

Leveraging Deep Learning to Enhance Consular Services in Indonesia

I. Introduction

The provision of efficient and excellent consular services is of paramount importance for Indonesia, a nation with a significant number of citizens residing and traveling abroad. These services form a crucial link between the state and its people overseas, encompassing a wide array of needs from facilitating routine administrative procedures such as passport and visa issuance to providing critical support during emergencies and times of crisis. The quality and accessibility of these services directly influence the well-being, security, and overall experience of Indonesian nationals in foreign countries, playing a vital role in shaping the nation's global image and fostering positive international relations.

Artificial Intelligence (AI), and more specifically its subfield Deep Learning, has emerged as a transformative force across numerous sectors, demonstrating its capacity to revolutionize the delivery of public services. Deep Learning's ability to analyze vast amounts of data and discern intricate patterns enables the automation of repetitive tasks, provides deeper insights for informed decision-making, and ultimately enhances the efficiency, accessibility, and overall quality of services offered by governmental bodies.¹ Examples from diverse public sectors such as healthcare, transportation, security, and citizen support illustrate the broad applicability and tangible benefits that can be realized through the adoption of AI technologies.

While Indonesia has taken initial steps in exploring the application of AI within its public service landscape through initiatives like SahabatAI and SARI⁸, there remains a significant opportunity to further harness the advanced capabilities of Deep Learning to specifically elevate the standards of its consular services. Identifying the precise areas within Indonesian consular operations where Deep Learning can address existing limitations in efficiency, accessibility, and quality, while also anticipating and meeting the evolving needs of Indonesian citizens abroad, constitutes the central problem that this research endeavors to explore.

To address this problem, this research aims to achieve the following objectives: first, to conduct a comprehensive exploration of the current landscape of Artificial Intelligence applications within public services globally, excluding Indonesia; second, to analyze existing AI implementations specifically within consular services by governments worldwide, identifying successful use cases, challenges encountered, and lessons learned; third, to evaluate the functionalities, strengths, and weaknesses of current Indonesian AI initiatives relevant to public service and citizen support, namely NLP SahabatAI and SARI (Sahabat Artifisial Migran Indonesia); fourth, to investigate the state-of-the-art advancements in Deep Learning and Natural

Language Processing techniques that hold potential for enhancing consular service delivery; and fifth, to propose a Deep Learning-based framework tailored to the specific needs and context of Indonesian consular services, outlining its architecture, functionalities, and methodology for training and evaluation.

II. Literature Review

- **Artificial Intelligence in Public Services: A Global Perspective (Excluding Indonesia)**

- Examination of AI applications in various public sectors (e.g., healthcare, transportation, security).

Governments across the globe are increasingly recognizing the transformative potential of AI in reshaping the delivery of public services. The adoption of AI technologies allows for the automation of routine tasks, leading to streamlined processes and improved efficiency. By enhancing situational awareness and improving compliance, AI empowers government employees to concentrate on tasks that require higher-level cognitive functions and direct engagement with the public.¹ For instance, AI-driven tools can accelerate crisis response by analyzing real-time infrastructure data, enhance citizen engagement through AI-powered virtual assistants, and bolster data security through advanced threat detection and compliance monitoring.¹ In the realm of procurement, AI can assist officers by analyzing vendor proposals and ensuring adherence to regulations, thereby optimizing decision-making processes.¹

Deep Learning, a subfield of AI, is also playing a crucial role in various public sectors. It is being utilized for public safety initiatives, infrastructure monitoring, and the automation of document processing, demonstrating its versatility in addressing diverse governmental needs.⁵ Furthermore, predictive analytics, powered by AI, enables governments to make more informed decisions regarding resource allocation, policy formulation, and the anticipation of citizens' needs.⁵ Concrete examples of this include the US Department of Defense's use of AI for predictive maintenance of aircraft systems, allowing for proactive interventions before failures occur.⁵ Similarly, the US Social Security Administration employs predictive analytics to proactively identify and address potential service delivery issues, ensuring smoother operations.⁵

Beyond these examples, AI is enhancing public safety through the implementation of predictive policing systems and improving disaster response capabilities by processing real-time data from various sources.⁵ In urban planning, AI technology is used to evaluate data on population trends,

energy consumption patterns, and traffic flow, leading to more efficient and sustainable urban development.⁵ Moreover, AI is enabling the delivery of personalized citizen services in critical sectors like healthcare and education by tailoring services to meet the unique needs of each individual.⁵ Finally, AI facilitates data-driven policy-making by analyzing large datasets to identify trends and patterns, and it modernizes tax collection processes through the detection of tax evasion patterns.⁵ The integration of AI-powered tools, particularly generative AI, is further enhancing the efficiency and reach of citizen services by providing round-the-clock access through chatbots and intelligent virtual assistants.⁶ These tools can simplify complex procedures, provide immediate assistance, and even help citizens complete application forms.⁶ In healthcare, AI can optimize the allocation of resources by analyzing patient data and hospital capacities, ensuring that critical public health needs are met effectively.⁶ The education sector is also benefiting from AI, which enables personalized learning experiences by analyzing individual learning patterns and tailoring content and assessments accordingly.⁶ Furthermore, AI plays a vital role in preventing identity theft and other forms of fraud by detecting unusual patterns of activity in real-time.⁶ Deep Learning, with its ability to analyze complex datasets, is enabling governments to improve outcomes while reducing costs in areas such as detecting tax evasion, tracking the spread of infectious diseases, and enhancing surveillance and security measures.⁷ AI-powered systems can also analyze traffic patterns, road conditions, and accidents to significantly reduce traffic congestion, leading to improved commuting times and reduced fuel consumption.⁷ Sentiment analysis, leveraging Deep Learning algorithms, allows governments to better understand public queries, requirements, and complaints, enabling proactive responses and improved citizen engagement.⁷

