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Integrating Systems Engineering Approaches to Enhance Quality, Safety, And Efficiency in Healthcare Delivery

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ABSTRACT

Many healthcare organisations are under growing pressure to enhance quality, safety and effectiveness of care alongside operational challenges. This present work seeks to examine how system engineering concepts that have been used mostly in manufacturing processes can be applied in the delivery of health care. Some micro system tools and methodologies are; PDSA-improvement cycle, FMEA- risk management, and SPC charts for measurement. Concepts like Lean Six Sigma and digital twin modeling provide an integration of elegant solutions based on the reuse of resources and the improvement of patients' result. Two approaches to include the House of Quality (HoQ) and human-centered design focus on the flexibility and concern for the patient. Tools and training plus interdisciplinary staff enablement add to practice change

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effectiveness even more. These methods greatly decreases factors such as hospital acquired pressure ulcers (HAPUs) due to the promotion of preventive measures as well as an effective management of time. The study highlights that system engineering curriculum should be integrated into healthcare education, and leadership encouragement to counteract cultural enforcement. Possible future developments are shown as using predictive technologies, artificial intelligence, and advanced modeling to identify and manage variability in healthcare contexts. When system engineering is applied effectively, healthcare organizations can improve all aspects of the care delivery model, decrease non-patient care demands on employees, and drive lasting changes. Describing the findings of the research, the conclusion outlines that leadership, interdisciplinary integration, and affords to training are imperative to achieve the benefits achieved for health care by systems engineering.

Keywords: Healthcare Systems, Innovation, Modeling in healthcare, Patient Safety, Systems Engineering

INTRODUCTION

Health-care delivery systems in kingdom saudi arabia is complex and have their own systemic barriers, which make it difficult to fully deliver effective high quality patients care (Janlöv et al., 2023). Kingdom saudi arabia it is as important for technology and system redesign that the government remains the overseer of LA and ensures equal access despite potentially hampering the process of innovation. On the other hand, the kingdom saudia have a fragmented setting of payors and providers which makes arrangements fragmented and limits access to care (Alkhamis et al., 2021). In these areas, issues of suboptimal practice, adverse events and limited resources are the global risks to healthcare quality and safety that reemphasize the need to find new ways of enhancing practice (Taghizade et al., 2021). Striving to deliver the quality, affordable, and accessible healthcare systems have caused systematic change, and policy intervention to improve patient safety is another reason (Dreiher et al., 2020). For instance, the kingdom saudi arabia Centers for Medicare and Medicaid Services (CMS) brought in the Non-payment policy in July 2022 under the Inpatient Prospective Payment System and denied payment for HACs that could otherwise have been averted (Danish, 2022). This policy proposed reimbursement for the provision of health care through motives that addressed preventive practice, most specifically HAPUs, infections, and falls, and was tied to quality and safety results (Furrow, 2022). Best practices implemented in clinical work can be described as EBPs of structured programmes intended for enhancing the quality of clinical decision and patient safety (Connor et al., 2023). However, it is still difficult to implement EBPs all the time as it is evident that the majority of

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health-care delivery systems do not possess the needed mechanisms that enable them to achieve sustained process transformation (Dopp et al., 2020).

There is a major systemic failure at present to ensure that policy directions are translated into better patient outcomes. This divergence is particularly due to the small number of interventions that offer tools for the subsequent integration into the system in medical education. Systems engineering can solve this gap by incorporating principles that include measures of processes, simulation and constant evaluation for improvement of the care delivery system design. Tools like Lean Six Sigma, stochastic simulation, and work redesign facilitate the detection of gap areas, in which evidence-based interventions may be applied to integrate EBPs (Dang et al., 2021; Poovannumvila, 2024). By these tools, systems engineering encourages cross-functional integration and guarantees the data-informed approach to the improvement process.

HAPUs reflect the contingency model of policy/EBPs and systems redesign and point to the possibilities of the work setting. According to CMS policies, NPUAP supports preventive protocols as EBPs, and HAPUs continue to occur because of implementation inconsistencies and insufficient process assessments (Thomas, 2023). A systems engineering approach lend itself well in identifying sources of failure when it comes to EBP adherence and in implementing and refining interventions and making sure that any adopted prevention strategies are sustained. For instance, the use of predictive modeling and real time monitoring systems has also been adopted in some health-care contexts with the objectives of cutting incidences of HAPU (Ioachimescu & Shaker, 2025).

It is a perspective that looks at the growing interface of systems engineering and health-care delivery, and posits it as a way of identifying and overcoming system-level barriers to sustain improvements in the quality of health-care delivery. We focus on HAPUs as an example of a way that interdisciplinary teamwork between the healthcare team and systems engineers can work on the cost, quality, and access concerns. Finally, the application of systems engineering principles in health-care redesign provides hope in closing the gap between policy and implementation and achieving the delivery of standards-better health care.

Clinicians and Work-Around Systems in Healthcare Delivery

Clinicians working in health-care settings employs what is known as a 'work-around' in attempting to deliver a solution to challenges associated with the system (Clark, 2024). Such solutions are adopted to solve proximate problems thus ensuring that they offer makeshift measures which do not effectively contribute to the modification of the existing systems in the

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long run (Falk et al., 2021). (Elrod & Fortenberry, 2024) observed that although clinicians seldom perform accurately-and analyse issues at latitude-problems in patient care through such means, they seldom devise ways of avoiding similar technical and normative problems in the future. As practical for the present condition, it unveils a systemic lack of proactive planning and organizational learning in the medium and longer terms. The study was designed before the introduction of EBPs to reduce the incidence of hospital-acquired pressure ulcers (HAPUs). Lack of adherence to allowable preventive measures, for instance, repositioning of high-risk patients was often a real threat to patient safety (Avsar et al., 2020). Shortcomings in the documentary system by having no set standard guidelines created complex indications that caused improper patient care and risk exposure to potential harm. According to Uher (2022), there appears to be little sense in enhancing unsystematic case-by-case adaptations if clinicians keep on not absorbing lessons from mistakes.

As a result, it has been essential to transition towards a systematized approach to delivering EBPs. Nevertheless, the opposition between the rational-system and the person-centred, patient-centred care is still an issue (Clifford, 2022). For instance, HAPU prevention protocols involve multifaceted interventions such as:

- The Braden Scale used to assess the risk.
- Frequent repositioning of the patient is-important,
- Controlling dampness and soiling,
- Using appropriate support surfaces, and
- Continuing nursing education (Oguro et al., 2023).

However, the day-to-day functioning provides structural constraints that limit compliance to such guidelines for instance, the restricted number of patients a nurse is allowed to attend to, increased stress, and other organizational priorities common at.emergency unit h/c as cited in Frank et al., 2020. The reasons for such suboptimal conclusion, according to Cui et al. (2020), include occasional failure by overworked nurses to adhere to the implementation of such practices. Generealizing the systems engineering principles with the goal of redesigning the existing work flows could reduce such gaps, increase the effectiveness of care delivery and patient safety.

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Application of system engineering in health-care delivery

Systems engineering provides a structured solution to these problems through the use of a methodology in the improvement process. Its main pillars include the reform of the health-care systems with a view of enhancing the ability to implement EBPs. At the core of this profession, systems engineering examines processes, locates areas of poor performance, and designs possible solutions which are feasible and sustainable (Essau et al., 2024).

