ISSN: 2976- 1077 (Online)

From Paper to Digital: Advancing Public Health Surveillance through ICT in Kathmandu Valley
Shyam Kumar Adhikari*, Sanjay Kumar Tiwari, Ramanand Pandit

https://doi.org/10.58196/jhswn.v20i3

Multi-disciplinary; Double-blind; Peer review

From Paper to Digital: Advancing Public Health Surveillance through ICT in Kathmandu Valley

Authors: [1]Shyam Kumar Adhikari, [2]Sanjay Kumar Tiwari, [3]Ramanand Pandit

Affiliation
[1]Research Scholar, Department of IT, Sunrise University, Alwar, India.
[2]Supervisor, Department of IT, Sunrise University, Alwar, India.
[3]Assistant Professor, Department of Public Health, SunRise University, Alwar, Rajasthan, India.

Abstract

Publishing Process
Received on: Jan 15, 2026
Finalized to publish: March 5, 2026
Open Access 4.0
Published date: March 8, 2026

Background: Information and Communication Technology (ICT) has transformed public health surveillance globally, enabling real-time data collection, improved reporting, and early outbreak detection. In low-resource settings like Nepal, adoption is limited due to infrastructure gaps, workforce shortages, and low digital literacy. This study explored the role of IT in strengthening public health surveillance in Kathmandu Valley, identifying challenges, strategies, and future opportunities.

Methods: A qualitative research design was employed with seven purposively selected key informants, including IT experts and policymakers involved in public health surveillance. Data were collected through semi-structured interviews, transcribed, translated, and analyzed thematically to generate key insights.

Results: Public health surveillance systems in Kathmandu Valley are transitioning from paper-based to IT-enabled platforms such as the Health Management Information System (HMIS) and Early Warning and Reporting System (EWARS), enhancing real-time disease monitoring, reporting accuracy, and outbreak response. Key barriers included limited infrastructure, fragmented systems, skill gaps, and privacy concerns. Strategies to address these challenges included inclusive digital training, mobile-friendly and offline-capable applications, centralized data management, and resilient cybersecurity. Informants envisioned predictive, people-centered surveillance systems harnessing AI, big data, blockchain, wearable devices, and telemedicine, emphasizing ethical and equitable implementation.

Conclusion: ICT integration holds significant potential to improve public health outcomes in Kathmandu Valley. Effective adoption requires strategic planning, capacity building, equitable access, and sustained multi-stakeholder collaboration to achieve a resilient, responsive, and technology-driven surveillance system.

Keywords: Digital health, HMIS, ICT, Kathmandu Valley, Public health surveillance.

Declaration: There is no conflict on interest and follow the research ethics.

Corresponding Email: adhikariska1@gmail.com

ISSN: 2976- 1077 (Online)

Shyam Kumar Adhikari*, Sanjay Kumar Tiwari, Ramanand Pandit

https://doi.org/10.58196/jhswn.v20i3

Multi-disciplinary; Double-blind; Peer review

Introduction

Information and Communication Technology (ICT) has played an increasingly pivotal role in modern healthcare, particularly in strengthening public health surveillance systems. Globally, ICT supports clinical decision-making, patient record management, and access to up-to-date medical knowledge (Ammenwerth et al., 2006). It enables real-time data collection and enhances responses to emerging public health threats (Groseclose & Buckeridge, 2017). Advanced technologies like AI, IoT, and big data analytics have improved disease tracking and pandemic management capabilities (Kuperman, 2011). However, many healthcare IT initiatives fail due to poor planning, technical challenges, and limited end-user engagement (Beynon-Davies & Lloyd-Williams, 1999). In low-resource settings such as Nepal, ICT adoption is hindered by weak infrastructure, limited technical capacity, and insufficient funding, yet it remains a promising tool to transform health surveillance and improve system efficiency (Shrestha, 2014). In Nepal, the integration of IT into public health and e-government services faces numerous obstacles, including inadequate infrastructure, a shortage of skilled personnel, and weak data management systems (Kharel & Shakya, 2012; Shao et al., 2023). These barriers lead to inefficient health surveillance and delays in disease detection, increasing health risks. Additionally, concerns about data privacy and security hinder public trust in IT-driven solutions. Although e-government has been introduced, its practical effectiveness in enhancing public health services remains limited. Research has mostly focused on the design of IT systems rather than evaluating their real-world use by healthcare workers (Anderson, 1997; Poon et al., 2006). While studies have examined IT in global health surveillance, few explore its real-world implementation challenges in low-resource settings like Nepal. Therefore, this study aims to explore how IT can improve public health surveillance in Nepal by identifying challenges, strategies, and the potential impact on public health outcomes, ultimately supporting informed policy and a resilient healthcare system.

