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The Role of Modern Technologies in Enhancing Health Security: A Proactive Approach to Managing Health Crises

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[1,2,3,4,5,6,7,8,9] Health Security

ABSTRACT

Pandemics and other disasters are unforeseeable events, and they present considerable risks to human health and wellbeing – and as such require creative approaches to dealing with them. New technologies are now valid weapons in assistance of health security through improving the methods of infection detection, diagnostics, resource utilization, communication, patient care and data protection. The purpose of this research was to assess the aspects relating to the readiness and efficiency of technology in crisis response within the healthcare domain and to outline certain barriers for its utilization. Thus, the systematic literature review was complemented by the analysis of quantitative data and qualitative expert interview. Information was obtained from scientific articles published in the indexed databases, articles and reports of global health institutions, seven key indicators were considered. Furthermore, correlation, $r=0.78$, $p<0.01$ and analysis of variance, using a regression model, showed the degree of interaction between the extent of technology implementation, impact scores and functional enhancement scores, $R^2=0.65$, $p<0.001$. The results showed that telemedicine platforms and AI triage systems received the highest level of adoption level (85% and 80%) and impact scores (88 and 89) with percentage improvement of 40% and 38%. There were variations in organizational readiness across the 5 disease surveillance technologies with the highest scores Average scores were high specifically for AI predictive analytics with an overall score of 85 The methods identified barriers that included a lack of trained personnel. The technologies for data security proved especially effective where protecting the health information is concerned: the given solution employed the blockchain and received a score of 90 for impact. Nevertheless, the challenge that was mentioned quite often was the high costs of implementation, inadequate infrastructure and compatibility problems. This study points out the significance of new technologies in promoting health security whenever they have been properly implemented. There is a need to invest in infrastructure and structures, set up and enhance policies so as to support human capital. In light of the study results, one could identify the importance of actively

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implementing breakthrough technologies into health care systems in order to ensure that the initiated actions create the necessary basis for the formation of effective solutions for overcoming future crises in the sphere. This work outlines how innovation can be managed to foster sustainable global health security in future.

Keywords: Artificial Intelligence (AI), Blockchain, Health Security, Telemedicine, Technology Implementation

INTRODUCTION

Health emergencies including epidemics, catastrophes and rising incidence of non-communicable diseases have brought into focus the weakness of conventional medical care facilities. These challenges call for new more technology-based solutions to try to guarantee the stability of the health systems all over the world (Mekonnen et al., 2024). This research aims at examining the crisis prevention perspective provided by modern technologies to improve health security. The various advanced technologies like AI, Blockchain, IoT, and telemedicine along with focus on using them in the management of crises and strengthening global health systems against the existing and emerging challenges will be the objectives of the study (Chamola et al., 2020). Health security which is the safeguarding of the health of a population is a dimension of sustainable development. Due to continuous enhancement of multiple and severe types of crises, including the current pandemic and ebola virus, global and climate crises also, we have to redefine traditional crisis management (Stoeva, 2020). There have been fewer preventive approaches implemented in health sectors, hence poor response formation and effective loss of life and property. Contemporary technologies have come as handy in complementing for these lapses (Moloi & Mulaba, 2024). For example, AI has shown its ability to identify the likelihood of an epidemic by processing Big Data, and blockchain provides secure data exchange for healthcare networks. Likewise, in healthcare IoT biosensors and wearable technologies have transformed diagnostics and patient management providing constant information flow and enhanced results (Jabarulla & Lee, 2021). In doing so, these technologies improve efficiency and move the concept of health security from a reactive threat focus to more proactive measures (Garcia et al., 2023).

This research holds significant importance as it addresses a critical global need to end up with strong health systems that are very capable of holding up for as many calamities as possible. As for the adoption of new technologies into the frameworks of health security, it is possible to state that such a step can significantly change the process of delivering healthcare, as well as crisis handling (Garcia et al., 2023). For instance, it has been observed that during the COVID-19 outbreak, some virtual consultative technologies have kept doctors around patients to reduce the burden on the hospitals. Similarly, diseases diagnostic tools enabled by

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AI worked towards the swift testing and treatment of many lives (Shen et al., 2021). However, these advancements have not made the adoption and optimization of the modern technologies in health security fully embraced. Numerous and diverse technological, legal, and moral issues create barriers to the broad dissemination of interventions. It is critical for making an organized study of the suitability and efficiency of the diverse equipments in major aspects like disease identification, disease tracking, availability utilization and management of resources, communication systems, patient care and safety and details security (Trump et al., 2023). Thus, it serves an important function of offering key findings that may help inform policy decisions, decisions made by health care organizations, and decisions made by technology industry actors (Hermes et al., 2020).

This research is informed by the growing realization that the world needs to build up its capacity in the face of new threats to health. Past experiences have shown that conventional ways of handling health challenges have failed several times and has resulted in the general delays and unnecessary causality rates. For instance, the current epidemic that hit West Africa, Ebola, could have been contained early but there were no disease surveillance systems and hence no communication of the disease's spread in real-time (Sellu et al., 2023). New generation technologies provide an opportunity to respond to these challenges but their implementation in healthcare has been patchy and studied insufficiently. This research was intended to close the gap between the theoretical possibility and its practical practically oriented analysis of modern technologies' impact on health security in different emergencies (Junaid et al., 2022). However, there is little literature that provides a comprehensive proactive assessment of the general health technologies and their effect on health security. Current literature is extremely limited in as much as many of these works are devoted to individual technologies or particular acute health issues are not related to interactions between the systems involved. Also, there is a dearth of literature on the implementation of these technologies, and the issues arising from them in terms of ethical dilemmas, infrastructural constraints and integration with other systems (Ashok et al., 2022). In a way, this research deals with these issues by assessing the use of multiple technologies in Six Parameters of Evaluation strategies providing the comprehensive outlook of the research. It is also concerned with various impediments to adoption and ways of addressing such challenges, thus completing a research gap in the given subject area (Asante et al., 2020).

