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The ARUP Framework for Sustainable Nursing Innovation: A Conceptual Model for Transforming Healthcare Systems

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Abstract

With the Adaptation, Regeneration, Utilization, and Preservation approach, this paper suggested a more comprehensive perspective of nursing innovation and sustainability in health care.

Methods: Based on a PRISMA 2020-guided systematic literature evaluation of research published between 2000 and 2026 that was gathered from Scopus, Web of Science, PubMed, ScienceDirect, Google Scholar, and other pertinent sources, this study creates a conceptual framework. After detailed screening and thematic synthesis 60 suitable studies for ARUP development were identified. The paradigm is supported by three cognate theoretical positions (the triple bottom line approach, Socio-Technical Systems Theory and Diffusion of Innovations Theory).

Results: The ARUP Framework is an integrated model that brings together these different views and blends nursing innovativeness with sustainable health care outcomes. The framework highlights four interconnected components of sustainable nursing innovations: Utilization which emphasizes the use of work in an efficient way, using evidence and technology; Regeneration – emphasizing the ability to regenerate, including the training, recruitment and retention of the nursing workforce, leadership and organizational learning; Adaptation – emphasizing adaptation to changing technology/environment; Preservation – emphasizing patient safety, environmental management, ethical practice and long-term healthcare sustainability. All these dimensions are expected to contribute to improving the quality of healthcare, efficiency on resources use, resilience of the institutions, environmental performance standards and clinical outcomes. The ARUP Framework is a new sustainability model for nurses, incorporating the theories and bases for innovation in the healthcare field, but with a novel approach that combines environmental, nursing organizational, technological, and clinical focus all into a single, integrated framework. It also provides helpful guidance to healthcare executives, nurse managers, educators, researchers, and healthcare policymakers, and can serve as a conceptual foundation for the continued empirical research and validation. The framework enables evidence and sustainability based innovation in nursing practices and healthcare delivery in order to promote integration of sustainability in the practice of everyday caring.

Keywords: Sustainable Healthcare, Nursing Innovation, Environmental, Management, Digital Health, Organizational Resilience.

1. Introduction

The pressure is present on several fronts for healthcare systems all over. Life is always changing due to technological progress, and it can be hard to keep up with it all. Patients are increasingly looking for higher standards, hospitals and clinics are facing scarcity of staff, less financial resources and even climate change is making its mark. These are all intimately linked issues and drive an urgent need for new concepts and solutions to assist those who should be here today—and from tomorrow—with care now and forever. Sustainable practices are a way to ensure healthcare organizations are resilient, using natural resources sustainably and long-term economically sustainable – and to help raise the standard of patient care. As the largest healthcare workforce, nurses drive innovation through the use of digital tools, practice evidence-based care, enhance delivery of high-quality care and manage resources effectively. However, there is more to making healthcare more sustainable than just a technology infusion. It also relies on the readiness of organisations for change, good leadership and inter-disciplinary collaboration, and enabling resilient systems. Past research has shown that integrating

social and technical factors, applying implementation science, and considering complex systems are all important for successful healthcare innovation (Carayon et al., 2006; Greenhalgh et al., 2004; Damschroder et al., 2009; Nilsen, 2015; Braithwaite et al., 2021). The ARUP Framework (Adaptation, Regeneration, Utilization, and Preservation) is presented, building on the aforementioned ideas. This model helps us to empower nurses to be leaders in moving towards more sustainable healthcare, for good, for the patient, for the community. Incorporating and combining technology, strength, wise utilization of resources, and thinking big for long-term impact, the ARUP Framework will support nurses not only for today's tasks, but for the future. The ARUP Framework provides a holistic solution to tackling the key areas, which are often dealt with one by one by others, without recognising nursing specifically. The purpose of this model is to lay a solid ground for reform of nursing practice, health care management, education and policy, as well as further research in sustainable health care innovation.

2. Research Objectives

To serve as a conceptual guide for ARUP (Adaptation, Regeneration, Utilization, and Preservation) and guide nursing innovation to create sustainable health outcomes through a connection of patient-focused, organizational, technological, and environmental initiatives.

Specific Objectives:

1. To conduct a literature search on areas of nursing innovation and sustainable health care.
2. To find the main dimensions that facilitates sustainable nursing innovation.
3. To process, integrate ideas on the basis of theories and develop this into a coherent ARUP concept for the understandability and applicability of nurses in real practice situations.
4. To paint pictures of how these four elements of Adaptation, Regeneration, Utilization and Preservation can be a synergy to make health practices more sustainable for everyone involved, practically, for nurses.
5. To propose a conceptual model that will guide nursing practice, education, leadership, policy, and future research.

3. Methodology

This study uses a conceptual based research method with steps that follow the Systematic Literature Review (SLR) guidelines queued by PRISMA 2020 in developing a new concept of ARUP (Adaptation, Regeneration, Utilization and Preservation). A search was attempted for information in reliable resources such as Scopus, Web of Science, PubMed, ScienceDirect, Google Scholar and others. Journal articles, books, policy reports and guidelines are read from 2000 to 2026 (a period of 26 years).

