

# An Analysis of Machine Learning-Based Decision Support Systems for Enterprise Resource Planning

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**Abstract:** The ERP systems have become part and parcel of effective operations of organizations through integration of business processes in different parts of the organizations like finance, supply chain and human resource. However, rising due to the complexity of the business, the long-established ERP systems have limited ability to help in terms of offering actionable insights, which make it possible to utilize in strategic decision-making. Machine learning (ML) is an explosive technology that has changed ERP systems and improved their performance to assist in decision-making. The paper under review gives a detailed overview of the role of machine learning methods in the ERP systems and their impact on making strategic decisions with specific reference to the integration of machine learning methods in the ERP systems. This paper discusses most used ML algorithms: classification, regression, clustering and reinforcement learning, and their use in the optimization of ERP including demand forecasting, inventory management, financial planning, and customer relationship management (CRM). By using ML in ERP systems, it is possible to be able to ensure that the predictability can be done, in the context of the point of anomaly discovery, along with the possibility of providing real-time support of decision-making, which can result in the operational efficiency of enhanced operations as well as the realization of cost savings, and even improved eventual resource allocation. Also discussed in the review is the difficulties associated with the utilization of ML-based decision support systems in ERP such as quality of data, compatibility between systems, and experts. Lastly, the paper discusses future trends and how the capabilities of deep learning and AI-based ERP system will affect the businesses willing to use advanced systems to make better decisions.

**Keywords:** Machine Learning, DSS, Enterprise resource planning, ERP, Strategic decision-making.

## Introduction

A contemporary business world is distinguished by a flurry of information, generated by a variety of different sources, including Enterprise Resource Planning systems, point-of-sale interactions, or the use of IoT sensors (Pasupuleti et al., 2024). Enterprise Resource Planning systems play a significant role today as they bring the integration of the key business operations in different functional areas, such as finance, supply chain management, human resources, and production control (Tavana et al., 2020). Although these ERP systems had been optimized in terms of data management and streamlining of operations, they have significantly lacked the power to bring improvement in strategic decisions (Gupta & Kohli, 2004). This limitation is due to the historical basis of the ERP system to perform mainly data reporting and transaction processing, which in itself has a limitation of providing foretelling capabilities or the support of decision-making in the present (Emam & Hassan, 2021). To resolve this shortcoming, it is proposed to supplement the ERP systems with superior analytical tools and, therefore, equip the organizations with the ability to make informed decisions based on the data.

Applying machine learning algorithms to ERP systems plays the role of a paradigm shift because in this way, ERP systems can utilize large data repositories, identify trends and historical patterns, and make predictions that can be used to make better decisions (Khedr & S, 2024). Machine learning enables ERP systems to predict future changes in demand, optimise inventory management tactics, detect the presence of anomalies on the financial transaction that are the signs of fraud or inefficiencies, and offer customised recommendations on resource allocation (Sinha & Dhanalakshmi, 2021). The adoption of machine learning in ERP systems enables a descriptive, predictive, and prescriptive analysis, which can reveal a detailed picture and emerging information in huge quantities of electronic data (Nurkasanah, 2021).

## Study background

Although Enterprise Resource Planning systems are now needed by organizations so that they can effectively streamline their operations and unify all business functionalities, their conventional architectures tend to be ineffective in supporting the immediate needs of enterprises to make highly sophisticated decision-making processes in the increasingly changing contemporary business environment (Emam & Hassan, 2021). The main functions of traditional ERP systems are transaction and record dealing that means they cannot provide real-time data-driven insights that need to be used in making strategic decisions. The fact that machine learning is integrated into the ERP system is also a huge breakthrough as it will allow making a prediction using it and enables improved decision making of the ERP systems (Pasupuleti et al., 2024). The machine learning algorithms may then process massive historical and real-time data sets in order to determine trends, predict future behaviors and to automate the processes in the operation and thus enhance the decision-making capacity of the ERP systems (Pasupuleti et al., 2024). Through the application of machine learning, all the organizations can convert their existing ERP systems to intelligent decision support systems rather than simple transactional systems; the latter offer

competitive advantages and even survival in the rapidly changing markets (Gupta & Kohli, 2004). Machine learning enables predictive analytics when it is integrated into the ERP system as it allows organizations to predict the trends, streamline the operations, and improve the decision-making processes (Pasupuleti et al., 2024).

**Justification**

The importance of a better decision support of the ERP systems in the current business environment can be witnessed by the fact that businesses are under constant cost-cutting, efficiency enhancement and need to respond to changes in the market scenario. Conventional ERP systems usually lack the ability to give the analytical functions necessary to accomplish these. The gap is filled out by machine learning that allows ERP systems to do not just automatize the processes but also make data-driven predictions and offer actionable insights to be used in strategy-based decision-making.

