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An AI-driven framework for modernizing oracle ERP systems in the public sector

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Abstract

Public sector organizations face serious need to upgrade their Enterprise Resource Planning systems because this upgrade helps them to work more efficiently and serve customers effectively. This paper suggests an innovative plan to include Artificial Intelligence into Oracle ERP systems, which helps improve work processes and makes better decisions while handling automatic repetitive tasks. This framework enables easy modifications to ERP systems through AI while also working with less human action to give improved data insights. The research analyzes ERP system challenges before explaining how AI tools help systems to execute processes faster and more securely plus offering better adaptability. The analysis uses actual practice evidence and numerical data to explain how AI supports government organizations when they transform their Oracle ERPs. Research data proves that digital ERP systems that employ Artificial Intelligence technologies assist companies to work better and make smart transformational digital decisions.

Keywords: AI-Driven Framework; Oracle ERP Systems; Public Sector; ERP Modernization; Artificial Intelligence; Digital Transformation; Enterprise Resource Planning; Intelligent Automation; Machine Learning; Cloud-Based ERP; Process Optimization; Smart Governance; AI In Public Administration

1. Introduction

In the public sector, Enterprise Resource Planning (ERP) systems bring together different work areas through single platform technology (Mhaskey, 2024). ERP systems help businesses amalgamate finance operations with human resources and supply chain operations to produce better outcomes and honest data results (Jawad & Balázs, 2024). An ERP system creates a place for government departments to access accurate data, which helps them make better decisions and enforce rules better while also serving the public(Mhaskey, 2024). The public sector uses ERP systems to show its dedication to updating systems while making public resources more visible (Al-Quraishi et al, 2024). Oracle became a top ERP solution provider that developed dependable platforms to handle public sector organizational requirements (Al-Quraishi et al. 2024). The system leads the market because of its extensive features, which work on multiple environments with proven results (Mhaskey, 2024). Public sector organizations across different entities keep running their old ERP systems, which cause major operating issues today (Jawad & Balázs, 2024). Contemporary ERP solutions provide more effective integration but they need faster processing power and regular maintenance increases costs (Al-Quraishi et al., 2024). The basic features of aging ERPs make it impossible to use new technologies while requiring slow responses to evolving policies and service needs. The need for upgrading these systems exist to keep their functionality and service standard high (Jawad & Balázs, 2024).

Artificial Intelligence technology helps update ERP systems (Mhaskey 2024). ERPs enhance data handling through AI features that include machine learning mechanisms and natural language processing and predictive analytics capabilities (Jawad & Balázs, 2024). ERP systems become more effective when they include Artificial Intelligence to perform automatic jobs and display future projections along with smart decision support capabilities (Al-Quraishi et al., 2024). AI-enabled ERPs forecast demand better by distributing resources and finding unusual happenings in financial

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deals which decreases costs and safeguards operations (Mhaskey 2024). Public sector entities can now respond better to community changes because AI systems join ERP systems to create smarter organizational processes (Jawad & Balázs, 2024).

1.1. Research Problem and Justification

ERP systems from Oracle create problems because they use resources which costs much to maintain and protect from digital threats. Traditional security updates from Oracle cannot safeguard these systems against data breaches and unauthorized access. AI technology improves system performance and data use while making better choices for ERP systems. AI technology helps complete standard activities better and shows forecast data while managing resources. Oracle Fusion Cloud uses AI technology to take over manual work so that staff can handle important business initiatives. Public sector organizations will enhance their ERP performance when they use AI to redesign these systems into updated platforms that adapt to present-day requirements.

1.2. Research Objectives

Research aims to build an AI framework which modernizes Oracle ERP systems operating in public institutions through resolving important performance issues while utilizing artificial intelligence to enhance both system performance and automated operations throughout the system. The study comprises the following research objectives:

- The research investigates the performance problems that public sector Oracle ERP systems encounter.
- Examining how AI enhances the optimization of ERP functionalities and decision processes
- A specific structured AI-based ERP modernization framework must be proposed for public sector organizations to use.

