Document Process Automation with Artificial Intelligence for Logistics Sector

Chief Assist. Prof. Miglena Stoyanova, PhD
University of Economics - Varna, Varna, Bulgaria
m_stoyanova@ue-varna.bg

Abstract

The logistics sector serves as the backbone of global commerce, facilitating the movement of goods across vast networks. The efficient management of documents is key to operational success in this industry. Document process automation powered by artificial intelligence offers a transformative solution to the challenges inherent in document-intensive workflows. The current study clarifies the essential role of AI-driven document process automation in optimizing document-related processes in the logistics domain. Through a systematic analysis, it highlights the imperative need for document process automation integration, its operational benefits, and the underlying considerations for successful implementation.

Introduction

The logistics sector serves as the backbone of global commerce, facilitating the movement of goods across vast networks. In an age where supply chains span continents and the efficiency of these operations is at the heart of economic success, the logistics industry faces a critical challenge – document processing. This seemingly simple yet complex task forms the basis of logistics operations, ensuring the timely delivery of goods from producers to consumers. However, the volume, complexity, and variability of documents, ranging from bills of lading and invoices to customs declarations, create significant operational difficulties. Traditional document processing methods, relying on manual labor and rule-based systems, often fail in the face of this daunting challenge, leading to errors, delays, and increased operational costs.

The logistics industry, characterized by its multifaceted nature, struggles with an ever-increasing flow of documents, each of which carries important information for the flow of goods. These documents, while essential, are a huge conundrum. For example, bills of lading vary in format from one carrier to another, each imposing its own structure and terminology. Such variability complicates the implementation of uniform document processing procedures, leading to inefficiencies, manual interventions and a higher probability of inaccuracies. Moreover, the global reach of the logistics sector involves handling documents in multiple languages, which necessitates language detection and translation – an additional layer of complexity for conventional document processing systems.

Automated document processing is gaining significant popularity. Whether it concerns document scanning or data extraction, tasks centered around documents are undergoing rapid automation. This fact is equally applicable to the logistics industry.

In this era of rapid technological advancement, a promising solution emerges to alleviate the challenges, inherent in logistics document processing – artificial intelligence (AI). AI, particularly in the form of machine learning (ML), offers a transformative way forward. By giving machines the ability to understand, interpret, and act on documents, AI promises of revolutionize logistics operations. It offers the potential to increase efficiency and customer service, accelerate and improve data processing accuracy, and reduce operational costs. This emerging technology offers numerous advantages that are of great importance in today's digitally-driven logistics sector.

The current research work explores the world of document process automation with AI in the logistics sector. It also studies the challenges, posed by document variability in the field, and outlines the transformative potential of this technology, its real-world applications, and the myriad benefits it provides to the logistics companies, striving to compete in an increasingly complex global supply chain landscape.

1. Essence of document processing automation

Businesses deal with a huge amount of data every day. Most of that data is unstructured or semi-structured and captured in different documents – paper documents, scans, text documents, emails or online forms. Document processing is the process of extracting valuable data from various types of documents. Traditionally, this term is referred to the manual process of reviewing paper or electronic documents and entering data into databases. Now, with the rapid development of technology, document processing refers to the use of automated tools that can process documents with little or no human intervention.

Solutions for document processing automation become an essential tool for businesses to save time, reduce errors and increase productivity. These tools can learn and recognize patterns and structures in different types of documents, using artificial intelligence and machine learning. They can extract data from documents and turn them into structured data, which after that can be integrated into databases or other systems.

Document processing automation solutions can provide companies with a competitive advantage, enabling them to accelerate and enhance decision-making through the utilization of precise and promptly available data. Through the reduction of both time and resources used for manual processing, businesses can direct these valuable assets toward strategic endeavors that lead to growth and innovation.

The simplest digital tool used for document processing is OCR (Optical Character Recognition) software, which reads analog documents and converts their content into an editable format. Recent advances, particularly involving AI and ML tools, are more sophisticated and show the ability to recognize the significance and relevance of data in documents. This marked the beginning of the era of Intelligent Document Processing (IDP).

Document processing automation, also referred to as IDP, uses the capabilities of document scanning and data extraction procedures to automate tasks driven by documents. The application of this technology is relevant in a wide range of industries such as banking, insurance, healthcare, etc. (Chakraborti et al., 2020). In particular, it is beneficial for logistics enterprises that face the need to manage significant volumes and different categories of documents on a daily basis (Shamout et al., 2022). Leveraging document automation powered by machine learning enables these companies to extract relevant data from documents of any type or origin. This includes invoices, bills of lading, order details, and even customer feedback surveys. This facilitates the extraction of valuable insights into the business landscape, thereby improving decision-making processes spanning areas such as marketing, sales, risk management, finance, production planning, supply chain operations, etc. (Helo & Hao, 2022).

