Enterprise Resource Planning Systems in the Era of Intelligent Computing: A Comprehensive Survey of AI Integration, Security Frameworks, and Emerging Paradigms (2020–2026)

Supplementary Materials Repository

This repository contains the complete supplementary materials supporting the systematic literature review submitted to **Humanities and Social Sciences Communications**.

📋 Repository Contents

Core Documentation

- **PRISMA_2020_Checklist.pdf** - Completed PRISMA 2020 checklist documenting compliance with all 27 reporting items
- **README.md** - This file, providing an overview of all supplementary materials

Supplementary Documents

- **Supplementary_S1_Search_Strategies.docx** - Complete search strategies for all databases consulted
- **Supplementary_S2_Screening_Selection.pdf** - Complete list of 147 included publications with screening logs
- **Supplementary_S3_Data_Extraction.pdf** - Structured data extraction forms and methodology
- **Supplementary_S4_Synthesis_Materials.pdf** - Synthesis tables, comparative matrices, and meta-analysis

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🔍 Study Overview

Study Type: Systematic Literature Review
Time Period: January 2020 – January 2026
Total Papers Analyzed: 147
Search Completion Date: January 28, 2026
Final Selection Date: January 31, 2026

Research Objectives

This systematic review examines transformational developments in Enterprise Resource Planning (ERP) systems, analyzing:

1. AI/ML integration approaches and performance
2. Security frameworks and anomaly detection mechanisms
3. Cloud and distributed architectures
4. Adoption frameworks and critical success factors
5. Industry 4.0 integration and cyber-physical systems
6. SME-specific implementations and challenges
7. Emerging technologies (blockchain, quantum computing, XR)
8. Process mining and business intelligence

📊 Key Findings Summary

Publication Distribution by Dimension

- **AI and Machine Learning Integration:** 38 papers (26%)
- **Security and Anomaly Detection:** 29 papers (20%)
- **Cloud and Distributed Architectures:** 24 papers (16%)

- **Adoption and Implementation:** 18 papers (12%)
- **Industry 4.0 Integration:** 15 papers (10%)
- **SME Implementation:** 12 papers (8%)
- **Emerging Technologies (Blockchain):** 7 papers (5%)
- **Process Mining and Analytics:** 4 papers (3%)

Temporal Trends

- **AI/ML Research Growth:** +180% (2020-2025)
- **Security Research Growth:** +90% (2020-2025)
- **Blockchain Research Growth:** +150% (2020-2025)
- **Overall Publication Acceleration:** Particularly pronounced after 2023 with generative AI breakthroughs

Performance Highlights

- **AI/ML Detection Accuracy:** 93-97% with <5% false positive rates
- **Cloud Adoption:** 61% of new implementations use cloud-native or hybrid architectures
- **AI Integration:** 73% of implementations incorporate AI capabilities
- **Smart Factory Impact:** 18-25% productivity gains, 30-40% defect reductions

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📁 Detailed File Descriptions

PRISMA_2020_Checklist.pdf

Complete PRISMA 2020 checklist documenting adherence to systematic review reporting standards. Includes:

- Title (Item 1)

- Abstract (Item 2)
- Introduction (Items 3-4)
- Methods (Items 5-16)
- Results (Items 17-24)
- Discussion (Items 25-27)

Supplementary_S1_Search_Strategies.docx

Contents:

- Complete search strings for each database
- Boolean operators and search syntax
- Date ranges and filters applied
- Database-specific search strategies:
  - IEEE Xplore (1,524 initial records)
  - ACM Digital Library (891 initial records)
  - ScienceDirect (672 initial records)
  - SpringerLink (542 initial records)
  - Google Scholar (218 initial records)
- Citation chaining methodology
- Total initial records: 3,847 (3,142 after deduplication)

Supplementary_S2_Screening_Selection.pdf

Contents:

- Complete bibliography of 147 included papers
- PRISMA flow diagram documentation

- Inclusion/exclusion criteria at each stage
- Screening logs with decision rationales:
    - Initial screening: 3,142 records
    - Title/abstract screening: 353 full-text assessed
    - Final inclusion: 147 papers
- Exclusion reasons breakdown:
    - Not ERP-focused (1,247)
    - Gray literature (523)
    - Non-English (312)
    - Duplicate content (289)
    - Outside date range (214)
    - Not peer-reviewed (204)
    - Insufficient rigor (87)
    - Lack of contribution (54)
    - Inadequate evaluation (38)
    - Low-quality venue (27)

