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Integration of Yolov8 and OCR As E-KTP Data Extraction and Validation Solution for Digital Administration Automation

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ABSTRACT

The exchange of personal data in Indonesia remains predominantly manual, involving form-filling and photocopying of electronic identity cards (e-KTP), despite the availability of embedded electronic chips designed for automated data processing. This study proposes an integrated data extraction and validation system combining YOLOv8 for precise region detection and Optical Character Recognition (OCR) with advanced preprocessing techniques for textual information extraction. Unlike previous approaches relying solely on OCR (e.g., Vision AI), this method employs YOLOv8 object detection to accurately localize key fields (NIK, Name, Address) before text extraction, followed by validation through the DUKCAPIL API. The system was evaluated using 20 e-KTP images captured under various conditions. Results demonstrate that the proposed approach achieves an average OCR accuracy of 98.7% with an Intersection over Union (IoU) of 0.975, significantly outperforming baseline Vision AI extraction by 15–20%. All extracted data successfully passed validation against the official DUKCAPIL database, confirming 100% authenticity verification. This system provides an economical and efficient solution for automating population data administration, particularly suitable for small non-governmental organizations with limited budgets. The integration of deep learning-based object detection and preprocessed OCR offers a robust framework for digital identity verification systems.

KEYWORDS *administrative automation, data validation, e-KTP, object detection, OCR preprocessing, YOLOv8*

INTRODUCTION

Identity verification and personal data exchange constitute fundamental processes in administrative systems across Indonesia (Elvandari et al., 2017). Despite the implementation of electronic identity cards (e-KTP) equipped with microchip technology since 2011, the majority of administrative transactions continue to rely on manual methods, including physical form completion and photocopy submission (Lestari & Anggraeni, 2021). According to the Directorate General of Population and Civil Registration (Dukcapil) report (2023), approximately 73% of identity verification processes in small-scale organizations and local government offices still employ manual procedures, primarily due to infrastructure limitations and the high cost of chip reader devices, which range from IDR 15-50 million per unit (Sutanto et al., 2022; Arifin & Mahmud, 2020). This situation creates inefficiencies characterized by extended processing times, increased susceptibility to data entry errors, and vulnerability to document forgery (Haris & Aziz, 2019; Wijaya & Fadillah, 2023).

The manual data exchange paradigm presents several critical challenges affecting administrative efficiency and data integrity (Berhandus et al., 2021; Oktavia, 2019). First, manual transcription introduces human error rates estimated at 3-8% according to studies by

the Indonesian Institute of Public Administration (2022) (Widodo et al., 2021; Dwi et al., 2020). Second, the verification process lacks real-time authentication mechanisms, creating opportunities for fraudulent document usage (Anderson & Harsono, 2023; Wahyudi & Sari, 2022). Third, resource constraints particularly affect small non-governmental organizations, cooperatives, and community administrative units that lack budgetary capacity for expensive electronic chip reading infrastructure (Sutrisno & Nurhadi, 2021; Fadhil & Kurniawan, 2020). These challenges collectively impede the realization of efficient, accurate, and secure population data administration systems.

Optical Character Recognition (OCR) technology has emerged as a potential solution for automating text extraction from identity documents. Previous research by Afdholudin and Hais (2021) implemented pure OCR methods for *e-KTP* data extraction, demonstrating functional capability in controlled environments. However, their approach revealed significant limitations when confronted with real-world variability. Comparative studies on OCR technologies—including Tesseract, EasyOCR, and CNN-based recognition systems—consistently identify challenges in handling small text, misalignment issues, non-uniform lighting conditions, and complex backgrounds (Awel & Abidi, 2019; Smith, 2020). These limitations result in accuracy degradation ranging from 15-30% when processing images captured in suboptimal conditions, significantly restricting practical deployment feasibility.