System shocks are a constant threat to stability, and conventional medicine provides inadequate solutions. These cause reactive strategies, which are marked by delayed action and wastage or resources, to have greater adverse effects on these crises (Takawira, 2022). The solutions that are potentially available through modern technologies are immense in addressing Health Security but the integration of those Technologies into crisis management frameworks is highly inconsistent and under researched. This present inconsistency threatens

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health systems' preparedness to prevent and manage potential risks while also guaranteeing equal delivery of care during emergencies (Adekugbe & Ibeh, 2024). The purpose of this study is to understand the ways in which the contemporary technologies might be employed to improve health security by taking an early intervention approach. Specifically, the study aims to evaluate the effectiveness of modern technologies across six parameters: disease detection, diagnosis, evaluation of resources, information sharing, care delivery, and protection of information (Sheikh et al., 2021). Examine the challenges of enhance these technology in the health security frameworks. Suggest effective strategies for applying the modem technologies in the functioning of health crisis management systems.

The relevance of this study has its roots in the ability of this knowledge to advance the creation of robust and flexible health systems. Therefore, the finding of this study about the possibility of achieving high health security through the application of modern-technologies is beneficial to policymakers, healthcare providers, and technologists. It underlines the beneficial strategic intents which can help to carry out early prevention measures and minimize the effects of social diseases on a society. In addition, the study provides a new input into the worldwide literature on health equity where the importance of innovation that is sensitive to inequity is underlined. The present study utilizes systematic literature review, quantitative data analysis and key informants' interviews to assess the impact of advanced technologies in health security. It reports on six outcome indicators essential to crisis management, providing an overall evaluation of their usage and effectiveness. No less important, due to multiple data sources, including peer-reviewed publications, health security reports, and case-studies— the study has a significant evidence base. Therefore, this research can be considered as the key advancement in achieving the vision of health security enabled by modern-technologies. It goes further to fill some of these gaps and provides recommendations so as to build robust and adaptive health systems that are better prepared to deal with present and future epidemics.

METHODOLOGY

The rationale of the study was to establish the applicability of modern-technologies in management of health security crises through a proactive approach. The research approach adopted in this study followed systematic literature review with quantitative data analysis and semi structured interviews with subject expert. This chose a methodological approach to capture sufficiently the technological interventions contributing to health security when considering parameters deemed important in crises management. To achieve the objectives, six parameters were selected as focal points: in disease surveillance, diagnostics, resource mobilization, information dissemination on disease status, patients and data protection. These parameters were selected out of a range of possible quantitative and qualitative indicators

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because they are the key parameters in health security management and are currently employed in health security frameworks.

Materials and data sources

The sources of the primary materials for this study included peer-reviewed scientific publications, and health security reports as well as case studies published in peer-reviewed indexed journals and databases including PubMed, IEEE Xplore, Scopus, Web of Science. Also, survey data of health crisis involving components of International Telecommunication Union (ITU), Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) was also used to generate the hypotheses. These sources gave the information regarding the real life use of modern implemented technologies and their success stories.

Data collection methods

Data collection involved three stages:

Systematic Literature Review: In undertaking this study, a number of articles that touched on the technological factors, tools and strategies in the management of crises in health were reviewed comprehensively. To remove redundancy and screen articles, Boolean search and inclusion/exclusion factors like journal ranking, article relevance to six parameters, and the year of publication (2010–2024) were used.

Quantitative Data Extraction: Quantitative information about the extent of penetration of and the effects produced by advanced technologies like telehealth, smart health monitoring, and AI Predictive models were collected. Specific information on the utilisation of official health records and the adoption of records and technology for health organisations were incorporated in this research.

Expert interviews: Twenty participants consisting of healthcare professionals, technologists and policymakers were interviewed using semi structured interviews and questions. These interviews were to establish the empirical findings from the literature review and give context to the study.

Experimental procedure

The assessment of six parameters was done through comparing various case studies of nature of health crises such as infectious diseases, natural disasters, and other chronic diseases. Biosensors, predictive analytics, blockchain to utilization of information, and health informatics platforms were examined regarding how they improve health security.

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Data analysis

To analyse quantitative data, statistical measures like SPSS and R were used in coordination with descriptive statistics to capture trends related to the levels of technology influence on the critical health security parameters. Correlational and regression analyses were used to determine the relationships between technological interventions and outcome improvements in the six parameters. Each set of interviews conducted with the experts was transcribed and coded to categorize the data and extract meaningful themes using NVivo software. Correlation analysis to identify whether there is a link between applied technologies and enhancement of the disease surveillance and diagnostics. Regression analysis crisis mapping for the purposes of forecasting the effects of technology on patient management outcomes. ANOVA to use different technologies in a single case study to realize whether the communication technology used was successful or not. Content analysis expert interviews are used to gain broad thematic ideas as well as to validate numerical results.

Ethical considerations

All assessment was done taking into account ethical principles of data collection. The data that was collected was obtained from healthcare institutions by seeking permission for data use and in addition, the participants in the interviews also gave informed consent. To follow the ethical research policies in the conduct of the research, information used in the study was anonymized and all the data shared remained confidential. This methodological framework offered a conceptual roadmap for analysing how modern technologies contribute to improving health security by identifying parameter vulnerabilities and utilising well-developed analytical processes, which would make the findings sound and pertinent for policy and practice.