Intelligent document processing frees document-oriented tasks from time-consuming and expensive manual processing, thus significantly increasing the efficiency of logistics teams. The main steps involved in intelligent document processing with AI are as follows:
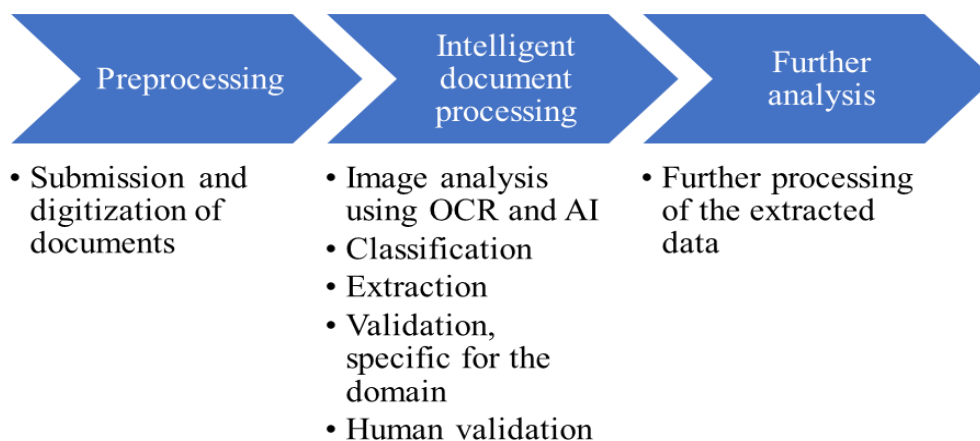
Figure 1. Intelligent document processing with AI

Documents can typically exist at different levels of quality, which can affect the data extraction results. Preprocessing is the initial step in document processing which involves various techniques such as cropping, binarization, noise reduction, de-skewing, etc. These techniques help improve the quality of documents before processing begins. Thus, the good quality of documents reduces the probability of errors in the following stages.

Documents may comprise numerous pages with varying formats. Intelligent document classification uses AI-based technologies to automatically classify and segment multi-page documents to retrieve relevant pages of information before extraction. In this step documents are categorized by type or structure based on patterns and content. This helps determine which data extraction rules to apply, making the following process more accurate.

The extraction step uses OCR and ICR (Intelligent Character Recognition) to digitize documents, and ML technologies to extract specific data based on rules set by the user. All these technologies can identify and extract data from different types of documents, including handwritten and printed documents. Usually, IDP solutions have a library of pre-trained extraction models that include the correct extraction fields. Relevant information is extracted from the documents before being validated for accuracy.

After the data is extracted, it goes through a series of validation rules and AI-driven techniques that aim to improve the extraction results. These can be pre-defined rules, validated in an automatic way and enhanced using RPA (Robotic Process Automation) techniques (for example RPA bots). Any unverified data can further be validated by a human user manually, allowing the process to continuously learn and improve over time. This step ensures that the retrieved data is accurate and of high quality.

The final step involves storing the validated data in the document processing solution for possible further processing and analysis, as well as integrating it with downstream applications. Integrating the data with other applications makes it possible to use it to support business processes and decision making.

2. Document processing automation challenges for logistics

The process of document processing and data extraction poses several challenges, including high costs, time consumption and error proneness. The accuracy of the results often depends on the skills of individuals trained to extract precise information from documents characterized by complex layouts or formats containing elements such as fuzzy text or blurry images.

Despite advancements in RPA technology, which have notably enhanced the efficiency of document processing across many industries, specific challenges have prevented logistics companies from reaping equivalent benefits.

One of the biggest challenges is the large volume of documents that logistics companies work with on a daily basis. These documents range from bills of lading and customs declarations to invoices and purchase orders. Managing such a vast volume of different documents can be overwhelming, leading to operational difficulties. This volume challenge becomes particularly acute in global logistics, where goods cross international borders, requiring multiple documents for compliance and tracking.

Another critical challenge is the variability of document formats. Documentation within the logistics sector lacks standardized formats (Vasilev et al., 2023). Some examples of different document types include bills of lading, CMRs, proofs of delivery, purchase orders, invoices, etc. While many share common attributes such as consignee details, package dimensions and volume, different carriers and partners often use their unique templates and layouts of documents. This variability leads to difficulties in applying standardized processing methods. Traditional automation systems struggle to adapt to these different formats, leading to inefficiencies and errors. In addition, the logistics industry often works with paper documents, which creates additional complexities in terms of digitization and data extraction.