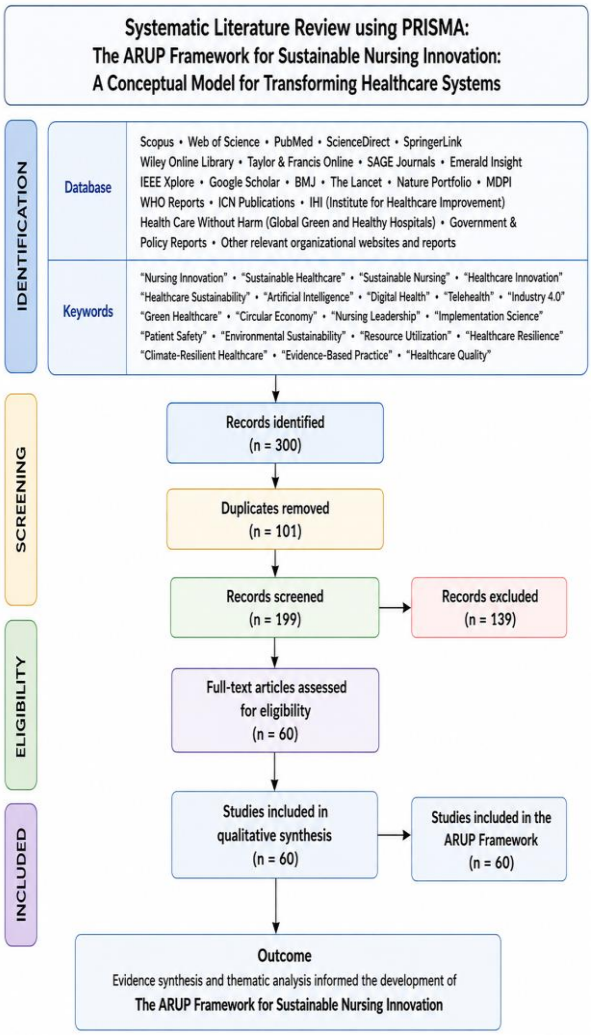

Figure 1. PRISMA 2020 Flow Diagram of the Literature search & study selection process

Source: Developed by **Ms. Lungsanghungle Newme** with the assistance of **ChatGPT (OpenAI)**based on the author's conceptualization of the ARUP Framework.

To find ideas, we were looking for key words that were relevant to us, like 'nursing innovation,' 'healthcare sustainability,' 'digital health,' 'artificial intelligence,' and 'environmental sustainability,' ensuring that we

searched to see what matters most in our changing healthcare landscape. In the course of research process a complete set of 300 different publications were identified, however 101 of these duplicate publications were filtered, leaving 200 unique publications. Consequently, we looked through the other 199 articles, removed 139 articles and came up with 60 articles of merit which we utilized in comprehending the primary thought of our examination. Based on the synthesized evidence, the four dimensions that appeared closely related—Adaptation, Regeneration, Utilization, and Preservation (ARUP)—were developed as the conceptual framework for the sustainable nursing innovation.

4. Literature Review

Table I. Literature Review Matrix

ARUP FRAMEWORK: THEORITICAL FOUNDATION	
ADAPTATION Focuses on innovation adoption,digital transformation, and organizational readiness in nursing practice. **Key Sources**: Turner(2007), Greenhalgh et al. (2004), Damschroder et al.(2009), WHO (2021), Greenhalgh & Papoutsi(2019), Lampropoulos et al.(2025), (Abdolkhani et al., 2022), Lokmic-Tomkins et al. (2023), Tsarfati & Cojocaru (2022), Babalola & Tulk Jesso (2025), Booth et al. (2021), Topol (2019), Arnaert & Debe (2019), Nilsen (2015) and Griggs et al. (2017)	**REGENERATION** Emphasizes organizational resilience, system thinking, and continuous improvement for sustainability. **Key Sources**: Braithwaite et al.(2021), Carayon et al.(2006), Ploeg et al.(2014), Moullin et al.(2020), Cummings et al.(2018), West et al.(2015), Onnis (2016), Kruger et al. (2025), Yu, Raphael, Mackay, Smith, & Fernandez (2025), Liu & Wu (2025), Berniak-Woźny and Rataj (2023), Aiken et al. (2014), WHO (2023), Atobishi and Nosratabadi (2026) and Ismail et al. (2025).
UTILIZATION Centers on resource optimization, Lean/Six Sigma principles, and enhancing operational efficiency. **Key Sources:** Lima et al.(2021), Taner et al.(2012), Porter(2010), Saha et al.(2025), Ahsan and Siddique(2022) , Antony et al.(2018),Iwuchukwu et al. (2025),Wang et al. (2025),Alharbi (2025), Darach et al. (2025), Kleib et al. (2021),Sahoo et al. (2025),Richie et al. (2025), Stiel et al. (2026) and Choi et al. (2025)	**PRESERVATION** Prioritizes environmental stewardship, green healthcare practices, and climate-resilient nursing. **Key Sources:** Luque-Alcaraz et al.(2024), de-Diego-Cordero et al.(2025), Yeboah et al.(2024), MacNeill et al.(2021), Moore et al. (2017), Braithwaite et al. (2024),Dolcini et al. (2025), Campbell-Lendrum et al. (2023), Health Care Without Harm (2021), Kuiter, Herrmann, & Mertz (2025), Fox, Gardner, & Osborne (2015),McGain & Naylor (2014),Nguyen (2026), Aljohani et al. (2026) and Bekaert (2026).

Table II. Theoretical Foundations Supporting the Development of the ARUP Framework

Theory	Main Focus	ARUP Dimension	Contribution
Diffusion of Innovations Theory	Adoption of innovation	Adaptation	Explains how nurses adopt AI, telehealth, and evidence-based innovations.
Socio-Technical Systems Theory	Integration of people and technology	Regeneration & Utilization	Explains how leadership, workforce capability, technology, and workflows interact to enable sustainable innovation.
Triple Bottom Line	Sustainable organizational performance	Preservation	Ensures innovation simultaneously benefits people, the environment, and the economic sustainability of healthcare systems.