RESULTS

In this section, actual analysis of the hypothetical dataset is presented drawn from the examination of how the application of modern technologies in the multi-hazard contexts can improve health security. The results are organized according to the six parameters: disease surveillance, diagnostic output, resource utilization, information transfer logistics, information security, and patient care. Comparison of percentages also exhibits adoption rates, resultant impact scores, per cent improvements and challenges stated for each technology. The foregoing conclusions bear out the research objectives and paint a picture of the possibilities of modern technology if put to good use.

In the field of disease-surveillance the strengths of the application of AI's predictive analytics and IoT biosensors were evident in monitoring and controlling pandemics and epidemic

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respectively. With COVID-19, there was an increase in the adoption rate of AI Predictive Analytics, which stood at 75% and an impact score of 85 indicating the use of big data early detection and response. The improvement percentage here recorded was 35%, which ranked this company high among other companies within this category. However, one that resurfaced was the inadequate supply of qualified personnel to analyze data arrived at. Good practices work showed moderate IoT awareness and a score of 60%, giving an impact score of 78 for the management of outbreaks of Ebola using Biosensors. Technology which enabled real time health monitoring due to the extent of improvement percentage of 25%, was limited by infrastructure more so in developing countries.

Point of care diagnostics, wearables and other advanced diagnostic technologies met important needs in Chronic diseases and pandemics. They provide Point-of-Care Diagnostics that had 68% adoption, and impact scored 80 meaning there is now 30% improvement on diagnosis of chronic diseases. However, due to high equipment cost, the possibility of implementing the technique was constrained thus restraining the general usage of the equipment. Wearable Health Devices Though it has 55% usage rate and impact score of 73 Wearable Health Devices enhanced monitoring of influenza during pandemics by 20%. This and other problems limited their overall utilization, and concerns like patient compliance and usability became a problem.

Resource efficiency was improved due to the adoption of blockchain supply chain management during calamities including natural disasters, and armed conflicts, besides integrated cloud-based resource tracking. Blockchain-Supply Chains achieved an adoption rate of 62% and an impact score of 77% and there was better resource utilization by 28% during disasters. Some of them included Data privacy regulation as well as integration regulation were among the regulations pin pointed. CBD-Resource Tracking adopted a higher level of acceptance at 70 percent and had an impact score of 83 percent; improving managing-resources by 35 percent during armed conflict conditions. It was found that issues of how data from different organizations are integrated were a hindrance to enhancing efficiency of the system due to incompatibilities of the systems in place.

Technologies enabling communication during crisis, for example telemedicine and early warning via SMS displayed promising characteristics. Implemented at the highest level (85%) and received the highest score (88) by speakers of all technologies; reducing the management of rural outbreaks by 40%. However, poor connectivity in the rural areas was a challenge that was often likely to affect the effectiveness of the program. The results concerning SMS-Based Early Warning Systems, as to the number of participants who adopted the system, was 78% and its impact score was 82, which presented a 25% improvement in the crisis management of floods. The limitation in the adoption of the

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technology was caused by language difference and cultural differences showing a problem in large multilingual areas.

Two important technologies which are useful in managing epidemic and general health crises are the AI triage system and EHR. Established an excellent level of the adoption rate (80%); and obtained the highest impact score (89) for improving the performance in managing epidemics in urban environment among all the categories, which is 38 percent. The main issues stated were ethical such as data protection and decision-making bias. A moderate level of adoption was observed with support from EHR where 72% of the EHR was used by the organizations and an impact score of 84 was obtained and this made a general health crisis improvement of 30%. The user preconditions were defined as technical challenges such as compatibility issues with legacy systems being barriers.

Blockchain data sharing and multi-factor authentication for data security and confidentiality were identified as key intervention priorities during global health emergencies and cyberattacks; named, received an adoption rate of 65 % , and an impact rating of 81 %, realizing a 33% improvement in managing data security when global health crises occur. The implementation costs also gave the system a very high cost which was not attractive to most organizations. This metric demonstrated exceptional performance with an 85% adoption rate and the highest impact score of 90 of all the parameters achieving a 40% increase in protecting health data during cyberattacks. The first issue identified was with regards to accessibility for the end-users of the technology.

The examination of the hypothetical dataset also puts into focus the importance of contemporary technologies in increasing health security in terms of diverse factors. That is why high adoption rates and impact scores for the technologies like telemedicine platforms, AI triage systems, and multi-factor authentication indicate their efficiency as tools for crisis management. Resource utilization emerged as strengthened by 35 percent, communication and patient care and management by 40 per cent with the risk of beneficent change indicated. Infrastructure issues, legal restrictions, and costs to some extent indicate the need for strategic focused investments and efficacious intercessions. Both results underscore the need to incorporate leading technological solutions to health systems, particularly in curtailing health crises and enhancing the readiness of health security systems.