Insight: The extensive and varied applications of AI across global public sectors highlight its potential to drive significant improvements in efficiency, service quality, and citizen satisfaction. The examples in healthcare, security, and transportation, which often involve critical and sensitive operations, suggest that AI can be effectively adapted to the specific needs of consular services. The trend towards personalized and proactive service delivery through AI also presents a valuable direction for enhancing citizen experience in the consular domain.

Chain of Thought: The successful integration of AI in diverse public sectors, addressing challenges ranging from resource optimization to enhanced security and personalized services, builds a strong case for its applicability to consular services. The common threads of automation, data-driven

decision-making, and improved citizen engagement observed across these sectors can serve as guiding principles for exploring AI adoption in the Indonesian consular context.

- In-depth analysis of AI implementations within consular services by governments worldwide (e.g., triage, information dissemination, fraud detection).

Several governments are already leveraging AI to modernize their consular services, demonstrating the technology's growing importance in this specialized domain. The UK's Foreign, Commonwealth and Development Office (FCDO) has taken a significant step by deploying an AI-powered triage system for consular inquiries. This system is designed to provide UK citizens living or traveling overseas with rapid responses to their questions, reducing wait times from days to mere seconds.¹⁸ The FCDO anticipates that this is just the beginning, predicting that AI and other new technologies will fundamentally transform diplomatic practice in the coming years, enhancing diplomatic impact and boosting productivity.¹⁸

The US Department of State is also actively engaged in exploring and implementing AI across its Consular Affairs (CA) operations. Their initiatives include the use of an AI text editor to refine the readability of public-facing content on travel.state.gov, ensuring that information regarding international travel safety and security is clear and accessible.¹⁹ Furthermore, CA employs AI through its Predictive Analytics Platform for various applications, including checking the quality of passport photos submitted during online renewals, providing immediate feedback to applicants.¹⁹ AI is also used to measure the impact of consular service changes on key outcomes like efficiency and customer experience, allowing for better prediction of future impacts.¹⁹

Natural Language Processing (NLP) and secure Large Language Models (LLMs) are leveraged to evaluate customer feedback and sentiments from unstructured text data, identifying actionable insights for service improvement initiatives.¹⁹ Additionally, AI translation models are used to increase the capacity to provide consular content on websites in customers' preferred languages, ensuring accuracy while reducing resource needs.¹⁹ The Department also has plans for future AI applications, such as a FOIA Web ML Document Indexer and a Violence Against Civilians Model.¹⁹

Beyond these specific examples, AI can broadly assist in consular services by automating routine operations and supporting human cognition through data analysis and pattern identification in service demand.²⁰ For instance, AI could serve as a digital consul assistant, managing the uneven demand for services like emergency passports and visas by identifying peak periods and helping to

allocate resources effectively.²⁰ In times of crisis, AI systems can aid embassies and Ministries of Foreign Affairs (MFAs) by analyzing the nature and severity of events in real-time, streamlining the decision-making process, and managing public expectations.²⁰ Moreover, AI can improve the customer experience for routine tasks like passport applications and visa vetting by automating standard submission steps and identifying potential bottlenecks.²¹ It also offers the potential to detect patterns indicative of organized visa fraud rings, highlighting suspicious links between seemingly independent travelers for review by human adjudicators.²¹ Predictive techniques can help forecast demand for consular services, enabling better resource planning, and simulations can be used to assess the potential impacts of changes in eligibility criteria or processes on revenue, resource allocation, and migration patterns.²¹

Insight: The adoption of AI in consular services by entities like the FCDO and the US Department of State demonstrates a clear trend towards leveraging this technology to enhance efficiency, improve citizen experience, and address specific operational challenges such as fraud detection and demand forecasting. Their focus on NLP and LLMs for tasks like customer feedback analysis and translation highlights the relevance of these techniques for the Indonesian context.

Chain of Thought: The initiatives undertaken by leading consular authorities provide concrete examples of how AI can be applied to streamline various aspects of consular operations. By examining their specific use cases and the technologies they employ, Indonesia can gain valuable insights into potential high-impact areas for AI implementation in its own consular services.

- Identification of common challenges, research gaps, and future directions in the application of AI in these domains, with potential relevance to the Indonesian context.

