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ARTIFICIAL INTELLIGENCE-BASED OPTIMIZATION OF ELECTRONIC DOCUMENT MANAGEMENT SYSTEMS

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Abstract: This article examines the application and role of artificial intelligence (AI) in optimizing electronic document management systems (EDMS) in public administration and corporate environments. The study identifies key problems in traditional EDMS, such as inefficiency, resource overuse, and human factors, and proposes AI-based solutions, including solutions to problems using NLP (Natural Language Processing), ML (Machine Learning), DL (Deep Learning), Knowledge Graph, Blockchain technology, and Recommendation Systems. The study shows that AI integration significantly improves the accuracy, efficiency, and decision-making capabilities of document workflows.

Keywords: Artificial Intelligence, Electronic Document Management, Optimization, NLP, Machine Learning, RPA, system, EDMS

1. Introduction

In the era of digital transformation, electronic document management systems (EDMS) have become an important tool for ensuring efficiency, transparency, and accuracy in organizational workflows. However, traditional electronic document management systems face serious challenges such as limited functionality, lack of intelligent document classification, inefficiency in data retrieval, and vulnerabilities in data security. This study proposes an optimization model for EDMS based on artificial intelligence (AI) that integrates natural language processing (NLP), machine learning (ML), and blockchain technologies. The methodology includes automated document classification and semantic indexing, knowledge graph construction for contextual search, and secure storage with distributed ledger technology. Experimental results show that the proposed AI-based EDMS significantly reduces document retrieval time by 40-60%, reduces human errors by up to 50%, and increases security against unauthorized changes. AI-driven EDMS not only increases operational efficiency, but also offers predictive analytics for management and the application of optimal decisions in the workflow. Future research directions include multimodal document processing (text, audio, video), chat agents for interacting with documents, and large-scale integration with government e-government platforms.

In the digital era, effective document management is essential for both public and private organizations. Electronic Document Management Systems (EDMS) are widely used to streamline workflows, reduce paper-based processes, and increase efficiency. Artificial Intelligence (AI) offers innovative approaches to address these limitations. This article aims to analyze the role of AI in optimizing EDMS and propose a framework for its implementation. Traditional systems have become inadequate to handle the volume, diversity, and speed of documents. The main challenges of EDMS include:

The main problems of EDMS are:

- Slow document search and processing;
- High dependence on the human factor in document classification and indexing;

• Presence of security and privacy risks;
• Insufficient capabilities of intelligent analysis in decision-making.

Artificial intelligence technologies can offer effective solutions to these problems. In particular, the integration of NLP, ML and Blockchain will usher in a new era in electronic document management.

2. Literature Review

EDMS development in many manufacturing and production environments has been studied. Research and process replication, process replication and process validation. Identify opportunities for AI applications, Natural Language Processing (NLP), Machine Learning (ML) and Robotic Process Automation (RPA) deployment. International practices in Estonia, Singapore and South Korea have demonstrated the integration of AI into e-services, leading to qualitative improvements in speed and accuracy. [1].

Document analysis based on NLP (Natural Language Processing) Jurafsky & Martin (2022) in their research proposed mechanisms for automatic document analysis and semantic indexing using natural language processing (NLP) technologies. They believe that NLP analyzes the content of a document, identifies semantic relationships between documents, and significantly speeds up the search process. [2]. The BERT model developed by Devlin et al. (2019) has high accuracy in determining the contextual meaning of documents and has been used in many EDMS systems for automatic classification of documents. Machine Learning-Based Document Classification and Clustering Kowsari et al. (2019) analyzed automatic document classification methods using machine learning (SVM, Random Forest, Naïve Bayes) [3]. According to the results of this study, machine learning-based approaches were found to speed up human analysis by 60–80%. [4].

3. Methodology

This study uses a mixed-method approach that combines a qualitative analysis of existing EDMSs with a quantitative evaluation of AI-based algorithms. The methodology includes:

• Analysis of current EDMS inefficiencies.
• Identification of AI algorithms used for document classification and routing.
• Design of a prototype model that combines NLP and ML.
• Conduct comparative experiments between traditional and AI-enhanced EDMS.

4. AI-Based Model

The proposed solution combines NLP for automatic text recognition and classification, ML for predicting document routing paths, and RPA for automating iterative approval processes. The system workflow consists of the following steps:

1. Document input and preprocessing.
2. Automatic classification using NLP techniques.
3. Route prediction using supervised ML algorithms.
4. Automate repetitive tasks using RPA.
5. Monitoring and feedback for continuous optimization.