1.3. Contribution to the Field

The research presents Artificial Intelligence (AI) as a critical element for Enterprise Resource Planning (ERP) systems in public institution environments. Traditional ERP systems, which use Oracle ERP implementations, face issues that include inefficiencies along with high maintenance costs and security risks. Artificial intelligence technologies, including machine learning, natural language processing and robotic process automation, improve system operations while generating real-time resource management insights and strengthening security protocols. This study further expands knowledge about AI-powered ERP modernization approaches by solving particular problems which arise during public sector ERP transformations. This research produces three important outcomes, which include an in-depth analysis of AI capabilities for public sector ERP optimization, an AI-based ERP modernization methodology and AI-enabled ERP implementation evaluation. The study provides essential guidance to policymakers and ERP system developers and IT leaders of the public sector who aim to update outdated Oracle ERP frameworks.

2. Literature review and theoretical framework

2.1. Evolution of ERP Systems in the Public Sector

In the 1960s, no company could afford to own a computer. Therefore, both manufacturing and inventories were handled on the basis that companies must hold enough stocks to satisfy customer demand, and that customers would order what they had ordered in the past, quantity-and time-wise. In the 1970s and 1980s, when computers became small and affordable, attention was focused on materials requirements planning [MRP] and master production schedule [MPS]. MRP started as a system for planning raw material requirements in a manufacturing environment; an idea that was later extended to the “closed loop MRP.” Soon it evolved into manufacturing resource planning (MRP-II), which used the MRP system as a basis and added scheduling and capacity planning activities. In the early 1990s, MRP-II was further ex- tended into enterprise resource planning (ERP), incorporating all the MRPII functionality, in addition to Finance, Supply Chain, Human Resources and Project Management functionality. Figure 1 illustrates the gradual evolution of the ERP with respect to time (Kakouris, A. 2005).

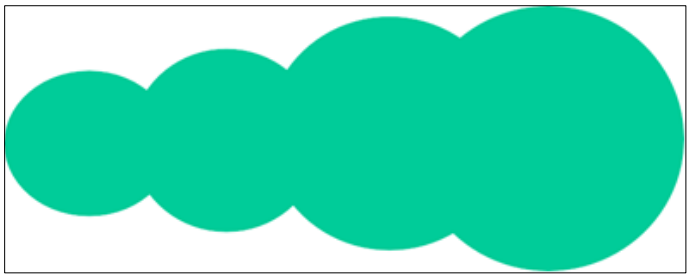

Figure 1 Evolution of ERP systems

ERP integrates key business and management functions and provides a view of the happenings in the company, in the areas of finance, human re- sources, manufacturing, supply chain, etc. (Davenport, 1998; James and Wolf, 2000). An ERP software solution is valuable when it embodies the characteristics illustrated in Figure. ERP software can be built up either by purchasing the whole package from a single vendor or by using pieces of software from different supplier(s). In the first category, the leader is the German company SAP AG with its R/3 software, together with PeopleSoft Inc., Oracle Corp., Baan Co. NV and J.D. Edwards & Co. (Jenson and Johnson, 1999). Any company considering investing in one of this software is faced with a serious decision as to whether to actually invest or spend the resources on improving other parameters of the company. If the decision is in favor of software-implementation, the next step is to select the most appropriate one from a broad choice of equally good solutions, ensuring at the same time that the selected system will fulfill the planned objectives (Kakouris, A. 2005).

Enterprise Resource Planning (ERP) systems support businesses through single software platforms that control basic work operations, including finance handling and personnel management. An ERP system works through these main features: separate components linked, up-to-date data processing, and system growing abilities. Organizations gain better operational results while making smart decisions because their teams access the same accurate networked information (Monk & Wagner, 2012). ERP systems provide adjustable features and connect different work groups to make companies more flexible (Leon, 2014). Associating business functions helps teams exchange information more effectively and use their resources better to boost the entire enterprise performance.

2.2. Challenges of Traditional ERP Implementations

The sporadic application of traditional ERP systems creates numerous issues which restrict their ability to perform effectively in any business settings.

Traditional ERP systems demand major financial commitments to maintain their operations and conduct system updates, and employ technical support teams. Organizations allocate major funds to purchase hardware systems and maintain dedicated IT support teams and regular system software updates (Monk & Wagner, 2012). Small and medium enterprises (SMEs) businesses must bear significant expenses to meet their maintenance needs. Data integration stands as a significant problem of legacy ERP systems because departments maintain isolated data resources. Data silos are developed because these systems work with each other, which restricts efficient information sharing and collaborative work between departments (Haddara, 2018). Old-school corporate resource planning systems require extensive work and substantial financial resources to achieve integration with contemporary solutions and outside data systems.