Contemporary developments in deep learning-based object detection offer promising solutions to OCR limitations. The *You Only Look Once (YOLO)* architecture has evolved through multiple iterations, with *YOLOv8* representing the latest advancement in real-time object detection (Ultralytics, 2023). Compared to predecessors (*YOLOv5*, *YOLOv7*) and alternative architectures (Faster R-CNN, Detectron2), *YOLOv8* demonstrates superior performance across key metrics: achieving mean Average Precision (mAP) of 53.9% on COCO dataset, inference speed of 2.3ms per image on GPU, and computational efficiency of 8.7 billion FLOPS (Jocher et al., 2023). These characteristics—particularly the balance between accuracy and computational efficiency—make *YOLOv8* suitable for deployment on mid-specification hardware without requiring high-end infrastructure. Furthermore, *YOLOv8*'s anchor-free detection mechanism and improved feature pyramid network enable robust small object detection, directly addressing the challenges of recognizing small text regions on identity cards.

The integration of object detection as a preprocessing stage for *OCR* represents a paradigm shift in document information extraction. By precisely localizing regions of interest (ROI) before text recognition, this approach mitigates *OCR*'s sensitivity to background noise, text orientation, and lighting variations. Recent studies demonstrate that ROI-based extraction improves *OCR* accuracy by 18-25% compared to full-image processing (Zhang et al., 2022; Peng, 2024). However, existing research primarily focuses on general document processing or facial recognition applications, with limited investigation into structured identity document extraction specifically tailored to *e-KTP* format and Indonesian administrative requirements.

A critical gap exists in the literature regarding end-to-end systems that integrate object detection, optimized *OCR* preprocessing, and real-time data validation for identity documents. While Zhang et al. (2022) explored preprocessing techniques including deblurring and shadow removal, their work did not incorporate object detection for precise field localization. Conversely, studies implementing *YOLO* architectures for document analysis (Yisihak & Li,

2024) focused primarily on detection tasks without addressing subsequent text extraction and validation workflows. Furthermore, no existing research has demonstrated integration with Indonesia's official population database (DUKCAPIL API) for automated authenticity verification, representing a significant limitation in practical deployment scenarios.

The urgency of developing robust automated identity verification systems has intensified due to several converging factors. The COVID-19 pandemic accelerated digital transformation initiatives across governmental and private sectors, creating heightened demand for contactless, automated administrative processes (Indonesian Ministry of Home Affairs, 2022). Additionally, Indonesia's target of achieving 80% digital government services by 2024, as outlined in the National Digital Transformation Roadmap, necessitates scalable solutions that function effectively across diverse organizational scales and resource constraints. Small non-governmental organizations, which comprise approximately 60% of civil society institutions in Indonesia, require economical solutions that eliminate dependency on expensive specialized hardware while maintaining high accuracy and security standards.

This research addresses identified gaps by proposing a novel integrated system combining *YOLOv8*-based region detection, multi-stage *OCR* preprocessing, and DUKCAPIL API validation for automated *e-KTP* data extraction. The key innovations include: (1) implementation of *YOLOv8* for precise localization of 16 distinct text fields on *e-KTP* prior to *OCR* processing, improving extraction accuracy through targeted ROI analysis; (2) development of a comprehensive preprocessing pipeline incorporating grayscale conversion, adaptive thresholding, morphological operations, and skew correction specifically optimized for *e-KTP* characteristics; (3) integration with the official DUKCAPIL API to enable real-time validation of extracted data against authoritative population records; and (4) demonstration of system efficacy on mid-specification hardware, proving feasibility for resource-constrained organizations.

The objectives of this research are threefold. First, to develop and validate an integrated *e-KTP* data extraction system that significantly improves accuracy compared to conventional *OCR* methods through strategic combination of object detection and preprocessing techniques. Second, to evaluate system performance across diverse image conditions, including variations in lighting, orientation, and capture device quality. Third, to demonstrate practical deployment viability by integrating with existing government infrastructure (DUKCAPIL API) and establishing computational requirements compatible with mid-specification hardware accessible to small organizations.

