

Autonomous Logistic Research Agent

Course Name: Agentic AI

Institution Name: Medicaps University – Datagami Skill Based Course

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Table of Contents

Sr.	Section	Page
1.	Introduction	3
	1.1 Scope of the Document	
	1.2 Intended Audience	
	1.3 System Overview	
2.	System Design	4
	2.1 Application Design	
	2.2 Process Flow	
	2.3 Information Flow	
	2.4 Components Design	
	2.5 Key Design Considerations	
	2.6 API Catalogue	
3.	Data Design	7
	3.1 Data Model	
	3.2 Data Access Mechanism	
	3.3 Data Retention Policies	
4.	Interfaces	8
5.	State and Session Management	8
6.	Caching & Future Optimizations	8

7.	Deployment Architecture	9
8.	Non-Functional Requirements	9
	8.1 Security Aspects	
	8.2 Performance Aspects	
9.	Known Limitations & Future Enhancements	10
10.	10. References	10

1. Introduction

The Autonomous Logistics Researcher Agent is an AI-powered Agentic system designed to automate logistics research and industry intelligence generation. The system leverages Large Language Models (LLMs), LangChain, and CrewAI to autonomously search, validate, analyze and summarize logistics-related information from multiple reliable sources.

Unlike traditional AI chat systems, this solution follows an Agentic AI approach where multiple specialized agents collaborate to perform structured research tasks. The system produces professional, structured research reports and stores them in a persistent knowledge repository for future retrieval and continuous learning.

Problem Statement

The logistics industry is rapidly evolving due to advancements in AI, automation, and digital technologies. However, logistics research is still largely manual, time-consuming, and fragmented across multiple sources, making it difficult to extract structured and actionable insights efficiently.

There is a need for an intelligent, autonomous system that can understand logistics-related queries, gather and analyze information from credible sources, generate structured research reports, and maintain a persistent knowledge repository to support faster and more informed decision-making.

1.1 Scope of the Document

This High-Level Design document covers:

- Overall system architecture and technology stack
- Major components and their responsibilities
- Information and process flows
- API design and endpoint catalogue
- Data model and storage strategy
- Authentication, session management, and CORS strategy
- Deployment architecture on Railway and Vercel
- Non-functional requirements: security and performance
- Known limitations and planned future enhancements

This document does not cover detailed low-level implementation code.

1.2 Intended Audience

This document is intended for:

- Faculty evaluators
- Industry mentors
- System architects
- Developers
- Project Stakeholders

1.3 System Overview

The system enables:

Strategic Intelligence Queries

- Autonomous Multi-Agent Processing
- Verified Research Insights
- Structured Knowledge Outputs

The system consists of a multi-agent orchestration engine where each agent performs a specialized task such as:

- Query interpretation
- Web search
- Source validation
- Data analysis
- Report generation
- Knowledge storage

It ensures accurate, scalable, and continuously improving logistics intelligence generation.

2. System Design

2.1 Application Design

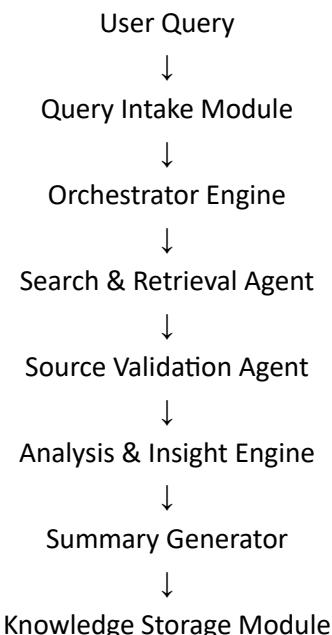
The system follows a modular micro-component architecture:

Modules:

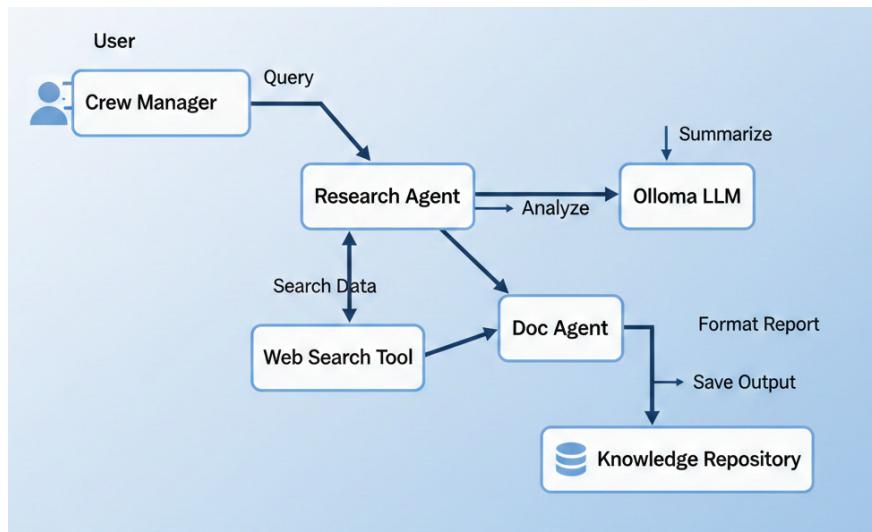
- Query Intake Module
- Orchestrator Engine
- Search & Retrieval Agent
- Source Validation Agent
- Analysis & Insight Engine
- Summary Generator
- Knowledge Storage Module

Each module is independently scalable and loosely coupled.