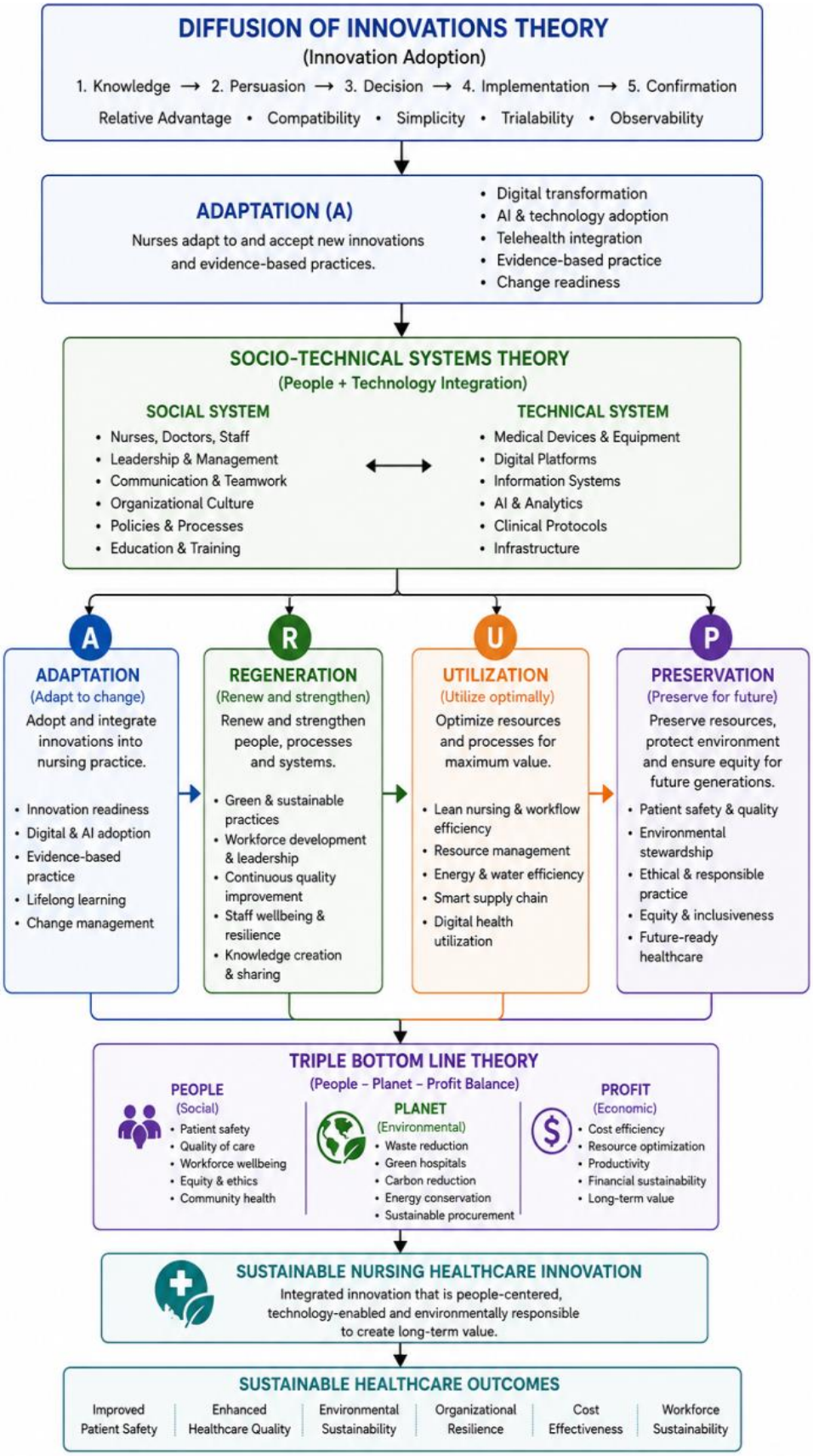

Figure 2. Development of the ARUP Framework: Theoretical Foundation (e.g., Diffusion of Innovations Theory, Socio-Technical Systems Theory, and Triple Bottom Line)

Source: Developed by **Ms. Lungsanghungle Newme** with the assistance of **ChatGPT (OpenAI)**based on the author's conceptualization of the ARUP Framework