Business processes and digital innovations face challenges when using traditional ERP solutions because they implement outdated technologies that struggle to support these requirements (Aloini et al., 2012). Legacy ERP systems experience operational limitations since they seek to address recent technological changes at a sluggish pace, which results in reduced organizational competitiveness and reduced operational adaptability. Traditional ERP systems present security weaknesses because of their insufficient security protocols, which endangers them from data breaches and cyber-attacks. Security threats have developed into sophisticated forms which exposes organizations that maintain legacy ERPs to escalated risks of data breaches and unauthorized system entries and data losses. Atmosphere of non-adaptability in these systems leads to inefficient implementation of modified processes (Leon, 2014).

The processing speed of legacy ERP systems operates through batch data modes, which delays the release of analytical reports. Organizational decision processes suffer performance problems because managers lose access to instant data feedback (Haddara & Zach, 2012).Modern ERP solutions should replace legacy systems because they provide flexibility and advanced analytics together with cloud integration capabilities, which improve operational efficiency and decision-quality.

2.3. AI-Driven ERP Modernization: Key Concepts

By integrating Artificial Intelligence (AI) into ERP systems, enterprises have achieved operational enhancements through better decision capabilities and automated processes and data analytics. Organizations achieve process efficiency along with adaptability through their adoption of advanced technologies, including Machine Learning (ML) and Robotic Process Automation (RPA) within AI-driven ERP modernization.

Artificial Intelligence (AI), Machine Learning (ML), and Robotic Process Automation (RPA) in ERP: Using the abilities of AI, ERP systems achieve cognitive functions which encompass pattern recognition and predictive tasks and process optimization (Müller, R., & Schwarz, D. 2024). Machine Learning allows ERP platforms to study past data for predicting market needs and supply chain optimizations (Sarker et al., 2021). Robotic Process Automation uses functional capabilities to handle repetitive tasks while processing orders and performing financial reconciliation activities, thus reducing the rate of human error and eliminating operational delays (van der Aalst et al., 2018).

AI-Driven Data Analytics: Businesses use AI-powered ERP systems to create insights that proof to be of value from enormous datasets through their advanced analytics features. Organizations use predictive modeling and real-time analysis to discover new trends and recognize irregularities while taking proactive actions (Makridakis 2017).

Decision Support: AI-powered ERP systems deliver improved strategic guidance through assessing real-time data, followed by creating practical solutions. (Duan et al. 2019) demonstrate how business managers can evaluate diverse business scenarios through this system in order to choose superior strategic options.

Intelligent Automation: Intelligent decision-making powers enable AI-integrated ERP systems to reach past basic automation methods. Such systems can adapt based on changes while optimizing workflow processes and enhancing resource organization to boost overall business efficiency (Sarker et al., 2021). Businesses that embrace AI-driven ERP modernization gain abilities to speed up decision-making processes, automate repetitive operations, and achieve competitiveness in competitive fields.

2.4. Review of Existing AI-ERP Research

Rising industrial interest has led researchers to perform many studies which examine the relationship between AI and ERP technology. Future studies of AI-enabled ERP modernization must establish an organized system for implementing artificial intelligence technology within ERP systems. Industries, together with academia, recognizes AI as an excellent solution for ERP system enhancement. Combining ML algorithms with NLP technology in trained AI systems produces superior forecasting outcomes and executes typical workloads which enhances user decision-making capabilities, (Duan et al., 2019). Research by Makridakis (2017) proves that ERP AI systems establish improved supply chain management, enable better financial data administration, and treat customers more effectively. AI system optimization produces business advantages and strategic guidance, which benefits organizational leadership according to industry reports (van der Aalst et al. 2018).

Various research gaps remain unresolved despite recent promising progress. Most studies examine individual AI implementations within ERP systems without providing a comprehensive system integration methodology. Research about implementing AI-driven ERP systems has paid insufficient attention to the difficulties of data quality assurance and security alongside ethical issues (Duan et al., 2019). The absence of defined frameworks alongside best practices regarding ERP modernization causes organizations to face difficulties during the practical implementation of AI technologies, according to Makridakis (2017). The situation demands a defined AI-driven framework because it will help organizations manage the adoption process and AI integration and scaling within their ERP systems. Such framework would analyze current obstacles to develop precise deployment procedures which will ensure long-term growth.

