

# A Survey on Digital Solutions in Postal Industry

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**Abstract :** The postal system plays a very important role in economic, cultural and social growth, and so on for a country. While there have also been radical improvements in the field of communication, the postal service is still indispensable. Digitization has reached this area of economy as well in the past few years. Traditional postal services are being driven by electronic replacement, as both customers and companies embrace automated processes across multiple domains. Under digital economy conditions postal services need to modernize their position to suit the digital age. This paper reviews various technology based solutions proposed for the process automation in postal services.

**IndexTerms - Technology, Digital Mail Room, Postal Solutions, Optical Character Recognition, Address Recognition, Return Mail**

## I. INTRODUCTION

Postal services have operated for over two thousand years, and play a significant role in all countries' economic growth. Postal facilities are important for corporations as well as for people alike. Worldwide, postal services play a critical, daily role in keeping countries, economies and people connected despite the digital transformation in the communication aspect. In order to cope up with the challenges that arise in the Postal mail processing steps, various technology based solutions are adopted worldwide. Many countries now have digitalized many stages in the postal mail processing pipeline. However, certain operational issues occur as a result of digitization. Hence, the researchers and engineers all over the world are trying to make the digital transformation more efficient and avoid any human intervention needed.

Some of the issues addressed using digital solutions:

- Material handling
- Return mail handling
- Sorting of mail pieces
- Mail tracking
- Optimization in machinery utilization

Some of the challenges while adapting to digitization are:

- Lack of Standardization in packing dimensions, material and structure
- Handwritten metadata information
- Multiple scripts used
- Security concerns.

## II. DIFFERENT SOLUTIONS

This section reviews various technology based solutions proposed for addressing the challenges faced in Postal Industry.

1. In the paper "The design and optimization of postal distribution center using a network model"[1], the main functions of the postal distribution center and the operation process are explained. It is also emphasized in this paper how the degree of automation affects the parcel handling quick and accurate.

The postal center has different sub systems based on the functions like receiving, opening, delivery, packaging and dispatch. For each of these sub systems, a detailed network model is explained. The evaluation of the network models is made based on specific parameters and indexes. Utilization and availability metrics for each component is found in order to avoid any bottlenecks in the system. Overall, this network based model can help the designers make better decisions and tune parameters to check feasibility of the decisions.

2. "The Internet of Postal Things"[2] is another paper in which how the advancements in sensors and wireless technology can be utilized to revolutionize the postal industry. IoPT is expected to transform the infrastructure including vehicles, mailboxes, machines, carriers and so on to help the US Postal Service(USPS) in the area of data management. The IoPT platform would be secure, scalable and interoperable with the legacy infrastructure and will be built using five foundational elements: a technology infrastructure to capture and transmit real-time data securely from several thousands of objects, a data architecture, cloud storage, multi-device interfaces to present the data (APIs) and lastly the policies to regulate access to the IoT network.
3. An automation system is presented [3] in which the attributes such as PIN code and city name information on the postal document is used. At first, the data like stamp and seal are detected. Also, from the structure of the envelope, the Destination Address Block (DAB) is identified. Segmentation process is carried out on this block. The main challenge here is that India is a multi-lingual and multi-script nation and address may contain more than one script. To overcome this and identify the script

using which PIN code is written, water reservoir based technique and two stage Artificial Neural Network are used. General classifiers for recognizing PIN codes in English and Bangla. For recognition of city names, an NSHP-HMM (non-symmetric half plane-hidden Markov model) based technique is proposed.

The process of implementing this technique begins with preprocessing where data is collected and noise is removed followed by stamp and DAB detection. Also, the script is identified and PIN code box detection and numeral extraction is done. In the next step, numeral recognition is based on Multilayer Perceptron. Finally, the city names are recognized. The below Table 1 summarizes the results obtained.