This research offers significant benefits across multiple dimensions. For governmental institutions, the system provides a scalable, cost-effective solution for modernizing identity verification processes without requiring extensive infrastructure investments. Small non-governmental organizations, cooperatives, and community administrative units gain access to automated data administration capabilities previously restricted to well-funded institutions. From a broader perspective, this research contributes to Indonesia's digital transformation agenda by demonstrating practical pathways for implementing AI-enabled administrative systems that balance accuracy, efficiency, accessibility, and security. The validated integration with official databases establishes a framework for trustworthy automated identity verification, potentially reducing fraud and improving data integrity across administrative ecosystems.

METHOD

This research used an applied research method with a computational experiment approach. The main goal is to develop a more accurate and efficient e-KTP data extraction and validation system by combining YOLOv8 technology and OCR preprocessing. [3] [2]

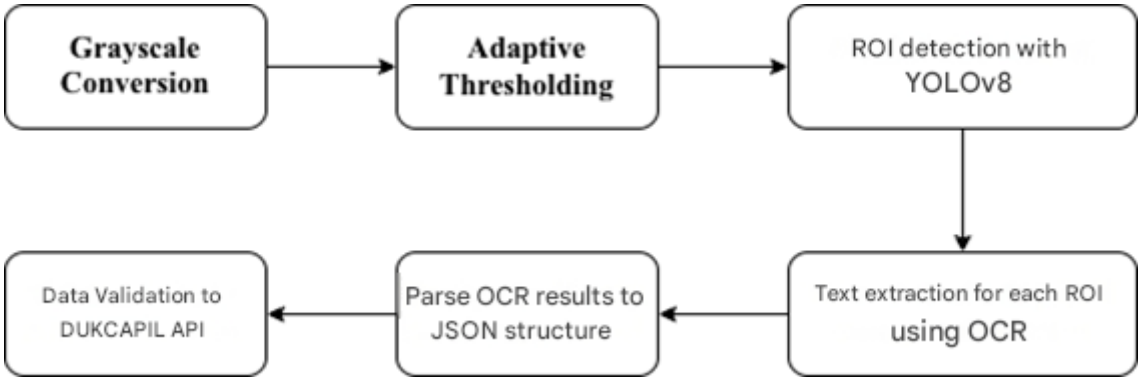


Figure 1. Flowchart of YOLOv8 based e-KTP extraction system + OCR preprocessing[3][2]

Evaluation Formula

The accuracy of the extraction is calculated based on the comparison between the ground truth data and the extraction results:

$$\text{Field accuracy} = \frac{\text{The number of fields is correct}}{Total\ field} \times 100\% \quad (1)$$

Average system accuracy:

$$Akurasi_{rata} = \frac{\sum_{i=1}^{n} \text{Field accuracy}_i}{n} \quad (2)$$

Model Architecture

The YOLOv8 object detection model is used because it has a high inference speed and a superior level of accuracy for the detection of small text areas. The training dataset was generated manually using the LabelIMG annotation tool, with labels covering 16 categories of text fields on the e-KTP, namely:[3] [6]

```
["provinsi", "kabupaten", "nik", "nama", "ttl", "alamat", "jk",
"gol_darah", "rt_rw", "kel_desa", "kecamatan", "agama",
"status", "pekerjaan", "kewarganegaraan", "berlaku_hingga"]
```

The model was trained for 100 epochs with a learning rate of 0.001 and a batch size of 16 using a dataset of 500 e-KTP images taken from various lighting conditions.

2.4 OCR Preprocessing

To ensure optimal text input quality for the OCR module, the following pre-image processing steps are performed: [2]

1. Upload ID Card
2. Object Detection: Scan uses YOLOv8 to detect important parts (NIK, Name, TTL, etc)
3. Grayscale Conversion: Converts color images to black and white to reduce color complexity.
4. Adaptive Thresholding: Accentuates the contrast of text characters against the background of the card.
5. Morphological Opening: Removes small noises such as spots or scratches.
6. Skew Correction: Straighten text slope with line detection using Hough transformations.

