Agentic AI application for CO2 management on farm

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Abstract

This project presents a Proof of Concept (PoC) for an Agentic Artificial Intelligence (AI) system designed to optimize dairy farm management and track carbon emissions. By integrating Retrieval-Augmented Generation (RAG) and Digital Twin architectures, the AI functions as an automated assistant accessible via a mobile messaging application. The platform successfully ingests both structured operational logs and unstructured documents, enabling farm personnel to retrieve operational procedures and emission metrics accurately without requiring technical expertise.

Introduction

Dairy farming significantly contributes to greenhouse gas emissions. While effective mitigation requires accurate tracking, conventional farms rely on inefficient, fragmented offline records. To address this, this study proposes an Agentic AI framework integrating relational and vector databases. This intelligent platform conducts contextual analysis to autonomously generate data-driven strategies for precise emission reduction and sustainable farm management.

Methodology

System Overview

The cloud architecture utilizes Amazon Web Services (AWS) to host the n8n workflow platform for continuous operation. Supabase serves as the backend repository, employing PostgreSQL for structured farm data and PGVector for unstructured documents.

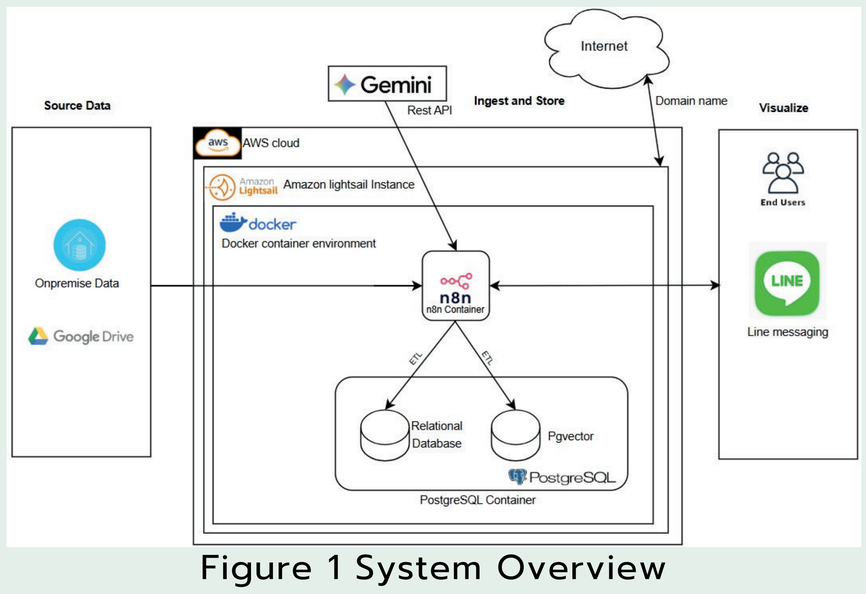

Figure 1 System Overview

Digital Twin Modelling

Physical farm resources are mapped using Digital Twins Definition Language (DTDL) on Microsoft Azure Digital Twin. This establishes logical connections between operational entities such as livestock inventories, utility consumption, and milk production providing the AI with contextual awareness.

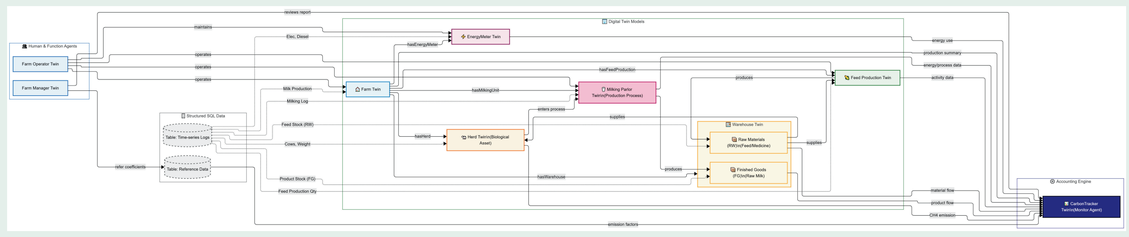

Figure 2 Digital Twin Model

Results

System performance was evaluated for computational accuracy. The Agentic AI autonomously queried the relational database to calculate carbon emissions, explicitly generating step-by-step mathematical workflows. Cross-validation against the backend database confirmed that the AI-derived metrics precisely matched the actual recorded values, ensuring absolute numerical reliability directly within the mobile interface.

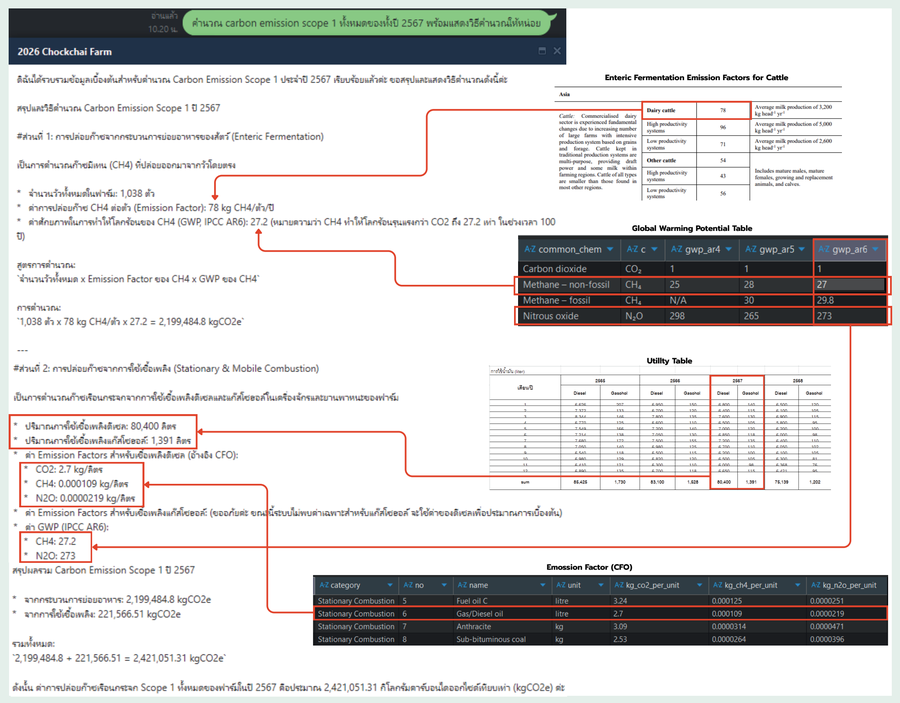

Figure 3 Validating AI accuracy with database logs.

Conclusion

This project successfully transforms agricultural records into an intelligent, automated management system. By integrating a robust data ingestion pipeline with a dual-database RAG architecture, the platform optimizes data management. Consequently, personnel can efficiently access operational insights and visualizations via an intuitive mobile interface, significantly reducing monitoring complexity without resource-intensive infrastructure. The conclusion section should be included.

References

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