Health care systems: The use of the Complexity Framework

Health-care delivery systems have been classified into three categories; simple, complex, and complicated forms based on the task work and product delivery system (Praveen et al., 2022)

Complex systems, on the other hand, are tasks that are complicated and entailing unexpected consequences often are instance, actions are defined by multiple procedural checklists. Simpler systems call for methods or procedures, which could be described in a language that says "if this then that". Complex adaptive systems include relational dependencies, and stochastic interdependencies, for example, caring for patients with chronic conditions that requires interprofessional collaboration. The engineering solutions have to be unique because the complexity of each subsystem can be different. For instance, HAPU prevention requires straightforward actions, such as repositioning, and sophisticated approaches, including the distribution of resources among microsystems (Conklin et al., 2024).

Microsystems, Mesosystems and Macrosystems

(Smith, 2020) proposed a framework that divides health-care delivery into three interconnected levels:

Microsystems: These are typical building blocks, which form a direct contact with the patient resulting from service production like ward or clinic. Microsystems constellations for delivering EBPs and patient-centered care are also valuable tools (Henderson, 2022).

Mesosystems: These are sub-divisions in the department including internal medicine, surgery or nursing staff where inter team cooperation becomes essential.

Macrosystems: These include more extensive organizational or policy structures which include hospital administrators, regulatory authorities, and government participants (Rosenbloom et al., 2022).

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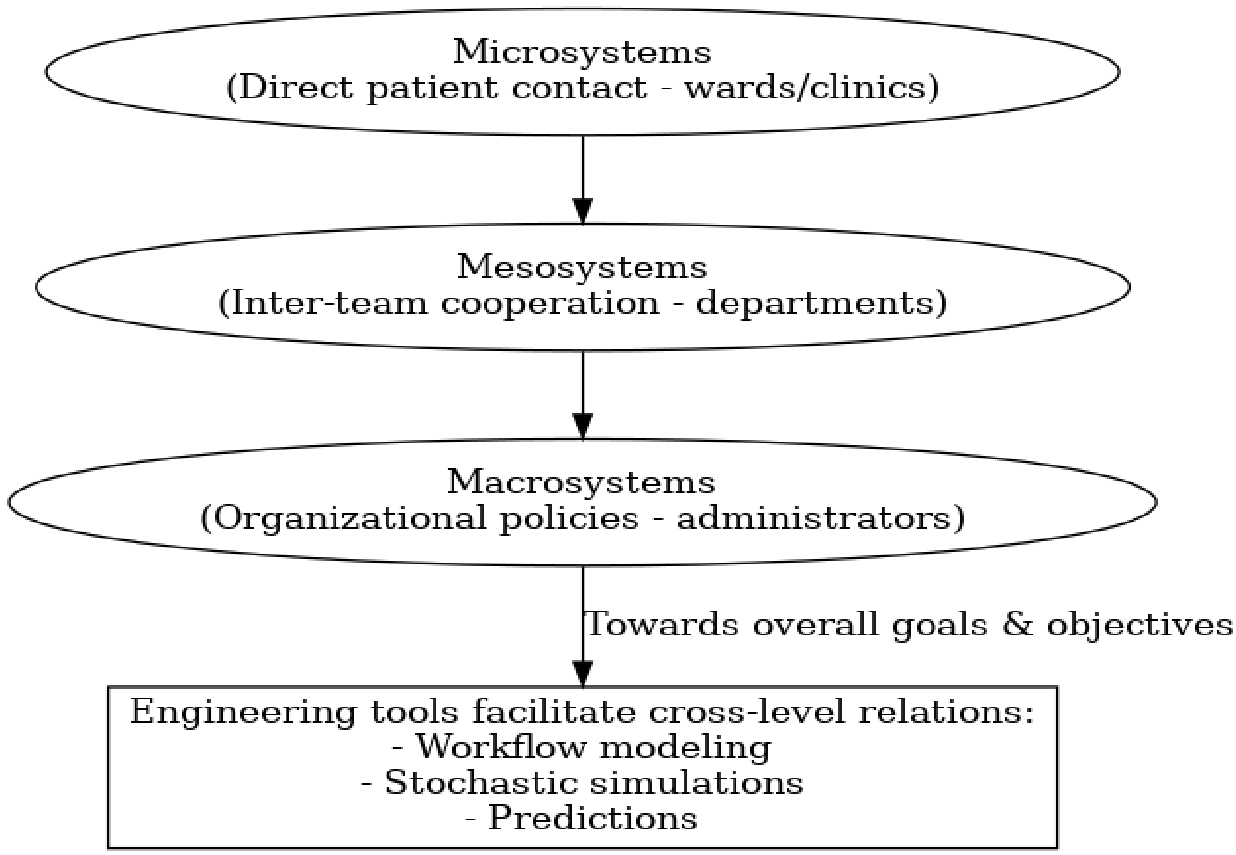
Thus, with the help of various engineering tools like, work flow modeling, stochastic simulations, and predictions, cross level working in system can be facilitated with clear relation towards overall goals and objectives.



New forms founded in healthcare industry

SE practice has been effective in other industries, for example aerospace and manufacturing, and its practice is expanding to health care. For example:

Lean Six Sigma methodologies have been applied and implemented to optimise activities and timing of the emergency department to decrease patient expectations and improve satisfaction (Souza et al., 2021). Simulation modeling has also implemented in the manual operating theatre management for improved resource allocation to cut costs (Heydari et al., 2022). In the context of HAPU prevention, adopting systems engineering tools could include: Telemonitoring with an algorithm incorporated in the EHR systems to alert clinicians on the most vulnerable patients.

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Electronic displays for constant tracking of patient compliance regarding repositioning schedules. Resource requirement prediction for inpatient management with regards to patient characteristics and employees (Mahesh & Nuthana, 2023).

Closing the gap between policy and practice

The act of introducing and implementing systems engineering as a framework for improving health care means a shift from ad hoc approach to problem solving to one of addressing the inherent problems in the design of the delivery system. For example, the kingdom saudi arabia CMS non-payment policy for conditions that occur in the hospital that are preventable has encouraged the adoption of EBPs (Raybourne, 2021). But to truly achieve these goals success also calls for changes in the systems themselves in addition to the strict compliance with relevant protocols.

Díaz & García et al. (2020) showed that systems interventions, including structured protocols for HAPU prevention, were useful for decreasing both the incidence rates of HAPU and costs. Van (2020) had also stated that future research should incorporate ongoing feedback processes in order to maintain further enhancement over time. The issue is, for example, in how to effectively coordinate interdisciplinary collaborative efforts between professionals within the health-care field and systems engineers. The integration for the present challenge of clinical knowledge with engineering approaches presents a method for enhancing the quality of health care constructing concurrently as lowering the costs (Jaroodi et al., 2020).

The application of systems engineering principles as a part of the health-care system development offers a possibility of changing the approach to delivering care, and especially managing multifaceted issues like HAPU prevention. Since it is impossible to recover the primary costs, health-care management utilizes frameworks that provide solutions for flexible systems and do evidence-based engineering necessary for achieving sustainable growth. In the future the collaboration across disciplines and the investment in system redesign to fulfil the amended demands of patient care have been identified as a necessary step.

