

# CSC3101 - Capstone

## SmartAdmin: AI-Assisted Workflow Automation with LLM, RAG and RPA for Last-Mile Logistics

BSc (Hons) in Computing Science



### Introduction

The rapid growth of last-mile delivery services in Singapore has increased operational loads on logistics providers like uParcel. Customer service agents handle routine modification requests (e.g., address updates, rescheduling, vehicle changes) via natural-language messages, requiring manual interpretation and execution across internal systems.

This leads to scalability issues, inconsistencies, and errors during peak periods. Traditional solutions like adding manpower fall short. Industry trends show AI adoption in logistics focuses on analytics or chatbots, not direct workflow automation.

This project develops **SmartAdmin**, an AI prototype integrating LLMs, RAG, structured action planning, and RPA to interpret requests, validate actions, and assist execution with human oversight. It augments operators, ensuring safety and reliability in real-world logistics.



### Problem Definitions, Objectives & Scope of Work

**Problem:** High-volume delivery modifications at uParcel involve interpreting unstructured customer messages and manual browser-based updates, leading to **inefficiency, errors, and poor scalability.**

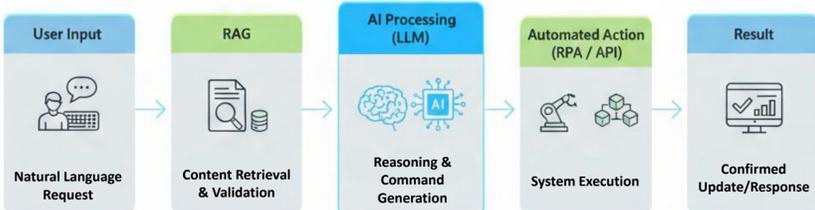


**Objective:** Investigate how large language models (LLMs) can support logistics operations by translating natural-language delivery modification requests into safe, structured and executable actions within uParcel's existing systems.

- Scope:**
- Design and developed **SmartAdmin**, an AI-assisted workflow system that:
    - Interprets natural-language delivery modification requests
    - Generates structured, validated action plans
    - Executes workflows via browser-based automation
    - Enforce safety, governance and auditability
  - Evaluation on feasibility** of integrating large language models with automated workflow execution in a logistics environment with a specific focus on uParcel's delivery modification workflows



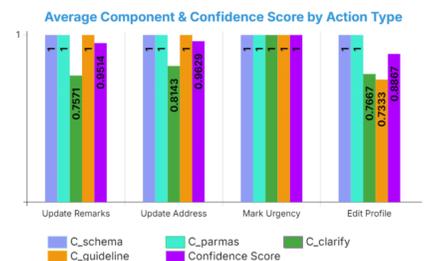
### Workflow & Technologies



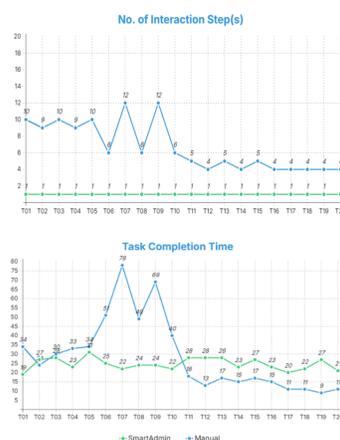
### Analysis & Evaluation Result

This section analyses the performance and impact of **SmartAdmin**, focusing on interpretation accuracy, safety control, and workflow efficiency in supporting logistics administrative tasks.

**Action Interpretation Accuracy (RQ1)**  
 SmartAdmin can reliably interpret natural-language delivery modification requests and convert them into structured action schemas with **F1-score 0.9691** for action types/parameters on 100-test dataset (**precision 0.94, recall 1, average confidence score 0.953**)



**Safety and Controlled Automation (RQ2)**  
 SmartAdmin adopts a safety-first design based on a default-block policy combined with human-in-the-loop (HITL) approval and whitelist control. Analysis confirms that unsafe or unauthorized actions are consistently blocked or escalated before execution. SOP-based validation and role-based access control prevent policy violations, while full audit logging ensures traceability of all AI decisions and automation outcomes. (**82.1% of HITL Intervention Rate, 0 unsafe action executed, 100% of activity/action logged**)



**Workflow Efficiency and Operational Impact (RQ3)**  
 SmartAdmin significantly reduces manual interaction steps required to complete low-complexity administrative tasks. By consolidating multi-step browser workflows into a single confirmation action, operator effort and cognitive load are reduced. However, the analysis also highlights a trade-off where AI processing and automation overhead introduce latency, meaning that very simple tasks may not always achieve net time savings. The system therefore provides the greatest value in repetitive or moderately complex workflows where effort reduction outweighs execution latency. (**Reduced manual steps by 82.3056% but average completion time reduction is negative at -25.622%**)

### Conclusion & Reflection

This capstone project designed and evaluated **SmartAdmin**, an AI-assisted workflow automation prototype that integrates large language models (LLMs), Retrieval-Augmented Generation (RAG) and browser-based robotic process automation (RPA) to support logistics administrative workflows at uParcel. The project demonstrates that LLM-driven systems can move beyond informational support and safely perform operational tasks when embedded within a conservative, governance-aware architecture.

However, the project also highlights both the potential and the limitations of integrating generative AI into operational enterprise systems. A key insight is that **accuracy alone is insufficient** for real-world deployment, safety, governance and human oversight are equally critical.

Overall, this capstone project provided valuable experience in building a full end-to-end AI system that balances technical performance with operational safety and usability. It reinforces the view that AI should function as a **human-centered augmentation tool rather than a fully autonomous agent**, particularly in safety-sensitive domains such as logistics operations.

### References

[1] P. Lewis, E. Perez, A. Piktus, et al., "Retrieval-augmented generation for knowledge-intensive NLP tasks," in Proc. Adv. Neural Inf. Process. Syst., vol. 33, 2020, pp. 9459–9474. [Online]. Available: <https://arxiv.org/abs/2005.11401> [2] DHL Trend Research, "Generative AI in logistics operations: Current adoption and future trends," in DHL Logistics Trend Radar, 7th ed., 2025. [Online]. Available: <https://www.dhl.com/discover/en-global/news-and-insights/reports-and-press-releases/logistics-trend-radar-2024> [3] A. Dalsaniya and K. Patel, "Enhancing process automation with AI: The role of intelligent automation in business efficiency," Int. J. Sci. Res. Arch., vol. 5, no. 2, pp. 322–337, 2022, doi: 10.30574/ijrsr.20.....and more