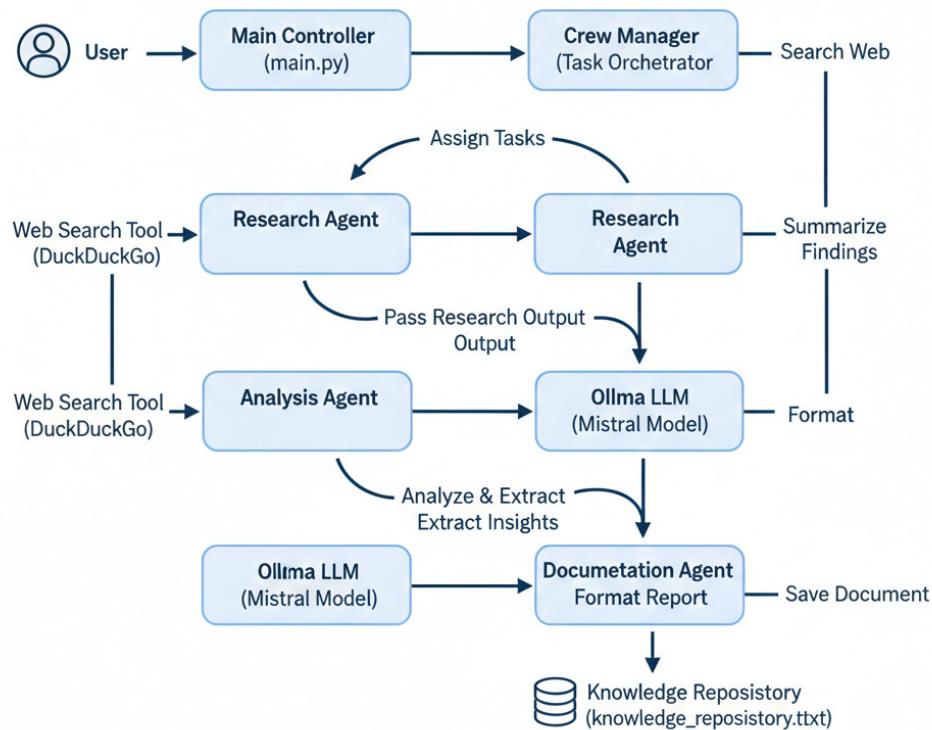
2.2 Process Flow



2.3 Information Flow



2.4 Components Design



2.5 Key Design Considerations

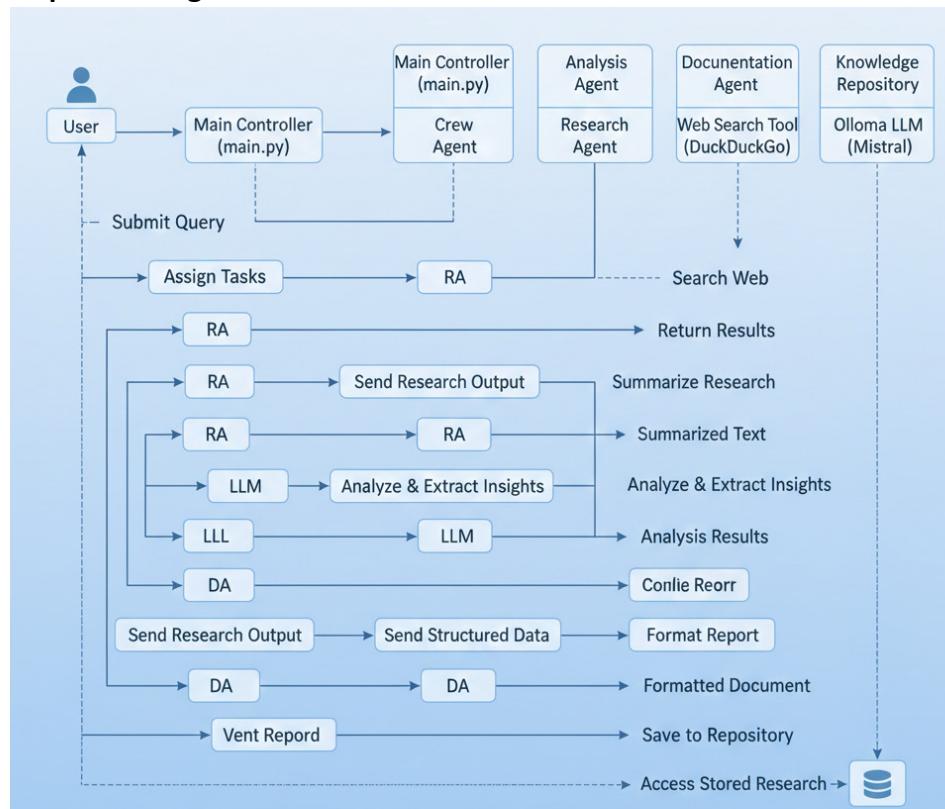
- Modular and scalable architecture
- Agent-based orchestration
- Source reliability validation
- Persistent knowledge storage