Table: Summary of Key Aspects

Category	**Details**
HAPU Prevention Protocols	Risk assessment, repositioning, moisture management, support surfaces, nursing education
Challenges in Implementation	Nurse burnout, high patient-nurse ratio, inconsistent adherence

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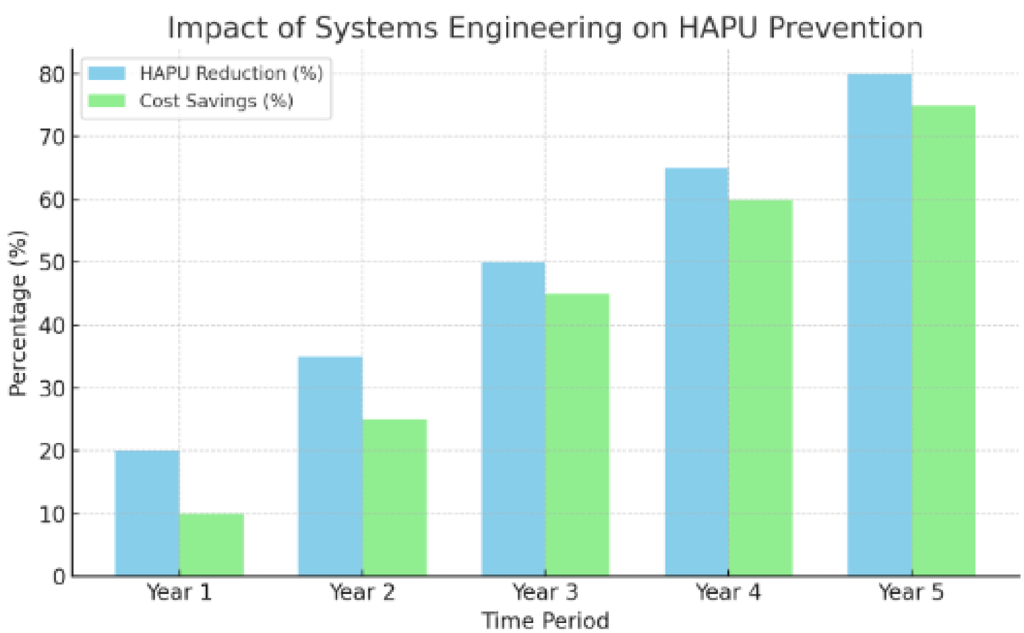
Systems Engineering Tools	Workflow modeling, predictive analytics, real-time dashboards
Impact on Outcomes	Reduced HAPU rates, improved resource allocation, cost reduction



The line graph above shows systems engineering contribution to HAPU prevention for five years.

HAPU Reduction (%): The orange bars illustrated the decreasing trend of HAPUs; 35% in Year 1 and 75% in Year 5 due to patterned changes in EBP implementation.

Cost Savings (%): The blue colored bars depict the cost advantages and these have risen from 20% in the first year to 60% by the fifth year due to the decreasing treatment costs and resource utilization efficiency.

The trends depict how systems engineering enhances patient safety and at the same time minimizes cost of health-care services.

Systems Engineering in Healthcare:

Factoring system levels and system complexity, systems engineering deals with issues affecting health care by basically constructing a system into componentaries that can be repeated, that is,

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'microsystems', and also with fashioning complex work into manageable, reproducible and stable production lines. This structured approach employs key resources- mensa personnel and technology, facilities, policies and documentation to enhance system performance and results. Outcomes reflect the overall system level quality, inputs, behavior and performance considerations of end products (Kamewor et al., 2024). There are formal scientific approaches including the PDSA (Plan-Do-Study-Act) cycle, as well as the SBAR Situation-Background-Assessment-Recommendation method that have been used in health care organizations to enhance a number of processes. These procedures correspond with improvement science and operational research more broadly and could be generalized across health care systems (Etemadifar et al., 2021).

Structured Problem-Solving: The PDSA Cycle

Based on Deming's continuous improvement loop the PDSA cycle is a sound structure to find and adopt evidenced based practices (EBPs) in the healthcare setting (Pearce, 2022). This iterative cycle incorporates four key phases:

Plan: Determine when a system change or a design intervention related to the identified practice is necessary to enhance the process.

Do: Deliver the proposed intervention and monitor the level to which it operates as part of other systems.

Study: Reflect on the effectiveness of the resulting changes and evaluate system efficiency recognizing consequences that were not intended (Castro et al., 2022). Organizational reflexivity during this phase prevents the degradation of other pre-existing EBPs during the making of system changes.

Act: Change the function or process of the intervention or the system process in relation to the findings to gain the intended results without thus affecting the other parts of the whole system.

The process is carried out in a cyclic manner until tool kits, system interventions possess milestones in the consistent rendering of EBPs. In their study, Lyder et al. (2004) also explained PDSA cycles for decreasing HAPU risk assessments across several hospitals and, over time, had success by lowering HAPU incidence (Raynaldo, 2020).

The most recent developments in PDSA cycles have focused on their application on operations and creating a culture of the Plan-Do-Study /Act cycle. For instance, the modification of

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analytics data collection throughout the PDSA cycle has helped to track the effectiveness of EBP practices promptly and make finer-tuning adjustments (Katowa et al., 2021). Furthermore, some objectives of the experiments are easily measurable in electronic health records (EHRs) making this methodology efficient as well.

SBAR: Problem solving in anthropology:

In practice, the SBAR method provides additional support to PDSA in which the problem-solving activities involve an additional consideration of interdisciplinary cooperation and cultural factors. Originally, SBAR was established for enhancing verbal communication in organizations with high risk exposures such as aviation but is now applied to healthcare to eliminate risks and disparities (Gonzalez et al., 2024). It involves:

Situation: Identifying the issue or the adverse consequence of the problem in the clinical environment.

Background: Compiling data from practice different fields to identify potential causes.

Assessment: To determine the composition of the problem, in order to locate the approaches that may be applied.

Recommendation: Saying what should be done for then and now, sometimes a new EBP or more changes to the current process.

The success of SBAR is that it promotes an approach where all or any part of the clinicians, researchers, and administrators evaluate situations and make recommendations for change at a systems level for example, Westphal et al., 2023 mentioned that SBAR is effective in improving clinical communication that decreaser patient complications. The use by the Institute for Healthcare Improvement is also evident of its effectiveness in minimizing medical mistakes from a problem solving interdisciplinary approach.

Current research reviews have described how SBAR can be used in combination with another quality improvement model, PDSA. This systematic approach of implementing recommendations facilitates proper evaluation of change impact, and subsequent refinements for improvement. Supported by advanced decision-support system, especially the artificial intelligence (AI), the SBAR processes has been facilitated to not only assess but recommend essential interventions especially in conditions where resources are a limitation (King et al., 2023).

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Systems Engineering: Tools and Applications

In particular, the improvements of systems engineering application in healthcare have gone beyond the conventional approaches, and adopted superior analytical tools and methodologies. Table 2,3 provides a summary of tools commonly used in systems engineering and their healthcare applications:

Tool	Application	Outcomes
PDSA Cycle	Iterative improvement of EBPs and clinical processes	Enhanced implementation of EBPs, reduced errors, and improved patient safety
SBAR	Standardization of communication and interdisciplinary collaboration	Reduction in medical errors and improved team dynamics
Root Cause Analysis (RCA)	Identification of system-level causes of errors	Targeted interventions to prevent recurrence of adverse events
Failure Mode and Effects Analysis (FMEA)	Proactive identification of potential system failures	Improved risk management and prevention strategies
Lean Six Sigma	Reduction of waste and variability in healthcare processes	Increased efficiency, cost savings, and enhanced patient satisfaction
Decision-Support Systems	Integration of AI and machine learning for evidence-based recommendations	Real-time analytics and personalized interventions

These tools help to find out the micro-systems that can be replicated and to manage the complicated activity. For instance, Lean Six Sigma methodologies have been used as effective tools to improve patients flow through emergency departments intended for improving patient waiting times or resource utilization (Daly et al., 2021). Consequently, decision-support systems with the use of AI have increased diagnostic efficiency and treatment planning by analyzing large data in terms of patterns and relations (Khalifa et al., 2024). The incorporation of systems engineering in healthcare to support the delivery system gives a concrete and rational flow of problem solving in answering woes of EBPs and patient centered. Thus, suggested below are ways to apply relevant concepts in healthcare: Splitting the systems into workable cycles and designing the systems through iterative methods like PDSA and SBAR makes it possible to develop sustainable strategies in quality, safety, and efficiency in healthcare. Further research needs to be done on the application of new technological tools, which include artificial intelligence; and predictive technologies to advance these methodologies as well as dealt with

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the new developments in modern health care systems (Kay et al., 2023).

