Agree), mean (4.14) and standard deviation (0.80) So, we conclude that the use of Smart Systems in the healthcare sector in hospitals within the Jeddah region with a high degree
- The level of Performance Development in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with degree (Agree), mean (4.11) and standard deviation (0.80) low value, So, we conclude that the level of Performance Development in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia with a high degree
- There is a positive significant impact of using smart systems on developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia
- There is a positive significant impact of using smart systems on performance effectiveness in hospitals within the Jeddah region, Saudi Arabia
- There is a positive significant impact of using smart systems on performance efficiency in hospitals within the Jeddah region, Saudi Arabia
- There is a positive significant impact of using smart systems on performance quality in hospitals within the Jeddah region, Saudi Arabia
- There is a positive significant impact of using smart systems on innovation in performance in hospitals within the Jeddah region, Saudi Arabia
- There is no significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to gender
- There is no significant difference between the responses of the research sample regarding the use of smart systems in developing performance in

the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to Age

- There is a significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to educational level and these differences were to the responses of the category of Master's/PhD
- There is no significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to job level
- There is a significant difference between the responses of the research sample regarding the use of smart systems in developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia, attributable to years of experience and these differences were to the responses of the category of More than 20 years
- There is a positive strong statistically significant relationship between the use of smart systems and the development of performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia
- There is a positive strong statistically significant relationship between the use of smart systems and performance effectiveness in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia
- There is a positive strong statistically significant relationship between the use of smart systems and performance efficiency in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia
- There is a positive strong statistically significant relationship between the use of smart systems and performance quality in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia

- There is a positive strong statistically significant relationship between the use of smart systems and innovation in performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia

Conclusion

This study highlights the significant role that smart systems play in advancing performance development within the healthcare sector in the Jeddah region of Saudi Arabia. By examining staff perspectives across hospitals, the research underscores widespread recognition of the benefits offered by smart devices, robust communication networks, and big data solutions in enhancing service quality, coordination, and decision-making. The findings point to a workforce ready to embrace technological change, provided that strong infrastructure, targeted training, and sound data governance are in place. Moving forward, healthcare organizations should prioritize these enabling factors to fully realize the potential of smart systems, ensuring more efficient, effective, and high-quality patient care.

Recommendations

- Provide a strong and reliable communication network infrastructure, secure data centers, and continuous technical support to form a robust foundation for adopting smart systems.
- Design and implement continuous, tailored training programs for medical and administrative staff at all levels to ensure their ability to use smart systems effectively and efficiently.
- Establish clear frameworks and policies for big data collection, storage, use, and sharing, with a focus on privacy protection and compliance with international and local standards.
- Foster a work environment that supports innovation and embraces technological change.

- Work on integrating various smart systems to avoid data fragmentation and improve information flow between different departments and services.

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Appendices

Questionnaire

I am pleased to provide you with this questionnaire, which is a requirement for a
supplementary research project entitled:

Evaluating the Impact of Using Smart Systems in Developing Performance in the Health Sector in Saudi Arabia

This research aims to evaluate the Impact of Using Smart Systems in Developing Performance in the Health Sector in Saudi Arabia

I hope you read all the paragraphs carefully and answer them by putting a check mark (✓) in front of the appropriate choice for the paragraph. Please note that this questionnaire will be used for scientific research purposes only, and it is confidential. The research results will be arranged based on the respondents' answers. Therefore, I hope you read the paragraphs carefully and answer honestly so that the research results can be used.

Thank you

First demographic data:

1- Gender:

- 1 Male** ()
2 Female ()

2- Age (years):

- | | | |
|----------|--------------------------------|----------------|
| 1 | Less than 30 years old | () |
| 2 | From 30 to 39 years old | () |
| 3 | From 40 to 49 years old | () |
| 4 | 50 years old and over | () |

3- Education Level

- #### 4- Job Level

- ## 5- Years of Experience

- Second Put (✓) next to the right answer:**

Independent Variable: Smart Systems.