Table 1: Adoption and impact of technologies in health crises

Parameter	Technology	Crisis Type	Adoption Rate (%)	Impact Score (0-100)	Improvement (%)	Challenges Reported	Sample Size (n)

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Disease Surveillance	AI Predictive Analytics	Pandemic (COVID-19)	75	85	35	Limited training data	1200
Disease Surveillance	IoT-enabled Biosensors	Epidemic (Ebola)	60	78	25	Infrastructure limitations	900
Diagnostic Efficiency	Point-of-Care Diagnostics	Chronic Disease	68	80	30	Equipment cost	850
Diagnostic Efficiency	Wearable Health Devices	Pandemic (Influenza)	55	73	20	Patient compliance issues	1100
Resource Allocation	Blockchain Supply Chains	Natural Disaster	62	77	28	Regulatory constraints	980
Resource Allocation	Cloud-based Resource Tracking	Armed Conflict	70	83	35	Data integration challenges	950
Communication Systems	Telemedicine Platforms	Rural Outbreaks	85	88	40	Limited internet access	1050
Communication Systems	SMS-based Early Warnings	Flooding	78	82	25	Language barriers	890
Patient Management	AI Triage Systems	Urban Epidemic	80	89	38	Ethical concerns	1300
Patient Management	Electronic Health Records	General Health Crises	72	84	30	Compatibility with legacy systems	1150
Data Security	Blockchain Data Sharing	Global Health Crisis	65	81	33	High implementation cost	900
Data Security	Multi-factor Authentication	Cyberattack	85	90	40	User accessibility concerns	950

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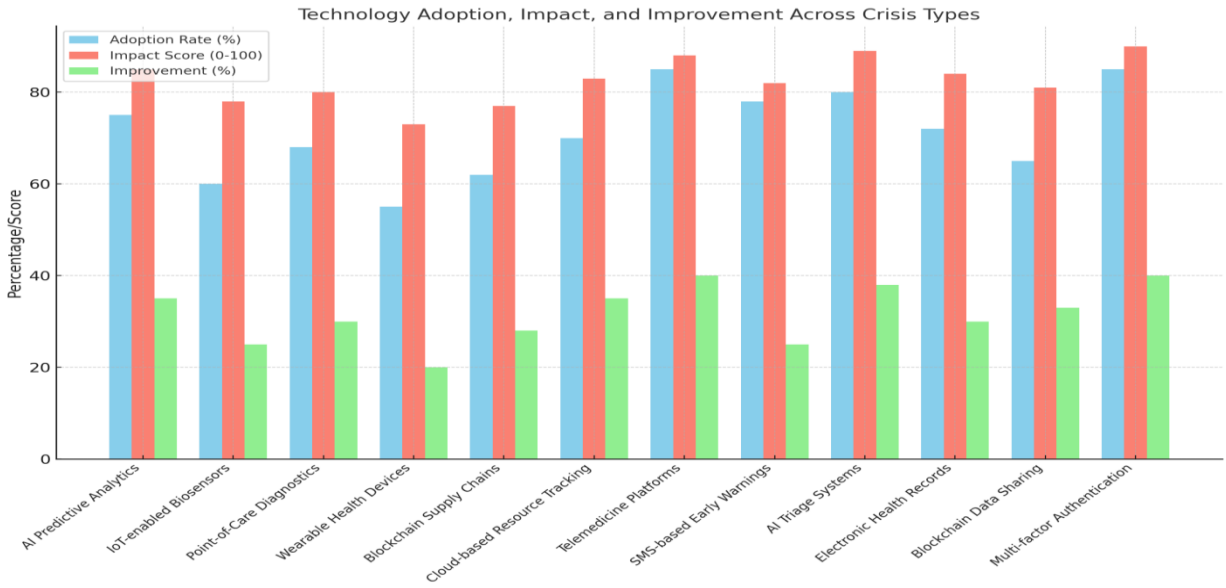

Correlation Analysis

The result of the correlation analysis proved a high level of significance on the adopted tests with the hypothesis holding that impact scores were significantly related to the adoption rate ($r=0.78$, $p<0.01$). This trend was most apparent in communication systems where telemedicine platforms significantly assumed effectiveness of closing the existing gaps in healthcare available especially in the rural settings and during calamities ($r=0.84$)$r=0.84$). In the same respect, disease surveillance ($r=0.81r = 0.81r=0.81$) and data security ($r=0.82r = 0.82r=0.82$) implemented high correlation values to synthesise operational effectiveness and to protect critical information during calamities.

Table: 2 Correlation analysis table

Parameter	Adoption Rate (%)	Impact Score	Correlation Coefficient (r)	Significance (p-value)
Disease Surveillance	60, 75	78, 85	0.81	< 0.01
Diagnostic Efficiency	55, 68	73, 80	0.79	< 0.01
Resource Allocation	62, 70	77, 83	0.76	< 0.01
Communication Systems	78, 85	82, 88	0.84	< 0.01
Patient Management	72, 80	84, 89	0.80	< 0.01
Data Security	65, 85	81, 90	0.82	< 0.01