Despite the promising applications of AI in government and consular services, several common challenges need to be addressed. Financial constraints often pose a significant barrier to AI adoption, particularly for agencies operating on tight budgets.² Additionally, a shortage of professionals with the necessary AI skills can hinder the development and implementation of effective solutions.² Many government agencies also rely on outdated IT infrastructure that may not be readily compatible with modern AI technologies, requiring costly upgrades.²³ Furthermore, managing the complexities of data, including ensuring its quality, accessibility, security, and privacy, is crucial for successful AI implementation but often presents a significant hurdle.² Ethical considerations, such as the potential for

algorithmic bias and the need to protect citizen privacy, demand careful attention throughout the AI development and deployment process.² Building trustworthy AI systems requires a focus on objectivity, transparency, and accountability, with robust oversight mechanisms in place.²

Several research gaps also exist in the field of AI for government services. There is a need for clearer and more consistent terminology around 'AI' to facilitate better understanding and effective use within the public sector.²⁶ A comprehensive understanding of where AI is currently deployed across government and more rigorous evidence on the actual effectiveness and impact of AI tools in public sector settings are also lacking.²⁶ Further research is needed to better understand and address the specific data challenges within different public sector domains, as well as the intricate sociotechnical dynamics surrounding AI deployment.²⁶ Additionally, there are weaknesses in existing AI governance mechanisms and public procurement processes that need to be addressed to ensure responsible and value-driven AI adoption.²⁶ More specifically within the realm of citizen services, research could explore the full potential of AI and machine learning beyond current pilot stages, delve into predictive AI capabilities, investigate AI applications based on non-query data, and explore the use of AI for emergency response and personalized education.²⁷ Further investigation into AI for detecting fraud and corruption, improving crime reporting, proactive social service interventions, proactive infrastructure repairs, and anticipating cyberattacks is also warranted.²⁷ Looking towards the future, several trends and directions are emerging in the application of AI in public services. This includes the development of multimodal AI capable of analyzing various data formats, the evolution from simple chatbots to more sophisticated AI agents, the use of AI to enhance knowledge work through assistive search, and a growing emphasis on creating seamless and personalized experiences for citizens.²⁸ Governments will need to establish robust governance structures to oversee the development and deployment of AI, while also addressing challenges related to data privacy, security, and potential workforce disruptions.³ Future work should prioritize the ethical and responsible utilization of AI, ensuring fairness, transparency, and accountability in its application within the public sector.²⁹

Insight: The challenges and research gaps identified globally highlight key considerations for Indonesia as it seeks to enhance its consular services with AI. Addressing issues like financial constraints, skill development, data management, and ethical implications will be crucial for successful implementation. The future directions point towards more sophisticated and integrated AI solutions that Indonesia could strategically pursue.

Chain of Thought: By understanding the common hurdles faced by other nations in their AI adoption journeys, Indonesia can proactively plan and implement strategies to mitigate these challenges within its consular services. The identified research gaps provide potential areas for further investigation and innovation, while the future directions offer a glimpse into the evolving landscape of AI in public service delivery.

- **Current AI Initiatives in Indonesian Public Services**

- Comprehensive review of NLP SahabatAI: its architecture, functionalities, applications within public services, and identified strengths and weaknesses. Sahabat-AI stands as a significant milestone in Indonesia's journey towards leveraging Artificial Intelligence for the benefit of its citizens. This open-source Large Language Model (LLM) ecosystem, a collaborative effort between Indosat Ooredoo Hutchison (IOH) and PT GoTo Gojek Tokopedia Tbk (GoTo Group), is specifically designed to understand and generate text in Bahasa Indonesia and various regional dialects.¹⁰ The primary aim of Sahabat-AI is to elevate the status of local languages in the digital sphere, promote linguistic diversity across the Indonesian archipelago, and reduce the nation's reliance on foreign AI models that may not fully grasp the nuances of the local context.¹⁰

The capabilities of Sahabat-AI are multifaceted, encompassing general language understanding, the ability to follow instructions provided in natural language, translation between English, Indonesian, Javanese, and Sundanese, and the generation of various forms of textual content.⁸ Functioning as a shared platform, Sahabat-AI offers personalized services tailored to meet the specific needs of business customers, thereby facilitating seamless business-to-government (B2G) and business-to-business (B2B) interactions.¹⁰ Initial use cases demonstrate its potential in simplifying traditionally complex government services, such as providing guidance on KTP (national identity card) applications, clarifying taxation procedures, and assisting with updates to personal information like address or marital status.¹⁰ Furthermore, Sahabat-AI powers Dira, GoTo's voice assistant integrated into the Gojek and GoPay applications, enabling users to effortlessly access services through voice commands in local languages.¹⁰

In its initial phase, Sahabat-AI was launched with LLMs containing 8-billion and 9-billion parameters, made freely available for download on the Hugging Face platform.¹¹ This open-source approach fosters a collaborative environment, inviting contributions from research institutions, universities, media organizations, government agencies, and other partners to further enhance this Indonesian AI technology.¹¹ The strengths of Sahabat-AI lie in its

specific focus on Indonesian languages, its capacity to accurately follow instructions, its impressive performance in benchmark evaluations, and its inherent flexibility for application across a wide range of tasks.⁸ However, some evaluations have indicated potential weaknesses, including observed biases related to race and inconsistencies in reasoning concerning age.³³

Additionally, current versions of Sahabat-AI require developers to undertake their own safety fine-tuning, highlighting an area for further development.³⁴

Insight: Sahabat-AI represents a foundational asset for Indonesia in the realm of indigenous AI development. Its commitment to local languages and its open-source nature create a unique opportunity to build customized solutions for public services, including the specific needs of consular services. The identified biases, however, underscore the importance of rigorous testing and ethical considerations in its application.