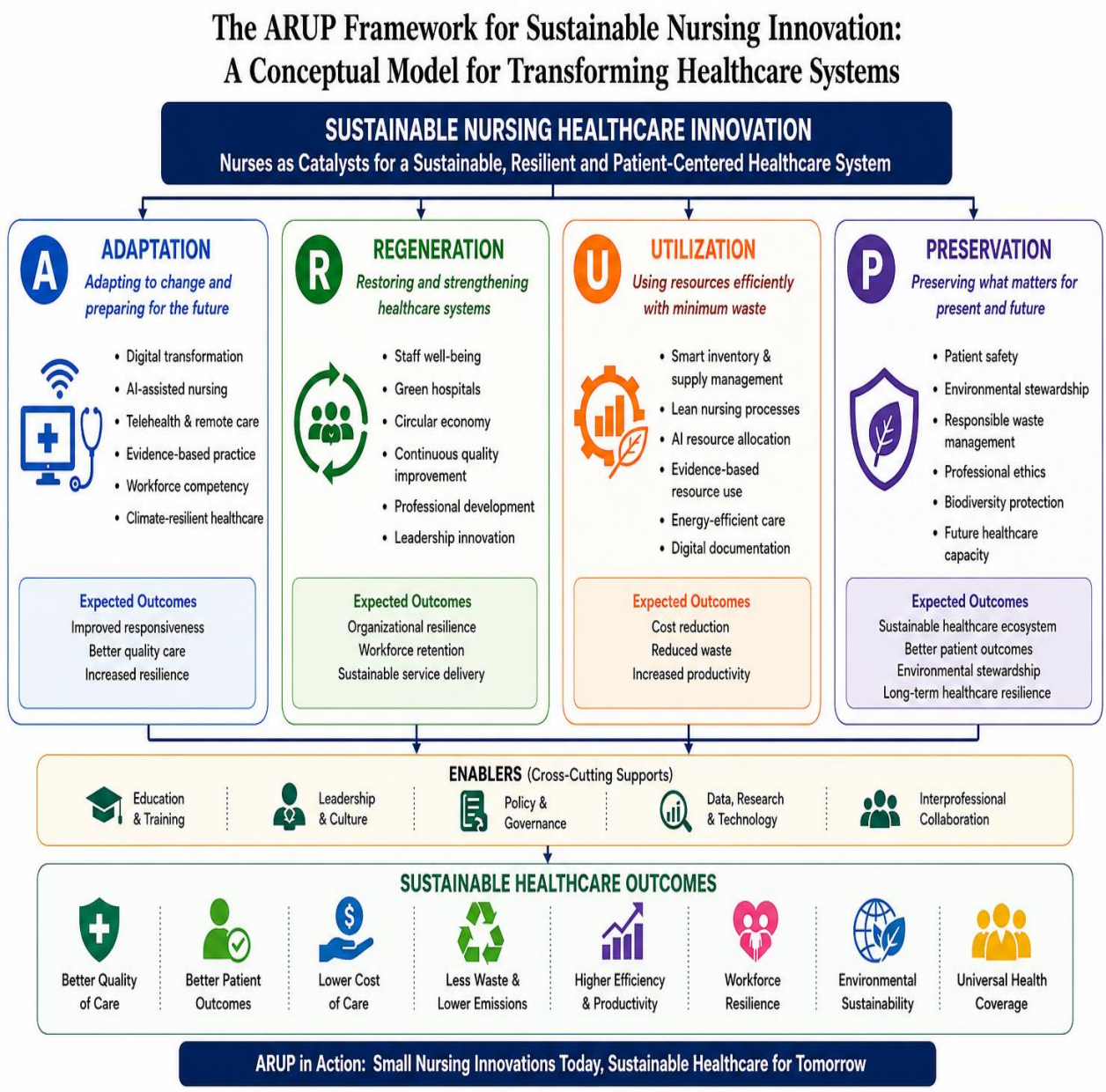

Figure 3. Proposed ARUP Model (A Conceptual Model for Transforming Healthcare System)

Source: Developed by Ms. Lungsanghungle Newme with the assistance of ChatGPT (OpenAI) based on the author's conceptualization of the ARUP Framework.

The ARUP Framework offers a clear and practical way to support sustainable nursing health care innovation. It is built on four main ideas: Adaptation, Regeneration, Utilization, and Preservation. These areas help nurses lead change by supporting leadership, education, policy, research, and the use of technology. The framework aims to improve health care quality, make patient care safer, strengthen organizations, use resources wisely, protect the environment, and create lasting improvements. Unlike older models that mainly focus on the environment, the ARUP Framework centers nurses in driving sustainable change. It brings together environmental management, resource use, workforce development, and new technology as a simple guide for nursing research, practice, teaching, and policy.

5. Finding

Sustainable nursing & health care innovation is evident in more than the use of new technology, as reported in the literature. It requires a balanced strategy characterized by robust institution, smart use of and better care for the environment, and a health focus for the patient. Through the review, four areas of sustainable health care (Adaptation, Regeneration, Utilization and Preservation) were identified as drivers

of health care innovation. The ARUP framework provides evidence for how Adaptation enables nurses to use digital tools, engage in evidence-based practice and respond to climate needs. Regeneration is all about assisting and strengthening organizations: developing good leaders; creating learning and development opportunities; and ensuring employees are empowered and valued. Utilization involves the efficient use of resources - making the best use of what we have, the use of digital tools, ensuring processes are efficient and effective and using energy to work better and create less waste. Preservation is doing all we can to ensure that health care is safe, reliable and equitable currently and indefinitely into the future. This implies putting patients first, caring for the environment and what is right, and getting everyone access to what they require.

Also the review reveals that it may be possible to make the nurses more innovative when they unite these four areas. This contributes to better care, better health, better organizations, more efficient use of resources, sustainable workforce, less harmful environments and movement toward health care for all.

Table III. Summary of Literature Review Objectives, Key Findings, and Outcomes:

Objective	Findings	Outcomes
Review nursing innovation literature	Nursing innovation is increasingly recognized as a key strategy for improving healthcare sustainability.	Established the importance of nursing innovation as a foundation for sustainable healthcare systems.
Identify sustainability dimensions	Four major dimensions (Adaptation, Regeneration, Utilization, and Preservation) consistently emerged from the literature.	Identified the core dimensions that underpin sustainable nursing healthcare innovation.
Integrate existing theories	Diffusion of Innovations Theory, Socio-Technical Systems Theory, and the Triple Bottom Line provide complementary theoretical support for the ARUP framework.	Developed a robust theoretical foundation that explains innovation adoption, organizational integration, and sustainability.
Develop ARUP framework	The ARUP framework integrates innovation adoption, organizational development, resource optimization, and sustainability into a single conceptual model.	Proposed a comprehensive conceptual framework to guide nursing innovation, healthcare management, education, and policy.
Explain sustainable healthcare outcomes	ARUP contributes to improved healthcare quality, patient safety, workforce resilience, environmental sustainability, operational efficiency, and cost-effectiveness.	Demonstrated how the ARUP framework can support resilient, efficient, patient-centered, and environmentally sustainable healthcare systems while providing a basis for future empirical validation.

