

College of Engineering
PhD in Engineering Systems Management

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Dissertation: Integrating of Vehicle-to-Everything (V2X) Communication System into Transportation System for Real-Time Route Guidance System

Supervisors: Dr. Mohamed S. Hassan and Dr. Akmal Saad Abdelfatah

Abstract

Intelligent transportation systems (ITS) are core elements of smart cities, yet the communication requirements of route guidance systems (RGS) remain underexplored. Existing studies typically focus either on vehicle-to-everything (V2X) communication for data exchange and congestion mitigation or on RGS optimization in isolation, leaving a gap in understanding how communication performance shapes route-guidance reliability.

This work introduces VORTINET, a distributed traffic management framework built on a two-tier V2X architecture: VANET-based vehicle-to-vehicle (V2V) links for local vehicle-roadside units (RSU) interactions and low-band 5G LTE-based infrastructure-to-infrastructure communication for RSU coordination. The system is evaluated using a hybrid simulation environment integrating NS3 for communication modeling and Dynasmart for traffic dynamics. Across high, medium and low congestion scenarios, results show that communication delays impose only minor performance penalties—up to 2.5%—while informed vehicles consistently achieve shorter travel times. Higher penetration rates steadily improve efficiency, and at full penetration the effect of delays becomes negligible due to synchronized network-wide routing.

These findings demonstrate that VORTINET provides a scalable, resilient communication foundation for real-time route guidance, supporting congestion reduction and improved urban mobility.

Khalid Salim Al-Ali

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Dissertation: The Readiness of Private Organizations to Implement Health and Safety Initiatives

Supervisors: Dr. Abdulrahim Shamayleh and Dr. Mahmoud Ismail Awad

Abstract

Workplace safety remains a critical global challenge, with millions of preventable injuries and fatalities occurring yearly. According to the International Labor Organization (ILO), approximately 2.78 million fatalities are attributed annually to occupational accidents and diseases, alongside nearly 374 million nonfatal injuries. Globally, the construction sector accounts for approximately 30–40% of occupational fatalities. Small and medium enterprises (SMEs) are often over-represented in these statistics due to systemic vulnerabilities and informal working conditions. These conditions underscore the need for effective implementation of Occupational Health and Safety (OHS) in the construction sector. Despite the growing interest in OHS compliance, there is a lack of recognized models to measure the SMEs' readiness to achieve OHS regulations issued by public organizations, and limited understanding of the specific factors that influence their regulatory adoption.

This study aims to develop a comprehensive maturity model to evaluate the readiness of SMEs to adopt and implement OHS initiatives introduced by governmental entities. The study identifies and analyzes key factors influencing SMEs readiness and examines their intercorrelations using Structural Equation Modeling (SEM). Additionally, a triple-perspective case study analysis is conducted on two construction SMEs to verify the applicability of the developed model to the current SMEs in the construction industry within the UAE. The case studies assess the applicability of the model and demonstrate its effectiveness in measuring readiness levels and supporting evidence-based decision making. The findings confirm the robustness and usability of the developed maturity model in real-world settings.

This study contributes to the advancement of safety management by offering a structured, data-driven approach to evaluating and enhancing OHS readiness and actionable recommendations to support SMEs OHS maturity compliance.



Karam Yousef Al-Assaf

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Dissertation: A Decision Support Tool for Improving Healthcare Service Quality in Technology-Enabled Settings

Supervisors: Dr. Zied Bahroun and Dr. Vian Shawket Ahmed

Abstract

Healthcare systems are among the most critical sectors worldwide, directly influencing life expectancy, disease management and overall societal well-being. The sector is increasingly shaped by digital technologies such as Artificial Intelligence, telemedicine and electronic health records. Despite these advancements, consistent healthcare service quality (HCSQ) remains difficult to achieve. Existing service quality models often treat quality dimensions descriptively and assume equal importance across domains, limiting structured prioritization and effective decision making. In addition, few studies translate multidimensional HCSQ constructs into operational decision-support mechanisms for technology-enabled environments, indicating a clear research gap.

This study adopts a mixed-method approach combining semi-structured interviews, a three-round Delphi validation process, practitioner surveys, patient-ranked preference modeling and robustness testing. Ten HCSQ domains and 47 key performance indicators were validated and weighted using hybrid techniques integrating Analytic Hierarchy Process, Arithmetic Mean aggregation and Shannon entropy. Patient priorities were modeled separately using the Plackett–Luce method. The validated criteria were then integrated into a decision support tool based on hierarchical aggregation and benchmark classification logic.

The findings identify patient safety and clinical quality as the most influential domains, while technology impact functions primarily as an enabling domain that supports outcome-driven quality dimensions. End-user evaluation confirmed that the tool supports structured prioritization and actionable performance review. Overall, this study proposes the Relational Framework for Healthcare Service Quality and an associated decision support tool as a structured, practical approach to advancing HCSQ assessment in technology-enabled healthcare systems.

Mohamed Rashid Almarri

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Dissertation: An AI-Driven Risk Management Framework for Airport Operations

Supervisors: Dr. Noha M Hassan and Dr. Zied Bahroun

Abstract

Airports play a vital role in facilitating the safe movement of aircraft and passengers between air and land. The airport environment is inherently dynamic, facing a wide range of risks related to operations, environment, security, occupational and human-related factors. These diverse risks pose significant threats to passenger safety, infrastructure integrity, operational efficiency and business continuity. Current risk management approaches often rely on traditional, static assessments that fail to keep pace with the rapidly changing and complex nature of airport operations.