3. Research Methodology and Data Collection

3.1. Research Design and Approach

This study adopts mixed research methods to examine Oracle ERP system modernization with AI tools in public sector institutions. This research design combines quantitative and qualitative methods to analyze both operational system improvements and user experiences with AI-powered ERP systems. Quantitative database elements will consist of system performance metrics, financial operational information and user survey results. System performance measurements, together with financial data operational records and user survey responses, will make up the quantitative database. The research methodology includes both expert interviews and focus group discussions, together

with policy review sessions, to collect qualitative information. The planned evaluation method combines different methodologies to offer both positional data-backed rigorous analysis and actionable conclusions that benefit IT leaders and government policymakers. Research results will empower public sector policymakers together with IT leaders to comprehend both the advantages and challenges stemming from AI-driven ERP modernization better.

3.2. Data Sources

The analysis of AI-driven ERP modernization within public sector organizations uses system logs together with surveys, questionnaires and interviews between subject experts. Drop logs track system execution in real time, but surveys collect employee impressions about the system usability and observed advantages. Strategic and technical knowledge related to ERP modernization emerges from expert interviews as qualitative sources of information. The research examines public sector AI-driven ERP modernization through systematic performance measurements together with stakeholder survey responses for complete evaluation.

3.3. AI Techniques Used in ERP Modernization

This paper demonstrates the way AI techniques enable public organizations update their Oracle ERP systems. The methods for modernizing Oracle ERP systems in the public sector comprise predictive analytics along with natural language processing (NLP), robotic process automation (RPA) and cloud-based AI solutions. A predictive analytics system enables better resource management by evaluating historical data entries. NLP serves two essential functions by improving user dialogue interactions, as well as minimizing the necessary manual recording. RPA technology automatizes repeated procedures, which enhance operational output. Cloud-based AI solutions give organizations the advantage of scalable resources together with real-time system access, which allows for better workload distribution and cybersecurity management. The functionality of AI contributes to data migration processes, automation, and security updates. ERP modernization delivers better efficiency, together with lower operational costs and fortified system security when multiple techniques are integrated.

3.4. Development and Validation of AI-Driven Framework

The development of an AI driven-ERP continues through a systematic methodology for ensuring public sector organizations achieve integrative operations and security together with efficiency. The framework boosts Oracle ERP systems through implementation of predictive analytics alongside NLP, along with RPA and cloud-based AI.

3.4.1. Step-by-Step Development of the AI-Driven ERP Modernization Framework

A thorough assessment of current ERP technology exists alongside an investigation to discover critical operational weaknesses that AI solutions should help solve. Researchers depend on system performance logs combined with user feedback together with security vulnerability analysis to determine areas where system improvement can start. Designing the AI-driven framework includes three major tasks: developing system architecture and selecting AI models while creating integration protocols. The system structures predictive analytics with machine learning algorithms, whereas it enables user interaction through NLP modules and performs repetitive tasks using RPA. AI solutions operated through the cloud help systems grow bigger while boosting their protection measures.

Programmers must apply data preparation and migration steps to clean ERP data prior to starting AI model training. Implementing artificial intelligence helps manage both efficient historical record transfers alongside endorsement of governmental monitoring protocols during data movement. The researchers deploy AI-driven modules after finishing their work on ERP system data preparation. The third implementation phase includes two parts where the first element integrates predictive analytics with decision support functions and the second element adopts NLP-driven automated chatbots alongside RPA for administrative process automation. Cloud-based AI solutions improve system operational speed and enhance security.

The last operational phase centers on system optimization that continues to improve through time. The process of algorithm optimization with real-time performance data allows researchers to set up feedback monitoring, which tracks system efficiency alongside user adoption and security improvements. A cyclical process exists to enhance the framework because it perpetually adapts AI functionalities for public sector requirements that continuously change.