- Low hallucination through multi-source verification
- Extendable for real-time monitoring

2.6 API Catalogue

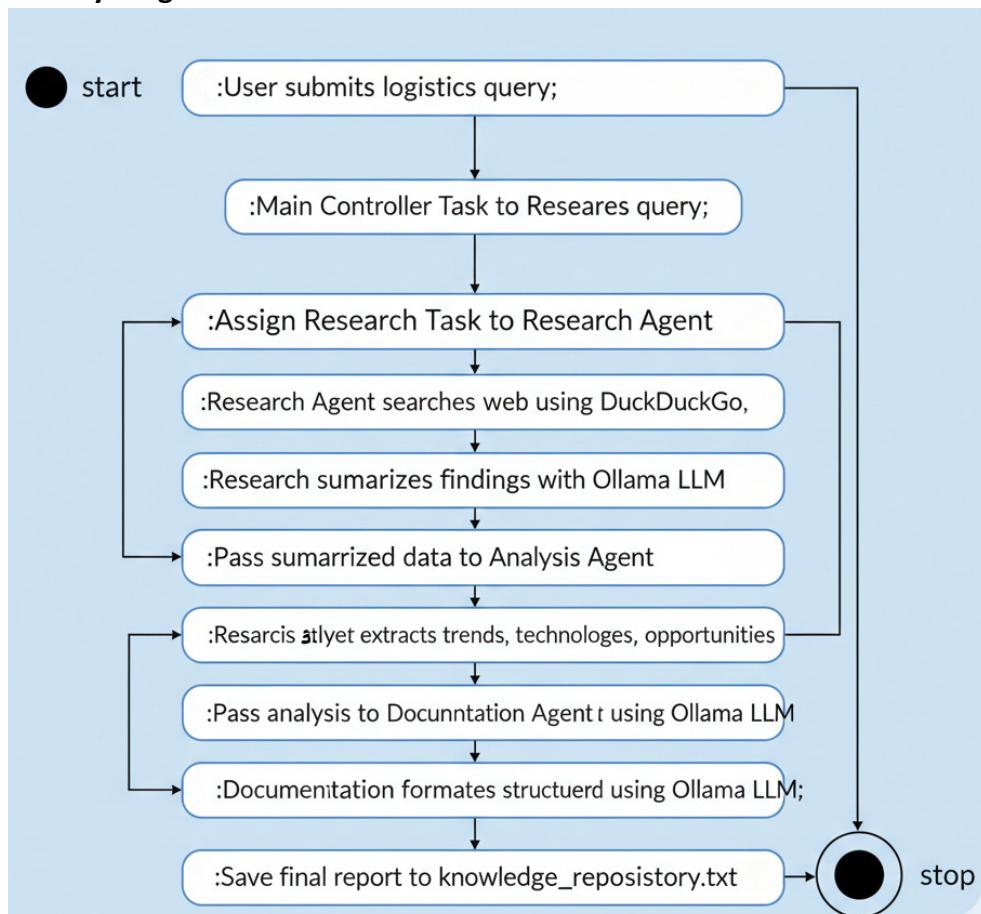
API	Purpose
OpenAI GPT API	Reasoning & summarization
Tavily Search API	Web research
News APIs	Industry news
Vector DB API	Memory storage