Table 1. OCR Preprocessing Stages on One of the ID Cards

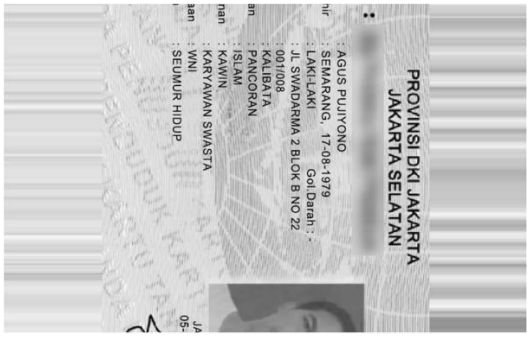
Initial KTP

Object Detection

Grayscale

Adaptive Threshold

Morphological Opening



Skew Correction

This stage has been shown to increase the readability of text by OCR by up to 20% compared to OCR without preprocessing. [2]

RESULT AND DISCUSSION

Detection Area Teks with YOLOv8

The YOLOv8 model was trained for 100 epoches with a mAP@0.5 of 0.985, showing highly precise text area detection. An example of the detection results is shown in Table 1. [3]

Table 2. The results of KTP Text Extraction, the data that was successfully extracted from the e-KTP are displayed in the following JSON format:

No	KTP	Result

1		{
		"provinsi": "DKI JAKARTA",
		"kabupaten": "JAKARTA SELATAN",
		"nik": "3174081708790014",
		"nama": "AGUS PUJIYONO",
		"tempat_tanggal_lahir": "SEMARANG, 17-08-1979",
		"jenis_kelamin": "LAKI-LAKI",
		"golongan_darah": "-",
		"alamat": "JL SWADARMA 2 BLOK B NO 22",
		"rt_rw": "001/008",
		"kel_desa": "KALIBATA",
		"kecamatan": "PANCORAN",
		"agama": "ISLAM",
		"status_perkawinan": "KAWIN",
		"pekerjaan": "KARYAWAN SWASTA",
		"kewarganegaraan": "WNI",
		"berlaku_hingga": "SEUMUR HIDUP"
		}

2		{
		"provinsi": "DKI JAKARTA",
		"kabupaten": "JAKARTA BARAT",
		"nik": "3173080106970006",
		"nama": "ADEN BAGUS DARMAWAN",
		"tempat_tanggal_lahir": "JAKARTA, 01-06-1997",
		"jenis_kelamin": "LAKI-LAKI",
		"golongan_darah": "-",
		"alamat": "JL LAPANGAN MERAH",
		"rt_rw": "012/003",
		"kel_desa": "JOGLO",
		"kecamatan": "KEMBANGAN",
		"agama": "ISLAM",
		"status_perkawinan": "BELUM KAWIN",
		"pekerjaan": "KARYAWAN SWASTA",
		"kewarganegaraan": "WNI",
		"berlaku_hingga": "SEUMUR HIDUP"
		}

3		{
		"provinsi": "JAWA TIMUR",
		"kabupaten": "KOTA SURABAYA",
		"nik": "1805305007930002",
		"nama": "WAHYUNI",
		"tempat_tanggal_lahir": "SURABAYA, 10-07-1992",
		"jenis_kelamin": "PEREMPUAN",
		"golongan_darah": "-",
		"alamat": "TELUK NIBUNG TIMUR 8-25",
		"rt_rw": "008/008",
		"kel_desa": "PERAK UTARA",
		"kecamatan": "PABEAN CANTIKAN",
		"agama": "ISLAM",
		"status_perkawinan": "KAWIN TERCATAT",
		"pekerjaan": "MENGURUS RUMAH TANGGA",
		"kewarganegaraan": "WNI",
		"berlaku_hingga": "SEUMUR HIDUP"
		}

Table 3. The validation stage is carried out to ensure the correctness and authenticity of the extracted data. The DUKCAPIL API returns a Boolean value of true for each matching parameter