The document scanning process should ideally capture all information from various sources without affecting document layout or image quality. Relying solely on Optical Character Recognition (OCR) leads to numerous challenges. It can't account for different layouts changing across multiple pages within a single document or disparities between images of the same size, but slightly different content due to patterns like drapery. Consequently, such limitations lead to false interpretations by automated extraction systems, subsequently yielding inaccurate downstream decisions.

Furthermore, not all documents are composed in the same language, which is another obstacle in processing logistics documents. For international shipments, documents may be prepared in different languages, which requires language detection and translation. Detecting the language of a document automatically presents a recurring challenge for IDP. Ensuring accuracy and consistency in the translation of documents can be challenging, as nuances in language can affect the meaning and interpretation of valuable information. Language barriers can slow the processing of documents and create opportunities for misunderstanding.

In addition, the time-sensitive nature of logistics operations adds pressure on document processing automation. Delays in document processing may directly impact shipment schedules, affecting the timely delivery of goods. In industries where perishable goods or time-sensitive deliveries are common, such delays can have significant consequences on products' quality and customer satisfaction. Automation systems must not only be accurate, but also efficient in processing documents rapidly to meet the demands of the logistics industry.

The stated challenges highlight the importance of adopting advanced technologies such as artificial intelligence and machine learning to streamline document processing and improve the efficiency and reliability of logistics operations.

3. Intelligent automation with AI for logistics document processing

Documents often contain huge volumes of information requiring processing, organization, and analysis (Sulova et al. 2022). AI-powered document processing automation leverages machine learning algorithms to autonomously execute several distinct tasks, including language detection, extraction of relevant data from different document types without loss in quality or precision and identification of document components within images. As a result, these processed documents become more understandable to human analysts during subsequent analysis (Ng et al., 2021).

Human specialists play a major role in training machine learning technology, guiding it to use statistical pattern recognition methods. These methods encompass artificial neural networks and decision trees that are refined using labeled training examples, provided by domain experts (Cioffi et al., 2020). This training process assists the machine learning model to recognize specific patterns and generalize its knowledge to new scenarios where previously unseen patterns need to be identified. AI's role in document analysis heavily relies on tasks related to Natural Language Processing (NLP). NLP is a field of study combining computer science, artificial intelligence and computational linguistics, which deals with the interactions between computers and human (natural) languages. The objective of natural language processing is to achieve computational understanding of natural languages, thereby facilitating their use across many different applications including machine translation, information extraction, speech recognition, text mining and summarization (Khurana et al., 2023).

A. Differences between IDP and OCR

OCR is a well-established technology with decades of widespread adoption in the field of document processing. The primary objective of OCR is to transform an image containing text into a readable text format (Awel & Abidi, 2019). This is the initial step that serves as a starting point for subsequent document-related automation. Often, OCR systems are coupled with rule-based extraction methods to further analyze the document. This technology demonstrates efficacy when applied to structured or semi-structured data. Despite its popularity within the sphere of document recognition and analysis due to its accuracy, OCR has some limitations. Foremost among them is restricted flexibility, which makes adapting to changing requirements or business processes a challenge to companies.

Contrasting this, a machine learning algorithm specialized in intelligent document processing can automatically identify various elements within documents without human intervention, by using computer vision techniques in combination with natural language processing technologies. Therefore, the need to manually define document layout and content extraction rules is eliminated, even if there are changes over time. The extracted data can undergo further analysis and processing to automate different business scenarios, thereby improving logistics data management. The solution with AI has the capability to extract essential information from digital documents in real-time, such as items from invoices and totals. Instead of looking at characters individually, it looks at the document images as a whole. This allows it to display the products that are for sale even in the presence of typos or illegible text, relying on the associated product codes for identification. By combining machine learning solutions with conventional software development, powerful automated workflows can be created that adapt to business processes and support the digital transformation of the logistics companies.

Table 1 summarizes the main differences between OCR and IDP with AI.

Table 1. Differences between OCR and IDP with AI

	Traditional OCR	**IDP with AI**
Data extraction	From structured documents	From unstructured documents and images
Requirements	Manual efforts for template settings	Machine learning structures, extracts insights from complex data

B. Reducing the challenges of document processing and analysis with machine learning

Intelligent document automation, powered by machine learning, is relatively young compared to other AI applications like image recognition or natural language processing. However,

its growth is rapid, with numerous companies already embracing its potential (Klumpp, 2018). Document scanning and data extraction are suitable entry points into the field of artificial intelligence due to several inherent advantages that make them particularly appealing to businesses within the logistics sector.