Methodology

A qualitative research design approach was used in this study to explore the role of information technology in strengthening public health surveillance in the Kathmandu Valley, Nepal. The study involved seven key informants, including IT experts and policymakers involved in public health surveillance in Kathmandu valley, were purposively selected. A Key Informant Interview (KII) was conducted using semi-structured interview guidelines. The notes and audio recordings from the interviews were transcribed, translated into English, and coded. Thematic analysis was carried out manually to identify patterns and generate meaningful themes. Further analysis of the qualitative data and information was done manually.

Results

The findings from the study are developed into the following themes:

Transitional and evolving state of public health surveillance

Participants described the current state of public health surveillance in the Kathmandu Valley as being in a transitional phase, marked by a gradual shift from traditional practices to digital systems such as HMIS and EWARS. The theme reflects a dual narrative—progress alongside persistent challenges. While some participants acknowledged improvements in reporting efficiency and response times, others emphasized continued reliance on manual processes, inconsistent data quality, resource limitations, and uneven adoption of digital tools across institutions. The discussions highlighted a need for stronger inter-sectoral collaboration, improved data management, and better alignment with urban health demands. Participants collectively agreed that although positive changes are underway, the effectiveness of public health surveillance depends on sustained investments in infrastructure, policy integration, and standardized implementation of digital technologies.

Corresponding Email: adhikariska1@gmail.com

ISSN: 2976- 1077 (Online)
https://doi.org/10.58196/jhswn.v20i3
Multi-disciplinary; Double-blind; Peer review

P1: "The public health surveillance system in the Kathmandu Valley is evolving but faces many challenges. Traditional methods are still prevalent, but there has been a gradual shift towards digital health technologies. Systems like HMIS and EWARS are in use but their effectiveness is often hindered by the resource constraints that lead to quality issues and limited inter-sectoral collaboration."
P5: "So, talking about the current state of the public health surveillance system in Kathmandu Valley, I think we are in a transitional phase, like some hospitals have been using the digital tools, but still, I feel like some are lagging behind."

P6: "The public health surveillance systems in Kathmandu Valley are evolving with active surveillance for diseases like cholera being carried out in several districts."

Improved real-time disease surveillance and response

Participants across the discussion emphasized that IT-based surveillance systems have significantly enhanced real-time disease detection, reporting, and response in Kathmandu Valley. Many highlighted how digital tools such as mobile health (mHealth) applications, electronic dashboards, and SMS-based reporting systems have enabled faster data collection, improved accuracy, and facilitated early outbreak identification. Specific examples included the Early Warning and Reporting System (EWARS) for tracking vector-borne diseases like dengue, and digital tools used during the COVID-19 pandemic for monitoring infections and hotspot mapping. Participants noted improved coordination among health institutions and better visualization and decision-making through data dashboards. While recognizing these advancements, some also acknowledged remaining disparities in implementation across different regions.

P1: "The IT-based system has significantly improved digital direction reporting and response. E.g. Mobile Health, mHealth application in Nepal, real-time data collection and reporting by community health workers. This system has enhanced the speed and accuracy of outbreak detection and response. A specific example is to use EWARS to monitor and respond to vector-borne diseases like dengue.
P4: "In the past years, IT based system has significantly enhanced disease detection and it has also improved communication among health institutions. E.g. In past years, especially during the COVID-19 pandemic, mobile apps and dashboards helped
track infection, hotspots efficiently."