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3	We utilize smart sensors for remote monitoring of patient conditions (e.g., vital signs monitors).					
4	We have virtual reality/augmented reality technologies available to support training or medical procedures.					
Communication Network (Infrastructure)						
5	We have a strong and reliable internet network infrastructure within the institution.					
6	Our network enables seamless and instant communication between different departments and staff.					
7	Our communication network is regularly updated to keep pace with technological advancements.					
8	Our network has robust security measures to protect patient data and sensitive information.					
Big Data Databases						
9	We have effective systems for collecting and storing large volumes of patient data (records, images, test results).					
10	We can easily access historical clinical and administrative data for trend analysis.					
11	Big data is used to support clinical and administrative decision-making in our institution.					
12	We possess the necessary resources (human and technical) to effectively analyze and interpret big data.					
Artificial Intelligence						
13	We use Artificial Intelligence/Machine Learning systems for disease diagnosis or prediction.					
14	AI is utilized in our institution to improve appointment scheduling and waiting list management.					

15	We have AI-powered systems to assist physicians in making treatment decisions.					
16	We leverage AI to analyze big data for pattern identification and healthcare improvement.					

Dependent Variable: Performance Development

Items		Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
Performance Effectiveness						
1	The use of smart systems has contributed to improving the accuracy of medical diagnoses.					
2	Smart systems have led to an increased success rate for treatments provided to patients.					
3	Smart systems have enhanced our ability to achieve the institution's strategic goals.					
4	Smart systems have helped in improving compliance with health standards and protocols.					
Performance Efficiency						
5	Smart systems have reduced the time required to complete administrative and clinical tasks.					
6	Smart systems have contributed to decreasing human errors and duplicated processes.					
7	Smart systems have led to improved utilization of available resources (e.g., equipment, staff).					
8	Smart systems have accelerated the process of information exchange between departments and staff.					
Performance Quality						
9	Smart systems have contributed to improving the overall quality of healthcare services provided to patients.					

10	Smart systems have enhanced patient experience and their satisfaction with the care received.					
11	Smart systems have helped in providing safer healthcare for patients.					
12	Smart systems have enabled the provision of personalized healthcare tailored to each patient's needs.					
Innovation in Performance						
13	Smart systems have encouraged the development of new and innovative working methods within the institution.					
14	Smart systems have contributed to the provision of new healthcare services that were not previously possible.					
15	Smart systems have enhanced the ability to adapt quickly to emerging health challenges.					
16	Smart systems have played a role in motivating staff to adopt innovative ideas and solutions.					

Thank you

Abstract

The healthcare sector is rapidly evolving with the adoption of smart systems to enhance service quality. This study examines the impact of using these systems on performance development in hospitals within the Jeddah region of Saudi Arabia. This study aims to evaluate the impact of using smart systems on developing performance in the healthcare sector in hospitals within the Jeddah region, Saudi Arabia. This study uses a descriptive analytical method to evaluate the impact of smart systems on performance development in hospitals in the Jeddah region, Saudi Arabia. All employees in 11 government hospitals in the Jeddah region, totaling approximately 9,500 staff across medical, nursing, technical, and administrative roles. The sample will be selected from these employees to ensure accurate representation, with size calculated to maintain an estimation error within 5%. The study indicates broad agreement among participants on the positive role of smart systems in Jeddah-region hospitals. Respondents generally recognize the value of smart devices, communication networks, and big data databases in improving healthcare delivery. The sample is predominantly female, mid-career, and well-educated, with many working in frontline technical and clinical roles. Overall, these results suggest strong acceptance of technology's role in enhancing coordination, decision-making, and operational effectiveness in the healthcare sector. From these results, the study recommends that Provide a strong and reliable communication network infrastructure, secure data centers, and continuous technical support to form a robust foundation for adopting smart systems, design and implement continuous, tailored training programs for medical and administrative staff at all levels to ensure their ability to use smart systems effectively and efficiently and establish clear frameworks and policies for big data collection, storage, use, and sharing, with a focus on privacy protection and compliance with international and local standards.

Keywords: Smart Systems - Smart Devices - Communication Network - Artificial Intelligence - Performance Development - Performance Effectiveness - Performance Efficiency - Performance Quality - Innovation in Performance.