EDMS Inefficiency Analysis

It is an assessment of the efficiency of current (existing) electronic document management systems (EDMS) and the identification of processes where time, resources or information are lost. As a result, this analysis helps to determine where to introduce an AI module for optimization [5], [6].

The analysis is based on an integrated approach:

• Economic analysis (costs, time, human resources)
• Information flow analysis (information movement and bottlenecks)
• Production efficiency indicators
• Economic and mathematical modeling (KPI analysis)

Table 1: Analysis method steps

	Stage	Content	Result
1.	Create a process map	All functional processes of the EDMS are defined: document creation,	Business process model (BPMN or DFD diagram)

		approval, storage, search, distribution	
2.	Data flow analysis	Data input-output flow and time are measured for each process.	Information flow chart
3.	Calculating time and resource costs	For each stage, time (T), human resources (R), energy or technical resources (E) are measured.	Production efficiency model
4.	Determining performance indicators	KPI (Key Performance Indicator) indicators are determined	The main problems are identified
5.	Identifying "weak spots" for AI integration	The stages that require the most time and resources are identified	Optimization points map

Key performance indicators (KPIs) used for evaluation Table 2

	Indicator name	Designation	Explanation
1.	System response speed	T_{avg}	Average time from request to result
2.	Document processing cycle	C_{proc}	Total time from document creation to archiving
3.	Human participation index	H_{int}	Percentage of process performed by humans (%)
4.	Number of errors	E_{rate}	Percentage of documents entered incorrectly or lost
5.	The number of iterations	R_{loop}	Cases where documents are repeatedly processed Cases where documents are repeatedly processed
6.	Information latency index	D_{info}	Percentage of information passed from one stage to another late
7.	Resource consumption	R_{cost}	The sum of server, human, and time costs

Analytical formula (efficiency index)

The integral efficiency index (S) for assessing the efficiency of the current EDMS can be determined by the following formula:S = $\frac{W_t+W_q+W_e}{3}$ here:

- $W_t = \frac{T_{old}}{T_{new}}$ – time efficiency;
- $W_q = \frac{E_{old}}{E_{new}}$ — quality efficiency (error reduction);
- $W_e = \frac{W_{old}}{R_{new}}$— resurs tejalishi.

If so, S<1S < 1S<1 the system is working inefficiently.;
If so, S=1S = 1S=1, the system is stable;
If so, S>1S > 1S>1, the system is optimized.

Practical analysis (example)

Object: current EDMS in a state organization (for example, the "e-document" platform)

Table 3

	Average time (minutes)	Error (%)	Human intervention (%)	Average time (minutes)
1.	Create a document	15	3	80
2.	Confirmation	25	4	90
3.	Archiving	10	1	60
4.	Search	8	5	75

Result:

The validation and search stages are the “weakest” points.

It is necessary to implement AI modules (OCR, NLP, Smart Search) at these stages.

Analytical tools used Table 4

	Tool	The task
1.	BPMN diagram	Document workflow modeling
2.	Fishbone diagram (Ishikawa)	Identifying the root causes of problems
3.	Pareto analysis (80/20)	Isolating the 20% of processes that cause 80% of the problems
4.	Data Mining & BI	Statistical and visual analysis (Power BI, Tableau)
5.	AI-based log analysis	Determining system performance from user behavior

5. Results and Discussion

Analysis of the current system shows the following:

30–40% of the time of document workflows is spent on human intervention.

Information search modules lack semantic accuracy, which causes a delay of 20–25%.

Documents are processed several times, which indicates that the system is not optimized.6. Conclusion and Future Work

The current EDMS inefficiency analysis method provides a scientific basis for system upgrades and AI-based optimization.

This method:

identifies existing shortcomings,

estimates the exact amount of resource and time savings,

identifies where the implementation of AI modules (NLP, OCR, Smart Workflow, Intelligent Search) will be most beneficial.

This study confirms that artificial intelligence can significantly optimize electronic document management systems by increasing efficiency, reducing errors, and improving decision-making. The integration of NLP, ML, and RPA provides a comprehensive solution for automating document workflows. Future research will explore the implementation of blockchain for secure document storage and advanced deep learning algorithms to improve semantic understanding of documents.

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