UML Diagrams:-

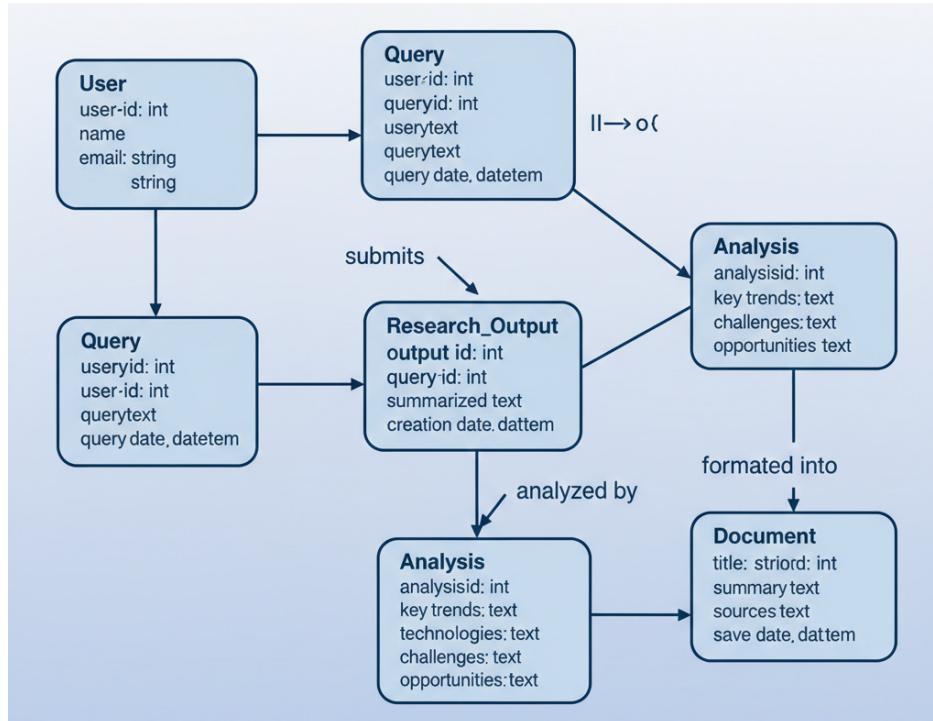
Sequence Diagram



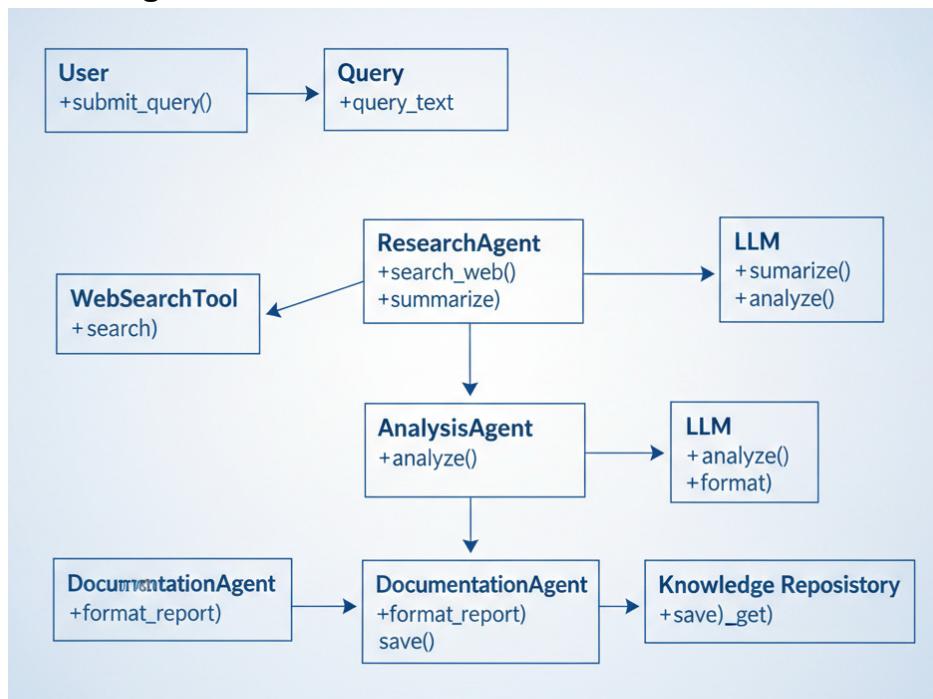
Activity Diagram



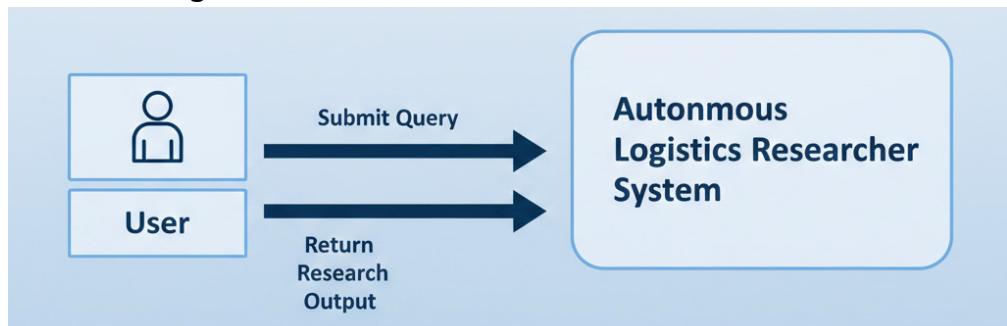
Entity Relationship Diagram



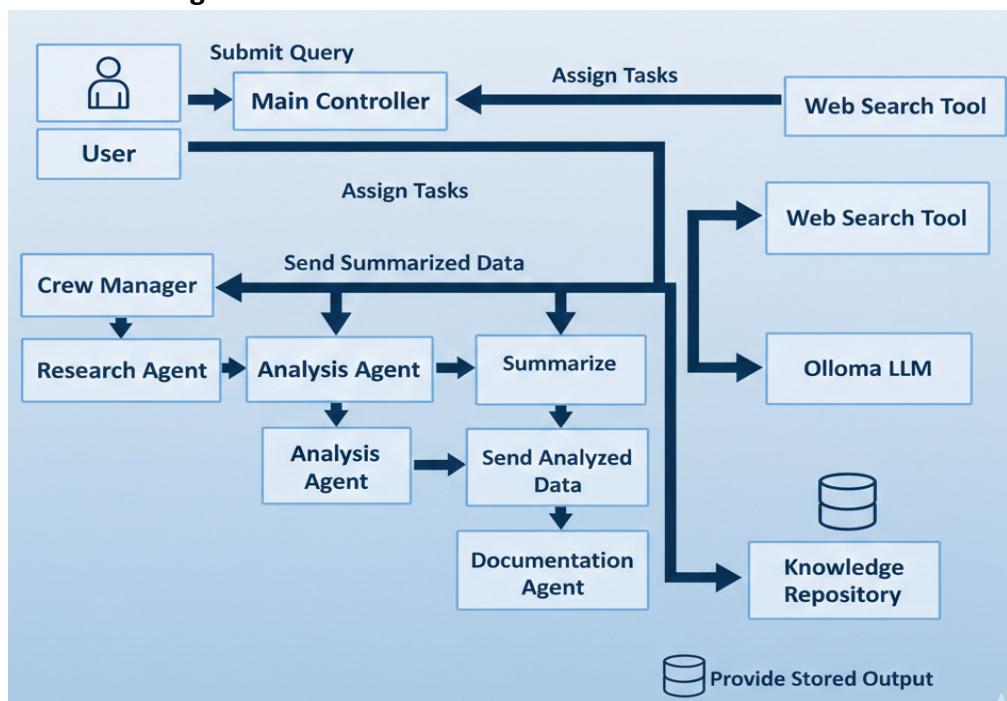
Class Diagram



Data Flow Diagram - Level 0