6. Discussion

The ARUP Framework: Adaptation, Regeneration, Utilization and Preserving offers a neat and easy framework to consider nursing innovation in the field of long-term care. Preservation ensures that everyone will have access to safety and reliability now and in the future. It's all about doing right things, considering the environment, making care accessible for everyone and always putting patient safety first. Existing frameworks are limited in their scope, covering only one dimension of innovation (technology, organization and environmental protection) and failing to capture a comprehensive view of nursing. The ARUP framework combines technology, organization, environment and people in one framework. This encompasses all the way an innovative health care provider who can play a critical role in the attainment of excellence, building

robust organizations and making the health care system a lasting place of change through nurses.

Adaptation is all about getting interprofessional healthcare teams ready for today rapid changes in healthcare. This includes adopting new care pathways that are more environmentally sustainable as well as the new methods of providing health care to patients, which includes digital tools, AI, tele-emergency and tele-health services. The changes will be realized if nurses can be "flexible" and willing to try new things and if they're supported to use new tech in daily practice.

Regeneration is about more than just changing organizations. It focuses on developing the workforce, strong leadership, employee well-being, ongoing quality improvement, and environmentally responsible health care. Based on Socio-Technical Systems Theory, regeneration symbolizes a health care's strengthening and resilience formed through the interaction of health care professionals, the health care culture and technology.

Utilization emphasizes the use of health care resources to help achieve these goals with digital technologies and energy usage, smart allocations, efficient use, and evidence-based decision making. This is beneficial for the sustainability, reduces waste and costs, and makes things more efficient.

Preservation aims to provide safe, trustworthy and accessible health care for present and future generations. It strongly focuses on patient safety as the highest priority in all aspects of healthcare provision, protecting the environment, treating patients in an ethically and equitably culture and creed and managing resources effectively.

The ARUP paradigm reveals that whereas one of these four areas is not enough, a combination of these areas leads to innovations in nursing health care that are sustainable. The framework connects innovation and creative thinking with the health and wellness of nursing practice, health care organizations, communities, and the environment, and brings together the themes of smart resource use and sustainability. The framework is a new and practical framework that provides a bridge between innovation and design thinking, and the health and wellness of nursing, health care systems, communities, and the environment, as well as themes of smart resource use and sustainability. It offers a strong base for more sustainable health care systems, better patient results, qualified staff and better performance of health care organizations.

7. Implications

A). Implications for Practice and Academia:

The ARUP framework is a hands-on guide that helps nurses, healthcare teams, researchers, and educators work together, use technology wisely, and care for people and the environment—making healthcare safer and more sustainable for everyone. It also provides researchers with a foundation for exploring and measuring sustainable healthcare practices.

B). Theoretical Implications:

The ARUP Framework gives nurses a simple, practical way to support sustainable healthcare. Its four parts—Adaptation, Regeneration, Utilization, and Preservation—help improve care, use resources wisely, and build a healthier future.

C). Conceptual Implications:

The ARUP Framework is a simple, practical way for nurses to drive real change—not just with technology, but by staying flexible, building supportive teams, caring for people and the planet, and using resources wisely. It helps healthcare systems give better, safer care for everyone, now and in the future.

8. Future Research Directions

The ARUP framework provides us with the complete picture of sustainable nursing, but we must do some testing in any health care environment to ensure that it is both effective and useful. Research should be conducted to develop and validate easy-to-adapt measures for each of the four ARUP domains, which would enable us to better understand that they are reliable and meaningful. The data analysis tools can be employed as Structural Equation Modeling (SEM) or Partial Least Squares (PLS-SEM), where researchers can examine the relationships between Adaptation, Regeneration, Utilization, and Preservation with regards to nursing innovation and improved healthcare outcomes. A comparative study across hospitals, primary healthcare and community healthcare is advised to check the applied possibility in the different organizational settings. Long-term studies could reveal the results of implementing the ARUP framework over a term of years when evaluating components such as

healthcare quality, staffing levels, patient safety, environmentally friendly working, and sustainability.

Future research should explore some of the latest technologies that can be incorporated into the ARUP framework, such as artificial intelligence, machine learning, robotics, block chain, the Internet of Things (IoT), and predictive analytics, to further enhance nursing innovation. An analysis of various studies conducted in different countries and cultures would also indicate whether the framework is role-moduring all over the world and whether it would apply to all frameworks of healthcare systems.

9. Conclusion

The purpose of this conceptual study was to create a comprehensive model to promote sustainable healthcare innovation: ARUP Framework. The three major ideas around which the framework was constructed are: Diffusion of Innovations Theory, Socio-Technical Systems Theory, and the Triple Bottom Line. It combines the technology with robust organizations, smart resource utilization and long term care in an easy-to-follow method of healthcare sustainability. Making nursing sustainable is not just one of using new technology, as demonstrated in the ARUP framework. This requires teamwork, effective leadership, continuous staff development, a caring attitude for the environment, informed decision making, patient safety and prudent use of resources. Each of these four ideas contributes to better health, better results for patients, better care for staff, better care for the environment, efficient care processes and the durability of health and social care organizations, which is why they are linked together in the framework.

In summary, the ARUP framework provides a solid basis for fresh ideas concerning nursing and sustainable healthcare. For policy makers, researchers, leaders, teachers and health system practitioners, it's a helpful resource for developing environmentally-appropriate, patient-focused, and resilient health systems. The model should be further tested and improved to enhance its contribution to nursing practice and sustainable healthcare even more in the future.