The machine learning can be brought to ERP systems to automate the complex decision-making process and, in turn, make more accurate and timely decisions, thus demand forecasting, risk assessment, or resource optimization. This makes the ERP systems more strategic in nature so that the systems are no longer just mere means of running operations but also very important elements of strategy formulation and development. This means that incorporating machine learning into the ERP systems is crucial in case the organization is interested in enhancing their decision-making processes and gaining competitive advantage.

**Study Objectives**

- To discuss the importance of machine learning found in improving decision support systems in ERP systems.
- To reexamine the kinds of machine learning algorithms which can be used in ERP systems and how they will influence decision making.
- To define the most important areas within ERP in which machine learning will be able to provide maximum values.
- To consider the challenges and shortcomings of the implementation of machine learning in ERP systems.
- To examine the upcoming trends in machine learning and their possible influence on the ERP systems.

**Table 1: Machine Learning Techniques in ERP Systems and Their Applications**

ML Technique	Application Area	Description and Benefits
Classification	Customer Relationship Management (CRM)	Used to segment customers, predict customer churn, and enhance service offerings.
Regression	Financial Forecasting	Predicts financial trends, cash flow, and revenue generation for more accurate budgeting and planning.
Clustering	Inventory Management	Groups similar items together to optimize stock levels, reducing overstock and stockouts.
Neural Networks	Demand Forecasting	Used for predicting future demand based on historical data, optimizing production and inventory levels.
Reinforcement Learning	Resource Allocation, Scheduling	Optimizes the allocation of resources across various tasks and departments, improving overall operational efficiency.

**Literature Review**

The introduction of machine learning in Enterprise Resource Planning systems is transforming the way enterprises manage their resources and streamline their operations and make data-informed decisions (Costa et al., 2020). Machine learning algorithms are also slowly finding their way to supplement a whole range of functionalities in ERP and offer predictive analytics, automation, and intelligent decision-making support (Tirkolaei et al., 2021). The continuous digital transformation of corporate operations has resulted in large scale of both structured and unstructured data, opening up further opportunities to get further insights (Pasupuleti et al., 2024). This data can be processed through machine learning methods to reveal trends, patterns, and anomalies that could not be noticed otherwise, leading to more accurate forecasting, inventory management, financial planning, and resources removal (Aamer et al., 2020). Machine learning can be used to derive information of greater value out of the data used by the machine, and its use is thus not limited to research and niche applications (“Introduction to Machine Learning,” 2019). Machine learning makes better decisions based on knowledge derived out of sensor information, especially in situations where the surrounding environment conditions keep changing (Sinha & Dhanalakshmi, 2021). The use of machine learning in forecasting also has a significant effect on the demand forecasting which allows businesses to shift towards proactive supply chain management rather than the reactive supply chain. Time

series forecasting and regression models analyse the past sales information, market trend and external factors etc, and predict the future demand with high level of accuracy (Khedr & S, 2024).

### Material and Methodology

The proposed research takes the systematic review methodology to study the given nature of ERP systems and integrating machine learning. Lit-based review will be carried out regarding the peer-reviewed research articles, conference papers and industry reports in the last five years. In this paper, the author examines various machine learning techniques that can be used in the ERP systems in terms of area of application, the benefits, and limitations involved.

The literature room-offers works that have been looked into under the following aspects:

- ML and Demand Forecasting and Supply Chain Management
- ML on frauds and finance planning
- Project Management and Resources Allocation ML
- Instructions of using ML as part of ERP System Difficulties and Restrictions of incorporating ML into ERP System

### Discussion and Results

The main advantages of using machine learning within the ERP systems include that it provides benefits to the aspect of increasing business operations and decision-making process. The significant results are:

- Demand Forecasting-Machine learning models in demand forecasting are more accurate and therefore assist the organization to plan its manufacturing and inventory to meet the market requirements.
- Inventory management: ML can also be utilized in inventory control system with the objective of reducing the frequency of human location and optimization of stock solution in a real time system.
- Financial Planning: On the ERP systems, the ML algorithms can help organizations to determine the trends, anomalies and provide fine-tuning on cash flow management.
- Resource Allocation: Reinforcement learning methods of machine learning assist in allocation of resources to the projects and this has seen efficient and effective utilization of the resources.

However, the challenges exist in the form of the data quality, the complexity of ML models, and integration of ML with the existing ERP infrastructure in spite of the mentioned advancements.