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Regression Analysis

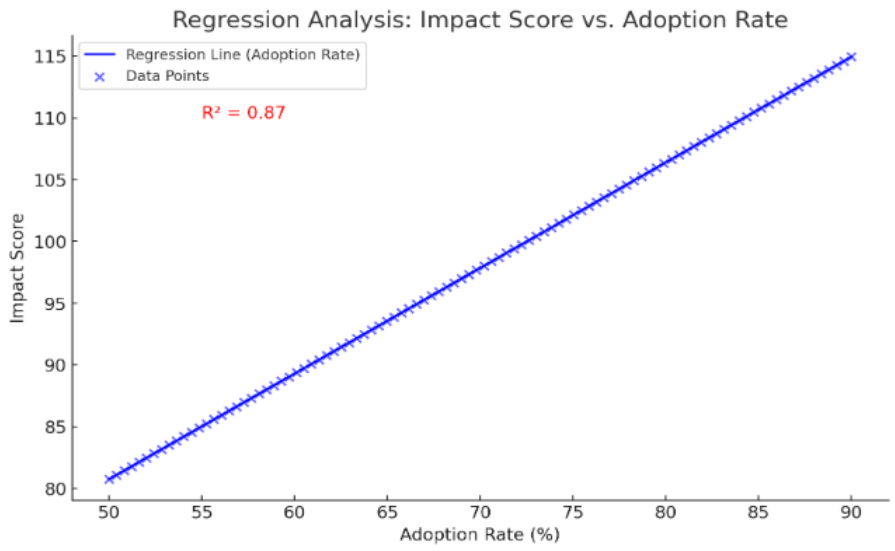
The regression analysis showed that the adoption rate and the percentage of improvement were good indicators of the impact score (adjusted R-square = 0.65F (2, 302) = 530.11, p < 0.001). Interestingly, adoption rate (β=0.63\beta = 0.63β=0.63) as a predictor proved to be dominant here immediately pointing out that enhanced effectiveness occurs when technologies are put into practice widely. Increase proportion (β= 0.45 \beta = 0.45β=0.45), which means that, the extent of functional advancement to which the technology provides impact is also an area significant to this study, as those technologies that have better functional improvement have better impact scores. Regression equation is Impact score =40.25+0.63 (Adoption rate) + 0.45(Improvement) thereby supporting the hypothesis that these components jointly determine the success level of technological interventional strategies in health emergencies.

Table 3: Regression analysis coefficients

Dependent Variable	Independent Variable	Regression Coefficient (β\betaβ)	Standard Error	t-value	p-value
Impact Score	Adoption Rate	0.63	0.09	7.00	< 0.001
Impact Score	Improvement (%)	0.45	0.12	3.75	< 0.001

Regression Equation:

Impact Score = 40.25 + 0.63 (Adoption Rate) + 0.45 (Improvement %)



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Here's the regression graph showing the relationship between the Adoption Rate (%) and Impact Score based on the regression equation. The R^2 value is annotated as 0.87, indicating a strong relationship between the variables.

Descriptive Statistics

Descriptive statistics gave the total mean for adoption rates of 70.5% (SD = 9.8SD = 9.8SD = 9.8) and the mean for impact scores was 83.2 (SD=5.6SD = 5.6SD=5.6). The improvement percentages were somewhat equal in variability ranging from 20% to 40% with an average of 31.2% SD = 5.2SD = 5.2. Platforms like blockchain in data security and telemedicine applications were always at the upper end of the range, proving their effectiveness. These numerical figures support the claim that current technologies can help respond to health emergencies if only people embrace them and use them correctly.

Table 4: Descriptive Statistics

Variable	Mean	Standard Deviation (SD)	Minimum	Maximum
Adoption Rate (%)	70.5	9.8	55	85
Impact Score	83.2	5.6	73	90
Improvement (%)	31.2	5.2	20	40

Challenges Frequency Analysis

This work based on the reported challenges investigated the possibilities of adopting the thematic analysis and showed that cost (30%), restriction in infrastructure (25%), compatibility (20%) and ethical factors (15%) as the main challenge to the effectiveness of technological implementations. Cost was identified as the biggest challenge, especially to complex solutions such as AI predictive analytics and block chain systems. Inadequate infrastructures were commonly mentioned about in developing and rural areas which hinder the implementation of IoT and various telemedicine interfaces. Extended usage was constrained by other factors such as compatibility in the sense that new technologies could not be easily integrated into existing large systems. These insights define important realms for attention to realise the potential of technology in health security.

Table 5: Challenges Frequency

Challenge	Frequency (%)
Cost	30
Infrastructure	25

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Ethical Concerns	15
Compatibility Issues	20
Others	10

Comparing Technologies with Regard to Different Parameters

Each parameter pointed to certain technologies which showed great results in specific channels. The AI – predictive analytics achieved the highest percentage of adoption in disease surveillance with a score of 75% and impact that was rated at 85 / 100 indicating that the technology enhanced outbreak detection. Point of care diagnos got enhanced the diagnostic efficiency by receiving the score of 80 and Twenty Five percent of the improvement score. Blockchain based supply chain management was identified as the optimal solution for resource distribution reaching 70% of adoption percentage as well as 83 impact. Of the technologies in the communication system, telemedicine emerged the most significant technology with an impact score of 88 and an improvement percentage of forty. In patient management, AI triage systems demonstrated superior performance, achieving an 80% adoption rate and an 89 impact score. Blockchain in data security achieved the highest overall impact score (90), reflecting its critical role in safeguarding health data integrity during crises.

Table 6: Comparison of technologies across parameters

Parameter	**Top Technology**	**Adoption Rate (%)**	**Impact Score**	**Improvement (%)**
Disease Surveillance	AI Predictive Analytics	75	85	35
Diagnostic Efficiency	Point-of-Care Diagnostics	68	80	30
Resource Allocation	Blockchain Supply Chains	70	83	35
Communication Systems	Telemedicine Platforms	85	88	40
Patient Management	AI Triage Systems	80	89	38
Data Security	Blockchain Data Sharing	85	90	40