Chain of Thought: The development of a national-level LLM like Sahabat-AI signifies a strategic move towards empowering Indonesia with its own AI capabilities. This initiative provides a culturally and linguistically relevant foundation upon which to build specialized AI applications for various sectors, including the potential enhancement of consular services.

- Detailed analysis of SARI (Sahabat Artifisial Migran Indonesia): its purpose, features, target users, and reported impact or limitations.

SARI, which stands for Sahabat Artifisial Migran Indonesia (Artificial Friend of Indonesian Migrants), is an AI-powered online assistant developed through a collaborative effort between the Indonesian Ministry of Foreign Affairs and UN Women Indonesia.¹⁴ Launched in April 2025, SARI is specifically designed to address the information needs of Indonesian migrant workers (PMI), with a particular focus on women, who constitute a significant portion of this demographic.¹⁴ The primary purpose of SARI is to bridge the information gap often faced by migrant workers by providing accessible, unbiased, and non-discriminatory information, especially to those who may be vulnerable to violence and exploitation.¹⁴

SARI complements existing digital platforms developed by the Ministry of Foreign Affairs, such as the Portal Peduli WNI (Care for Indonesian Citizens Portal) and the Safe Travel application.¹⁴ A key feature of SARI is its ability to respond to user input in various Indonesian regional languages, recognizing that many migrant workers may primarily communicate in their local dialects when they venture abroad.¹⁵ This multilingual capability is crucial for ensuring that language barriers do not impede access to vital information and support. SARI aims to provide real-time information delivery and improved access to essential services for female migrants without judgment, acting as a friendly

virtual assistant that bridges the distance between the government and its citizens working overseas.¹⁴ The development of SARI is considered a form of digital solidarity and artificial empathy, striving to make information more equitable and accessible for Indonesian migrant workers.¹⁴ The Ministry of Foreign Affairs intends to promote SARI within migrant worker communities through collaborations with local media outlets and migrant worker organizations, including exploring a partnership with Radio Republik Indonesia (RRI) to reach remote areas.¹⁴ SARI is integrated as an additional feature within the Ministry's 'Safe Travel' application, making it readily available to its target users.¹⁵ The development of SARI reflects the Indonesian government's commitment to leveraging technology, including AI, to enhance the support and protection of its citizens residing overseas.¹⁶ The AI technology powering SARI is being designed with the capacity to detect the language used by the migrant worker and respond with empathy, aiming to create a supportive and understanding interaction.¹⁶

Insight: SARI represents a targeted application of AI to address the specific challenges faced by Indonesian migrant workers, particularly women. Its focus on multilingual support and unbiased information delivery highlights the potential of AI to enhance inclusivity and provide critical assistance to vulnerable populations within the consular service domain.

Chain of Thought: The development of SARI underscores the Indonesian government's proactive approach to utilizing AI for enhancing consular services. By focusing on the unique needs of migrant workers and providing support in their native languages, SARI demonstrates a commitment to leveraging technology for citizen well-being and protection on an international scale.

- **State-of-the-Art in Deep Learning and Natural Language Processing for Service Enhancement**

- Overview of relevant Deep Learning architectures and techniques applicable to consular service enhancement (e.g., Transformers, Recurrent Neural Networks).

Deep Learning, a subset of artificial intelligence, has achieved remarkable success in various domains, including Natural Language Processing (NLP). Its ability to learn complex patterns from vast amounts of data makes it exceptionally well-suited for enhancing consular services. Among the relevant Deep Learning architectures, Transformer networks have emerged as a state-of-the-art approach for handling sequential data, particularly in NLP tasks. Their self-attention mechanisms allow them to capture long-range dependencies within text, making them highly effective for tasks such as

machine translation, text summarization, and question answering, which are all pertinent to consular service enhancement.³⁵ Recurrent Neural Networks (RNNs), especially their variants like Long Short-Term Memory (LSTM) networks, are also crucial Deep Learning techniques for processing sequential data. LSTMs are particularly effective at remembering information over extended sequences, making them valuable for tasks like sentiment analysis, language modeling, and potentially for understanding the context of lengthy consular inquiries.³⁶

- Exploration of current SOTA in multilingual chatbots, information retrieval, sentiment analysis, and automated document processing using NLP and Deep Learning.

The field of multilingual chatbots has witnessed significant advancements, with state-of-the-art models now capable of engaging in conversations across multiple languages with increasing fluency and contextual understanding.³⁸ These advancements are largely attributed to the use of deep learning techniques, including neural networks that can understand the nuances, slang, and dialects of different languages. Models like Meta's SeamlessM4T represent a push towards even more sophisticated multilingual solutions, aiming to provide real-time translation across numerous languages, effectively breaking down communication barriers.³⁸

Information retrieval (IR), the task of finding relevant information from a collection of resources, has been significantly enhanced by Deep Learning and NLP. Current state-of-the-art systems leverage neural ranking models that use shallow or deep neural networks to rank search results based on their relevance to a user's query.⁴⁰ Techniques like semantic search, which focuses on understanding the meaning behind queries rather than just matching keywords, and personalized recommendations, which tailor results to individual user preferences, have also seen substantial improvements due to Deep Learning.⁴¹

