Product Shipment  
Tracking System

A blue and pink logo

AI-generated content may be incorrect.

A truck on the road

AI-generated content may be incorrect.Frank van der Linden

Group 2

11th April 25

Version 0.2

# Version History

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| **Version** | **Date** | **Author(s)** | **Changes** | **State** |
| 1.0 | 05/04/25 | Group 2**[[1]](#footnote-2)** | **Iteration 0:** Barcode-Based Shipment Tracking with Zoning System | Draft |
| 2.0 | 12/04/25 | Group 2 | **Iteration 1:** Product Shipment Tracking System | Draft |

# Distribution

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# Introduction

What?  
*Logicall* is a comprehensive logistics provider with 35 offices across 12 countries. Their services include air and ocean freight forwarding, warehousing and fulfilment, parcel management, road transport and technical services. With a strong foundation in the logistics industry, *Logicall* delivers reliable and integrated solutions to meet diverse supply chain needs.

To further streamline their operations, *Logicall* aims to automate their shipment tracking process for items moving through conveyor belts in warehouses. The current manual tracking system is not only inefficient but also fails to scale with increasing shipment volumes. This initiative seeks to implement an AI-powered system for real-time tracking, enhancing accuracy and operational efficiency.

Why?  
**Manual tracking** poses significant challenges:

* **Time inefficiencies**: Manual recording and tracking slow down the overall processing time.
* **Human error**: Human errors lead to mislabelling, lost shipments and delayed deliveries.
* **Scaling limitations**: The system struggles to handle large volumes effectively.

Compared to an **AI tracking system**, which could:

* Reduce errors
* Increase processing speed
* Enhance shipment traceability

## Who Benefits?

* ***Logicall*:** Gains in operational efficiency, cost savings and enhanced logistics capabilities.
* **Warehouse staff:** Reduced workload and fewer manual tasks.
* **End customers:** Improved delivery accuracy and real-time shipment updates.
* **Future clients:** A scalable model for logistics automation applicable to other facilities.

How?  
We propose using a combination of:

* **AI-based barcode detection:** Using *YOLOv8* for high-accuracy detection.
* **Object tracking system:** Tracking detected shipments through video frames.
* **Video analysis and spatial inference:** Virtual mapping of items to zones post-unpacking.

# Domain Understanding

Problem Statement **How can we ensure that each shipment is accurately tracked and linked to the correct product or location in a fully automated manner?**

**Would occasional human oversight interfere with system performance?**

**How can we mitigate potential challenges like occlusion, motion blur, or overlapping items?**

## Exploratory Observations

* Shipments are labelled with barcodes, which are vital for identification.
* Camera footage captures items in motion, enabling temporal and spatial analysis.
* Preliminary tests with Pyzbar highlighted the need for advanced models to handle motion blur.

## Research Objectives

* Develop and train a robust barcode detection model using *YOLOv8*.
* Improve decoding accuracy by applying bounding-box-based localisation.
* Replace QR codes with a virtual zoning solution based on spatial inference.
* Address common challenges like overlapping shipments and blurred footage.

# Analytical Approach

Target Output  
A dynamic mapping of:

**Barcode ID → Virtual Zone ID** based on real-time detections from video footage.

## Type of Problem

* **Object Detection:** Detecting barcodes in video frames.
* **Object Tracking:** Following shipments across frames to maintain continuity.
* **Spatial Inference:** Assigning virtual zones based on conveyor positions and timing.

## Pipeline

1. Use *YOLOv8* to detect barcodes and boxes in each video frame.
2. Apply *Pyzbar* to decode detected barcodes.
3. Train the detection model with datasets from *Roboflow* for enhanced accuracy.
4. Establish virtual zones by dividing the conveyor into sections, tracked by time and position within the video.
5. Match each shipment to its corresponding virtual zone using temporal and spatial logic.

# Data & System Setup

## Data Sources

* Real-world video footage from *Logicall’s* warehouse operations.
* Barcode datasets from *Roboflow*, used for training *YOLOv8*.
* Synthetic datasets for testing scenarios like overlapping shipments and blurred barcodes.

## Hardware Setup

Four high-resolution cameras positioned strategically:

* Two focus on barcodes (pre- and post-unpacking).
* Two capture broader overviews to ensure mapping continuity.

# Constraints & Ethics

## Constraints

* No real-time processing;
* No model deployment or integration;
* Limited analytics or dashboarding;
* Low resolution videos;

## Ethics:

* No personal or identifiable data is processed.
* All datasets are either client-owned or publicly available.
* Footage contains no identifiable individuals, ensuring compliance with privacy standards.

# Phasing

## Iteration 0:

* Initial draft of Project Proposal;
* Train barcode detection model;
* Run on real footage;
* Match barcodes to zones;

## Iteration 1:

* Redefine Project Proposal;
* Discard QR codes idea;
* Train model on *Roboflow*;

## Iteration 2:

* Redefine system;
* Improve camera stability, lighting;
* Crop detections before decoding;
* Deploy system in near real-time;
* Add analytics (missed scans, confidence metrics)

# Conclusion

This project aims to revolutionize Logicall’s shipment tracking process by implementing an AI-driven system that integrates barcode detection, object tracking, and spatial inference. By addressing inefficiencies in the current manual system, this initiative will significantly enhance operational efficiency, reduce errors, and support scalability for future demands. With the phased implementation plan, Logicall can transition seamlessly to a modern, automated tracking solution.

1. **Group 2 -** Hayder Alghurabi, Baloum, Nadiem Baloum, Ivet Kalcheva, Güray Karaarslan, Kaloyan Rakov and Ivaylo Slavov [↑](#footnote-ref-2)