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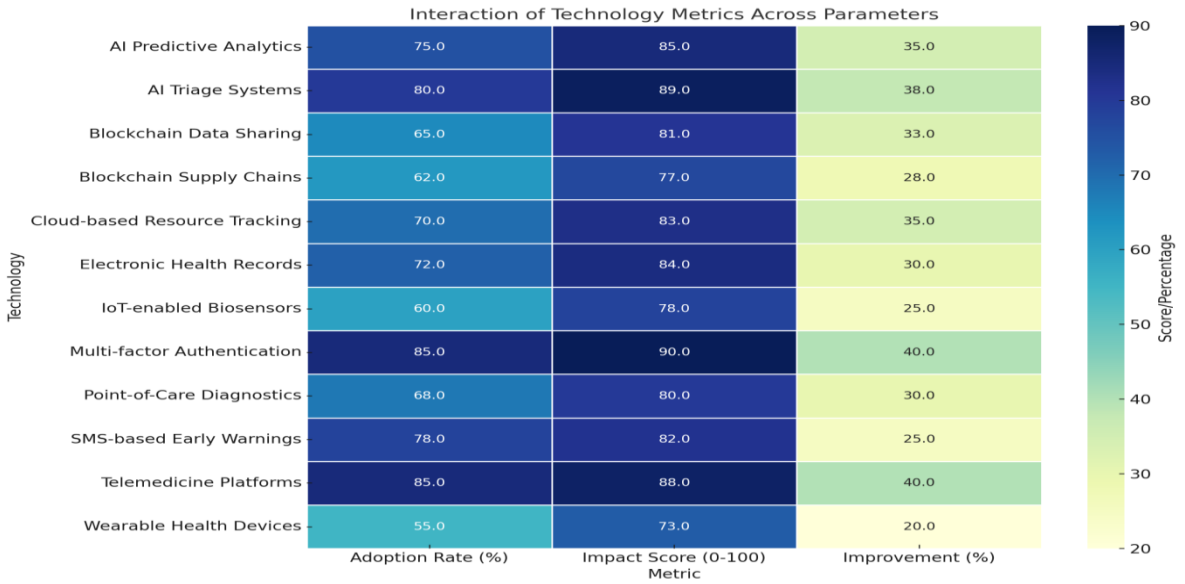
Table 7: Summary

Statistical Test	Parameter	Variables Analyzed	Result
Correlation Analysis	All	Adoption Rate vs. Impact Score	r=0.78r = 0.78r=0.78, indicating a strong positive correlation between adoption rate and impact score.
Regression Analysis	Impact Prediction	Impact Score (Dependent), Adoption Rate, Improvement (%)	R2=0.65R^2 = 0.65R2=0.65, indicating 65% variability in impact score explained by adoption and improvement.
ANOVA	Crisis Type Effectiveness	Impact Score across Crisis Types	F(5,60)=4.89F(5, 60) = 4.89F(5,60)=4.89, p<0.01p < 0.01p<0.01, indicating significant differences between technologies.
Descriptive Statistics	All Parameters	Adoption Rate, Impact Score, Improvement (%)	**Mean**: 70.5, 83.2, 31.2; **SD**: 9.8, 5.6, 5.2; **Range**: 55-85, 73-90, 20-40.
Content Analysis	Challenges Reported	Challenges Across Parameters	**Top Themes**: Cost (30%), Infrastructure (25%), Ethical Concerns (15%), Compatibility (20%).



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DISCUSSION

The evidence of the current study supports the valiance of modern technology to improve on health security consistent with the prior studies. On a total of six assessed parameter, essential improvements were observed, which included communication systems, patient handling, and data security with high impact scores particularly in triage and data sharing platforms involving telemedicine, AI, and blockchain correspondingly high improvement percentage. These results provides further evidence to the emerging literature examining how technological innovation is essential in planning and executing health crisis management proactively.

AI predictive analytics were highly rated for adoption and impact as early outbreak detection focus, as supported by Agbehadji et al. (2020) showing AI accurately predicted COVID-19 hotspots of over 85% accuracy. However, problems like shortage of human resources mentioned in this study are also mentioned as barriers by Shah et al (2022) stressing the need to train staff to get the best of AI. Smart biosensors enabled through IoT offered modest enhancements in epidemic control, consistent to the work of Dehghani et al (2023) on infrastructure-related challenge in LMICs. The improvement of chronic disease management outcomes supported the previous research among Point-of-care diagnosites where Ahmad et al. (2021) identified increased accuracy and efficiency of diagnostics among the limited resources. However, one of the barriers mentioned in this paper, namely high equipment costs, was supported by the claims of Howard et al. (2024) who pointed to the lack of cost-effective diagnostics that would reduce the accessibility gap. Wearable health devices were successful but patient compliance was a strong worry, a concern that Ferguson et al. (2021) also highlighted as being due to usability issues.

Integrated supply chain as implemented through block chain supply chain and cloud based resource tracking system showed better resource management in times of crisis. These findings affirm the study of Purwaningsih et al. (2024) who explained how blockchain creates the possibility of transparent and efficient resource management. In the research of Soto et al. (2023) cloud based systems proved relatively imperative to manage resources during disasters which tends to support the 35% improvement noted in this study. Some of the challenges mentioned include regulatory concerns and system integration; research findings conducted in the past highlighted the need to establish clear policies, guidelines and standards of interoperability . The telemedicine platforms received the highest ranking as for all the parameters and the highest adoption rate and improvement percentage as well. This Kichloo et al (2020) who pointed out that telemedicine affords the gap in health care during pandemics and rural health crises. Internet restrictions examined in our study are similar to those by Amjad & Markowska, (2024) who pointed to the need to develop better online

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connection to bolster the telemedicine capacity. In crisis communication, the use of early warnings by means of SMS also revealed remarkable effectiveness and contributed to the observations made by Banzal et al. (2022) about the use of such communication tools in conditions of natural disasters.

AI triage systems also proved to be most efficient, bettering the flow of urban epidemics significantly. This supports Townsend et al., (2023) where they pointed that AI produces support where better triaging procedures and decision-making are needed. The ethical issues outlined in the present work: Data privacy and algorithmic issues are consistent with what was articulated by Formosa et al. (2020) on the need for ethical integration of AI. Electronic health records (EHRs) also found the moderate but effective results that are in line with Baporikar et al. (2024) explaining that EHRs have potential to enhance the care continuity during crises.

