

Editorial Introduction to Issue 48 of CSIMQ: Reducing Uncertainty of Complex Socio-Technical Systems

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This issue of *Complex Systems Informatics and Modeling Quarterly* continues the examination of different characteristics of complex socio-technical systems, such as the relationship between psychological and technical factors in the automation of routine tasks, hidden insights from data analytics, and reducing uncertainty in complex and distributed systems.

The first two studies examine automation of routine tasks and operations to reduce resource consumption such as energy, human labor, and time. Both studies consider Higher Education Institutions as their primary application areas.

The first article, “Robot-Mediated Attendance Verification in Higher Education: A Socio-Technical Evaluation”, represents the study conducted by researchers from Tallinn University of Technology (Estonia) about facilitating the attendance tracking task in higher education. The main challenges of this task are identity verification and time efficiency. The authors propose a non-stationary solution – a robot-mediated multi-factor attendance verification system. The study explores socio-technical aspects of using the system: reduction of the administrative workflow, as well as how the system is perceived by students and lecturers. The authors concluded that the system may provide a feasible approach to attendance checking in identity-sensitive scenarios with promising estimated attendance processing times under the observed classroom conditions.

The second article, “Stay-Contextual Trigger: A Confidence-Based Algorithm for Energy-Efficient and Behaviorally Grounded Mobile Notifications”, is presented by researchers from Diponegoro University and Institut Teknologi PLN (Indonesia). The authors explore the open question in human-centred mobile design – whether a user is ready to receive the assisting notifications while moving from one geographical point to another. The Confidence-Based Weighted Algorithm (CBWA) suggested by the authors integrated activity recognition, temporal dwell logic, and behavioral history into a unified, lightweight decision engine for mobile environments. The results of validation showed that the number of redundant notifications was reduced significantly while keeping their assisting nature. Additionally, this approach also allowed for reducing daily smartphone battery use.

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The next articles are devoted to applications of artificial intelligence-based solutions to infer hidden states in e-commerce sentiment analysis and predict future events in energy domain to be more prepared for infrastructure failures and to improve repair crew schedule planning.

In “HCASO: Hybrid Cross-Lingual Attention with Contrastive Alignment and Optimized Lexical Fusion for Bilingual E-Commerce Sentiment Analysis”, presented by the authors from SRM Institute of Science and Technology (India), a unified bilingual model (English and Chinese) is proposed. The HCASO model is designed as a statistically validated alternative to shared-encoder models. The model is jointly trained using cross-entropy, mean squared error intensity regression, and contrastive objectives, and it is calibrated post-hoc with temperature scaling. As a result, HCASO reliably understands human sentiment across both English and Chinese without getting confused by the language differences.

The next article, “Quantile Regression for Power Grid Damage Prediction”, is prepared by a group of researchers from Riga Technical University (Latvia) and addresses the challenge of predicting electrical grid damage in the Latvian regions of Zemgale and Kurzeme using machine learning and quantile regression techniques. The research is based on the real data of Latvian JSC “Sadales tīkls” collected in the period from 2009 to 2025 and presented by four groups of features – environmental characteristics, infrastructure characteristics, seasonal specifics, and weather observations. The research indicates that the 2-cell model (organized by state regions) is the most effective approach for planning the deployment of repair crews; however, prediction could be further improved by incorporating meteorological data specifically from the period immediately preceding the occurrence of damage.

The issue is concluded with research results on establishing structural clarity across complex, decentralized environments.

In “Zero Trust in Heterogeneous Multi-Cloud Environments: A Systematic Literature Review and a Decentralized Federated Trust Framework”, the authors from Petro Mohyla Black Sea National University (Ukraine) review the latest published results (2020–2026) on implementing Zero Trust Architecture across heterogeneous multi-cloud environments that are complicated by incompatible identity models, policy semantics, trust anchors, and credential-lifecycle mechanisms. After reviewing 31 distinct studies selected from Scopus, the Web of Science Core Collection, and IEEE Xplore, the authors concluded that centralized and federated approaches continue to be characterized by operational maturity; however, they still rely on identity service providers, brokers, and policy models that are tied to specific providers. As a result, the authors proposed and reviewed a decentralized federated trust framework that combines portable credentials, local verification, issuer and credential-lifecycle controls, policy mapping, and resource-local enforcement.

In “Sensemaking of Organizational Rule Systems: Requirements for a Modeling Method”, the researchers from Stockholm University (Sweden) focus on eliciting requirements for a visual modeling method that supports non-rule expert practitioners in comprehending and navigating rule systems. The research was undertaken in the context of the Health Data Sweden (HDS) project and is a part of a *design science research* (DSR) PhD project related to HDS. Therefore, the research presents empirically supported findings on how organizational participants make sense of events within complex information environments. Thus, the study enhances the approach to the analysis of rules: while they have traditionally been examined primarily within a legal context or from the perspective of compliance with established norms, this work offers focusing also on how rules are understood, represented, and interpreted under complex conditions.

The CSIMQ editorial team thanks all the authors for submitting the results of their scientifically innovative and passionate work for evaluation and all the reviewers for providing their valuable feedback for the submitted articles.