Reference

[1] Antony, J., Palsuk, P., Gupta, S., Mishra, D., & Barach, P. (2018). Six Sigma in healthcare: A systematic review of the literature. *International Journal of Quality & Reliability Management, 35*(5), 1075–1092. https://doi.org/10.1108/IJQRM-02-2017-0027

[2] Aljohani, N.H.z., Alotibi, A.M., Aldhabi, A.A. *et al.* Impact of resilience and wellbeing program in nursing: an integrative review. *BMC Nurs* 25,14 (2026). https://doi.org/10.1186/s12912-025-04262-8

[3] Alharbi, M. F. (2025). Does Electronic Health Record Implementation Enhance Hospital Efficiency and Patient Outcomes? A Comprehensive Systematic Review. *Sage Open*, *15*(3). https://doi.org/10.1177/21582440251359791

[4] Arnaert, A., & Debe, Z. (2019). B.E.L.T.™: Framework for nurse champions to successful implement sustainable telehealth services. *Iris Journal of Nursing & Care, 1*(5). https://doi.org/10.33552/IJNC.2019.01.000521

[5] Atobishi, T., & Nosratabadi, S. (2026). Green Transformational Leadership and Sustainable Nursing Practices: Evidence from the Healthcare Sector. *Sustainability*, *18*(5), 2391. https://doi.org/10.3390/su18052391

[6] Aiken, L. H., Sloane, D. M., Bruyneel, L., Van den Heede, K., Griffiths, P., Busse, R., Diomidous, M., Kinnunen, J., Kózka, M., Lesaffre, E., McHugh, M. D., Moreno-Casbas, M. T., Rafferty, A. M., Schwendimann, R., Scott, P. A., Tishelman, C., van Achterberg, T., & Sermeus, W. (2014). Nurse staffing and education and hospital mortality in nine European countries: A retrospective observational study. *The Lancet, 383*(9931), 1824–1830. https://doi.org/10.1016/S0140-6736(13)62631-8

[7] Abdolkhani, R., Petersen, S., Walter, R., Zhao, L., Butler-Henderson, K., & Livesay, K. (2022). The Impact of Digital Health Transformation Driven by COVID-19 on Nursing Practice: Systematic Literature Review. *JMIR Nursing*, *5*(1), e40348. https://doi.org/10.2196/40348

[8] Booth R G, Strudwick G , McBride S , Oâ€™Connor S , Solano LÃ³pez A L. How the nursing profession should adapt for a digital future *BMJ* 2021; 373 :n1190 doi:10.1136/bmj.n1190.

[9] Braithwaite J, Smith C L, Leask E, Wijekulasuriya S, Brooke-Cowden K, Fisher G et al. (2024). Strategies and tactics to reduce the impact of healthcare on climate change: systematic review *BMJ* 2024; 387 :e081284 https://doi.org/10.1136/bmj-2024-081284

[10] Berniak-Woźny, J., & Rataj, M. (2023). Towards Green and Sustainable Healthcare: A Literature Review and Research Agenda for Green Leadership in the Healthcare Sector. *International journal of environmental research and public health*, *20*(2), 908. https://doi.org/10.3390/ijerph20020908

[11] Braithwaite, J., Ellis, L.A., Churruca, K., Long, J.C., Hibbert, P., Clay-Williams, R. (2021). Complexity Science as a Frame for Understanding the Management and Delivery of High Quality and Safer Care. In: Donaldson, L., Ricciardi, W., Sheridan, S., Tartaglia, R. (eds) *Textbook of Patient Safety and Clinical Risk Management . Springer, Cham.* https://doi.org/10.1007/978-3-030-59403-9_27

[12] Babalola, G., & Tulk Jesso, S. (2025). Supporting nurse's unseen decision-making needs: A human-centered innovation case study. *Proceedings of the International Symposium on Human Factors and Ergonomics in Health Care, 14*(1), 64–70. https://doi.org/10.1177/2327857925141014

[13] Bekaert S. Editorial: At the tipping point—nursing judgement, workforce sustainability, and patient safety. *Journal of Research in Nursing*. 2026;31(1-2):3-6. doi:10.1177/17449871261419019

[14] Carayon, P., Schoofs Hundt, A., Karsh, B. T., Gurses, A. P., Alvarado, C. J., Smith, M., & Flatley Brennan, P. (2006). Work system design for patient safety: the SEIPS model. *Quality & safety in health care*, *15 Suppl 1*(Suppl 1), i50–i58. https://doi.org/10.1136/qshc.2005.015842

[15] Cummings, G. G., Tate, K., Lee, S., Wong, C. A., Paananen, T., Micaroni, S. P. M., & Chatterjee, G. E. (2018). Leadership styles and outcome patterns for the nursing workforce and work environment: A systematic review. *International journal of nursing studies*, *85*, 19–60. https://doi.org/10.1016/j.ijnurstu.2018.04.016

[16] Choi J, Woo S, Ferrell A. Artificial intelligence assisted telehealth for nursing: A scoping review. *Journal of Telemedicine and Telecare*. 2025;31(1): 140-149. doi:10.1177/1357633X231167613

[17] Campbell-Lendrum, D., Neville, T., Schweizer, C. *et al.* Climate change and health: three grand challenges. *Nat Med* 29, 1631–1638 (2023). https://doi.org/10.1038/s41591-023-02438-w

[18] de-Diego-Cordero, R., Pérez-Jiménez, J. M., Rivero-Marin, S., Lucchetti, G., & Badanta, B. (2025). *Sustainability and nursing: An integrative literature review*. *Journal of Research in Nursing, 30*(7–8), 714–730. https://doi.org/10.1177/17449871251328920.