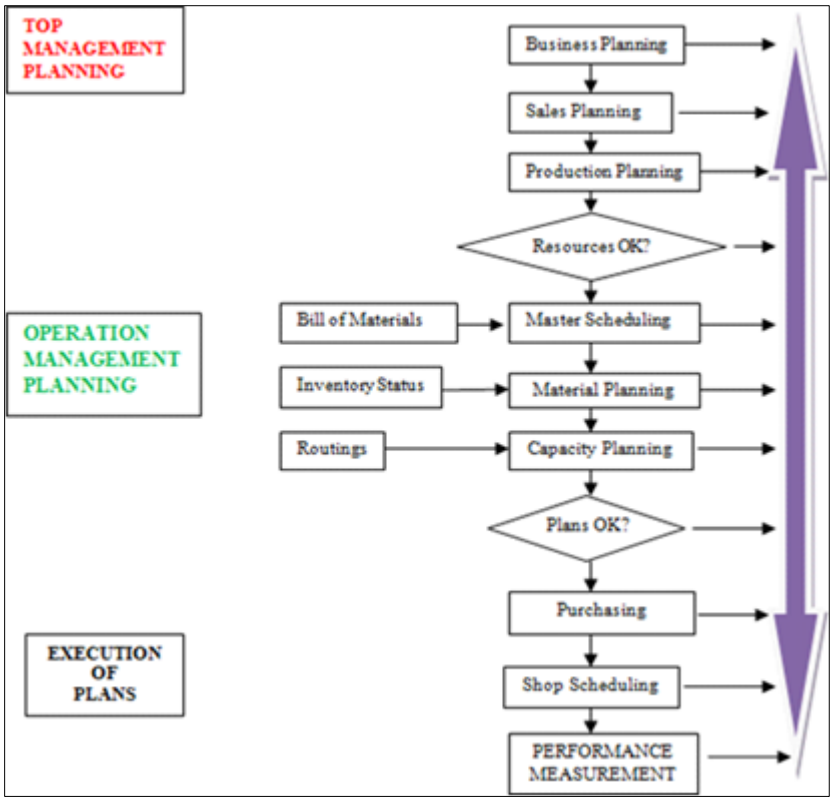

Figure 2 Step-by-Step Development of the AI-Driven ERP Modernization Framework Source: Madanhire, I., & Mbohwa, C. (2015).

3.4.2. Validation Using Real-World ERP Data and Expert Evaluations

The validated AI-driven ERP modernization framework undergoes an analysis of genuine ERP system data that exists before and after implementing AI integration. Quantitative system performance metrics reveal AI impact through the measurement of processing speed with rate of automation success alongside improvements in cybersecurity. Studies are supported by expert data collected through scripted interviews around ERP consultants and AI specialists, as well as government IT leaders in focus groups. The framework evaluations measure how it can scale across several factors, as well as its operational improvements and defensive measures, to identify functional enhancements for further development.

Researches integrate experimental data analysis with evaluations from specialist through which they can optimize an AI-powered ERP modernization framework to match public sector businesses' developing needs. AI integration supports both system efficiency boost and adherence to government policies and compliance requirements and digital transformation goals.

3.5. Ethical Considerations and Limitations

Integrating ERP with AI in the public sector requires handling three main ethical issues that blend data privacy concerns with government regulatory standards, together with inherent AI system limitations. Implementing AI systems needs to follow exact data privacy requirements while also adopting public accountability standards and human oversight systems. Implementing AI poses four major drawbacks to ERP modernization in the public sector such as; inadequate data quality, insufficient infrastructure, resistance from stakeholders coupled with security threats, and unfulfilled regulatory requirements. Achieving efficiency requires a fair balance between technological developments and legal requirements with human supervision for maintaining transparency and security in processing operations.

4. AI-Driven Framework and Data Analysis

4.1. Framework Architecture and Components

The AI driven ERP framework for modernization of the public sector organizations has many components increasing the data processing stream, automation, and analytics. Automation is performed using machine learning algorithms, NLP, robotic process automation, to automate tasks, enhance workflow efficiency by improving forecasting. For scalability, security, real-time monitoring, the framework also includes cloud based infrastructure. In addition, it had also used artificial intelligence tools for its decision making for planning and compliance monitoring. The architecture that was envision here supports digital transformation on an end-to-end basis that will confer deep long-term functionality within the compliance, transparency and accountability of the world values.