Supplementary_S3_Data_Extraction.pdf

Contents (43 pages):

- **Section 1:** Standardized data extraction template (50 fields across 10 forms)
    - Form A: Bibliographic Information
    - Form B: Research Classification
    - Form C: Methodology and Approach
    - Form D: Key Contributions and Findings
    - Form E: Performance Metrics and Results

    - Form F: Implementation Details
    - Form G: Limitations and Challenges
    - Form H: Future Work and Research Gaps
    - Form I: Quality Assessment
    - Form J: Additional Notes
- **Section 2:** Example completed extractions
    - Example 1: AI/ML Integration Paper (Sarferaz 2025)
    - Example 2: Security Paper (Yu et al. 2022)
    - Example 3: Cloud Architecture Paper (Alwis et al. 2025)
- **Section 3:** Data extraction summary statistics
    - Distribution by dimension, venue type, year
    - Research type distribution
    - Quality assessment distribution
- **Section 4:** Data extraction process notes
    - Timeline and phases
    - Inter-rater reliability (94% agreement)
    - Quality assurance measures

Supplementary_S4_Synthesis_Materials.pdf

Contents (32 pages):

- **Section 1:** Synthesis methodology overview
- **Section 2:** Dimensional synthesis tables
    - Table S4.1: AI/ML Integration (38 papers)
    - Table S4.2: Security and Anomaly Detection (29 papers)

    - Table S4.3: Cloud and Distributed Architectures (24 papers)
    - Table S4.4: Adoption and Implementation (18 papers)
    - Table S4.5: Industry 4.0 Integration (15 papers)
    - Table S4.6: SME Implementation (12 papers)
    - Table S4.7: Emerging Technologies (11 papers)
- **Section 3:** Quantitative meta-analysis
    - Table S4.8: Temporal publication trends (2020-2025)
    - Table S4.9: Geographic distribution analysis
    - Table S4.10: Venue analysis and impact
    - Table S4.11: Research method distribution
    - Table S4.12: Technology stack analysis
- **Section 4:** Comparative analysis matrices
    - Table S4.13: AI approach comparison matrix
    - Table S4.14: Security approach comparison matrix
    - Table S4.15: Cloud deployment comparison matrix
- **Section 5:** Gap analysis and future directions
    - Table S4.16: Research gap identification (15 critical gaps)
    - Table S4.17: Methodological quality summary
- **Section 6:** Synthesis validation and reliability
    - Inter-coder reliability (Cohen's Kappa = 0.89)
    - Data completeness analysis
    - Confidence level assessments
- **Section 7:** Supplementary calculations
    - Statistical tests performed

- Growth rate calculations
- Aggregation methods

🔬 Methodology

Search Strategy

Databases Searched:

- IEEE Xplore
- ACM Digital Library
- ScienceDirect
- SpringerLink
- Google Scholar

Primary Keywords: ERP, Enterprise Resource Planning, AI, Machine Learning, Security, Cloud Computing, Industry 4.0, Digital Transformation

Search Period: January 2020 – January 2026

Search Execution: January 5-28, 2026

Inclusion Criteria

1. Published between January 1, 2020 and January 31, 2026
2. Peer-reviewed (journals, conferences, workshops)
3. ERP systems as primary focus
4. Original research contributions
5. English language
6. Sufficient methodological rigor

Exclusion Criteria

1. Gray literature (technical reports, white papers)
2. Non-peer-reviewed publications
3. Publications outside date range
4. Non-English publications
5. Purely commercial or marketing materials
6. Insufficient methodological detail
7. Lack of original contribution

Quality Assessment

Each paper evaluated on:

- **Methodology Rigor:** Research design quality and appropriateness
- **Contribution Significance:** Novelty and impact of findings
- **Evaluation Comprehensiveness:** Thoroughness of evaluation and validation
- **Presentation Clarity:** Quality of writing and structure

Quality Scoring: 1-10 scale

- High Quality (8-10): 89 papers (61%)
- Medium Quality (6-7): 47 papers (32%)
- Lower Quality (4-5): 11 papers (7%)

Data Extraction Process

- **Phase 1 (Pilot):** 10 papers to refine template (Jan 5-7, 2026)
- **Phase 2 (Primary):** 137 papers extracted (Jan 8-25, 2026)

- **Phase 3 (Quality Check):** All extractions reviewed (Jan 26-28, 2026)
- **Phase 4 (Validation):** 20% re-extracted for consistency (Jan 29-30, 2026)

Inter-Rater Reliability:

- Cohen's Kappa: 0.89 (almost perfect agreement)
- Percentage Agreement: 94%
- Correlation: 0.92 (very strong)

📈 Key Statistics

Publication Venues

- **Top Venue:** IEEE Access (47 papers, 32%)
- **Journal Articles:** 98 papers (67%)
- **Conference Papers:** 47 papers (32%)
- **Workshop Papers:** 2 papers (1%)

Geographic Distribution

- **North America:** 62 papers (42%)
- **Europe:** 51 papers (35%)
- **Asia:** 26 papers (18%)
- **Other Regions:** 8 papers (5%)

Research Methods

- **Quantitative Analysis:** 78 papers (53%)
- **Prototype Development:** 52 papers (35%)

- **Experimental Study:** 45 papers (31%)
- **Mixed Methods:** 42 papers (29%)
- **Case Study:** 38 papers (26%)

Technology Stack

- **Python:** 72 papers (49%)
- **Java:** 38 papers (26%)
- **JavaScript:** 24 papers (16%)
- **TensorFlow/PyTorch:** 50 papers (34%)
- **Cloud Platforms (AWS/Azure/GCP):** 111 papers (76%)

🎯 Research Gaps Identified

Critical Gaps (High Priority)

1. **Federated Learning for Multi-Organization ERP**
2. **Explainable AI for Compliance Requirements**
3. **Zero Trust Architecture for Legacy Systems**
4. **Real-Time Anomaly Detection at Internet Scale**
5. **Adversarial Robustness of ML Models**
6. **Human-AI Collaboration Frameworks**
7. **Ethical AI Governance**
8. **Privacy-Utility Tradeoffs**

Medium Priority Gaps

9. Energy-Efficient AI
10. Multi-Modal AI Integration
11. Causal Reasoning
12. Transfer Learning Across Industries
13. Change Management for Autonomous Systems
14. Sustainability Metrics

Emerging Areas

15. Quantum Algorithms for ERP Optimization

📚 Citation

If you use these materials, please cite:

> [Author details to be added upon acceptance]
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> A Comprehensive Survey of AI Integration, Security Frameworks, and Emerging
> Paradigms (2020–2026)", Humanities and Social Sciences Communications, 2026.

📞 Contact

For questions regarding these supplementary materials, please contact:

- **Submission ID:** f2640a54-cd97-4216-8564-a2031a4bbacc
- **Journal:** Humanities and Social Sciences Communications

- **Support:** hsscomms@springernature.com

📋 Version History

- **v1.0 (January 31, 2026):** Initial release of all supplementary materials
  - PRISMA checklist completed
  - Search strategies documented (S1)
  - Screening and selection logs (S2)
  - Data extraction forms and examples (S3)
  - Synthesis tables and meta-analysis (S4)

📄 License

These supplementary materials are provided to support peer review and reproducibility of the systematic literature review. All underlying publications analyzed are subject to their respective publishers' copyright terms.

✅ PRISMA 2020 Compliance

This systematic review follows PRISMA 2020 guidelines:

- ✅ All 27 checklist items addressed
- ✅ Flow diagram included (Figure 1 in manuscript, detailed in S2)
- ✅ Complete search strategies documented (S1)
- ✅ Study selection process transparent (S2)

- ✅ Data extraction systematic (S3)
- ✅ Synthesis methods explicit (S4)
- ✅ Quality assessment rigorous (S3, S4)

🔐 Data Availability Statement

All materials necessary to verify the methodology and findings of this systematic review are publicly available in this repository:

1. **PRISMA Documentation:** Checklist and flow diagram
2. **Search Strategies:** Complete documentation for all databases (S1)
3. **Selection Process:** Screening logs and inclusion/exclusion decisions (S2)
4. **Data Extraction:** Standardized forms and extracted data (S3)
5. **Synthesis:** Complete analysis tables and calculations (S4)

The 147 publications analyzed in this review are publicly available through their respective publishers and digital libraries as cited in the manuscript references.

📊 Repository Statistics

- **Total Files:** 6
- **Total Pages of Documentation:** ~120 pages
- **Data Points Extracted:** 7,350+ (50 fields × 147 papers)
- **Tables Generated:** 17 major synthesis tables
- **Quality Assessments:** 147 papers evaluated
- **Repository Created:** January 31, 2026

- **Last Updated:** January 31, 2026

🙏 Acknowledgments

This systematic review was conducted following established guidelines:

- PRISMA 2020 (Page et al., 2021)
- Kitchenham & Charters (2007) guidelines for systematic literature reviews in software engineering

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