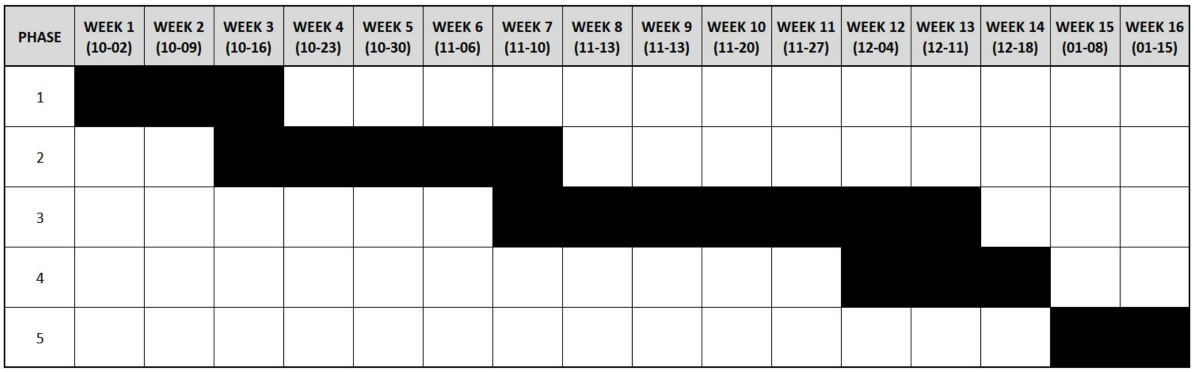
MDM2 – Case Study: Intelligent Systems in Production. One-Page Proposal

Team	**Team 3**
Members	Orlando Manrique Olmos, Arthur Noroes Reis, Binil Sajeev, Abdelraheem Zekry
Project Title	RL-Driven Warehouse Item Relocation Optimization
GitHub Repository URL	https://github.com/OrlandoManrique/IntelligentSystemsCaseStudy
Contact Email	orlando.manrique-olmos@stud.th-deg.de, arthur.noroes-reis@stud.th-deg.de
Industrial Application	Logistics and Warehouse Management: Optimizing item slotting and relocation strategies in modern warehouses to enhance operational efficiency.
Keywords	Reinforcement Learning, Warehouse Optimization, Item Relocation, Logistics, Slotting, AI
Submission Date	2025-10-16

Gantt Chart



1) Problem Statement & Measurable Outcomes	Traditional warehouses struggle to adapt to changing inventory and demand using rule-based methods. This project applies Reinforcement Learning to optimize item placement, measuring success via storage utilization, movement costs, number of operations, and overall efficiency and accessibility. The goal is a more dynamic and cost-effective warehouse layout.
2) Motivation & Industrial Relevance	This project tackles the challenge of balancing storage density with retrieval efficiency in modern warehouses. Warehouse operators and logistics companies benefit by reducing costs and improving throughput. By using a dynamic, data-driven approach instead of static rules, the system adapts to changing business needs, which is crucial in today's fast-paced supply chains.
3) Related Work Snapshot	Liu et al. (2025) applied Q-learning to minimize relocations in block-stacking systems, showing how reinforcement learning can optimize item movements in warehouses. Arslan (2025) combined Digital Twin technology with AI/ML to dynamically adjust warehouse operations, improving efficiency and inventory management. Together, these studies highlight the potential of intelligent algorithms and digital modeling for optimizing warehouse layouts and processes.
4) Method & Feasibility	We will model a realistic warehouse and generate a synthetic dataset to mirror real conditions while preserving data privacy. The warehouse will be represented as a 2D grid using NumPy and Pandas, with SimPy providing a simulation environment. A PyTorch-based Reinforcement Learning agent will learn optimal item movements using a reward-driven fitness function, with results fed back into the simulation for continuous improvement. Expected outputs include a functional MVP, the synthetic dataset, a visual analysis dashboard, and a documented framework on GitHub.
5) Milestones & Timeline	* **Phase 1 (Oct 16):** Finalize proposal, define MVP scope and requirements, set up the tech stack. * **Phase 2 (Nov 6):** Develop core code for warehouse representation and simulation environment. * **Phase 3 (Nov 27):** Begin training the RL agent, implement it and establish a testing framework. * **Phase 4 (Dec 18):** Generate preliminary results, record a demo video and create a dashboard. ***Phase 5 (Jan 15):** Write the report, prepare the final presentation and upload all files on GitHub.
6) Risks & Ethics	Limited access to real-world data is mitigated by generating a synthetic dataset based on actual warehouse parameters, ensuring data privacy and proper attribution. The combinatorial complexity of item arrangements poses a challenge, but the RL approach efficiently handles it while remaining feasible within the project scope.

Phase 1 rubric (15%): Team & GitHub (2%), On-time (2%), Topic & Proposal (5%) — Industrial Application, Problem+Outcomes, Feasibility+Timeline; Presentation (6%).