Sentiment analysis, the process of determining the emotional tone or attitude expressed in a piece of text, has also benefited greatly from Deep Learning. Models like BERT (Bidirectional Encoder Representations from Transformers) have achieved state-of-the-art performance on various sentiment analysis benchmarks, demonstrating their ability to understand context and capture subtle emotional cues in language.³⁶

Automated document processing (ADP), which involves digitizing and extracting information from documents, is another area where Deep Learning and NLP are making significant strides. Intelligent Document Processing (IDP) systems now utilize technologies like Optical Character Recognition (OCR),

NLP, and Deep Learning to accurately and efficiently handle complex documents, automating tasks such as classification, data extraction, and validation, leading to improved workflows and reduced manual effort.⁴⁷

- Discussion of recent advancements and emerging trends in Deep Learning and NLP research (2024-2025), drawing from key conferences (ACL, EMNLP, NeurIPS, ICML) and arXiv publications.

Recent years have witnessed rapid advancements in the field of Deep Learning and NLP, with significant contributions presented at key conferences like ACL (Association for Computational Linguistics), EMNLP (Empirical Methods in Natural Language Processing), NeurIPS (Neural Information Processing Systems), and ICML (International Conference on Machine Learning), as well as on the arXiv preprint server. One prominent trend is the development of Large Language Models (LLMs) with increasingly long context windows, enabling them to process and generate more extended sequences of text. Research is also focusing on improving the ability of LLMs to generate coherent and contextually rich long-form outputs, which has implications for tasks like summarizing lengthy consular documents or handling complex, multi-turn inquiries.⁵¹

There is a growing emphasis on understanding the inner workings of LLMs, including efforts to benchmark their robustness and uncertainty, and to leverage them for complex reasoning tasks across various domains.⁵³ The concept of "culture" in NLP is also gaining traction, with researchers exploring ways to build language models that are more sensitive to cultural nuances, which is particularly important for applications in multilingual and multicultural contexts like Indonesian consular services.⁵⁴ The sheer volume of research related to LLMs continues to grow, indicating the intense interest and rapid progress in this area.⁵⁵ Memory management within LLMs is also a critical area of investigation, with studies focusing on how to effectively store, retrieve, and utilize information over both short and long timeframes.⁵⁷ As LLMs become more prevalent in multilingual settings, the need for robust evaluation methods that can assess their performance across a diverse range of languages is also increasing.⁵⁸ Retrieval-Augmented Generation (RAG) remains a significant research direction, aiming to enhance the factual accuracy and reliability of LLMs by integrating them with external knowledge sources, a technique highly relevant for providing accurate consular information.⁵⁰ Researchers are also exploring the potential of using LLMs as encoders for machine translation and developing specialized multilingual models for domains like healthcare.⁶² Ensuring the safety and ethical use of LLMs is another key focus, with efforts to develop datasets and methods for

evaluating and improving their safety.⁶⁴ Finally, the paradigm of human-model cooperation is emerging, with research exploring how humans and LLMs can effectively collaborate on various NLP tasks.⁶⁵

III. Proposed Deep Learning Framework for Enhanced Indonesian Consular Services

- Identification of specific areas within Indonesian consular services that can be significantly improved through Deep Learning (e.g., handling citizen inquiries, document processing, personalized assistance).
 - **Handling Multilingual Citizen Inquiries:** A Deep Learning-powered multilingual chatbot, building upon the foundations of Sahabat-AI and leveraging state-of-the-art Transformer architectures, can be developed to handle the diverse linguistic needs of Indonesian citizens. This chatbot can provide instant responses to frequently asked questions across various consular service domains (e.g., visa requirements, passport procedures, emergency assistance), significantly reducing wait times and freeing up consular staff for more complex cases. The system should be trained on a comprehensive dataset of consular inquiries in Bahasa Indonesia and key regional languages.
 - *Insight:* The implementation of a sophisticated multilingual chatbot can address the significant challenge of linguistic diversity in Indonesia, ensuring that all citizens can access consular information and support in their preferred language, thereby enhancing inclusivity and service satisfaction.
 - *Chain of Thought:* Indonesia's rich linguistic landscape necessitates a solution that goes beyond standard Bahasa Indonesia. By leveraging a Deep Learning model trained on regional languages, the chatbot can provide a more personalized and accessible experience for a larger segment of the population.
 - **Automated Consular Document Processing and Verification:** Deep Learning models, combining OCR with advanced NLP techniques, can be employed to automate the processing and verification of various consular documents, such as visa applications, passport renewals, and citizen registration forms. This can streamline workflows, reduce manual data entry errors, and accelerate processing times. The system can be trained to identify and extract key information from these documents, perform initial verification checks against relevant databases, and flag any potential discrepancies or fraudulent submissions.
 - *Insight:* Automating document processing can lead to substantial gains in

efficiency and accuracy, reducing the administrative burden on consular staff and enabling faster service delivery to citizens. This is particularly crucial for high-volume services like visa and passport applications.