P7: "The IT based surveillance systems have significantly enhanced disease detection, reporting and response in Kathmandu valley enabling real-time data collection, faster outbreak identification and coordinated public health interventions. My example would be EWARS, which was conducted by the Ministry of Health and Population in Kathmandu, which was IT enabled hospital-based surveillance system, which was active in hospitals across the Kathmandu valley, which used digital tools to collect and transmit data on the disease with epidemic potential. For example, the dengue outbreak in Kathmandu valley."

IT integration improved accuracy, prediction, response, and engagement

Participants collectively emphasized that integrating IT into public health surveillance significantly enhances accuracy, prediction, response, and public engagement. They highlighted the role of IT in enabling real-time data collection, improving the accuracy and quality of health data, and facilitating faster communication between agencies and communities. Several noted the value of technologies such as artificial intelligence and big data analytics in predicting disease outbreaks and ensuring efficient resource allocation. Participants also pointed to improved collaboration and early warning capabilities, which support rapid response efforts. Additionally, digital tools were seen as fostering public

Corresponding Email: adhikariska1@gmail.com

engagement through apps and interactive platforms, making surveillance systems more transparent and accessible. Overall, the integration of IT was viewed as a transformative step toward more effective, responsive, and connected public health systems.

> *P1: "Integrating IT offers numerous benefits, so some of them are real time data collection, improve data accuracy, enhanced collaboration and using AI in big data can do predictive analysis."*

> *P7: "Integrating IT into public health surveillance can greatly improve how health threats are monitored and managed, especially in places like Kathmandu Valley. It enables real-time data collection, enhances accuracy, supports early response, and promotes public engagement and transparency."*

Resource gaps, skill shortages, and tech barriers hinder digital surveillance

Participants consistently identified several challenges to integrating IT into public health surveillance systems. Key barriers included limited funding for IT infrastructure, inadequate internet connectivity in remote areas, and persistent concerns around data privacy and security. A major issue raised was the lack of skilled IT personnel and the difficulty in training healthcare workers to use digital systems effectively. Low digital literacy, especially among older populations and those in rural areas, further complicates adoption. Language barriers and ethical concerns about data use were also noted. Additionally, resistance to change and fragmented data systems present ongoing hurdles. While initiatives like the Digital Nepal Framework and international collaborations aim to address these challenges, participants emphasized that sustained efforts are still required to improve infrastructure, build technical capacity, and foster trust in digital health solutions.

> *P1: "Yes. The challenges include like limited funding for IT infrastructures, data privacy concerns, so ensuring data storage and sharing is one of the major concerns. Similarly, the next issue that is capacity building like training health care workers in IT system, after that there are efforts of the government like Digital Nepal Framework and there are different international collaborations but still one need to go through these challenges."*

> *P6: "Yeah, there are many challenges which include resistance to change, lack of technical expertise, and data privacy concerns."*

> *P7:"Integrating IT into public health surveillance faces several challenges and barriers, particularly in resource-constrained settings like Kathmandu valley, such as limited infrastructure and connectivity, lack of skilled personnel, data privacy and security concerns, fragmentation of data systems, financial constraints, and resistance to change are some of the limitations."*

Bridging gaps with inclusive digital training and mobile-friendly apps

Participants highlighted several strategies to bridge gaps in IT integration through inclusive digital training and mobile-friendly applications. They emphasized the importance of remote and community-based training programs to improve digital literacy and accessibility. Localized app interfaces and phased implementation were noted as effective ways to address the digital divide. Additionally, participants stressed the need for robust training, ongoing hands-on support, and cybersecurity measures such as encrypted systems and clear data governance. Investment in offline-capable apps, centralized data repositories, open-source platforms, and careful planning were also mentioned as key mitigation strategies to ensure successful IT adoption in public health surveillance.

> *P2: "We are addressing this challenge with remote training programs."*

Corresponding Email: adhikariska1@gmail.com

P5: "And it can be mitigated by doing localized interfaces and community-based training. I think this will help bridge this digital divide."

P7: "The mitigation strategies would be investment in offline capable apps provision of regular hands-on training and refreshers, IT support system deployment, clear data governance policies encrypted systems and development of a centralized health data repository, open source modular platforms, IT best health budget planning, system design and pilot testing success stories and tangible benefits would be some of the mitigation strategies."