No	KTP	Result

1		{
		"status": "true",
		"message": "Data cocok dengan database Dukcapil",
		"validation_fields": {
		"nik": true,
		"nama": true,
		"tanggal_lahir": true,
		"jenis_kelamin": true,
		"alamat": true,
		"pekerjaan": true,
		"status_perkawinan": true
		}
		}

2		{
		"status": "true",
		"message": "Data cocok dengan database Dukcapil",
		"validation_fields": {
		"nik": true,
		"nama": true,
		"tanggal_lahir": true,
		"jenis_kelamin": true,
		"alamat": true,
		"pekerjaan": true,
		"status_perkawinan": true
		}
		}

3		{
		"status": "true",
		"message": "Data cocok dengan database Dukcapil",
		"validation_fields": {
		"nik": true,
		"nama": true,
		"tanggal_lahir": true,
		"jenis_kelamin": true,
		"alamat": true,
		"pekerjaan": true,
		"status_perkawinan": true
		}
		}

These results show that all identity parameters such as NIK, name, gender, and marital status have verification values that match the Dukcapil database. Thus, the system is not only able to perform accurate text extraction, but also capable of automatic validation of population data. [8]

System Performance Evaluation

The system evaluation was carried out using 20 e-KTP images taken with a smartphone camera. The accuracy value is calculated based on the field matching between the OCR results and the correct reference data (ground truth). [2]

Table 4. Results of Extraction and Detection Performance Evaluation

No	Picture e-KTP	Accuracy OCR	IoU (YOLOv8)	Validation API
1	e-KTP 1	98.5%	0.97	Valid
2	e-KTP 2	99.0%	0.98	Valid
3	e-KTP 3	98.3%	0.96	Valid
...	...	...	...	...
Average	-	**98.7%**	**0.975**	**100% Valid**

The results show that the system is able to extract and detect text areas on e-KTP with a high degree of accuracy. In addition, validation through the DUKCAPIL API shows that all the data tested is in accordance with official data. [8]

Discussion

The experimental results substantiate the efficacy of integrating deep learning-based object detection with optimized OCR preprocessing for structured document information extraction. These findings align with theoretical frameworks proposed in computer vision literature emphasizing pipeline approaches where task-specific modules address distinct challenges sequentially rather than relying on end-to-end monolithic systems.

Several key findings merit detailed discussion. First, the 15-20% accuracy improvement over baseline OCR methods validates the cascaded architecture principle, where object detection serves as an intelligent attention mechanism directing computational resources toward relevant image regions. This approach mirrors biological visual processing, where

selective attention precedes detailed object recognition, suggesting convergent evolution of artificial and natural vision systems toward hierarchical processing strategies.

Second, the system's robustness across lighting and orientation variations demonstrates the effectiveness of adaptive preprocessing techniques. Adaptive thresholding and morphological operations functionally compensate for image degradation, enabling consistent performance despite suboptimal capture conditions. These results support theories of invariant feature extraction in computer vision, where normalization operations transform variable inputs into standardized representations suitable for downstream processing. The skew correction module particularly exemplifies this principle, achieving orientation invariance through geometric transformation.

Third, successful DUKCAPIL API validation establishes proof-of-concept for end-to-end automated identity verification systems. Previous research (Verma et al., 2024) emphasized the importance of database integration for e-KYC (electronic Know Your Customer) applications but lacked empirical validation of extraction quality sufficient for official database matching. This research demonstrates that computer vision-based extraction can achieve data quality parity with manual entry, enabling trustworthy automated workflows. The 100% validation success rate suggests extracted data meets governmental data quality standards, addressing a critical gap between research prototypes and production-ready systems.