- *Chain of Thought:* The sheer volume of consular documents processed annually necessitates an automated solution. Deep Learning's ability to learn complex document structures and extract relevant information accurately can significantly expedite these processes.
- **Personalized Consular Assistance and Predictive Services:** By applying Deep Learning-based sentiment analysis to citizen inquiries and feedback, the system can identify urgent cases and citizens who may require additional support. Furthermore, by analyzing historical data and citizen profiles (with appropriate privacy safeguards), the framework can potentially predict upcoming needs for consular services (e.g., passport renewals based on expiration dates, visa extensions for long-term residents), enabling proactive communication and personalized assistance.
 - *Insight:* Providing personalized and proactive assistance can significantly enhance citizen satisfaction and trust in consular services. Identifying urgent cases ensures timely intervention, while anticipating future needs can prevent potential issues for citizens.
 - *Chain of Thought:* A one-size-fits-all approach to consular services may not adequately address the diverse needs of Indonesian citizens abroad. Deep Learning can enable a more nuanced and personalized approach, catering to individual circumstances and proactively addressing potential issues.
- Adaptation and improvement of existing AI models and research findings from the literature review to address the identified needs of Indonesian consular services.
 - The proposed multilingual chatbot module can be adapted from state-of-the-art Transformer models, fine-tuned on a large, curated dataset of Indonesian consular inquiries and leveraging transfer learning from existing multilingual models and Sahabat-AI.
 - The automated document processing module can be built using a combination of pre-trained CNNs for image processing and Transformer-based models for text extraction and verification, fine-tuned on specific Indonesian consular document formats.
 - The personalized assistance module can utilize sentiment analysis models adapted for Bahasa Indonesia and regional languages, combined with predictive modeling techniques to anticipate citizen needs based on historical data and profiles.
- Detailed proposal of a Deep Learning-based framework, outlining the

architecture, key components, and intended functionalities for enhancing service delivery.

- **Architecture:** A modular, cloud-based framework comprising three core modules: a **Multilingual Consular Chatbot**, an **Automated Document Processing System**, and a **Personalized Assistance and Prediction Engine**, all integrated through a secure **Central Data Repository**.
- **Key Components:**
 - **Multilingual Consular Chatbot Module:** Employs a Transformer-based LLM (e.g., fine-tuned Llama3 or Gemma2 based on Sahabat-AI) capable of understanding and responding in Bahasa Indonesia and major regional languages. Includes intent recognition, dialogue management, and a comprehensive knowledge base of consular information.
 - **Document Processing Module:** Integrates OCR technology with Deep Learning models (e.g., CNNs and Transformers) for intelligent extraction and verification of data from various consular documents (e.g., visa applications, passport forms). Includes modules for fraud detection and anomaly flagging.
 - **Personalized Assistance and Prediction Engine:** Utilizes Deep Learning-based sentiment analysis models to assess the urgency and emotional tone of citizen communications. Employs predictive modeling techniques to anticipate future consular service needs based on historical data and citizen profiles (e.g., passport expiry prediction).
 - **Central Data Repository:** A secure and scalable database for storing and managing citizen data, document information, interaction logs, and model training data, ensuring compliance with data privacy regulations.
- **Intended Functionalities:**
 - Providing instant, accurate, and multilingual responses to a wide range of consular inquiries 24/7.
 - Automating the initial processing and verification of consular documents, reducing manual workload and processing times.
 - Identifying and prioritizing urgent cases and citizens in distress through sentiment analysis.
 - Offering personalized information, guidance, and proactive notifications to citizens based on their individual needs and predicted service requirements.
 - Facilitating seamless communication between citizens and consular staff, with options for escalating complex issues to human agents.

IV. Training and Evaluation Methodology

- **Data Acquisition and Preprocessing:** Description of potential data sources for training the Deep Learning model (e.g., historical consular inquiries, FAQs, relevant policy documents) and the planned data preprocessing steps.
 - **Data Sources:**
 - Anonymized historical logs of citizen inquiries submitted through various channels (email, phone, in-person) to Indonesian consulates worldwide.
 - A comprehensive collection of Frequently Asked Questions (FAQs) and their official answers pertaining to all aspects of Indonesian consular services.
 - Digitized versions of relevant Indonesian government policy documents, regulations, and guidelines related to consular affairs.
 - Potentially publicly available large-scale Indonesian language datasets for pre-training or fine-tuning language models (e.g., from web crawls, news articles, social media, ensuring ethical considerations and data privacy).
 - **Data Preprocessing:**
 - **Text Normalization:** Implementing robust text cleaning techniques to handle variations in formatting, spelling errors, and informal language. This includes tasks like case conversion, removal of punctuation and special characters, and handling of abbreviations and acronyms.
 - **Tokenization and Vocabulary Building:** Employing appropriate tokenization methods (e.g., word-level, subword-level using techniques like Byte-Pair Encoding) suitable for Bahasa Indonesia and regional languages. Building a comprehensive vocabulary that covers the linguistic diversity of the data.
 - **Handling Multilingualism:** Developing strategies to effectively process and represent text in multiple Indonesian languages. This might involve using language identification tools, creating separate datasets for different languages, or utilizing techniques like multilingual embeddings.
 - **Data Augmentation:** Applying various data augmentation techniques relevant to text data, such as synonym replacement, back-translation, and random insertion/deletion of words, to increase the size and robustness of the training datasets for the chatbot and sentiment analysis modules. For document processing, augmentation might involve techniques like slight image rotations, translations, and noise addition to improve OCR robustness.
 - **Document Preprocessing:** For the automated document processing system, this will involve using high-accuracy OCR engines to convert scanned documents into machine-readable text. This will be followed by text normalization and tokenization as described above. Additionally,

document layout analysis might be necessary to correctly identify and extract information from different sections of the documents.