[19] Dolcini, M., Ferrè, F., Brambilla, A., & Capolongo, S. (2025). Integrating environmental sustainability into hospitals performance management systems: A scoping review. *BMC Health Services Research, 25*(1), 764. https://doi.org/10.1186/s12913-025-12928-x

[20] Damschroder, L.J., Aron, D.C., Keith, R.E. *et al.* Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implementation Sci* **4**, 50 (2009). https://doi.org/10.1186/1748-5908-4-50

[21] Darach, Nathidathip, Kim, Min Su, Wisesrith, Wasinee, Collins, Eileen G., Data Analytics and Administrative Decision-Making in Nursing Management: A Systematic Review, *Journal of Nursing Management*, 2025, 4344147, 18 pages, 2025. https://doi.org/10.1155/jonm/4344147

[22] Elabed , S., Shamayleh, A., Daghfous, A., & Angell, L. (2024). Sustainable Healthcare Supply Chain Innovations: A Systematic Literature Review. *Operations and Supply Chain Management: An International Journal*, 17(4), 295-310. https://doi.org/10.31387/oscm0590443

[23] Fox, A., Gardner, G., & Osborne, S. (2015). A theoretical framework to support research of health service innovation. *Australian health review: a publication of the Australian Hospital Association*, *39*(1), 70–75. https://doi.org/10.1071/AH14031

[24] Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., & Kyriakidou, O. (2004). Diffusion of innovations in service organizations: systematic review and recommendations. *The Milbank quarterly*, *82*(4), 581–629. https://doi.org/10.1111/j.0887-378X.2004.00325.x

[25] Greenhalgh, T., & Papoutsi, C. (2018). Studying complexity in health services research: desperately seeking an overdue paradigm shift. *BMC medicine*, *16*(1), 95. https://doi.org/10.1186/s12916-018-1089-4

[26] Griggs, C., Fernandez, A., & Callanan, M. (2017). Nursing and the barriers to sustainable health care: A literature review.*British Journal of Nursing, 26*(22), 1230–1237. https://doi.org/10.12968/bjon.2017.26.22.1230

[27] Health Care Without Harm. (2011). Global Green and Healthy Hospitals: A comprehensive environmental health agenda for hospitals and health systems. https://www.greenhospitals.net/

[28] Health Care Without Harm. (2021). Global road map for health care decarbonization: A navigational tool for achieving zero emissions with climate resilience and health equity. *Health Care Climate Action*. https://healthcareclimateaction.org/roadmap

[29] Ismail, H.A., Kotp, M.H., Basyouny, H.A.A. *et al.* Sustainable healthcare futures: how digital leadership stimulates nurses' green creativity: a quasi-experimental study. *BMC Nurs* 24, 251 (2025). https://doi.org/10.1186/s12912-025-02906-3

[30] Iwuchukwu, G., Anttila, M., Lantta, T., Varpula, J., & Ameel, M. (2025). A mixed-methods systematic review on the impacts and implementation of collaborative electronic documentation on nurse-patient relationship. *CIN: Computers, Informatics, Nursing, 43*(12), e01263. https://doi.org/10.1097/CIN.0000000000001263

[31] Kuiter, S., Herrmann, A., Mertz, M. *et al.* Should healthcare professionals include aspects of environmental sustainability in clinical decision-making? A systematic review of reasons. *BMC Med Ethics* 26, 78 (2025). https://doi.org/10.1186/s12910-025-01230-4

[32] Kruger, K., Brysiewicz, P., Lori, J., & Bell, S. A. (2025). The role of the nursing workforce in health system resilience during disasters: a scoping review of empirical studies. *International journal of nursing studies advances*, *9*, 100361. https://doi.org/10.1016/j.ijnsa.2025.100361

[33] Kleib, M., Chauvette, A., Furlong, K., Nagle, L., Slater, L., & McCloskey, R. (2021). Approaches for defining and assessing nursing informatics competencies: a scoping review. *JBI Evidence Synthesis*, *19*(4), 794–841. https://doi.org/10.11124/JBIES-20-00100

[34] Lima RM, Dinis-Carvalho J, Souza TA, Vieira E, Gonçalves B (2021), "Implementation of lean in health care environments: an update of systematic reviews". *International Journal of Lean Six Sigma*, Vol. 12 No. 2 pp. 399–431, doi: https://doi.org/10.1108/IJLSS-07-2019-0074

[35] Lokmic-Tomkins, Z., Bhandari, D., Bain, C., Borda, A., Kariotis, T., & Reser, D. W. (2023). Lessons Learned from Natural Disasters around Digital Health Technologies and Delivering Quality Healthcare. *International Journal of Environmental Research and Public Health*, *20*(5), 4542. https://doi.org/10.3390/ijerph20054542

[36] Liu, M., Yan, Z. & Wu, C. Comparative efficacy and acceptability of resilience-focused interventions for nurses: a systematic review and network meta-analysis of randomized controlled trials. *BMC Nurs* **24**, 418 (2025). https://doi.org/10.1186/s12912-025-03090-0

[37] Lampropoulos, G., Fernández-Arias, P., Del Bosque, A., & Vergara, D. (2025). Augmented Reality in Health Education: Transforming Nursing, Healthcare, and Medical Education and Training. *Nursing reports (Pavia, Italy)*, *15*(8), 289. https://doi.org/10.3390/nursrep15080289