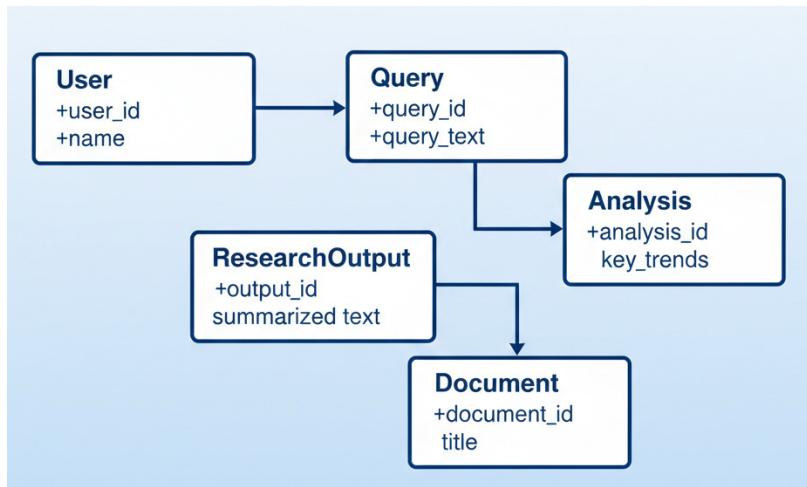


Data Flow Diagram – Level 1

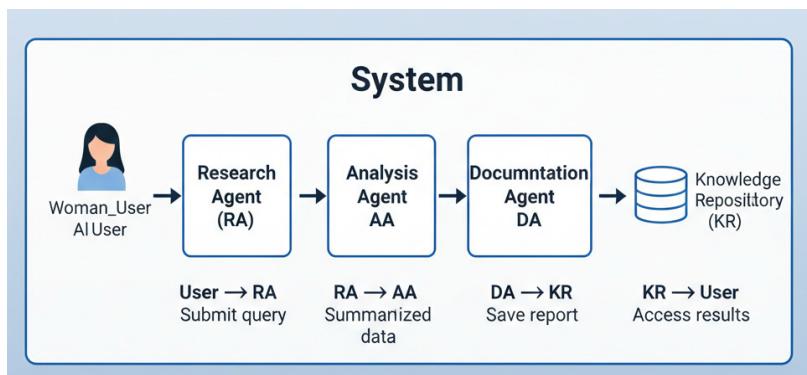


3. Data Design

3.1 Data Model



3.2 Data Access Mechanism

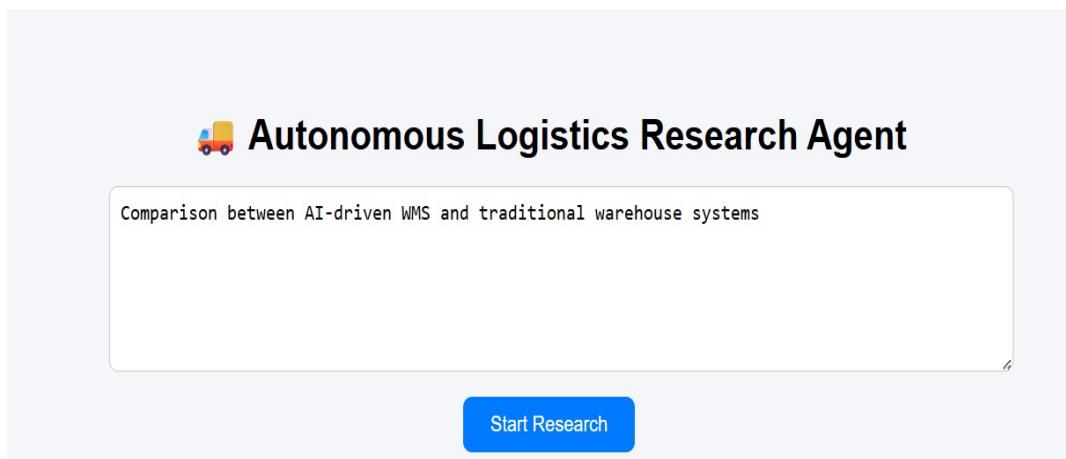


3.3 Data Retention Policies

- Research embeddings are stored per session in ChromaDB and remain until manually cleared.
- Chat and query history is retained until the user deletes it via the system API.
- Guest session data is not linked to a user ID and may be automatically cleaned in the future.
- No sensitive personal data is stored beyond Firebase-managed email and UID.