- **Model Training:** Specification of the chosen Deep Learning model, training parameters, optimization techniques, and computational resources required.
 - **Chosen Deep Learning Models:**
 - **Multilingual Consular Chatbot:** A pre-trained Transformer-based Large Language Model (LLM) like Llama3-8B or Gemma2-9B, potentially initialized with weights from Sahabat-AI, will be fine-tuned on the processed consular inquiry and FAQ dataset.
 - **Automated Document Processing System:** A combination of a pre-trained Convolutional Neural Network (CNN) for feature extraction from document images and a Transformer-based sequence-to-sequence model for information extraction. Models like ResNet or EfficientNet could be used for the CNN backbone, and a model like BERT or RoBERTa for the text processing component.
 - **Personalized Assistance and Prediction Engine:** A pre-trained multilingual Transformer model (e.g., a variant of BERT or XLM-RoBERTa) will be fine-tuned on the historical consular interaction data, labeled with sentiment and potentially indicators of future service needs.
 - **Training Parameters:** Key hyperparameters for each model, such as learning rate, batch size, number of training epochs, dropout rate, and weight decay, will be determined through experimentation and validation on a held-out development set. Techniques like learning rate scheduling (e.g., cosine annealing) and early stopping will be employed to optimize training.
 - **Optimization Techniques:** The AdamW optimizer will likely be used due to its effectiveness in training Transformer models. Gradient clipping will be implemented to prevent exploding gradients. For large models, techniques like parameter-efficient fine-tuning (PEFT) methods (e.g., LoRA, Adapter layers) might be considered to reduce computational costs.
 - **Computational Resources:** Training these Deep Learning models will require significant computational resources. Access to GPUs (e.g., NVIDIA A100 or H100) will be essential. Cloud-based platforms like Google Cloud, AWS, or Azure, which offer scalable GPU resources, will be considered for training and potentially deployment.
- **Evaluation Strategy:** Definition of appropriate evaluation metrics (e.g., accuracy, efficiency, user satisfaction) and a comprehensive evaluation plan, including testing scenarios and comparison with existing methods or baseline systems.
 - **Evaluation Metrics:**
 - **Multilingual Consular Chatbot:**

- **Accuracy/Precision/Recall/F1-score:** To measure the correctness and completeness of the chatbot's responses compared to a ground truth dataset of inquiries and answers.
- **BLEU and ROUGE scores:** To evaluate the fluency and relevance of the generated text responses.
- **User Satisfaction:** Measured through surveys and feedback forms collected from users interacting with the chatbot.
- **Response Time:** To assess the efficiency of the chatbot in providing timely responses.
- **Automated Document Processing System:**
 - **Accuracy of Information Extraction:** Measured as the percentage of correctly extracted key fields from consular documents.
 - **Document Processing Time:** To evaluate the efficiency of the automated system compared to manual processing.
 - **Error Rate:** Assessing the frequency of incorrect extractions or verifications.
- **Personalized Assistance and Prediction Engine:**
 - **Sentiment Analysis Accuracy:** Measured as the percentage of correctly classified sentiment (e.g., positive, negative, neutral, urgent).
 - **Prediction Accuracy:** Evaluating the accuracy of predicting future service needs (e.g., passport renewal within a specific timeframe).
- **Evaluation Plan:**
 - **Benchmarking:** Comparing the performance of each module of the proposed framework against existing methods used in Indonesian consular services (if quantifiable metrics are available) and against baseline Deep Learning models trained on similar datasets.
 - **Testing Scenarios:** Developing a diverse set of test cases that cover various types of consular inquiries, document formats, and citizen profiles to comprehensively evaluate the framework's performance under different conditions.
 - **User Studies:** Conducting pilot studies with a representative group of Indonesian citizens to assess the usability, effectiveness, and overall satisfaction with the AI-powered consular services in real-world scenarios. This will involve both quantitative metrics (e.g., task completion rates, satisfaction scores) and qualitative feedback.
 - **A/B Testing (Optional):** If feasible and ethically permissible, deploying the proposed framework to a limited subset of users while a control group continues to use traditional consular service methods. Comparing service delivery efficiency, user satisfaction, and other relevant metrics between

the two groups over a defined period.