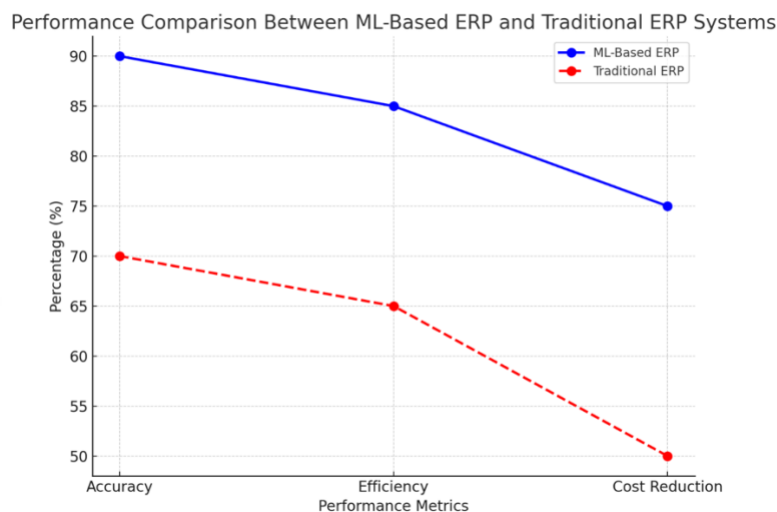
Lab Noise. Temporal resolutions: the threshold of how many of such resolutions one needs in a study depends on the minimum acceptable change.

**Table 2: Challenges and Solutions in Implementing Machine Learning in ERP Systems**

Challenge	Description	Proposed Solution
<b>Data Quality and Availability</b>	Inconsistent or incomplete data can affect ML model accuracy	Implement robust data cleaning and validation techniques to ensure high-quality data
<b>System Integration</b>	Difficulty in integrating ML models with existing ERP infrastructure	Use middleware and standardized communication protocols for easier integration
<b>Interpretability of ML Models</b>	Difficulty in understanding the decision-making process of complex ML algorithms	Use explainable AI techniques to increase transparency and trust in the system
<b>High Initial Cost</b>	High costs of deploying ML-enhanced ERP systems, particularly for small businesses	Start with pilot programs and scale the solution as ROI becomes evident
<b>Lack of Skilled Personnel</b>	Shortage of employees skilled in both ERP and data science	Invest in training programs or collaborate with external experts to bridge the knowledge gap

One of the most obvious flaws of the available research on the implementation of machine learning techniques to enterprise resource planning systems is the persistence of the linguistic bias (i.e., a tendency towards the works that are usually published in the English-speaking journals) (Costa et al., 2020). The limitation in this bias is obvious: that of the lost contribution and valuable data in the non-English sources, and, thus, of providing not the full and possibly one-sided view of the state of affairs in the world with regard to the application of ML in ERP

systems (Shaul & Tauber, 2013). Excluding the studies that are not related to English, one may take the risk of not noticing the presence of alternative strategies, odd methods and odd opinions which have been developed and implemented in various cultural and economic contexts that cannot fully allow getting the overview of the complexity of ML-inspired ERP solutions (Sharma et al., 2022).



**Figure 1: Performance Comparison between ML based ERP & Traditional ERP**

Here is the line graph comparing the performance of ML-based ERP systems with traditional ERP systems in terms of accuracy, efficiency, and cost reduction. The graph clearly shows the superior performance of ML-based systems across all metrics.

### Future Scope

Future research project should be aligned toward creating more complicated machine learning systems with a higher predictive capacity and which are subject to optimization in ERP systems (Pasupuleti et al., 2024). It includes research on more sophisticated techniques, such as deep learning, reinforcement learning and federated learning, and which performed well in other fields and would be modified to accommodate certain problems in the ERP (Grunova et al., 2024). To illustrate, intricate trends in the transaction data could be analyzed via deep-learning algorithms to determine the future demand or give a hint of a possible event in the course of supply-chain failure. The potential use includes improvement of the real-time resource allocation and schedule choices and as well, it could encompass collaborative model training across multiple organizations with the help of federated learning without compromising the data privacy. Besides, additional research should be conducted in a bid to acquire stronger algorithms that can cope when the data is dirty or incomplete, which is widely witnessed in real-life application of ERP. Researching into the application of hybrid techniques that takes the best of different machine learning techniques can also be beneficial (Pasupuleti et al., 2024).

### Conclusion

Machine learning has the potential to enhance decision support of the organizations in arriving to right decisions, taking them at the correct time and basing them on the data available in the ERP systems. Some of the areas that ML incorporated into the ERPs systems were seen beneficial included inventory management, demand forecasting, financial planning and resources allocation. However, data quality problems, system integration, and ML models complexities issues are the major challenges to integration. As the machine learning technologies continue with further development, the ERP systems will become of paramount importance that improves the strategic decisions-making and business processes streamlining across various industries.

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