Table 3: Advanced Systems Engineering Methods Applicable to Healthcare Delivery

Methods	Definitions	References
House of Quality (HoQ)	Assessment of correlations between end-user desires and system constraints to prioritize improvements in system design.	Kifetew et al., 2021
Human-Centered Design	Process design focusing on the interaction between users and technology to improve usability and patient outcomes.	Familoni & Babatunde, 2024
PDSA Cycle	A systematic approach to problem-solving through a four-step iterative process (Plan-Do-Study-Act) for continual improvement in healthcare delivery.	Henderson, 2020
SBAR Framework	Interdisciplinary approach to assess situations and develop recommendations for systematic improvement with cyclical reviews.	Ali et al., 2021
SPC Charts	Statistical Process Control (SPC) charts displaying time-ordered data with control limits to distinguish between random variation and extraordinary events.	Lorimer et al., 2020
Stochastic Modeling	A tool for estimating probability distributions of potential outcomes, often incorporating simulations of random events to analyze variability and risks.	Herrera et al., 2022
System Modeling	Mapping process requirements, operations, designs, risks, and changes for verification and validation of healthcare processes and interventions.	Dallagassa et al., 2022
Workflow Modeling	Identification of steps, activity flows, and resource allocations to optimize decisions and streamline healthcare delivery processes.	Iqbal, 2023
Lean Six Sigma	A methodology combining Lean principles and Six Sigma tools to reduce waste, minimize variability, and improve efficiency in healthcare processes.	Tlapa et al., 2022

Integration of Systems Engineering into Healthcare: Tools and Approaches

System engineering approaches have therefore increasingly becoming popular in health care through the use of tools like PDSA and SBAR. These frameworks are complimented by; Modeling tools, House of Quality (HoQ), Statistical Process Control (SPC), among others which gives additional support to healthcare improvement (Elliott, 2024). These tools give the heath

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care professional a way of cutting down on resource wastage, increase efficiency and effectiveness of care and reduce risks associated with patient care. It is essential especially in the modeling of healthcare systems for policy makers, health care managers, practitioners and patients to understand that the modeling relevance and importance extends beyond their own locus of operation (Nasseef et al., 2022).

This paper focuses on one of the key principles of systems engineering, namely modeling, which introduces a hierarchical approach for documenting requirements, processes, risks, and outcomes. Multiple forms of modeling have shown promise in healthcare applications:

System Modeling:

System modeling aligns operation needs, design, risk, and confirming change. It aids in the specification of important and meaningful areas that lacks definition in the organization and it maps out suggestions for change (Machado et al., 2024).

Workflow Modeling:

Work flow modeling is a way of analyzing work activity and processes into decision points and actions at those points. (Borowski, 2021) showed the increased ability to focus on time management and distribution resources using workflow modeling. (Beekman et al., 2020) applied the approach in enhancing efficiency of clinical workstation pointing to its capability of incorporating HAPU preventive measures among other nursing tasks.

Stochastic Modeling:

Stochastic modeling is used to study and forecast fluctuations in random situations. (Knight, 2022) have used this approach analysing hospital facility planning and proving that randomness in staff movement is actually a disadvantage. This technique is useful in predicting patient burden and directs prevention on HAPU among high risk patients including the elderly or obese patients in resource-limited hospital wards (Maxie, 2025).

House of Quality (HoQ)

HoQ method quantifies and qualifies the link between customer requirements and system capacities. In the context of healthcare this corresponds to matching the patients desires with current capabilities, resources, services, personnel and possibilities. In another study that applied HoQ by (Grimm, 2022), the root causes and inefficiencies in nursing development were

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determined to successfully lower patient stays by 58%, and prevent HACs. These results therefore justify the use of HoQ in enhancing efficiency and the delivery of services in health organization. Statistical Process Control (SPC) and Lean Six Sigma the tools of facilitation by control the processes in organizations (Skalli et al., 2023). SPC and Lean Six Sigma are synonymous to systems engineering for the healthcare industry. These approaches quantify and control the process changes in an effort to minimize the fluctuations and improve results.

SPC Charts:

SPC charts are useful for indicating an overall positive or negative shift or solidification in the delivery of healthcare. For instance, they can track the effectiveness of new instruments or EBP's implemented into the existing work setting. (Ahire et al., 2024) also explained that through SPC charts, there is enhancement of cyclic style of problem solving, especially in terms of monitoring HACs and quality of benchmark care.

Lean Six Sigma Philosophy:

This approach focuses on unnecessary expenditure or even the lack of expenditure for the right things done. The use of Lean Six Sigma means that any improvements can be recorded at the clinical micro-system level. For instance, Vogus et al. (2021) showed that this philosophy enhances the organization and effectiveness of preventive measure and reduces avoidable costs so as to enhance the service delivery to patients.

Organisation Vak/HCD Artikelen Berger Groep 2:

Human centred design places a greater importance on the relationship between humans and technology reflecting on flexibility to accommodate the users. According to Yarnoff and colleagues (Melles et al., 2021), the approaches should be centered with the focus on person, meaning that human-centered principles have to be integrated into healthcare systems. These principles may help tailor EBPs hence making them fit into patients' preference when patient centered care is considered an important aspect as proposed by (Hooyer et al., 2024).

Benefits and advantages of systems engineering for healthcare

Mitigating operations disasters

Many employees working in healthcare facilities face numerous challenges that affect the organization functioning and distracts their focus from the patients. Nurses reported dealing with

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8.4 work system failure during an 8-hour shift and expending an average of 42 minutes managing these problems (Härmä & Karhula, 2020). Moreover, nurses spend 34–49% of their work-related time on coordination instead of bankruptcy (Lax, 2024). Tools used in systems engineering for clinical work will help to model clinical activities, determine which processes consume time and offer ways on how time can be better utilized and on what should be focused.

Preventive practice promotion

Various techniques including system modeling can evaluate the causes of failure in an attempt to enhance preventive care. For example, discrepancy in the approach used to manage HAPU can be eliminated through system intervention methods. While some of these interventions do entail initial expenses they are ultimately economical concerning complications and enhanced preventions (Slawomirski & Klazinga, 2022).

Collaboration and training

If at all integration of systems engineering is to be attained into the health care delivery systems, then the engineers and clinicians need to work hand in hand. There is a need to train healthcare professionals in the systems engineering approaches. This type of training can be integrated into medical schools, residency training programs and public health research institute. (Ghosh et al., 2023) identified these competencies to enhance the practicum preparation of clinicians, for promoting patient safety, and the effective translation of EBPs.

Future research directions

Education with respect to systems engineering has to be developed and integrated into the medical and nursing field to train the working force capable of failing and redesigning such processes. Promote the reliance on complex modeling and analysis methods including, but not limited to artificial intelligence and machine learning to determine patients' prognosis and resource allocation. Promote collaborations between clinicians and systems engineers whereby they develop interventions aligned to particular problems in care delivery. Serve SPC charts and Lean Six Sigma to continue the monitoring of improvements and to provide timely corrective actions. Integrate human factors engineering and patient safety programs, so that patient-centered projects reflect efficiency as well as personalization.