Table 1: Summary of results

Stage	Accuracy	Source of errors
i. Postal Stamp ii. Seal detection	95.98% 98.55%	Overlapping of postal stamp/seal with the text portion of address part  Poor quality of images
Script Identification i. Handwritten ii Printed	89% 98.42%	-
PIN code box extraction	97.64%	Broken pin-code box  Poor quality of the images  Touching of the text portion of DAB with the pin-code box
Numeral Recognition i. 16-class classifier ii. English classifier iii Bangla classifier	92.10% 93.00% 94.13%	-
Word Recognition Word class - 76	86.44% (Found that accuracy decreases if word class increases)	-

- Another paper also focuses on automating certain processes in Indian Postal System [4]. The sorting process can be automated by destination address interpretation. The Automatic Mail Process (AMP) which is proposed scans a mail item and identifies the fields like PIN code and destination address. The address is converted into a 12 digit Delivery Point Code (DPC) which is later used in barcode generation and printing the same on the mail. All future sorting processes can be done using a mechanical sorter which reads the barcode to make sorting decisions. The main five modules of AMP is pre-processing unit, address block location unit, line and word separation unit, address parsing and recognition and DPC generation unit.
- The white paper by Pitney Bowes [5] talks about the return of first class mail sent by USPS (US Postal Service). In this paper, the statistics and the impact of government regulations are detailed and a solution is proposed. It states that 1.3 billion pieces are returned to the originating firm with the state "Return to Sender". The cost incurred per piece is around \$3, which makes around \$4.2 billion every year.

The paper lists the tools that are made available by companies and service providers in order to solve the First class returns. It has a range of tools like NCOALink, CASSTM, LACSLink, SuiteLink, MLOCR, Intelligent Mail, Address Change Service, Address Element Correction, AECII and many more. The industry technology trends are outlined where the solutions have been deployed at different levels with certain tradeoffs.

In the ideal approach that is explained, four major steps are outlined: Document capture and conversion, Address management, standardization and search, secondary processing and document repurposing and Reporting, auditing and metrics.

In the document capture step, the mail image is converted into an electronic form. This involves scanning and barcode capture. Address Management involves validating the addresses in the system and updating as needed. Secondary processing involves automatic checking and updating the number of times a mail item is returned and track the history. Also it involves intelligent systems to suppress bad addresses and raising alerts. In the final step, core reporting and audit details are presented which makes the return mail management service more effective.

- On the similar context of returns, Gianfranco, Michael, Koot and Mario [6] have come up with a model to manage product returns in the paper "Preventive Product Returns Management Systems: A Review and a Model". The proposed system consists of set of procedures that drive the decision making process and actions carried out to reduce the returns. They have proposed a framework that would help researchers and online retailers to understand the considerations better and implement preventive instruments. Although the paper deals with returns of products, the approach to take informed decisions can be studied to reduce the return mail items.

7. The solution brief of Discovery Return Mail Solution [7] by Lake Image gives a survey result that 25% of the addresses that companies hold deteriorates and experience an undelivered mail rate of 3 to 5 % or sometimes even as high as 30%. It refers the returned mail as a huge and costly problem.

It mostly concentrates on the automated data capture and generating data in downloadable format for further remediation by MIS (Management Information System) or address update/cleansing software. It is a complete solution with necessary hardware such as envelope feeder, belt driven transport base with diverter, PC controller, monitor, cameras and lighting. The system is able to read and decode the 2D barcodes and uses OCR to get the text through the envelope window. It produces a file in standard formats like CSV (Comma Separated Values) and .txt that can be downloaded or sent as an input to MIS. This MIS is responsible for data cleaning and getting the correct addresses for redelivery to take place successfully. The images that were captured is used for audit purpose in most cases. It is also helpful in retrieving documents later for redelivery since the hardcopies are shredded after scan.

8. In the paper “Integration of Hand-Written Address Interpretation Technology into the United States Postal Service Remote Computer Reader System” [8], Hand Written Address Interpretation (HWAI) technology which is incorporated by USPS has been explained. The Remote Bar Coding System(RBCS), which is an image management system for assigning bar codes to mail that is not fully processed by postal OCRs, have been retrofit with the Remote Computer Reader (RCR) into which the HWAI technology is integrated. During the first deployment of HWAI, it has resulted in less than 2% error rate.