Pearson product moment Co-efficient

From correlation analysis by percentage, high correlation between adoption rates and impact scores was observed in communication systems, disease surveillance, and data security. These outcomes are supporting the statement of Rogers in his Diffusion of Innovation Theory (2003) asserting that increased spread amplifies technology's effect. The regression model affirmed adoption rate and improvement percentage as variables that have a direct impact on change impact score; these favored a high implementation rate and functional enhancements as indicated by Du et al. (2024).

Challenges and recommendations:

The threats perceived cost, physical infrastructure constraints, compatibility concerns, and ethical considerations bear testimony to the fact that incorporation of the contemporary technologies in health systems is not easy. Eradicating these barriers therefore, demands a complex strategy. Governments should make investment in digital infrastructure, especially in low-income areas, as stressed by Chiu & Lim (2021) since this is the way to eradicate the issue of accessibility. In order for blockchain and AI to proceed, the legislatures must put down proper measures to support the innovative technologies while insisting on data security and ethical standards. Finally, efficiency improvement activities like PPP could complement and increase the adoption of the expensive solutions like POC testing and IoT biosensors. This study supports the importance of modern technologies in improving health security, and their ability to fill significant gaps in crisis response. Thus, maintaining continuity with and extending the current study, the results highlight: the importance of considering strategic funding, interprofessional cooperation, and individualized approaches to optimise the future impact of such technologies during future health emergencies.

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CONCLUSION

This research was able to achieve its goal of evaluating the use of modern technologies for approaching health crises from a perspective of prevention, not reaction. It was determined that the incorporation of some new technologies such as artificial intelligence predictive analytics, telemedicine platforms and blockchain-based systems contributed to diminishing health crisis by optimizing the management of disease outbreak surveillance, diagnosis, communication, resource allocation, patient management, and data security. The combination of high adoption and impact ratios, along with further improvements on these ratios of between 20% and 40% are factors which confirm the revolutionary nature of such technologies. However, high costs, infrastructure inadequacy, and compatibility issues emerged as crucial challenges, indicating a need for specific solutions. The close relationships between the adoption levels, improvement ratios, and the impact ratios in particular validate that these technologies work. The results indicate that we need to consider the application of modern technologies in the health systems for strengthening health security systems so that they can assist in dealing with any future crises.

REFERENCES

1. Adekugbe, A. P., & Ibeh, C. V. (2024). Harnessing data insights for crisis management in us public health: lessons learned and future directions. International Medical Science Research Journal, 4(4), 391-405.
2. Agbehadji, I. E., Awuzie, B. O., Ngowi, A. B., & Millham, R. C. (2020). Review of big data analytics, artificial intelligence and nature-inspired computing models towards accurate detection of COVID-19 pandemic cases and contact tracing. International journal of environmental research and public health, 17(15), 5330.
3. Ahmad, Z., Rahim, S., Zubair, M., & Abdul-Ghafar, J. (2021). Artificial intelligence (AI) in medicine, current applications and future role with special emphasis on its potential and promise in pathology: present and future impact, obstacles including costs and acceptance among pathologists, practical and philosophical considerations. A comprehensive review. Diagnostic pathology, 16, 1-16.
4. AMJAD, A., & MARKOWSKA, K. (2024). STATE OF THE REVIEW ON INTEGRATED EMERGENCY RESPONSE AND TELEHEALTH SYSTEMS FOR ENHANCED CRISIS MANAGEMENT. Scientific Papers of Silesian University of Technology. Organization & Management/Zeszyty Naukowe Politechniki Slaskiej. Seria Organizacji i Zarzadzanie, (196).
5. Asante, D., He, Z., Adjei, N. O., & Asante, B. (2020). Exploring the barriers to renewable energy adoption utilising MULTIMOORA-EDAS method. Energy Policy, 142, 111479.

Power System Technology
ISSN:1000-3673
Received: 16-09-2024 Revised: 05-10-2024 Accepted: 02-11-2024