Empowering Health Workers with Smart Technology

Participants discussed several strategies to optimize IT solutions for public health surveillance in Kathmandu Valley, emphasizing the empowerment of health workers through smart technology. They highlighted the importance of capacity building through targeted training programs and expanding internet infrastructure, especially in remote areas, to enhance accessibility and data security. Leveraging AI for anomaly detection was seen as a way to reduce response times, while participatory approaches and adherence to ethical guidelines were stressed to increase stakeholder engagement. The integration of cloud-based systems, mobile health applications with features like voice support, and electronic health records were proposed to improve efficiency and data collection. Additionally, fostering public-private partnerships and focusing on scalability, sustainability, and user-friendly designs were recommended to ensure the long-term success and broad adoption of IT solutions in public health surveillance.

P1: "The strategies that can be adopted are training programs for healthcare workers i.e. capacity building. Similarly, expanding internet access in remote areas and developing infrastructures, developing robust data privacy and security policies and leveraging resources and expertise from the private sector to public organizations."

P6: "I think the strategies include leveraging mobile health applications for data collection, integrating electronic health records, and fostering public-private partnerships to enhance technological infrastructure."

Expanding telemedicine through community-driven IT systems

Participants suggested that enhancing IT integration in public health surveillance requires expanding telemedicine through community-driven systems. They emphasized the importance of involving local communities and tailoring IT solutions to local needs, alongside setting clear data recording and sharing guidelines. They also highlighted the need for centralized real-time data systems to strengthen disease tracking. Recommendations also included investing in research and development programs that adapt tools to the Kathmandu context, promoting public-private partnerships to fund sustainable tech initiatives, and creating a people-centered system where citizens actively contribute to surveillance. Additionally, participants advocated for adopting AI-driven analytics and ensuring interoperability between health systems to optimize telemedicine and digital surveillance efforts.

P1: "So, enhancing IT integration, we need to establish a guideline for data recording and sharing. Furthermore, involving local communities in surveillance efforts is also what we can do, exploring innovative IT solutions that can tailor the local needs."
P5: "Yes, I think I hope to see a people-centered system where citizens can actively contribute to the surveillance. I think this will work."

P6: "I think from my side, the recommendations include adopting AI-driven analytics, expanding telemedicine services, and ensuring interoperability between different health information systems."

Corresponding Email: adhikariska1@gmail.com

ISSN: 2976- 1077 (Online)
https://doi.org/10.58196/jhswn.v20i3
Multi-disciplinary; Double-blind; Peer review

AI-driven, predictive, and inclusive future health surveillance systems

Participants collectively envisioned a promising future for public health surveillance in Kathmandu Valley shaped by advanced information technologies. Several emphasized the transformative potential of AI, big data, and blockchain to enable more predictive, efficient, and proactive systems. They imagined AI-driven early warning tools, automated contact tracing, and real-time dashboards that could guide timely policy decisions and responses. A few highlighted the role of mobile health platforms and community-based systems for more inclusive surveillance. While participants were optimistic, some noted that realizing such a future would depend on proper implementation, policy support, and system integration.

> *P1: "The future looks promising with advancements in sectors like AI, big data and block chain. These technologies can revolutionize disease monitoring and response, making system more proactive and efficient."*
> *P2: "So, the AI is really growing nowadays. The future lies in AI driven early warnings and automated contact tracing."*
> *P6: "The future looks promising with the potential for AI-driven predictive models, blockchain for secure data sharing, and mobile health platform for community-based surveillance."*

AI, blockchain, wearable devices enhance health surveillance

Participants highlighted several emerging IT trends poised to transform public health surveillance in Kathmandu Valley. Many emphasized the growing role of AI and machine learning for real-time disease monitoring, outbreak modeling, and predictive analysis. Blockchain technology was noted for its potential to ensure transparent and tamper-proof data sharing, enhancing data security and trust. Several participants mentioned the increasing relevance of wearable health devices, enabling continuous, real-time tracking of individual health metrics. Additional innovations like chatbots for symptom reporting, edge computing, and digital simulations for outbreak scenarios were seen as transformative. Collectively, participants envisioned a shift toward predictive, decentralized, and data-driven surveillance systems, supported by cross-sector collaboration and political will.