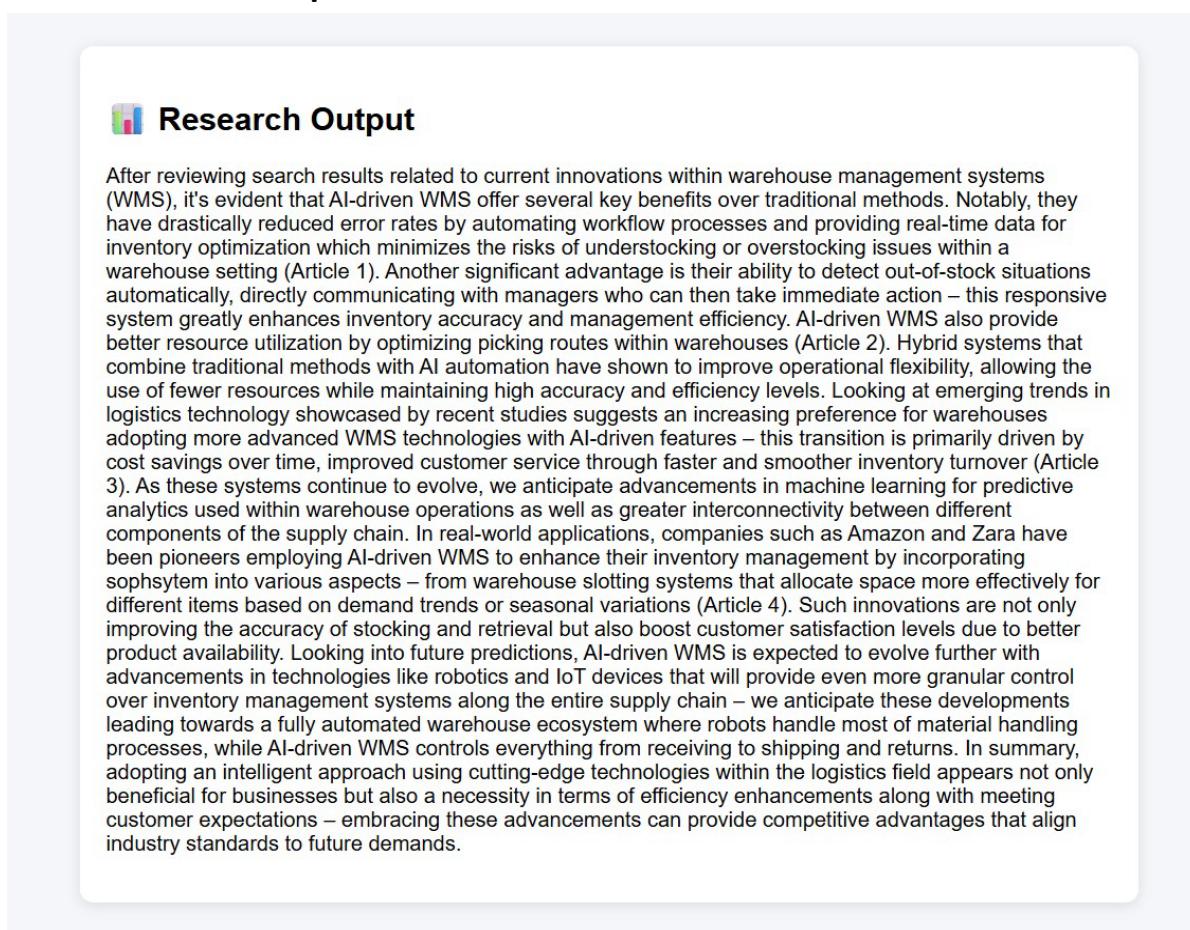
4. Interfaces

- **Research Input Interface**



The interface features a large title "Autonomous Logistics Research Agent" with a truck icon. Below it is a text box containing the text "Comparison between AI-driven WMS and traditional warehouse systems". At the bottom is a blue button labeled "Start Research".

- **Research Output Interface**



The interface features a title "Research Output" with a bar chart icon. Below it is a detailed text block about the benefits of AI-driven WMS over traditional methods, mentioning improved accuracy, reduced error rates, and better resource utilization through machine learning and predictive analytics.

After reviewing search results related to current innovations within warehouse management systems (WMS), it's evident that AI-driven WMS offer several key benefits over traditional methods. Notably, they have drastically reduced error rates by automating workflow processes and providing real-time data for inventory optimization which minimizes the risks of understocking or overstocking issues within a warehouse setting (Article 1). Another significant advantage is their ability to detect out-of-stock situations automatically, directly communicating with managers who can then take immediate action – this responsive system greatly enhances inventory accuracy and management efficiency. AI-driven WMS also provide better resource utilization by optimizing picking routes within warehouses (Article 2). Hybrid systems that combine traditional methods with AI automation have shown to improve operational flexibility, allowing the use of fewer resources while maintaining high accuracy and efficiency levels. Looking at emerging trends in logistics technology showcased by recent studies suggests an increasing preference for warehouses adopting more advanced WMS technologies with AI-driven features – this transition is primarily driven by cost savings over time, improved customer service through faster and smoother inventory turnover (Article 3). As these systems continue to evolve, we anticipate advancements in machine learning for predictive analytics used within warehouse operations as well as greater interconnectivity between different components of the supply chain. In real-world applications, companies such as Amazon and Zara have been pioneers employing AI-driven WMS to enhance their inventory management by incorporating sopsystem into various aspects – from warehouse slotting systems that allocate space more effectively for different items based on demand trends or seasonal variations (Article 4). Such innovations are not only improving the accuracy of stocking and retrieval but also boost customer satisfaction levels due to better product availability. Looking into future predictions, AI-driven WMS is expected to evolve further with advancements in technologies like robotics and IoT devices that will provide even more granular control over inventory management systems along the entire supply chain – we anticipate these developments leading towards a fully automated warehouse ecosystem where robots handle most of material handling processes, while AI-driven WMS controls everything from receiving to shipping and returns. In summary, adopting an intelligent approach using cutting-edge technologies within the logistics field appears not only beneficial for businesses but also a necessity in terms of efficiency enhancements along with meeting customer expectations – embracing these advancements can provide competitive advantages that align industry standards to future demands.

5. State and Session Management

- Each query treated as independent session
- Conversation memory stored using vector embeddings
- Session context maintained during execution

6. Caching & Future Optimizations

- Frequently searched queries cached
- Vector embeddings reused
- Reduced API calls
- Improved response time

7. Deployment Architecture

Service	Platform	Details
Frontend	Vercel	Auto-deploys on git push to main; preview URL per PR; SPA fallback via vercel.json
Backend	Render	Python 3.11 auto-detected; start command via Procfile; root directory: /backend

8. Non-Functional Requirements

- High reliability
- Low latency response
- Scalable agent architecture
- Modular design
- Fault tolerance
- Easy maintainability

9. Known Limitations & Future Enhancements

- **Known** **Limitations:**
Limited scalability, basic security, partial feature implementation, minimal error handling, and limited testing coverage.
- **Future** **Enhancements:**
Improve performance, add advanced security, enhance UI/UX, expand features, integrate more APIs, and implement automation with CI/CD.

10. References

- OpenAI API Documentation
- LangChain Documentation
- CrewAI Documentation
- Tavily API Documentation
- Research papers on Agentic AI systems