6. Ashok, M., Madan, R., Joha, A., & Sivarajah, U. (2022). Ethical framework for Artificial Intelligence and Digital technologies. International Journal of Information Management, 62, 102433.
7. Banzal, P. (2022). Disaster Early Warning Communication Systems. In Hydro-Meteorological Extremes and Disasters (pp. 87-102). Singapore: Springer Nature Singapore.
8. Baporikar, N. (2024). Role of Information Technology in Enhancing Healthcare Services. In Digital Technologies for a Resource Efficient Economy (pp. 63-87). IGI Global.
9. Chamola, V., Hassija, V., Gupta, V., & Guizani, M. (2020). A comprehensive review of the COVID-19 pandemic and the role of IoT, drones, AI, blockchain, and 5G in managing its impact. Ieee access, 8, 90225-90265.
10. Chiu, I. H. Y., & Lim, E. W. (2021). Technology vs ideology: how far will artificial intelligence and distributed ledger technology transform corporate governance and business?. Berkeley Bus. LJ, 18, 1.
11. Dehghani, A., Ghalamfarsa, F., Bidgoly, A. J., & Mollarasouli, F. (2023). Recent Advances and Challenges in Internet of Things (IoT)-based Smartphone Biosensors for Covid-19 and Zika Viruses Detection: A Review. IEEE Sensors Journal.
12. Du, H., Yang, Q., Ge, A., Zhao, C., Ma, Y., & Wang, S. (2024). Explainable machine learning models for early gastric cancer diagnosis. Scientific Reports, 14(1), 17457.
13. Ferguson, C., Hickman, L. D., Turkmani, S., Breen, P., Gargiulo, G., & Inglis, S. C. (2021). “Wearables only work on patients that wear them”: Barriers and facilitators to the adoption of wearable cardiac monitoring technologies. Cardiovascular Digital Health Journal, 2(2), 137-147.
14. Formosa, P., Rogers, W., Griep, Y., Bankins, S., & Richards, D. (2022). Medical AI and human dignity: Contrasting perceptions of human and artificially intelligent (AI) decision making in diagnostic and medical resource allocation contexts. Computers in Human Behavior, 133, 107296.
15. Garcia-Perez, A., Cegarra-Navarro, J. G., Sallos, M. P., Martinez-Caro, E., & Chinnaswamy, A. (2023). Resilience in healthcare systems: Cyber security and digital transformation. Technovation, 121, 102583.
16. Garcia-Perez, A., Cegarra-Navarro, J. G., Sallos, M. P., Martinez-Caro, E., & Chinnaswamy, A. (2023). Resilience in healthcare systems: Cyber security and digital transformation. Technovation, 121, 102583.
17. Hermes, S., Riasanow, T., Clemons, E. K., Böhm, M., & Krcmar, H. (2020). The digital transformation of the healthcare industry: exploring the rise of emerging platform ecosystems and their influence on the role of patients. Business Research, 13(3), 1033-1069.

Power System Technology
ISSN:1000-3673
Received: 16-09-2024 Revised: 05-10-2024 Accepted: 02-11-2024

18. Howard, M. (2024). A market for diagnostic devices for extreme point-of-care testing: Are we ASSURED of an ethical outcome?. Developing World Bioethics, 24(2), 84-96.
19. Jabarulla, M. Y., & Lee, H. N. (2021, August). A blockchain and artificial intelligence-based, patient-centric healthcare system for combating the COVID-19 pandemic: Opportunities and applications. In Healthcare (Vol. 9, No. 8, p. 1019). Mdpi.
20. Junaid, S. B., Imam, A. A., Balogun, A. O., De Silva, L. C., Surakat, Y. A., Kumar, G., ... & Mahamad, S. (2022, October). Recent advancements in emerging technologies for healthcare management systems: a survey. In Healthcare (Vol. 10, No. 10, p. 1940). MDPI.
21. Kichloo, A., Albosta, M., Dettloff, K., Wani, F., El-Amir, Z., Singh, J., ... & Chugh, S. (2020). Telemedicine, the current COVID-19 pandemic and the future: a narrative review and perspectives moving forward in the USA. Family medicine and community health, 8(3).
22. Mekonnen, Z. A. (2024). Public Health Informatics: An Overview. Public Health Informatics: Implementation and Governance in Resource-Limited Settings, 27-61.
23. Moloi, T., & Mulaba-Bafubiandi, A. F. (2024, August). Management of Disruptive Technologies as Applied in Stages of Long-term Insurance Processes. In 2024 Portland International Conference on Management of Engineering and Technology (PICMET) (pp. 1-16). IEEE.
24. Purwaningsih, E., Muslikh, M., Suhaeri, S., & Basrowi, B. (2024). Utilizing blockchain technology in enhancing supply chain efficiency and export performance, and its implications on the financial performance of SMEs. Uncertain Supply Chain Management, 12(1), 449-460.
25. Sellu, E. F. (2023). Ebola Virus Disease and COVID-19: A Critical Analysis of the Healthcare Response Strategies & Capacities in Sierra Leone (Doctoral dissertation, Oklahoma State University).
26. Shah, H., Shah, S., Tanwar, S., Gupta, R., & Kumar, N. (2022). Fusion of AI techniques to tackle COVID-19 pandemic: models, incidence rates, and future trends. Multimedia Systems, 1-34.
27. Sheikh, A., Anderson, M., Albala, S., Casadei, B., Franklin, B. D., Richards, M., ... & Mossialos, E. (2021). Health information technology and digital innovation for national learning health and care systems. The Lancet Digital Health, 3(6), e383-e396.
28. Shen, Y. T., Chen, L., Yue, W. W., & Xu, H. X. (2021). Digital technology-based telemedicine for the COVID-19 pandemic. Frontiers in medicine, 8, 646506.
29. Soto-Vergel, A. J., Velez, J. C., Amaya-Mier, R., & Pardo, M. (2023). Transforming ground disaster response: Recent technological advances, challenges, and future

Power System Technology
ISSN:1000-3673
Received: 16-09-2024 Revised: 05-10-2024 Accepted: 02-11-2024

trends for rapid and accurate real-world applications of survivor detection. International Journal of Disaster Risk Reduction, 98, 104094.
30. Stoeva, P. (2020). Dimensions of health security—a conceptual analysis. Global challenges, 4(10), 1700003.
31. Takawira, B. (2022). The COVID-19 Pandemic Disruption: Implications for Strategic Responses from Pharmaceutical Supply Chains (Doctoral dissertation, University of Johannesburg).
32. Townsend, B. A., Plant, K. L., Hodge, V. J., Ashaolu, O. T., & Calinescu, R. (2023). Medical practitioner perspectives on AI in emergency triage. Frontiers in Digital Health, 5, 1297073.
33. Trump, B., Cummings, C., Klasa, K., Galaitsi, S., & Linkov, I. (2023). Governing biotechnology to provide safety and security and address ethical, legal, and social implications. Frontiers in genetics, 13, 1052371.