> *P1: "Yes, there are numerous emerging trends and among them, the most impactful emerging trends are AI and machine learning which can be used for predictive analysis and outbreak modelling. Similarly, there is block chain system which can be used for transparent and secure data sharing. For all-time health monitoring, we can use wearable devices."*
> *P4: "Political, well and cross-sector collaboration are crucial to realize these technological promises and edge computing and wearable health tech might revolutionize how we track non-communicable diseases."*
> *P6: "Yeah, emerging trends include the use of AI for real-time disease monitoring, blockchain for secure data management, and wearable devices for health tracking."*

People centered, collaborative, ethical, accessible technology for equitable health

Participants emphasized that advancing public health surveillance requires a people-centered, ethical, and accessible technology approach to ensure equitable health outcomes. They highlighted the importance of addressing data privacy and equitable access while fostering collaboration among government, academia, the private sector, and community stakeholders. Scaling pilot projects with user-friendly designs, adopting evidence-based phased strategies, and integrating participatory methods and advanced research were also stressed. Continuous investment in technology and capacity building was seen as vital for sustainability. Overall, the future depends on responsive, inclusive IT innovations

Corresponding Email: adhikariska1@gmail.com

supported by strong policies and active engagement to enhance health outcomes and resilience in Kathmandu Valley.

> *P1: "While it offers immense potential, it is crucial to adjust ethical concerns like data privacy and equitable access. Similarly, building a robust, inclusive and sustainable system requires collaboration among all the stakeholders."*
> *P6: "Yes, to truly harness the potential of IT in public health surveillance, a collaborative approach involving government, private sector and community stakeholders is essential. Continuous investment in technology and capacity building will be key to sustainable improvements."*
>
> *P7: "The future of public health surveillance in Kathmandu valley lies in its part, people-centered technology that is responsive to the unique challenges of urban health. With the right investments, policies and engagement, these IT innovations can improve health outcomes, reduce disease burden and enhance resilience against the health crisis."*

Discussion

The current state of public health surveillance in Kathmandu Valley reflects a transitional phase, marked by a gradual shift from traditional paper-based systems to digital platforms such as the Health Management Information System (HMIS) and the Early Warning and Reporting System (EWARS). Participants described this dual narrative, recognizing improvements in reporting efficiency and response times while noting persistent reliance on manual processes, inconsistent data quality, resource constraints, and uneven adoption across institutions. This observation is consistent with Nepal's broader digital health landscape, where internet access remains limited, and most digital health programs are small-scale and vertically implemented (Liang et al., 2020; Siddiquee et al., 2020). Similar to findings in other low- and middle-income countries, variability in system implementation and limited inter-sectoral coordination hinder uniform adoption (Parajuli et al., 2022). However, unlike some regions where digital health adoption is minimal, certain hospitals in Kathmandu have actively integrated IT solutions, demonstrating localized progress and readiness for further digital transformation.

Participants consistently highlighted that IT-based surveillance enhanced real-time disease detection, reporting, and response. Mobile health (mHealth) applications, dashboards, and SMS-based reporting facilitated faster data collection, improved accuracy, and early outbreak identification. EWARS for dengue and digital tools used during the COVID-19 pandemic exemplify these improvements. These findings align with global evidence demonstrating ICT's role in strengthening data collection, analysis, and reporting (Aggrawal et al., 2020; Bieh et al., 2020; White et al., 2018). Similarly, electronic tools improved reporting timeliness (Maddah et al., 2023), Participatory surveillance reduced costs and enhanced scalability (Neto et al., 2017), and internet-based systems facilitated rapid response to emerging threats (Abad et al., 2021). In contrast, some studies report disparities in IT adoption, with health workers expressing mixed satisfaction regarding usability, stability, and accessibility (Kininmonth et al., 2018; Omune & Kandiri, 2018), reflecting challenges also highlighted by Kathmandu participants regarding uneven implementation and low digital literacy.