V. Conclusion and Future Directions

- Summary of the potential impact of the proposed Deep Learning framework on enhancing consular services in Indonesia.
 - The proposed Deep Learning framework holds significant potential to revolutionize Indonesian consular services by providing efficient, accessible, personalized, and multilingual support to Indonesian citizens worldwide. By automating routine tasks, providing instant information, and proactively addressing citizen needs, the framework can enhance service quality, reduce workload for consular staff, and improve overall citizen satisfaction.
- Discussion of the expected contributions of this thesis to the field of AI in public services and the specific context of Indonesia.
 - This thesis is expected to contribute to the growing body of knowledge on the application of AI, particularly Deep Learning and NLP, in the public sector. It will offer a specific and in-depth exploration of how these technologies can be tailored to the unique requirements of consular services within the Indonesian context, considering its linguistic diversity and existing national AI initiatives. The research will also contribute to understanding the challenges and best practices for developing and evaluating AI-powered solutions for citizen support in a multilingual environment.
- Identification of potential challenges and limitations of the proposed approach.
 - Potential challenges include the acquisition of large, high-quality, and representative datasets for training the Deep Learning models, particularly for less common regional languages and specific consular document types. Ensuring data privacy and security while utilizing sensitive citizen information will be paramount. Addressing potential biases in the AI models to ensure fair and equitable service delivery across all demographics will also be a critical concern. Furthermore, the successful integration of the proposed framework with existing consular service infrastructure and the need for ongoing maintenance and updates to the AI models will require careful planning and resource allocation.
- Recommendations for future research and development in leveraging Deep Learning and NLP for further advancements in consular services.
 - Future research could explore more advanced Deep Learning architectures, such as attention mechanisms and memory networks, to further enhance the performance and contextual understanding of the proposed chatbot and document processing systems. Investigating techniques for continuous learning and adaptation of the AI models to evolving consular service needs,

policy changes, and emerging citizen requirements would be valuable. Exploring the potential of multimodal AI, incorporating visual information for identity verification or document analysis, could offer further enhancements. Additionally, research focused on developing robust methods for explainable AI (XAI) in consular services could increase transparency and trust in the AI-powered system. Finally, conducting thorough studies on the ethical and societal implications of deploying AI in this sensitive domain, including addressing issues of bias and ensuring equitable access, is crucial for responsible innovation.

Key Tables to Include:

- 1. **Comparison of AI Applications in Consular Services (Global)** (Section II. Literature Review - Artificial Intelligence in Public Services: A Global Perspective)

Country	AI Application Area	Deep Learning/NLP Techniques Used (if specified)	Key Benefits	Challenges Identified
UK	Triage for Consular Queries	AI-powered triage system	Reduced response times (seconds vs. days)	Not specified
US	Content Refinement (travel.state.gov)	AI Text Editor	Improved readability of public-facing content	Not specified
US	Passport Photo Quality Check	FaceVACS	Instant feedback to applicants	Not specified
US	Customer Feedback Analysis	NLP, LLMs	Actionable insights for customer improvement	Not specified
US	Translation of Consular Content	AI Translation Models	Increased capacity, reduced	Ensuring accuracy and understanding

			resource needs	
US	Enhanced Search and Chatbot (TSG)	Chatbot, Improved Search	Processes FAQs and resources for predefined responses	More advanced conversational AI needed
Canada	Triage of Temporary Residence Applications	AI (Risk Categorization)	20% drop in processing time for high-risk applicants, 87% reduction in officer review for low-risk	Not specified
Finland, etc.	Language Identification & Assessment	AI	Improved migration management	Not specified
Finland, etc.	Identity Document Fraud Detection	AI	Improved migration management	Not specified
Finland, etc.	Migration Forecasting	AI	Improved migration management	Not specified

2. Features and Capabilities of Indonesian AI Initiatives (SahabatAI and SARI)

(Section II. Literature Review - Current AI Initiatives in Indonesian Public Services)

Initiative Name	Purpose	Target Users	Key Features (including specific NLP/Deep Learning functionalities)	Strengths	Weaknesses/Limitations (if identified)
SahabatAI	Elevate local languages, promote linguistic diversity, AI	Businesses, developers, government, public	General language understanding, instruction following,	Indonesian language focus, instruction-following,	Potential racial bias, inconsistencies in age-related

	sovereignty		multilingual translation (ID, JV, SU, EN), content generation, open-source LLM ecosystem	high accuracy (benchmarks), flexibility, open-source	reasoning, safety alignment needed
SARI	Bridge information gaps, provide unbiased support for migrant workers	Indonesian migrant workers (PMI), especially women	Real-time information delivery, multilingual support (Bahasa Indonesia and regional languages), accessible via 'Safe Travel' app	Provides accessible and unbiased information, supports regional languages, targets vulnerable population	Specific limitations not detailed in snippets

3. **State-of-the-Art Deep Learning and NLP Techniques for Consular Service Enhancement** (Section II. Literature Review - State-of-the-Art in Deep Learning and Natural Language Processing for Service Enhancement)

Technique	Relevant Applications in Service Enhancement	Key Advancements (2024-2025)
Transformer Networks	Multilingual Chatbots, Automated Document Processing, Information Retrieval, Sentiment Analysis	Longer context windows, improved long-output generation, enhanced understanding and reasoning, cultural awareness
Recurrent Neural Networks (LSTMs)	Sentiment Analysis, Language Modeling, Context Understanding in Chatbots	Continued relevance for sequential data processing
Multilingual Chatbots	Handling citizen inquiries in multiple languages	More fluent and context-aware models, real-time translation capabilities

Information Retrieval (IR)	Accessing consular information, providing relevant resources	Enhanced neural ranking models, improved semantic search, leveraging external knowledge (RAG)
Sentiment Analysis	Identifying urgent cases, understanding citizen feedback	More nuanced emotion detection, handling multilingual data, addressing biases
Automated Document Processing (ADP)	Streamlining visa applications, passport renewals, citizen registration	Intelligent document understanding, accurate information extraction, workflow automation

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