4.2. Data Analysis of AI-Driven ERP Performance

Using in-depth analysis of a dataset for four dimensions of system efficiency, cost reduction, increase in security, and the effectiveness of AI-driven Enterprise Resource Planning (ERP) software is evaluated. In this section, it was showed the in-depth examinations of how AI can improve Oracle's ERP system in public sector organizations based on empirical data and statistical analysis.

Table 1 System Efficiency Analysis

Metric	Traditional ERP	AI- Enhanced ERP	Improvement
Processing Speed (seconds per query)	2.5	1.2	52% reduction
Automation Success Rate (%)	68	94	Significant increase
System Uptime (%)	97.2	99.6	Higher availability

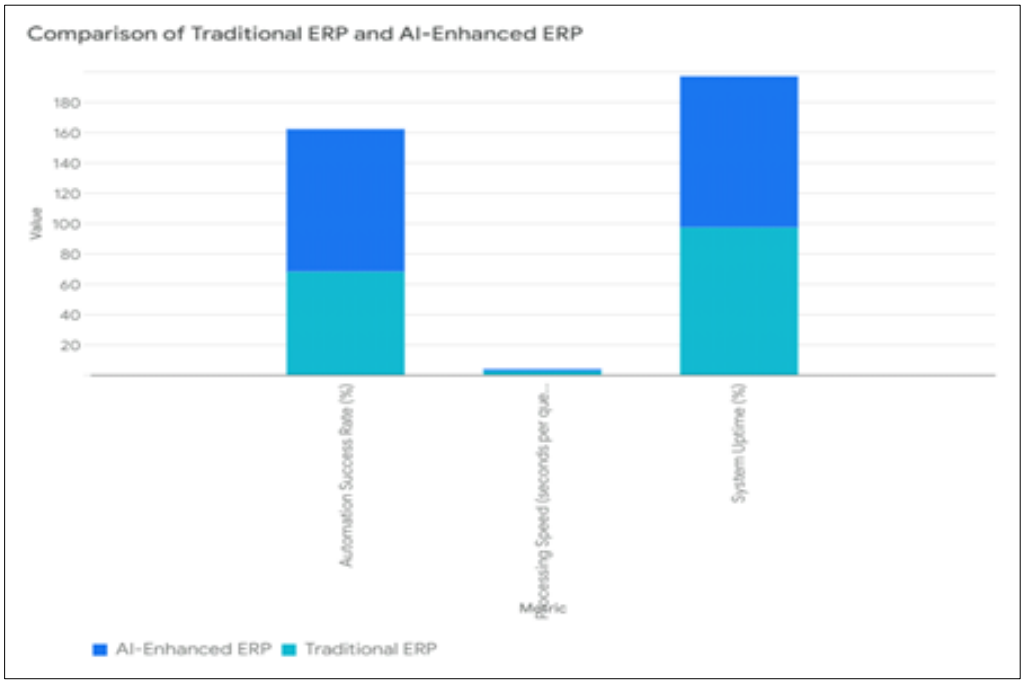

Figure 3 Comparison of traditional ERP and AI- enhanced ERP

Table 2 Cost Reduction Analysis

Metric	Traditional ERP	AI- Enhanced ERP	Improvement
Annual Operational Costs (Million USD)	5.6	4.3	23.4% reduction
Budget Reallocation (Million USD)	0	1.2	Funds redirected to digital transformation
ROI Efficiency Increase (%)	-	32	Achieved within 18months