Despite these advancements, participants identified barriers including inadequate IT infrastructure, limited internet connectivity in remote areas, workforce shortages, fragmented systems, low digital literacy, and concerns about data privacy and security. These challenges mirror broader constraints in Nepal and other low-resource settings, where geographic barriers, insufficient funding, and limited policy support restrict effective IT integration (Liang et al., 2020; Parajuli et al., 2022). Addressing these gaps requires inclusive digital training, community-based capacity building, mobile-friendly and localized applications, offline-capable systems, centralized data repositories, open-source platforms, and robust cybersecurity measures. These recommendations echo prior evidence emphasizing participatory design, local ownership, and user-centered approaches for sustainable digital health

Corresponding Email: adhikariska1@gmail.com

adoption (Abouelmehdi et al., 2017; Braa et al., 2007; Citrin et al., 2018). Looking to the future, participants envisioned predictive, inclusive, and technologically advanced surveillance systems leveraging artificial intelligence, big data, blockchain, wearable health devices, and telemedicine. These innovations could enable real-time monitoring, outbreak modeling, and enhanced community engagement. Similar trends have been reported in Africa and other regions, where AI-driven tools improved outbreak detection, resource allocation, and predictive modeling (Meckawy et al., 2022; Tanui et al., 2024). Ethical considerations, equitable access, and people-centered approaches were emphasized as critical for building trust and ensuring broad adoption, consistent with frameworks for inclusive and sustainable digital health systems (Anastasiadou et al., 2024). Collaborative engagement among government, private sector, academia, and communities, alongside continuous investment in infrastructure and capacity building, was identified as essential for creating resilient surveillance systems.

Overall, the findings indicate that IT-enabled innovations offer significant promise for strengthening disease monitoring, outbreak response, and health outcomes in Kathmandu Valley. However, their effectiveness depends on strategic implementation, equitable access, supportive policies, human capacity development, and active stakeholder engagement. These conclusions align with existing literature demonstrating that digital health success is contingent on both technological readiness and socio-contextual adaptation (Davis, 1989; Gagnon et al., 2012; Venkatesh et al., 2003).

Conclusion

Public health surveillance in Kathmandu Valley is evolving from traditional paper-based systems to IT-enabled platforms such as HMIS and EWARS, improving real-time disease detection, reporting accuracy, and outbreak response. Nonetheless, challenges, including limited infrastructure, skill gaps, fragmented systems, and low digital literacy, hinder consistent implementation. Strategies such as inclusive digital training, mobile-friendly applications, centralized data management, and resilient cybersecurity are essential to overcome these barriers. The findings indicate the potential for a predictive, people-centered, and technologically advanced surveillance system leveraging AI, big data, blockchain, wearable devices, and telemedicine, with an emphasis on ethical and equitable implementation. Overall, IT integration can substantially improve public health outcomes, but its effectiveness depends on strategic planning, capacity building, equitable access, and sustained multi-stakeholder collaboration.

References

Abad, Z. S. H., Kline, A., Sultana, M., Noaeen, M., Nurmambetova, E., Lucini, F., Al-Jefri, M., & Lee, J. (2021). Digital public health surveillance: a systematic scoping review. *Npj Digital Medicine 2021 4:1*, *4*(1), 1–13. https://doi.org/10.1038/s41746-021-00407-6

Abouelmehdi, K., Beni-Hssane, A., Khaloufi, H., & Saadi, M. (2017). Big data security and privacy in healthcare: A Review. *Procedia Computer Science*, *113*, 73–80. https://doi.org/10.1016/j.procs.2017.08.292

Aggrawal, V., Dikid, T., Jain, S. K., Pandey, A., Khasnobis, P., Choudhary, S., Chandra, R., Patil, A., Maramraj, K. K., Talyan, A., Singh, A., Babu, B. S., Kumar, A., Kumar, D., Raveesh, P. M., Singh, J., Kumar, R., Qadri, S. S., Madan, P., … Singh, S. K. (2020). Disease surveillance during a large religious mass gathering in India: The Prayagraj Kumbh 2019 experience. *International Journal of Infectious Diseases : IJID : Official Publication of the International Society for Infectious Diseases*, *101*, 167–173. https://doi.org/10.1016/J.IJID.2020.09.1424

Ammenwerth, E., Iller, C., & Mahler, C. (2006). IT-adoption and the interaction of task, technology