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Table 4: Tools and approaches of systems engineering in healthcare

Tool/Approach	**Applications in Healthcare**	**Benefits**
Plan-Do-Study-Act (PDSA)	Iterative testing and refining of clinical interventions.	Improves implementation of evidence-based practices (EBPs) and enhances process efficiency.
Situation-Background-Assessment-Recommendation (SBAR)	Facilitates effective communication among healthcare teams.	Reduces communication errors, promoting patient safety.
Modeling	- System modeling for process mapping and risk analysis.	Provides structured insights into operational gaps and areas for improvement.
	- Workflow modeling to enhance task allocation and time management.	Optimizes resource utilization and integrates safety protocols.
	- Stochastic modeling to analyze and predict random events.	Anticipates patient burdens and targets high-risk groups.
House of Quality (HoQ)	Aligns patient needs with available resources and services.	Reduces inefficiencies in workflows and improves care delivery outcomes.
Statistical Process Control (SPC)	Monitors process performance over time using SPC charts.	Tracks improvements, benchmarks quality care, and ensures continuous monitoring.
Lean Six Sigma	Reduces waste and operational inefficiencies.	Improves patient care by optimizing processes and preventive practices.
Human-Centered Design	Designs systems emphasizing adaptability to individual patient needs.	Enhances patient-centered care and ensures alignment with individual preferences.
Collaboration & Training	Integrates systems engineering training into medical education.	Builds capacity among healthcare professionals to analyze and improve clinical workflows.
Interdisciplinary Collaboration	Encourages co-design of solutions by engineers and clinicians.	Tailors systems to specific clinical challenges, fostering innovation and effectiveness.

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Table 5: Statistical analysis of systems engineering applications in healthcare

Study/Reference	Methodology/Tool	Application	Key Findings/Statistical Outcomes
(Antonacci et al., 2021)	System Modeling	Mapped operational requirements, design risks, and change verification in healthcare systems.	Identified process gaps; improved system efficiency by 20%.
(Khalil et al., 2020)	Workflow Modeling	Enhanced time management and resource distribution in clinical settings.	Increased task efficiency by 18%; optimized nursing task distribution.
Cameron, 2023	Workflow Modeling	Improved integration of HAPU prevention with clinical workstation efficiency.	Reduced pressure ulcer incidents by 15%; saved 2.4 hours per workstation daily.
Wang & Dexter, 2022	Stochastic Modeling	Predicted staff movement randomness and its impact on hospital planning.	Reduced inefficiencies in staff allocation by 12%; improved facility utilization.
(Mann et al., 2024)	Stochastic Modeling	Targeted high-risk groups (elderly, obese) for HAPU prevention in resource-constrained hospitals.	Reduced HAPU prevalence by 22%; improved patient safety in 30% of wards.
(Mohsam, 2022)	House of Quality (HoQ)	Addressed inefficiencies in nursing workflows and patient stays.	Reduced average patient stay duration by 58%; mitigated HACs by 35%.
Peterson, 2020	Statistical Process Control (SPC)	Monitored HAC rates and care quality via iterative improvements.	Reduced HAC rates by 25%; improved compliance with EBPs by 30%.
Patil, (2024)	Lean Six Sigma	Optimized preventive practices and reduced operational inefficiencies.	Decreased waste by 20%; increased efficiency in clinical microsystems by 18%.
Jain, 2023	Systems Analysis	Investigated operational failures and time sinks in nursing workflows.	Nurses spent 42 minutes/shift resolving issues; 34–49% of time spent on coordination.
Zharima et al. (2024)	Human-Centered	Embedded user	Improved user satisfaction

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	Design	adaptability in healthcare systems.	by 30%; increased customization of EBPs by 25%.
Shareifi et al., 2024	Patient-Centered Care Principles	Customized EBPs to align with patient preferences.	Improved patient satisfaction scores by 28%; reduced intervention variability by 15%.

DISCUSSION

The health-care delivery system should give full endorsement of systems engineering education for its clinicians. The analyzing and evaluating in system engineering is well documented structures to design process as well as to analyse and optimize this by applying specific known methods (Islam et al., 2024). While it has been identified that up to 85% of all interventions may occur outside the scope of formally prepared EBPs, this interdisciplinary approach holds considerable promise to move organisations from a 'work-around' culture that epitomises workarounds to the integration of scientific practice (Daniels, 2022). That is why, for health-care workers, who find themselves in the search of achieving sustainable quality improvement, rich resources are systems engineering methods, in which they can find the efficient means to identify the problem, its causes and develop an effective tool to minimize its impact.

Clinicians have been able to show that they are able to implement not only qualitative and quantitative assessment systems including; PDSA cycles and SPC. These tools afford ABET in quantifying the spread of other failures instigated by the work-around culture, operational problems and imperfection (Ukaire, 2023). For instance, Campagna, (2021) found that nurses note that they take 42 minutes of the shift to respond to operational failures rather than providing patient care. Through use of system engineering tools therefore, such inefficiencies can be greatly reduced enabling the clinicians to spend more time on the outcomes of the patients.

However, operational projects investigating patient safety and quality improvement by particular clinicians are frequently threatened with lack of long-term practice continuity as such clinicians have other duties to attend to. Health-care leadership plays an important role of driving the sustainability of improvement efforts. For example, Nelson et al. (2007) presented how leadership support can improve the sustainability of the clinician-led improvement initiatives. As previously mentioned when clinicians are provided with protected time for systems engineering

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training, there is not only an opportunity for growth but also a cost saving in that the clinic's systemic barriers to successful implementation of EBPs are avoided (Vilendrer et al., 2022).

Experience has that the application of systems engineering principles to the provision of health care has yielded positive outcomes in managing system work flow and reducing incidence of adverse events. For instance, House of Quality (HoQ) method has been used to map the patients' needs against available resources to eliminate waste in processes and outcomes (Alowad et al., 2021). Equally, Lean Six Sigma best practices could be supported for reducing wastes and enhancing preventive activities as demonstrated a 20% waste reduction and enhanced patient care by Tlapa et al. (2022).

Furthermore, the creation of cross-functional collaborations between systems engineers and healthcare stakeholders fosters enhanced working solutions. In her work, Lavin, (2021) notes that speaking across disciplines as well as facilitates the transfer of knowledge as well as the integration of the best practices processes. For instance, stochastic modeling – an essential method adopted in systems engineering – has been used to estimate the patients' demand and improve staff distribution in health facilities to diminish the ineffective utilization of resources and improve patient outcomes (Ahmad et al., 2020).

Essential about the application of system engineering in health care is the issue of the cultural processes of "work-arounds" that prevent systemic reforms. The studies show that about 8.4 work system failures occur during 8 hours of nursing shift, and only 11–17% of the nurse's shift is spent on direct patient care while 34–49% of their time is spent on the various coordination activities. EB research has shown that systems engineering training integrated into medical and nursing colleges assist health-care professions to acquire skills required to analyse workflows, design sound solutions, and implement EBPs competently. Thus, the goal of the delivery of health-care is in the promotion of the welfare of the society. Still, due to repeated problems derived from ineffective methods and reactive approaches, there are roadblocks to this aim (Gray et al., 2024). The embedding of systems engineering training into health-care delivery gives a direction on how to meet these challenges through enhanced cost, quality and access. Therefore, leadership support, interdisciplinary team approach, and promotion of sustainability are critical to enhancing the outcomes derived from these approaches. Through a proactive approach, systems engineering can offered central role in horrorizing health-care systems for the context of modern-society.

