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Sovereign Artificial Intelligence for Municipal Governance: A Case Study of Jazan Municipality's Local AI Ecosystem

Implementation of Open WebUI, RAG, Oracle 26ai, and Multi-Agent Systems

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ABSTRACT: Background: The enterprise intelligent assistant system has recently undergone a series of architectural and operational updates aimed at enhancing local inference efficiency, improving language model integration with internal work environments, and strengthening reliance on a sovereign infrastructure that operates entirely within the organization without data leakage to external services.

Objective: To develop and evaluate a comprehensive AI platform that enables natural language interaction with municipal databases while maintaining complete data sovereignty and supporting Arabic language requirements.

Methods: The system architecture integrates Open Web UI as the operating layer, Oracle 26ai for database intelligence, Retrieval-Augmented Generation (RAG) for document processing, and specialized AI agents for various municipal functions. Recent updates include the addition of Qwen3.5-35B-A3B-FP8 model using a specialized Docker image (hellohal2064/vllm-qwen3.5-gb10) with advanced features including Flash Infer, FP8 KV Cache, and Prefix Caching.

Results: The pilot deployment with 12 internal users demonstrated significant improvements: 77 messages processed within 24 hours, 98% reduction in document search time (from 45 minutes to under 1 minute), and 65% improvement in task completion speed. The system achieved 100% data sovereignty with zero external data transmission. Technical challenges including 100% root partition utilization were successfully resolved through cache cleanup and storage optimization.

Conclusion: This study demonstrates the feasibility and effectiveness of sovereign AI implementation in municipal governance. The proposed architecture provides a scalable model for government agencies seeking to leverage AI capabilities while maintaining data security and linguistic compatibility.

Keywords: *Sovereign AI, Local LLM, Open Web UI, RAG, Oracle 26ai, Municipal Governance, Arabic NLP, Mixture of Experts, Qwen3.5, Flash Infer*

1. INTRODUCTION

The integration of artificial intelligence (AI) into governmental operations represents a transformative shift in public administration, offering unprecedented opportunities for efficiency, transparency, and citizen engagement. However, government agencies face unique challenges when adopting AI technologies, particularly concerning data sovereignty, security compliance, and linguistic compatibility with local populations.

Data sovereignty has emerged as a critical concern for government entities worldwide. The requirement to maintain sensitive citizen and operational data within national boundaries while leveraging AI capabilities presents a significant architectural challenge. Traditional cloud-based AI solutions often involve data transmission to external servers, creating potential vulnerabilities and compliance issues.

The Kingdom of Saudi Arabia, through its Vision 2030 initiative, has prioritized digital transformation across all government sectors. Municipalities, as the primary interface between citizens and government services, stand to benefit significantly from AI adoption. However, the unique requirements of Arabic language processing,

including right-to-left (RTL) text direction and complex script handling, have limited the effectiveness of many international AI solutions.

This paper presents a comprehensive case study of Jazan Municipality's implementation of a sovereign AI ecosystem. The system addresses the aforementioned challenges through a locally-hosted architecture that maintains complete data sovereignty while providing advanced natural language processing capabilities optimized for Arabic.

2. LITERATURE REVIEW

2.1 Sovereign AI and Data Governance

The concept of sovereign AI refers to AI systems that operate entirely within a defined jurisdictional boundary, ensuring that data never leaves the controlled environment. This approach has gained traction among government agencies seeking to balance AI capabilities with data protection requirements. Previous studies have highlighted the importance of local infrastructure in maintaining data sovereignty, with several European municipalities implementing similar approaches following GDPR regulations.

2.2 Large Language Models in Government

The application of Large Language Models (LLMs) in government contexts has been explored in various studies. Brown et al. demonstrated the potential of LLMs for automating citizen inquiries, while Zhang and Liu examined the challenges of domain-specific fine-tuning. Recent advances in Mixture of Experts (MoE) architecture have enabled more efficient deployment of large models with reduced computational requirements, making local deployment more feasible for government agencies.

2.3 Arabic Natural Language Processing

Arabic NLP presents unique challenges due to the language's morphological complexity, diglossia, and script directionality. While significant progress has been made in Arabic language models, government-specific applications require

specialized handling of formal Arabic (Modern Standard Arabic) and domain-specific terminology. The Qwen series of models has demonstrated strong performance in Arabic language tasks, making them suitable candidates for government applications.

2.4 Retrieval-Augmented Generation

Retrieval-Augmented Generation (RAG) has emerged as a critical technique for grounding LLM outputs in authoritative sources. For government applications, RAG enables AI systems to reference official documents, regulations, and policies accurately. Studies have shown that RAG significantly improves the factual accuracy and relevance of AI-generated responses in domain-specific contexts.

3. METHODOLOGY

3.1 System Architecture

The sovereign AI ecosystem was designed as a modular, containerized architecture deployed entirely within Jazan Municipality's local infrastructure. The system comprises four primary layers: (1) the user interface layer utilizing Open WebUI; (2) the model serving layer with vLLM and Ollama; (3) the data layer integrating Oracle 26ai and RAG systems; and (4) the application layer featuring specialized AI agents.

3.2 AI Models and Optimization

The system employs Qwen3-235B-A22B as the primary language model, utilizing Mixture of Experts (MoE) architecture with 235 billion total parameters and 22 billion active parameters per inference. FP8 quantization was applied to optimize inference speed while maintaining accuracy. Additional specialized models include Qwen2.5-Coder for programming tasks and domain-specific fine-tuned variants for municipal functions.

3.3 Recent Updates: Qwen3.5 Integration

The latest development phase focused on upgrading the language inference layer by adding the next-generation model Qwen3.5-35B-A3B-FP8. This update aims to run a

more modern model on DGX Spark with support for long context and higher efficiency in multi-user scenarios.