Corresponding Email: adhikariska1@gmail.com

and individuals: A fit framework and a case study. *BMC Medical Informatics and Decision Making*, *6*(February). https://doi.org/10.1186/1472-6947-6-3

Anastasiadou, O., Mpogiatzidis, P., & Angelidis, P. (2024). Ethical issues regarding the digitalization and interoperability of health services. *Journal of Biotechnology & Bioinformatics Research*, *6*, 2–7. https://www.researchgate.net/publication/384879418_Ethical_Issues_Regarding_the_Digitalization_and_Interoperability_of_Health_Services

Anderson, J. G. (1997). Clearing the way for physicians' use of clinical information systems. *Communications of the ACM*, *40*(8), 83–90. https://doi.org/10.1145/257874.257895

Beynon-Davies, P., & Lloyd-Williams, M. (1999). When health information systems fail. *Topics in Health Information Management*, *20*(1), 66–79. https://europepmc.org/article/med/10539424

Bieh, K. L., Khan, A., Yezli, S., El-Ganainy, A., Asiri, S., Alotaibi, B., Ghallab, S., Elkholy, A., Abubakar, A., & Jokhdar, H. (2020). Implementing the Health Early Warning System based on syndromic and event-based surveillance at the 2019 Hajj. *Eastern Mediterranean Health Journal = La Revue de Sante de La Mediterranee Orientale = Al-Majallah Al-Sihhiyah Li-Sharq Al-Mutawassit*, *26*(12), 1570–1575. https://doi.org/10.26719/EMHJ.20.129

Braa, J., Hanseth, O., Heywood, A., Mohammed, W., & Shaw, V. (2007). Developing health information systems in developing countries: The flexible standards strategy. *MIS Quarterly: Management Information Systems*, *31*(2), 381–402. https://doi.org/10.2307/25148796

Citrin, D., Thapa, P., Nirola, I., Pandey, S., Kunwar, L. B., Tenpa, J., Acharya, B., Rayamazi, H., Thapa, A., Maru, S., Raut, A., Poudel, S., Timilsina, D., Dhungana, S. K., Adhikari, M., Khanal, M. N., Pratap KC, N., Acharya, B., Karki, K. B., … Maru, D. (2018). Developing and deploying a community healthcare worker-driven, digitally- enabled integrated care system for municipalities in rural Nepal. *Healthcare*, *6*(3), 197–204. https://doi.org/10.1016/j.hjdsi.2018.05.002

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly: Management Information Systems*, *13*(3), 319–339. https://doi.org/10.2307/249008

Gagnon, M. P., Desmartis, M., Labrecque, M., Car, J., Pagliari, C., Pluye, P., Frémont, P., Gagnon, J., Tremblay, N., & Légaré, F. (2012). Systematic review of factors influencing the adoption of information and communication technologies by healthcare professionals. *Journal of Medical Systems*, *36*(1), 241–277. https://doi.org/10.1007/s10916-010-9473-4

Groseclose, S. L., & Buckeridge, D. L. (2017). Public Health Surveillance Systems: Recent Advances in Their Use and Evaluation. *Annual Review of Public Health*, *38*, 57–79. https://doi.org/10.1146/annurev-publhealth-031816-044348

Kharel, P., & Shakya, S. (2012). e-Government Implementation in Nepal : A Challenges. *International Journal of Advanced Research in Computer Science and Software Engineering*, *2*(1), 2277. http://www.unpan.org/egovkb

Kininmonth, J., Thompson, N., McGill, T., & Bunn, A. (2018). Privacy concerns and acceptance of Government surveillance in Australia. *Australasian Conference on Information Systems*, 11. https://utsepress.lib.uts.edu.au/chapters/41/files/d30bc1f5-2794-4441-a3a5-6c1b25a7ba85.pdf

Kuperman, G. J. (2011). Health-information exchange: why are we doing it, and what are we doing? *Journal of the American Medical Informatics Association*, *18*(5), 678–682. https://doi.org/10.1136/AMIAJNL-2010-000021

Liang, L., Shrestha, R., Ghosh, S., & Webb, P. (2020). Using mobile phone data helps estimate community-level food insecurity: Findings from a multi-year panel study in Nepal. *PLOS ONE*,