A comparison with the non-automated process is made and it is stated that the automation makes the process 30 times faster. The Remote Bar Coding System utilizes the script images that Advanced Facer Canceler System (AFCS) captures and also the ones that OCR captures. For the cases where both of these steps do not work fine, RBCS is used for manual processing and barcoding. To reduce the costly operation, the Remote Computer Reader can be used. However, the challenges like the human errors and non-standardization of mail item dimensions poses risk of running into using the automated system. Thus, HWAI is integrated into RCR and this has significantly reduced the keying workload.

9. Another paper “Computer Vision and Image Processing in Postal Automation” [9] provides an overview of how computer vision, pattern recognition, signal processing and robot vision can be used in Postal Automation.

An end to end process solution has been given which not only includes the process of extracting barcode data but also the mechanization required to eliminate the manual steps like opening of a package, arranging them to be read by scanner and so on. Also, the generation of barcodes by reading the addresses by systems like machine print address reading, video coding VCR and Hand written address reading OCR are proposed. A detailed description of how the OCR has to work in this use case of address recognition is provided. The system with 3 modules namely Image Processing, Segmentation and character recognition, and on-text analysis and address recognition is used. This system is not only responsible for extracting the content, but also validates and gets the address in a pre defined format.

The system also has a solution for processing 3D parcels. It also proposes the use of Robots empowered with computer vision in material handling. Autonomous Guided Vehicles which is a flexible solution are based on active sensors for self-orientation. This is seen as the best solution that removes most of the manual efforts in station loading and unloading and also in material handling with the premises.

10. In a paper “Process of Detecting Barcodes Using Image Processing” [10], a system that can read barcodes is proposed based on image processing technology rather than the conventional laser barcode reader. The use of image processing has resulted in extraction of more information at a given time. In this paper, some of the algorithms that use segmenting for barcode pattern analysis from images are adopted. The paper briefs about the barcodes and the standards. It discusses the different methods for reading barcodes and their working in the most commonly used devices like mobile phones and digital cameras.

11. Xerox Global Services has their white paper “Unleash the Power of the Digital Mailroom” [11] to automate business correspondence and improve efficiencies and communications. This paper provides an overview of how Xerox global services is making changes to the mailroom so as to reduce time taken to get client response as well as the cost associated. These changes also improve communications and quality while it makes sure the compliance and regulations are met.

It uses unique software and certain set of workflow practices. It makes use of Smarter Document Technologies which is nothing but a set of advanced technologies needed to scan documents and extract content. Also, it is required to understand the context of the document for which intelligence is needed and then integrate the system with other management systems of a firm. It uses advanced machine learning algorithms to classify the documents by learning the features which could be either visual or textual. Classification can happen in three levels: just by a visual feature, analyzing a set of key words, and going through the entire document. Text categorization is the next step after classification that is described. In this step, clustering and categorization are used after an advanced OCR is applied. The third step is image categorization using image processing, computer vision and machine learning. Word spotting is another step that scans documents and looks for specific words. It is quicker than OCR and is suitable if each category of mail items have specific keywords compulsorily. The next step is multimodal categorization where multiple categorization techniques are used to boost the confidence about the results. Advanced Text Analysis is another step taken and it helps to find some commonly used fields like SSN, Telephone number and pin code.

With all these different workflows, the digital mailroom solution is described as a highly specialized “Smarter Document Process and Technologies” and this is combined with business process knowledge which can be applied to solve the challenges.

### III. CONCLUSION

The postal industry has to move towards digitization and many solutions like digital mailroom are expected to improve a lot in the near future with technologies like IoT, artificial intelligence, wireless technology and image processing. Without a doubt, the expenses incurred can be reduced if the shift from manual processing to automation is done incrementally and strategically.

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