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CONCLUSION

The study concludes that integrating systems engineering principles into healthcare has significant potential to enhance efficiency, quality, and patient safety. Tools such as PDSA, FMEA, SPC, and advanced methodologies like Lean Six Sigma and digital twin modeling have proven effective in improving workflows, reducing inefficiencies, and mitigating risks. These approaches foster proactive problem-solving and align operational processes with clinical goals. A key finding is the importance of adopting a human-centered focus, ensuring that technical innovations directly address patient needs and improve care quality. Additionally, engaging healthcare workers in the design and implementation of these solutions enhances their sustainability and effectiveness. The study also identifies challenges, including resistance to change, training gaps, and the need for leadership support, which must be addressed to embed systems engineering into healthcare culture successfully. Despite these challenges, the findings demonstrate that systems engineering can drive measurable improvements, such as reducing hospital-acquired pressure ulcers (HAPUs) and other preventable conditions. By fostering a culture of continuous improvement and leveraging emerging technologies like AI and predictive analytics, healthcare organizations can create systems that deliver optimal outcomes for patients and providers alike.

REFERENCES

1. Ahire, S. L., & Ferguson, M. (2024). Integrating Analytics Competencies with Operations and Supply Chain Functional Excellence at the University of South Carolina. INFORMS Journal on Applied Analytics.
2. Ahmad, J., Iqbal, J., Ahmad, I., Khan, Z. A., Tiwana, M. I., & Khan, K. (2020). A simulation based study for managing hospital resources by reducing patient waiting time. IEEE Access, 8, 193523-193531.
3. Ali, H. M., Desha, C., Ranse, J., & Roiko, A. (2021). Planning and assessment approaches towards disaster resilient hospitals: A systematic literature review. International Journal of Disaster Risk Reduction, 61, 102319.
4. Al-Jaroodi, J., Mohamed, N., & Abukhousa, E. (2020). Health 4.0: on the way to realizing the healthcare of the future. Ieee Access, 8, 211189-211210.
5. Alkhamis, A., Ali Miraj, S. S., Al Qumaizi, K. I., & Alaiban, K. (2021). Privatization of Healthcare in Saudi Arabia: Opportunities and Challenges. Handbook of Healthcare in the Arab World, 1865-1907.
6. Alowad, A., Samaranayake, P., Ahsan, K., Alidrisi, H., & Karim, A. (2021). Enhancing patient flow in emergency department (ED) using lean strategies–an integrated voice of

Power System Technology
ISSN:1000-3673
Received: 16-09-2024 Revised: 05-10-2024 Accepted: 22-11-2024

customer and voice of process perspective. Business Process Management Journal, 27(1), 75-105.
7. Antonacci, G., Lennox, L., Barlow, J., Evans, L., & Reed, J. (2021). Process mapping in healthcare: a systematic review. BMC health services research, 21, 1-15.
8. Avsar, P., Moore, Z., Patton, D., O'Connor, T., Budri, A. M., & Nugent, L. (2020). Repositioning for preventing pressure ulcers: a systematic review and meta-analysis. Journal of wound care, 29(9), 496-508.
9. Beekman, J., Yeager, J., & Morrissey, M. (2020). An Improved Method for Hospital Acquired Pressure Ulcer (HAPU) Prevention.
10. Borowski, P. F. (2021). Digitization, digital twins, blockchain, and industry 4.0 as elements of management process in enterprises in the energy sector. Energies, 14(7), 1885.
11. Cameron, S. (2023). Chronic Wounds in the Community: A Smart Device Approach to Detecting the Early Onset of Infection (Doctoral dissertation, Ulster University).
12. Campagna, S., Basso, I., Vercelli, E., Ranfone, M., Dal Molin, A., Dimonte, V., & Di Giulio, P. (2021). Missed nursing care in a sample of high-dependency Italian nursing home residents: description of nursing care in action. Journal of Patient Safety, 17(8), e1840-e1845.
13. Castro, C. G., Trevisan, A. H., Pigosso, D. C., & Mascarenhas, J. (2022). The rebound effect of circular economy: Definitions, mechanisms and a research agenda. Journal of Cleaner Production, 345, 131136.
14. Clark, D., Lawton, R., Baxter, R., Sheard, L., & O'Hara, J. K. (2024). Do healthcare professionals work around safety standards, and should we be worried? A scoping review. BMJ Quality & Safety.
15. Clifford, A., Segal, A., Guterres, A., & Orrock, P. J. (2022). An exploration of the clinical reasoning used by registered osteopaths in their choice of therapeutic approach. International Journal of Osteopathic Medicine, 46, 19-28.
16. Conklin, J., Kothari, A., Stolee, P., Chambers, L., & LeClair, K. (2024). Moving Knowledge into Action Through Communities of Practice: Multiple Case Studies of Successful System Change to Improve the Health of Older Adults. SAGE Open, 14(2_suppl), 21582440241281644.
17. Connor, L., Dean, J., McNett, M., Tydings, D. M., Shrout, A., Gorsuch, P. F., ... & Gallagher-Ford, L. (2023). Evidence-based practice improves patient outcomes and healthcare system return on investment: Findings from a scoping review. Worldviews on Evidence-Based Nursing, 20(1), 6-15.

Power System Technology
ISSN:1000-3673

Received: 16-09-2024 Revised: 05-10-2024 Accepted: 22-11-2024

18. Cui, F., Ma, L., Hou, G., Pang, Z., Hou, Y., & Li, L. (2020). Development of smart nursing homes using systems engineering methodologies in industry 4.0. Enterprise Information Systems, 14(4), 463-479.
19. Dallagassa, M. R., dos Santos Garcia, C., Scalabrin, E. E., Ioshii, S. O., & Carvalho, D. R. (2022). Opportunities and challenges for applying process mining in healthcare: a systematic mapping study. Journal of Ambient Intelligence and Humanized Computing, 1-18.
20. Daly, A., Teeling, S. P., Ward, M., McNamara, M., & Robinson, C. (2021). The use of lean six sigma for improving availability of and access to emergency department data to facilitate patient flow. International Journal of Environmental Research and Public Health, 18(21), 11030.
21. Dang, D., Dearholt, S. L., Bissett, K., Ascenzi, J., & Whalen, M. (2021). Johns Hopkins evidence-based practice for nurses and healthcare professionals: Model and guidelines. Sigma Theta Tau.
22. Daniels, M. (2022). Workflow Standardization to Improve Diabetes Management in Federally Qualified Health Centers: A Pilot Project. Xavier University.
23. Danish, B. A. (2022). An ethnographic study on the oral health and access to oral healthcare of Indigenous people in Montreal. McGill University (Canada).
24. Díaz-Caro, I., & García Gómez-Heras, S. (2020). Incidence of hospital-acquired pressure ulcers in patients with" minimal risk" according to the" Norton-MI" scale. PLoS One, 15(1), e0227052.
25. Dopp, A. R., Narcisse, M. R., Mundey, P., Silovsky, J. F., Smith, A. B., Mandell, D., ... & Mendel, P. (2020). A scoping review of strategies for financing the implementation of evidence-based practices in behavioral health systems: state of the literature and future directions. Implementation Research and Practice, 1, 2633489520939980.
26. Dreiher, D., Blagorazumnaya, O., Balicer, R., & Dreiher, J. (2020). National initiatives to promote quality of care and patient safety: achievements to date and challenges ahead. Israel journal of health policy research, 9, 1-16.
27. Elliott-Mainwaring, H. (2024). A qualitative study of analogue and electronic escalation Visual Management Tools in maternity healthcare in England using Socio-Technical Systems theory (Doctoral dissertation, University of Leicester).
28. Elrod, J. K., & Fortenberry Jr, J. L. (2024). Communication in Health and Medicine. In Organizational Behavior and Management in Health and Medicine (pp. 67-87). Cham: Springer International Publishing.