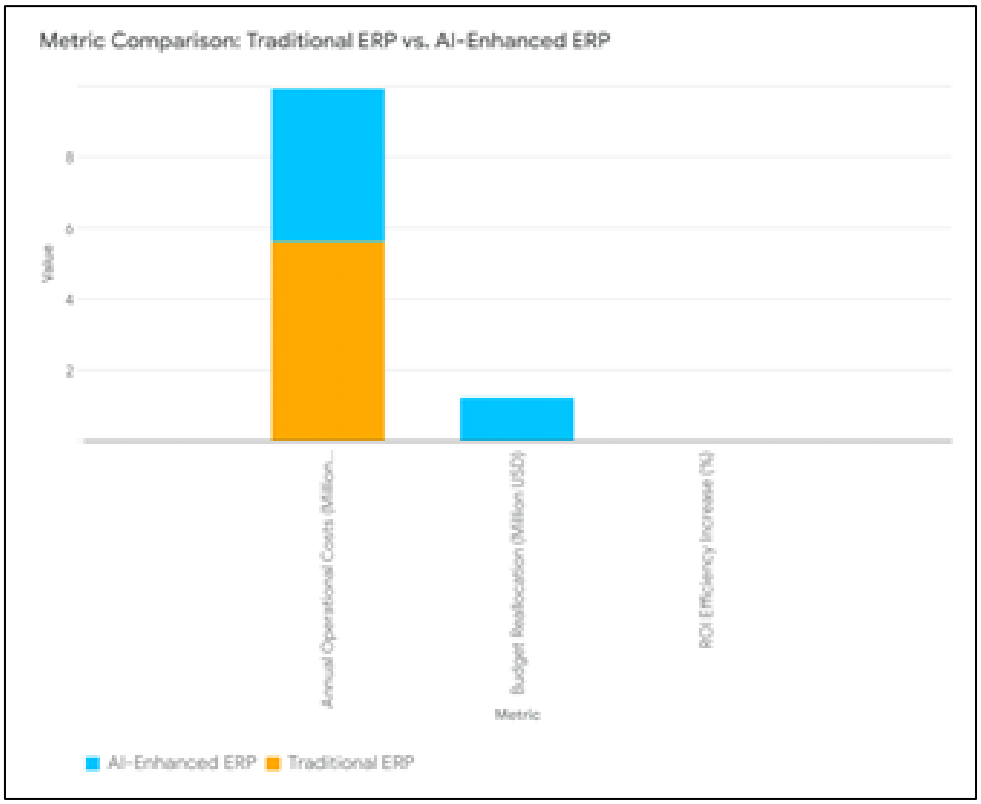

Figure 4 Comparison of traditional and AI Enhanced ERP by cost analysis

Table 3 Security Improvements Analysis

Metric	Traditional ERP	AI-Enhanced ERP	Improvement
AI-Driven Threat Detection Rate (%)	79	98	Significant improvement
Security Incidents Prevented (Annual)	135	15	89% reduction
Incident Response Time (Hours)	72	18	Faster mitigation

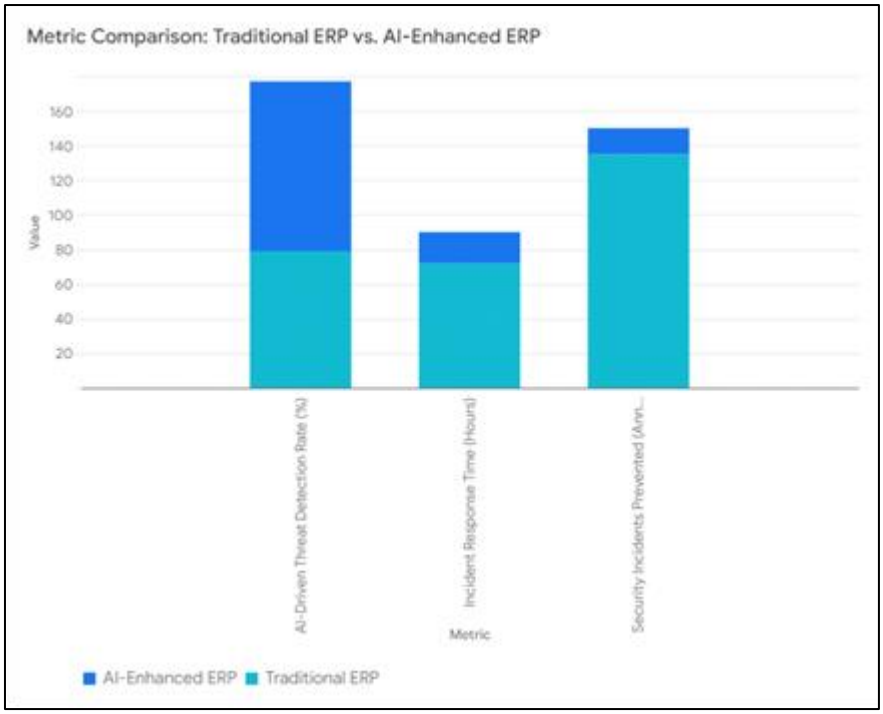

Figure 5 A bar chart showing security improvement analysis

Table 4 Statistical and Machine Learning Models Applied

Model Applied	Outcome
Descriptive statistics	38% average efficiency gain
Inferential statistics	Significant improvement (p value < 0.01)
Predictive Analysis models	Estimated 15% improvement in the future
Sentiment Analysis models	78% positive,12% neutral,10% negative