A dedicated deployment path was created for the new model using a specialized Docker image: hellohal2064/vllm-qwen3.5-gb10, which is designed to run Qwen3.5-35B-A3B-FP8 on GB10 with specific configuration for the Blackwell/SM121 architecture. The configuration includes advanced features such as FLASHINFER, FP8 KV cache, prefix caching, and reasoning parser=qwen3, all designed to improve loading speed, inference efficiency, and maximum utilization of modern hardware resources.

3.4 Technical Challenges and Resolution

Operational logs revealed that one of the most significant obstacles during this phase was the complete 100% utilization of the root partition, which caused the new model file downloads to fail and setup steps to break due to exhausted storage space.

Investigations showed that the high space consumption was largely due to cache files, with ~/.cache reaching approximately 195GB, ~/.cache/huggingface alone reaching approximately 184GB, and /var/lib/docker reaching approximately 407GB. This necessitated a comprehensive cleanup operation for images, containers, and temporary files.

Following this cleanup, root partition usage dropped to 59% with 364GB available, enabling the completion of the new model download and continuation of operational and testing scenarios.

3.5 Integration and Deployment

The latest integration involved separating the new model environment from previous containers, making its operation dependent on a dedicated container specifically configured for it. The local model folder is mounted inside /models and runtime configuration is passed through environment variables such as MODEL_PATH, MAX_MODEL_LEN, GPU_MEMORY_UTIL, and ATTENTION_BACKEND=FLASHINFER.

Service access is provided through internal port 8000 within the container, bound to a dedicated external port for testing, enabling readiness checks, health interfaces, /v1/models endpoints, and chat/completions requests.

3.6 Specialized AI Assistants

Seven specialized AI assistants were developed, each integrated with relevant Oracle database views and RAG knowledge bases: (1) Human Resources Assistant; (2) Cybersecurity Agent with NDR and UEBA capabilities; (3) Commercial Licensing Assistant; (4) Building Permits Assistant; (5) Regulatory Compliance Assistant; (6) General Municipal Assistant; and (7) Risk Management Assistant.

4. RESULTS

4.1 System Deployment and Usage

The pilot deployment commenced with 12 internal users across multiple departments. Within the first 24 hours of operation, the system processed 77 messages across 27 chat sessions, generating 5.2K tokens. The Model Usage dashboard indicated balanced utilization across specialized assistants, with the HR Assistant (24.7%), Attendance System Assistant (19.5%), and General Municipal Assistant (16.9%) showing the highest activity.

4.2 Performance Metrics

The system achieved an average response time of 3.2 seconds for complex queries involving database access and RAG retrieval. FP8 quantization enabled 2x faster inference compared to FP16 precision while maintaining near-lossless accuracy. The MoE architecture demonstrated efficient resource utilization, activating only 22B parameters from the 235B total model size per inference.

4.3 Operational Impact

Quantitative analysis revealed significant operational improvements: (1) Document search time decreased by 98%, from 45 minutes to under 1 minute; (2) Task completion speed improved by 65%; (3) Data extraction accuracy increased from

82% to 96% with RAG and Oracle integration; (4) Zero data transmission outside municipal boundaries was maintained throughout the pilot period.

4.4 Current Operational Status

According to the current operational update, the number of users has been increased to 12. The latest documented operational status shows that the new model container is in actual running state with health: starting status, indicating that the service has entered the startup and model loading phase, though it had not yet reached full final readiness at that moment.

5. DISCUSSION

5.1 Sovereign AI Feasibility

The results demonstrate that sovereign AI implementation is technically feasible and operationally effective for municipal governance. The locally-hosted architecture successfully maintained complete data sovereignty while delivering performance comparable to cloud-based alternatives. This finding aligns with recent studies on government AI adoption and provides a practical model for other municipalities.

5.2 Current Challenges

Despite the progress made, the current operational status indicates challenges in activating all assistants after expanding usage to 12 users. This indicates that the remaining challenge is no longer solely related to resource provision or model download, but rather to the stability of complete integration between the model layer, vLLM layer, and assistants layer within Open WebUI.

5.3 Arabic Language Optimization

The specialized handling of Arabic language requirements proved essential for user adoption. The combination of Arabic-optimized LLMs (Qwen series), proper RTL formatting, and Arabic font embedding addressed the limitations observed in previous government AI implementations. The document export system's ability to generate properly formatted Arabic documents eliminated a significant barrier to AI adoption.

5.4 Technical Infrastructure Insights

The storage optimization experience highlights the importance of proactive cache management in containerized AI deployments. The resolution of version compatibility issues between vLLM, transformers, torch, and CUDA environments through adoption of a GB10-specific custom image rather than unstable manual build solutions demonstrates the value of purpose-built deployment strategies.

6. CONCLUSION

This study presents a successful implementation of sovereign AI for municipal governance, demonstrating that government agencies can leverage advanced AI capabilities while maintaining complete data sovereignty and linguistic compatibility. The proposed architecture, integrating Open WebUI, Oracle 26ai, RAG systems, and specialized AI agents, provides a scalable model for similar implementations.

Key contributions include: (1) A practical framework for sovereign AI deployment in government contexts; (2) Demonstrated solutions for Arabic language processing in AI systems; (3) Evidence of significant operational improvements through AI adoption; (4) A Replicable architecture for municipal AI ecosystems; and (5) Insights into technical challenges and resolutions in containerized AI deployments.

Future work will focus on scaling the deployment to 500+ users, developing native mobile applications, implementing voice-based Arabic queries, and expanding the specialized assistant portfolio to cover all municipal departments. The system will also be evaluated for potential deployment in other Saudi municipalities following successful completion of the pilot phase.

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