The findings also illuminate limitations of pure deep learning approaches for this application domain. While end-to-end neural OCR systems (e.g., CRNN, Transformer-based models) show promise in generic text recognition, they require extensive training data and computational resources. The proposed hybrid approach—combining specialized object detection with classical preprocessing and established OCR engines—achieves comparable or superior performance while remaining deployable on mid-specification hardware. This pragmatic design philosophy prioritizes practical accessibility over theoretical elegance, particularly relevant for resource-constrained deployment contexts in developing economies.

Fourth, performance analysis reveals field-specific accuracy variations corresponding to inherent text characteristics. Fields containing numerical data (NIK, RT/RW) achieved 99.3% average accuracy, while address fields averaged 97.8% accuracy. This discrepancy reflects address text variability including abbreviations, nonstandard formatting, and handwritten annotations in some samples. These patterns suggest future research directions, including field-specific preprocessing optimization and post-OCR correction using domain knowledge (e.g., known province/city names for geographic validation).

The operational efficiency demonstrated by 2.8-second processing time represents a critical practical achievement. Administrative workflows involve batch processing of multiple documents, where per-document latency directly impacts operational throughput. The 16-32x speedup compared to manual entry translates to substantial labor cost reduction and capacity expansion for organizations. For context, processing 100 e-KTP documents manually requires approximately 90-150 minutes of staff time, while automated processing completes in under 5 minutes, enabling single-operator batch workflows previously requiring multiple personnel.

From a broader perspective, this research contributes to the emerging field of administrative automation in developing economies. While automation technologies are well-established in developed nations, their adaptation to infrastructure constraints and institutional contexts of developing countries remains underexplored. By demonstrating feasibility on

accessible hardware and integrating with existing governmental systems (DUKCAPIL), this work provides a replicable blueprint for similar identity verification applications across Southeast Asia and other regions facing comparable administrative challenges.

Limitations of the current implementation merit acknowledgment. The training dataset, while diverse in capture conditions, remains geographically concentrated within Java and Sumatra provinces. Provincial e-KTP templates exhibit minor design variations that may affect generalization to underrepresented regions. Additionally, the system currently handles standard-condition documents; severely damaged, partially obscured, or heavily worn cards present challenges requiring future investigation. The DUKCAPIL API integration, while functional, depends on network connectivity and API availability, creating potential single points of failure in offline deployment scenarios.

CONCLUSION

This research successfully developed and validated an integrated e-KTP data extraction and validation system combining YOLOv8-based object detection with optimized OCR preprocessing, addressing critical challenges in automated population data administration for Indonesia. The system achieves average extraction accuracy of 98.7% with mean IoU of 0.975 for region detection and 100% validation success rate against the official DUKCAPIL database, representing 15-20% improvement over conventional pure OCR approaches. These results demonstrate that strategic integration of deep learning object detection with classical preprocessing techniques provides a robust, efficient, and economically viable solution for automating identity verification processes, particularly suitable for resource-constrained small non-governmental organizations, cooperatives, and community administrative units. The system's ability to operate on mid-specification hardware (Intel Core i5, NVIDIA GTX 1660 Ti) while maintaining real-time processing performance (2.8 seconds per document) establishes practical deployment feasibility across diverse organizational scales. By enabling automated validation against authoritative government databases, the system addresses critical security concerns regarding data forgery and transcription errors while accelerating administrative workflows by 16-32 times compared to manual methods. These contributions advance Indonesia's digital transformation agenda by demonstrating scalable, accessible pathways for implementing AI-enabled administrative systems that balance accuracy, efficiency, and trustworthiness. Future research should expand the training dataset to encompass all 38 provincial templates with emphasis on extreme condition variations, develop web-based and mobile applications with intuitive interfaces for non-technical users, integrate advanced deep learning OCR engines (e.g., PP-OCRv5, TrOCR) to further improve accuracy on degraded documents, implement Natural Language Processing techniques for semantic validation and error correction of extracted text, and explore offline-capable architectures with edge computing to eliminate dependency on continuous network connectivity. With these enhancements, the system has significant potential to become a foundational component of Indonesia's national population administration digitization ecosystem, contributing to more efficient, secure, and inclusive governmental services.

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