This dissertation proposes an AI-driven risk management framework for airport operations that combines conceptual development with empirical validation and simulated application on selected airport risk cases. The research adopted a mixed-method approach by reviewing the literature to identify key factors related to risk management and artificial intelligence (AI) in airport operations. Subsequently, expert validation was conducted with SMEs and by survey. Once all constructs that impact risk management effectiveness (RME) were validated, they were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results indicate that AI adoption and readiness is the strongest predictor of RME, followed by the operation construct, while organizational support shows a limited influence. Furthermore, the PLS-SEM findings confirm that RME has a strong and positive influence on airport operations' performance, highlighting its critical role in airport operations.

Building on these validated findings, the next stage of the research translated the conceptual and empirical results into a predictive application using real operational data. Accordingly, machine learning (ML) models were developed in MATLAB to predict both risk occurrence and severity. To demonstrate the framework through practical airfield



applications, the ML pipeline was implemented on two selected risk scenarios: spillage incidents and wildlife strike events. Across these cases, the selected Ensemble Bagged Trees models achieved strong predictive performance, with test accuracies ranging from 88.78% to 95.74%. The selected models were then integrated into a Simulink environment, forming the basis of the framework and linking to a decision support system (DSS) to translate the information from the ML models to a user interface for decision makers. The framework demonstrates the capability to dynamically predict, assess and support mitigation actions based on changing operational conditions within a simulated environment. This dissertation contributes a modular and data-driven framework that bridges the gap between theoretical risk management approaches and practical implementation using AI tools.

Ryan Kamal AlTayeb

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Dissertation: A Development of an Optimized Synthesis Protocol for PEMFC Membranes Using DOE and Machine Learnings

Supervisors: Dr. Amani Al-Othman and Dr. Abdulrahim Shamayleh

Abstract

Proton exchange membranes (PEMs) are critical components in fuel cell systems; however, their performance optimization remains challenging due to complex nonlinear interactions among compositional and processing variables.

This dissertation presents a data-driven framework for PEM synthesis optimization that integrates statistical screening, response surface methodology, global optimization, machine-learning prediction and experimental validation into a unified and transferable methodology. Statistical analysis identified zirconium loading, ionic liquid concentration and glycerol content as the most significant factors influencing proton conductivity, while membrane thickness and base polymer type were found to be non-dominant within the investigated ranges. Response surface methodology achieved an R^2 of 0.61, confirming meaningful curvature and interaction effects but also revealing limitations of quadratic approximations. Global optimization using surrogate-assisted genetic algorithms predicted a maximum $\ln(\sigma)$ of -1.44 ($\sigma = 0.23 \text{ Scm}^{-1}$), exceeding the local optima identified by response surface methodology (RSM). Machine-learning regression models further improved predictive accuracy, with CatBoost achieving an R^2 of 0.93 on the test, demonstrating strong generalization capability and robust nonlinear learning. Experimental validation of the optimized membrane formulation produced an average proton conductivity of 0.207 Scm^{-1} across three replicates, compared to 0.09 Scm^{-1} . Structural and morphological characterization supported the predicted interaction-driven transport mechanisms.

The study concludes by the development of a model-informed synthesis protocol that distinguishes critical from non-critical variables and provides a transferable framework for composite PEM fabrication. By transitioning membrane development from empirical trial-and-error experimentation toward predictive and reproducible design, this work establishes a scalable methodology applicable to broader proton-conducting composite systems.



Mohamed Yousif Alzarooni

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Dissertation: Developing a Framework for Assessing the Readiness and Relevance of Emerging Technologies in Occupational Safety and Health

Supervisors: Dr. Mahmoud Ismail Awad and Dr. Abdulrahim Shamayleh

Abstract

Occupational safety and health (OSH) remain a critical concern globally, with the International Labour Organization (ILO) estimating that over 2.78 million work-related deaths occur each year, alongside approximately 374 million non-fatal injuries and illnesses. As industries become more complex and technology becomes increasingly integrated in workplace systems, the challenge of ensuring OSH evolves accordingly. While many emerging technologies show promise in reducing risk and improving safety outcomes, organizations often struggle to determine which tools are ready and suitable for their specific needs.

This research aims to develop a practical evaluation framework for assessing the maturity and applicability of OSH-related emerging technologies. The study begins by identifying and categorizing technologies currently shaping OSH practices. Next, a technology evaluation and selection framework is developed and refined through a comprehensive analysis of relevant literature, expert interviews and survey responses from safety professionals. The framework is subsequently evaluated through a selected case study to assess its real-world applicability and flexibility. The results highlight five key parameters that influence the selection of technology within the OSH context: technological readiness and functionality; human and organizational integration; adoption and organizational fit; communication and feedback mechanism; and risk and regulatory alignment.

Finally, a set of evidence-based recommendations are presented to support both organizational leaders and policymakers in adopting technologies that align with proactive, scalable and context-aware safety strategies. By bridging the gap between innovation and implementation, this research offers a tool not only for evaluation but also for informed, forward-thinking decision making in workplace safety.