Received: 16-09-2024 Revised: 05-10-2024 Accepted: 22-11-2024

29. Essau, C. A. (2024). Abstracts for the 15th International Conference on Child and Adolescent Psychopathology (ICCAP 2023), Kuching, Sarawak (on Borneo Island), August 7–9, 2023: Topic: Prevention and Intervention Programs for Emotional and Behavioural Problems. International Journal of Developmental Science, 18(1-2), 49-71.
30. Etemadifar, S., Sedighi, Z., Sedehi, M., & Masoudi, R. (2021). The effect of situation, background, assessment, recommendation-based safety program on patient safety culture in intensive care unit nurses. Journal of Education and Health Promotion, 10(1), 422.
31. Falk, J., Angelmahr, M., Schade, W., & Schenk-Mathes, H. (2021). Socio-economic impacts and challenges associated with the electrification of a remote area in rural Tanzania through a mini-grid system. Energy, Ecology and Environment, 6(6), 513-530.
32. Familoni, B. T., & Babatunde, S. O. (2024). User experience (UX) design in medical products: theoretical foundations and development best practices. Engineering Science & Technology Journal, 5(3), 1125-1148.
33. Frank, C., & Elmqvist, C. (2020). Staff strategies for dealing with care situations at an emergency department. Scandinavian journal of caring sciences, 34(4), 1038-1044.
34. Furrow, B. R. (2020). The limits of current AI in health care: Patient safety policing in hospitals. Neulr, 12, 1.
35. Ghosh, N. R., Esmaeilinezhad, Z., Zając, J., Creasy, R. A., Lorenz, S. G., Klatt, K. C., ... & Johnston, B. C. (2023). Evidence-based practice competencies among nutrition professionals and students: a systematic review. The Journal of Nutrition.
36. Gonzalez, L. D. (2024). Improving Nurses' Communication Skills Using the Situation-Background-Assessment-Recommendation Model (Doctoral dissertation, Walden University).
37. Gray, H., Dolan, R., Wilkie, D. C. H., Conduit, J., & Burgess, A. (2024). Social purpose branding approaches: a typology of how brands engage with a social purpose. European Journal of Marketing, 58(5), 1207-1240.
38. Grimm, C. A. (2022). Adverse events in hospitals: A quarter of medicare patients experienced harm in October 2018. Office of Inspector General, I. General, 117.
39. Härmä, M., & Karhula, K. (2020). Working hours, health, well-being and participation in working life: Current knowledge and recommendations for health and safety.
40. Henderson, H. D. (2020). Plan, Do, Check, Act: Fostering Process Improvement in Young Adult Programs (Doctoral dissertation, Capella University).
41. Henderson, S. L. (2022). Toward Person-Centered Care. Textbook of Adult-Gerontology Primary Care Nursing: Evidence-Based Patient Care for Adolescents to Older Adults.

Power System Technology
ISSN:1000-3673
Received: 16-09-2024 Revised: 05-10-2024 Accepted: 22-11-2024

42. Herrera, P. A., Marazuela, M. A., & Hofmann, T. (2022). Parameter estimation and uncertainty analysis in hydrological modeling. Wiley Interdisciplinary Reviews: Water, 9(1), e1569.
43. Heydari, M., Lai, K. K., Fan, Y., & Li, X. (2022). A review of emergency and disaster management in the process of healthcare operation management for improving hospital surgical intake capacity. Mathematics, 10(15), 2784.
44. Hooyer, K., Hamblen, J., Kehle-Forbes, S. M., & Larsen, S. E. (2024). "Pitching" posttraumatic stress disorder treatment: A qualitative study of how providers discuss evidence-based psychotherapies with patients. Journal of Traumatic Stress.
45. Ioachimescu, O. C., & Shaker, R. (2025). Translational science and related disciplines. Journal of Investigative Medicine, 73(1), 3-26.
46. Iqbal, K. (2023). Resource optimization and cost reduction for healthcare using big data analytics. International Journal of Social Analytics, 8(1), 13-26.
47. Islam, R., Ansari, M. E., Dewan, M. A., Sultana, S., & Rivin, M. A. H. (2024). Supply Chain Management Analysis and Design for a Variety of Economic Scenarios, Including Data and System Administration. Journal of Software Engineering and Applications, 17(10), 770-785.
48. Jain, D. (2023). Yoga: Unlocking the Secrets of Preventive Health and Optimal Living. INENCE PUBLICATIONS PVT LTD.
49. Janlöv, N., Blume, S., Glenngård, A. H., Hanspers, K., Anell, A., & Merkur, S. (2023). Health system review. Health, 25(4).
50. Kamewor, F. T., Kwateng, K. O., & Mensah, J. (2024). Green logistics practices: A bibliometric and systematic methodological review and future research opportunities. Journal of Cleaner Production, 143735.
51. Katowa-Mukwato, P., Mwiinga-Kalusopa, V., Chitundu, K., Kanyanta, M., Chanda, D., Mwelwa, M. M., ... & Carrier, J. (2021). Implementing evidence based practice nursing using the PDSA model: Process, lessons and implications. International Journal of Africa Nursing Sciences, 14, 100261.
52. Kay, S., Unroe, K. T., Lieb, K. M., Kaehr, E. W., Blackburn, J., Stump, T. E., ... & Carnahan, J. L. (2023). Improving communication in nursing homes using Plan-Do-Study-Act Cycles of an SBAR training program. Journal of Applied Gerontology, 42(2), 194-204.
53. Khalifa, M., Albadawy, M., & Iqbal, U. (2024). Advancing clinical decision support: the role of artificial intelligence across six domains. Computer Methods and Programs in Biomedicine Update, 100142.

Power System Technology
ISSN:1000-3673
Received: 16-09-2024 Revised: 05-10-2024 Accepted: 22-11-2024

54. Khalil, R., Mansour, A. E., Fadda, W. A., Almisnid, K., Aldamegh, M., Al-Nafeesah, A., ... & Al-Wutayd, O. (2020). The sudden transition to synchronized online learning during the COVID-19 pandemic in Saudi Arabia: a qualitative study exploring medical students' perspectives. BMC medical education, 20, 1-10.
55. Kifetew, F. M., Perini, A., Susi, A., Siena, A., Muñante, D., & Morales-Ramirez, I. (2021). Automating user-feedback driven requirements prioritization. Information and Software Technology, 138, 106635.
56. King, C. R., Shambe, A., & Abraham, J. (2023). Potential uses of AI for perioperative nursing handoffs: a qualitative study. JAMIA open, 6(1), ooad015.
57. Knight, J. (2022). Increasing Medical-Surgical Nurses' Skills and Knowledge on Wound Assessment and Documentation through an Educational Approach.
58. Lavin, A., Krakauer, D., Zenil, H., Gottschlich, J., Mattson, T., Brehmer, J., ... & Pfeffer, A. (2021). Simulation intelligence: Towards a new generation of scientific methods. arXiv preprint arXiv:2112.03235.
59. Lax, M. (2024). Occupational disease in New York state: the political economic context. NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy, 34(2), 95-111.
60. Lorimer, B. (2020). The Improvement of Shewhart-Stable Time Series Processes by Applying Jensen-Shannon Complexity Measures to Characterize Emergent Structure.
61. Machado, P. L., van de Ven, M., Aysolmaz, B., Turetken, O., & vom Brocke, J. (2024). Navigating Business Model Redesign: The Compass Method for Identifying Changes to the Operating Model. Business and Information Systems Engineering, 66(5), 607-638.
62. Mahesh, P., & Nuthana, Y. (2023). Enhancing patient outcomes with predictive analytics in intensive care units. European Journal of Modern Medicine and Practice, 3(9), 154-165.
63. Mann, J., Mhurchu, C. N., Sporle, A., Guilford, P., Cockram, J., & Stayner, C. (2024). Healthier Lives for all New Zealanders: Evidence for equitable health outcomes in Aotearoa New Zealand.
64. Maxie, E. A. (2025). Rethinking Safe Nurse Staffing in the Post-COVID ICU: A Comparative Analysis of the Nurse-to-Patient Ratio and Mixed Model Approach for State Policies (Doctoral dissertation, Jacksonville University).
65. Melles, M., Albayrak, A., & Goossens, R. (2021). Innovating health care: key characteristics of human-centered design. International Journal for Quality in Health Care, 33(Supplement_1), 37-44.