Specific machine learning solutions designed for document processing facilitate logistics document processing by offering a three-step approach, covering entire workflows and beyond. The steps are as follows:

1) **Data reading and extraction.** The process starts with reading the file and extracting all essential data in a structured way.
2) **Data refinement.** The extracted data is refined through data enrichment and postprocessing techniques, based on AI.
3) **Data application.** The normalized data is then applied to workflows and applications, facilitating seamless utilization.

Often certain components of intelligent document processing automation are available as pre-built cloud solutions. However, the most accurate and efficient results arise from machine learning algorithms specifically trained for given business requirements. This customized approach not only ensures accuracy, but also maximizes cost savings and operational improvements.

4. Benefits of custom AI solutions for document processing

The application of a document processing automation solution driven by the power of artificial intelligence enables logistics enterprises to process data easily and quickly from documents while increasing the accuracy of document analysis (Iyer, 2021). This technological advancement has the potential to reduce costs and increase productivity in an organization's document-oriented operations (Boute & Udenio, 2022). The integration of such a solution leads to several significant benefits for logistics companies:

- **Automation**

Among the primary advantages of intelligent document processing is its ability to significantly speed up and simplify documentation procedures. IDP with AI helps with a variety of tasks, ranging from document analysis to processing customer document data in customer service departments and analyzing incoming purchases from invoices. This technology's potential for additional automation is virtually limitless. After extraction and normalization of data it can be used to further refine and optimize workflows. Since document data is structured and normalized according to document types, it provides all the necessary information in a centralized location, avoiding the need for manual entry.

- **Accuracy**

Machine learning can be used to speed up and increase the accuracy of document processing, thereby reducing the occurrence of errors resulting from manual data input. The automation of document analysis removes the human errors related to tasks like document data parsing, document annotation, etc. IDP with AI identifies patterns within document data, enhancing result accuracy and subsequently refining business processes. The use of document automation technology ensures consistently high-quality results for every document processed through this system.

- **Efficiency**

Using IDP document processing software saves time by automating tasks and minimizing manual inputs. This results in reduced errors and increased productivity, enabling employees to focus on tasks of greater significance than manual data extraction from documents.

- **Financial savings**

Time and financial resources are imperatives in the logistics sector, which has lots of document-oriented activities. However, not all companies have the luxury of a dedicated document analyst, available 24/7 or sufficient human resources to manage the processing of large volumes of

documents. These circumstances can lead to increased costs and risk of errors resulting from simple mistakes. IDP steps in to reduce costs through accelerated processing, enhanced accuracy and reduced staffing requirements.

Data output is only the first step in driving workflow automation. In the context of document scanning and data extraction from both digital and paper documents, the best approach to overcome the challenges lies in adopting a customized machine learning solution. The reasons for this are:

1) Optimizing transportation resource allocation

Improvement of resource allocation can be achieved by predicting real-time customer demand, proactively planning transportation resources to meet future requirements and identifying potential bottlenecks before they negatively impact business performance.

2) Providing full visibility of delivery

Allowing a comprehensive view of all shipments by monitoring their real-time status at any point in their journey, ensuring full awareness of their location and live updates on possession changes.

3) Digitizing paper documents

Advancing the process of document scanning and data extraction through the integration of intelligent document processing automation with machine learning capabilities. This approach makes conventional document storage obsolete, thereby freeing up space for other critical company records, while dramatically accelerating search times.

4) Simplifying report creation

Automating report generation by seamlessly extracting information from various sources and deploying document templates to generate comprehensive reports. Normalized data can be effortlessly integrated into a report's structure for further in-depth business process analysis.

Conclusion

Nowadays document data is an important part of daily business operations. Logistics enterprises continuously seek ways to improve document processing and automation, given the significant resources and time allocation for these functions. Document automation driven by artificial intelligence emerges as a viable solution to enhance document processing, mitigate errors and increase productivity.

The benefits provided by document automation powered by machine learning are numerous. Accelerated document processing, elimination of human errors and cost savings due to document storage reduction constitute merely a subset of the benefits this paradigm offers. Moreover, intelligent document processing can unlock even greater advantages when applied in a customized way, covering a wider range of workflows and business operations. With simplified document storage and automated document reporting, document automation is definitely a need for logistics companies looking to streamline their operations.

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