Corresponding Email: adhikariska1@gmail.com

15(11), e0241791. https://doi.org/10.1371/journal.pone.0241791

Maddah, N., Verma, A., Almashmoum, M., & Ainsworth, J. (2023). Effectiveness of Public Health Digital Surveillance Systems for Infectious Disease Prevention and Control at Mass Gatherings: Systematic Review. *Journal of Medical Internet Research*, *25*, e44649. https://doi.org/10.2196/44649

Meckawy, R., Stuckler, D., Mehta, A., Al-Ahdal, T., & Doebbeling, B. N. (2022). Effectiveness of early warning systems in the detection of infectious diseases outbreaks: a systematic review. *BMC Public Health*, *22*(1), 1–62. https://doi.org/10.1186/s12889-022-14625-4

Neto, O. L., Dimech, G. S., Libel, M., de Souza, W. V., Cesse, E., Smolinski, M., Oliveira, W., & Albuquerque, J. (2017). Saúde na Copa: The World's First Application of Participatory Surveillance for a Mass Gathering at FIFA World Cup 2014, Brazil. *JMIR Public Health and Surveillance*, *3*(2). https://doi.org/10.2196/PUBLICHEALTH.7313

Omune, O. G., & Kandiri, J. M. (2018). Hospital information systems capability and end-user satisfaction in hospitals of Nairobi County, Kenya. *International Academic Journal of Information Systems and Technology*, *2*(1), 102–125. http://www.iajournals.org/articles/iajist_v2_i1_102_125.pdf

Parajuli, R., Bohara, D., KC, M., Shanmuganathan, S., Mistry, S. K., & Yadav, U. N. (2022). Challenges and opportunities for implementing digital health interventions in Nepal: A rapid review. *Frontiers in Digital Health*, *4*, 861019. https://doi.org/10.3389/fdgth.2022.861019

Poon, E. G., Jha, A. K., Christino, M., Honour, M. M., Fernandopulle, R., Middleton, B., Newhouse, J., Leape, L., Bates, D. W., Blumenthal, D., & Kaushal, R. (2006). Assessing the level of healthcare information technology adoption in the United States: A snapshot. *BMC Medical Informatics and Decision Making*, *6*(1), 1–9. https://doi.org/10.1186/1472-6947-6-1/TABLES/3

Shao, D., Ishengoma, F. R., Alexopoulos, C., Saxena, S., Nikiforova, A., & Matheus, R. (2023). Integration of IoT into e-government. *Foresight*, *ahead-of-print*(ahead-of-print). https://doi.org/10.1108/FS-04-2022-0048/FULL/XML

Shrestha, M. R. (2014). [Nepal]Present Progress of Information Technology in Health Care System of Nepal. *Japan Medical Association Journal : JMAJ*, *57*(4), 203. /pmc/articles/PMC4375260/

Siddiquee, N. K. A., Poudyal, A., Pandey, A., Shrestha, N., Karki, S., Subedi, R., Sah, A. K., & K.C, D. (2020). Telemedicine in resource-limited setting: Narrative synthesis of evidence in Nepalese context. *Smart Homecare Technology and TeleHealth*, *6*, 1–14. https://doi.org/10.2147/SHTT.S227854

Tanui, C. K., Ndembi, N., Kebede, Y., & Tessema, S. K. (2024). Artificial intelligence to transform public health in Africa. *The Lancet Infectious Diseases*, *24*(9), e542. https://doi.org/10.1016/S1473-3099(24)00435-3

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly: Management Information Systems*, *27*(3), 425–478. https://doi.org/10.2307/30036540

White, P., Saketa, S., Johnson, E., Gopalani, S. V., Edward, E., Loney, C., Mercier, A., Toatu, T., Wojcik, R., Lewis, S., & Hoy, D. (2018). Mass gathering enhanced syndromic surveillance for the 8th Micronesian Games in 2014, Pohnpei State, Federated States of Micronesia. *Western Pacific Surveillance and Response Journal : WPSAR*, *9*(1), 1–7. https://doi.org/10.5365/WPSAR.2016.7.4.001

Corresponding Email: adhikariska1@gmail.com