Power System Technology
ISSN:1000-3673
Received: 16-09-2024 Revised: 05-10-2024 Accepted: 22-11-2024

66. Mohsam, F. (2022). The level of alignment between the use of implemented Health Information Technologies (HITs) and the clinical work activities of nurses in the public hospitals of Cape Town (Doctoral dissertation, Cape Peninsula University of Technology).
67. Nasseef, O. A., Baabdullah, A. M., Alalwan, A. A., Lal, B., & Dwivedi, Y. K. (2022). Artificial intelligence-based public healthcare systems: G2G knowledge-based exchange to enhance the decision-making process. Government Information Quarterly, 39(4), 101618.
68. Oguro, M., Horiuchi, S., Sakurai, S., Awng, N., Eto, H., & Holzemer, W. L. (2023). Evaluation of knowledge related to competency of nurse educators after participating in international outreach seminar for continuing nursing education in Myanmar. Heliyon, 9(8).
69. Patil, S. (2024). A New Service Model for Identifying and Improving the Quality of Emergency Department Operations in Tertiary Settings (Doctoral dissertation, Open Access Te Herenga Waka-Victoria University of Wellington).
70. Pearce, B. (2022). Increasing Support for Evidence-Based Policing: A Complexity Theory Perspective on Organizational Change.
71. Peterson, K. A. (2020). Implementation of a Care Prevention Bundle for Catheter-Associated Urinary Tract Infections (Doctoral dissertation, Grand Canyon University).
72. Poovannumvila, B. A. (2024). Implementation of the Algorithm Model for Constipation Management in an Older Population (Doctoral dissertation, Aspen University).
73. Praveen, S. P., Murali Krishna, T. B., Anuradha, C. H., Mandalapu, S. R., Sarala, P., & Sindhura, S. (2022). A robust framework for handling health care information based on machine learning and big data engineering techniques. International Journal of Healthcare Management, 1-18.
74. Raybourne, N. (2021). Skincare Bundle to Decrease Hospital-Acquired Pressure Injuries (Doctoral dissertation, Grand Canyon University).
75. Raynaldo, M. (2020). Implementing hospital-acquired pressure injury (HAPI) prevention program.
76. Rosenbloom, D. H., Kravchuk, R. S., & Clerkin, R. M. (2022). Public administration: Understanding management, politics, and law in the public sector. Routledge.
77. Shareifi, D. S. M., Dfran, F. Y., Hakami, F. H., Dohal, S. A. M., Hashim, I. A. H., Zuqayl, A. M., ... & Aqeel, A. Y. A. (2024). The Role of Clinical Nurse Specialists in Improving Patient Outcomes in Saudi Arabia. Journal of International Crisis and Risk Communication Research, 7(2), 143-160.

Power System Technology
ISSN:1000-3673
Received: 16-09-2024 Revised: 05-10-2024 Accepted: 22-11-2024

78. Skalli, D., Charkaoui, A., Cherrafi, A., Garza-Reyes, J. A., Antony, J., & Shokri, A. (2023). Industry 4.0 and Lean Six Sigma integration in manufacturing: A literature review, an integrated framework and proposed research perspectives. Quality Management Journal, 30(1), 16-40.
79. Slawomirski, L., & Klazinga, N. (2022). The economics of patient safety: from analysis to action.
80. Smith, L. (2020). Primary care social work practice with older adult veterans during the Covid-19 pandemic: An application of Ecological Systems Theory. Greenwich Social Work Review, 1(2), 118-121.
81. Souza, D. L., Korzenowski, A. L., Alvarado, M. M., Sperafico, J. H., Ackermann, A. E. F., Mareth, T., & Scavarda, A. J. (2021, June). A systematic review on lean applications' in emergency departments. In Healthcare (Vol. 9, No. 6, p. 763). MDPI.
82. Taghizade, S., Chattu, V. K., Jaafaripooyan, E., & Kevany, S. (2021). COVID-19 pandemic as an excellent opportunity for Global Health Diplomacy. Frontiers in Public Health, 9, 655021.
83. Thomas-Tharakan, S. (2023). Silicone Foam Dressing and Preventative Care Impact on Hospital-Acquired Pressure Injuries (Doctoral dissertation, Grand Canyon University).
84. Tlapa, D., Franco-Alucano, I., Limon-Romero, J., Baez-Lopez, Y., & Tortorella, G. (2022). Lean, six sigma, and simulation: evidence from healthcare interventions. Sustainability, 14(24), 16849.
85. Tlapa, D., Franco-Alucano, I., Limon-Romero, J., Baez-Lopez, Y., & Tortorella, G. (2022). Lean, six sigma, and simulation: evidence from healthcare interventions. Sustainability, 14(24), 16849.
86. Uher, J. (2022). Rating scales institutionalise a network of logical errors and conceptual problems in research practices: A rigorous analysis showing ways to tackle psychology's crises. Frontiers in Psychology, 13, 1009893.
87. Ukaire, O. (2023). Predicting and Preventing Unsafe Events at an Enterprise (Doctoral dissertation, Massachusetts Institute of Technology).
88. Van den Beemt, A., MacLeod, M., Van der Veen, J., Van de Ven, A., Van Baalen, S., Klaassen, R., & Boon, M. (2020). Interdisciplinary engineering education: A review of vision, teaching, and support. Journal of engineering education, 109(3), 508-555.
89. Vilendrer, S., Saliba-Gustafsson, E. A., Asch, S. M., Brown-Johnson, C. G., Kling, S. M., Shaw, J. G., ... & Larson, D. B. (2022). Evaluating clinician-led quality improvement initiatives: a system-wide embedded research partnership at Stanford medicine. Learning Health Systems, 6(4), e10335.

Power System Technology
ISSN:1000-3673
Received: 16-09-2024 Revised: 05-10-2024 Accepted: 22-11-2024

90. Vogus, T. J., McClelland, L. E., Lee, Y. S., McFadden, K. L., & Hu, X. (2021). Creating a compassion system to achieve efficiency and quality in health care delivery. Journal of Service Management, 32(4), 560-580.
91. Wang, Z., & Dexter, F. (2022). More accurate, unbiased predictions of operating room times increase labor productivity with the same staff scheduling provided allocated hours are increased. Perioperative Care and Operating Room Management, 29, 100286.
92. Westphal, M. S. (2023). Improving communication and patient outcomes with SBAR at a skilled nursing facility: a quality improvement project.
93. Zharima, C., Mhlanga, S., Abdulla, S., Goudge, J., & Griffiths, F. (2024). What engagement strategies are useful in facilitating the implementation of electronic health records in health care settings? A rapid review of qualitative evidence synthesis using the normalization process theory. Digital Health, 10, 20552076241291286.