[38] Luque-Alcaraz, O. M., Aparicio-Martínez, P., Gomera, A., & Vaquero-Abellán, M. (2024). The environmental awareness of nurses as environmentally sustainable health care leaders: A mixed method analysis. *BMC Nursing, 23*, 229. https://doi.org/10.1186/s12912-024-01895-z

[39] MacNeill, A. J., McGain, F., & Sherman, J. D. (2021). Planetary health care: A framework for sustainable health systems. *The Lancet Planetary Health, 5*(2), e66–e68. https://doi.org/10.1016/S2542-5196(21)00005-X

[40] Moullin, J.C., Dickson, K.S., Stadnick, N.A. *et al.* Ten recommendations for using implementation frameworks in research and practice. *Implement Sci Commun* **1**, 42 (2020). https://doi.org/10.1186/s43058-020-00023-7

[41] McGain, F., & Naylor, C. (2014). Environmental sustainability in hospitals: A systematic review and research agenda. *Journal of Health Services Research & Policy, 19*(4), 245–252. https://doi.org/10.1177/1355819614534836

[42] Moore, J. E., Mascarenhas, A., Bain, J., & Straus, S. E. (2017). Developing a comprehensive definition of sustainability. *Implementation science: IS*, *12*(1), 110. https://doi.org/10.1186/s13012-017-0637-1

[43] Nilsen P. (2015). Making sense of implementation theories, models and frameworks. *Implementation science: IS*, *10*, 53. https://doi.org/10.1186/s13012-015-0242-0

[44] Nguyen, R. (2026). A three-pillar framework for nurse well-being: An integrative review of multilevel strategies. *International Journal of*

Nursing Practice, 32(3), e70163. https://doi.org/10.1111/ijn.70163

[45] Onnis, L. (2016). What is a sustainable remote health workforce? People, practice and place. *Rural and Remote Health*, *16*(3). https://doi.org/10.22605/RRH3806

[46] Yu, F., Raphael, D., Mackay, L., Smith, M., & Fernandez, R. (2025). Personal and work-related factors associated with nurse resilience: An updated systematic review using meta-analysis and narrative synthesis. *International journal of nursing studies*, *166*, 105054. https://doi.org/10.1016/j.ijnurstu.2025.105054

[47] Porter, M. E. (2010). What is value in health care? *New England Journal of Medicine, 363*(26), 2477–2481. https://doi.org/10.1056/NEJMp1011024

[48] Ploeg, J., Markle-Reid, M., Davies, B. *et al.* Spreading and sustaining best practices for home care of older adults: a grounded theory study. *Implementation Sci* 9, 162 (2014). https://doi.org/10.1186/s13012-014-0162-4

[49] Richie, C., Hinrichs-Krapels, S., Dobbe, R. *et al.* Environmental impacts of artificial intelligence in health care: considerations and recommendations. *Health Technol.* 15, 1087–1093 (2025). https://doi.org/10.1007/s12553-025-01003-4

[50] Saha, K., Farhanj, Z., & Kumar, V. (2025). A systematic review of circular economy literature in healthcare: Transitioning from a 'post-waste' approach to sustainability. *Journal of Cleaner Production, 505*, Article 145427. https://doi.org/10.1016/j.jclepro.2025.145427

[51] Stiel, H. E. M., Virtanen, L., Bakker, M. M., Heponiemi, T., Kainiemi, E., & Kaihlanen, A.-M. (2026). The potential of digital health technologies in saving nursing resources: A scoping review. *International Journal of Nursing Studies, 177,* 105366. https://doi.org/10.1016/j.ijnurstu.2026.105366

[52] Sahoo, M., Kumar, A., & Thakur, V. (2025). Promoting green healthcare initiatives: A systematic literature review, conceptual framework and future research agenda. *Journal of Cleaner Production.* https://doi.org/10.1016/j.jclepro.2025.145024

[53] Tsarfati, B., & Cojocaru, D. (2022). The Importance of Receiving Training in Computerized Technology for Nurses to Maintain Sustainability in the Health System. *Sustainability*, *14*(23), 15958. https://doi.org/10.3390/su142315958

[54] Topol, E. (2019). Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. *Basic Books.*

[55] Turner, R. (2007). Review of the book Diffusion of innovations (5th ed.), by E. M. Rogers. *Journal of Minimally Invasive Gynecology, 14*(6), 776. https://doi.org/10.1016/j.jmig.2007.07.001

[56] Wang, J., Lv, H., Chen, M., Liu, C., Ren, W., Jiang, H., & Zhang, L. (2025). A Systematic Review of Lean Implementation in Hospitals: Impact on Efficiency, Quality, Cost, and Satisfaction. *International journal of health policy and management*, *14*, 8974. https://doi.org/10.34172/ijhpm.8974

[57] West, M. A., Eckert, R., Steward, K., & Pasmore, W. A. (2014). Developing collective leadership for health care. *The King's Fund .https://catalog.nlm.nih.gov/discovery/fulldisplay/alma9916436883406676/01NLM_INST:01NLM_INST*

[58] World Health Organization. (2021). Global strategy on digital health 2020–2025. World *Health Organization*. https://apps.who.int/iris/handle/10665/344249

[59] World Health Organization. (2023). Operational framework for building climate-resilient and low-carbon health systems. *World Health Organization. https://www.who.int/publications/i/item/9789240081888*

[60] Yeboah, E. A., Adegboye, A. R. A., & Kneafsey, R. (2024). *Nurses' perceptions, attitudes, and perspectives in relation to climate change and sustainable healthcare practices: A systematic review*. *The Journal of Climate Change and Health, 16*, 100290. https://doi.org/10.1016/j.joclim.2023.100290