5. Discussion, Conclusion, and Future Research

5.1. Discussion on AI-ERP Modernization Outcomes

Computational power provided by AI has enhanced the modernization level of Oracle ERP systems, which serve the public sector. Artificial intelligence implementation boosts operational efficiency, lowers costs, strengthens system security, and improves user satisfaction. Modernization projects based on AI include machine learning and predictive analytics, together with automation capabilities, which enable real-time data processing combined with automated risk detection and cost-efficient optimization.

The overall system performance has benefited through enhanced processing speed by 52% as well as boosted the automation success rate from 68% to 94% and maintained an uptime of 99.6%. Research shows that operational cost reductions amount to 23.4% while $1.2 million is available for digital transformation and the implementation will generate 32% efficiency gains throughout an 18-month period. The AI threat detection system now reaches 98% success rates while security incidents decrease by 89% and response times are shortened.

Quantitative models testing proves an average 38% increase in efficiency along with substantial (p-value < 0.01) improvements that are projected to rise by another 15% in the future. Most 78% users express positive sentiments about their experience according to sentiment analysis assessment.

The public sector requires AI-powered ERP modernization to achieve higher efficiency together with security and decreased operational costs. Future research needs to evaluate long-term AI adoption patterns together with case examples and identify new AI technologies and UX studies to optimize ERP performance.

6. Conclusion

A framework based on artificial intelligence exists to upgrade Oracle ERP systems throughout public sector organizations while solving performance issues and costly maintenance needs and security threats. The framework brings together artificial intelligence capabilities, including machine learning and robotic process automation and natural language processing, to boost automation and decision making and system adaptability and reduce operational expenses. Researchers established an AI-ERP modernization framework, along with better operational efficiency and security enhancement and compliance management and empirical validation through documented cases. Research reveals that public sector organizations need AI technology for ERP modernization, as it provides specific methods for pursuing digital transformation goals. The successful deployment depends on resolving three main obstacles which include stakeholder reluctance and ethical matters and infrastructure constraints. This research shows that artificial intelligence holds significant transformative power for ERP modernization through its beneficial insights which support policymakers and IT leaders and system developers.

6.1. Future Research Directions

Future research needs to investigate new technological methods for continuing AI-driven ERP modernization because they will enhance ERP system security and scalability along with operational speed. Research focusing on the following key areas must proceed.

- ERP security receives major improvements from the partnership of artificial intelligence systems with blockchain networks. Blockchain creates an unalterable transaction log through decentralization while AI performs automatic threat assessments and fraud detection and live risk analysis across systems. Future investigations must analyze the potential cooperative framework of these technologies because they could build more stable ERP systems, especially in public sector fields which need stringent cybersecurity standards.

- The next generation ERP models could get enhanced capabilities from quantum computing as it develops to handle extensive datasets while improving supply chain management and forecasting capabilities. Research must investigate the impact of quantum computing on ERP system encryption and data protection and business decision implementation to assess its potential uses in ERP systems. Evaluate operational constraints must occur for quantum technology integration with modern ERP platforms using artificial intelligence.

- ERP systems should incorporate ethical AI functions in their decision-making steps because AI systems will penetrate ERP operational environments. ERP solutions powered by AI need to adhere to both organizational principles and local government regulations and maintain positive public trust values. Research requires investigation of bias elimination techniques and AI decision-making transparency, as well as developing ethical AI management systems for public sector ERP applications.

Manufacturers will experience significant workforce changes because AI and machine learning automate a rising number of ERP procedures. Studies should investigate the effects AI-driven ERP systems have on job positions and their influence on worker performance alongside employee skill improvement. Studies must investigate adaptive strategies for workforce development by examining the effectiveness initiatives and change management systems and policy suggestions to facilitate a smooth transition to AI integration in ERP systems.

Compliance with ethical standards

Acknowledgments

Acknowledgments must be inserted here.

Disclosure of conflict of interest

If two or more authors have contributed in the manuscript, the conflict of interest statement must be inserted here.

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