

Design of AGV deliveries: More AGVs or longer wagon trains?

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Introduction

- Previous research focus mostly on single load AGVs (load capacity = 1)
- Potential effects of using multiple load AGVs (Load capacity > 1):
 - Shorter travel distance per delivered unit load
 - Less traffic in the environment, less risk for congestions
 - Longer time needed for each delivery round
 - More difficult to control, to utilise the available load capacity
- The load capacity of the AGVs is vital in fleet sizing decisions and investments
- Conditions in the material flow affects the performance of AGV system with different load capacities

Purpose

The purpose is to determine how conditions in the material flow influence the minimum required fleet size of AGV systems of different load capacities in mixed-model assembly.

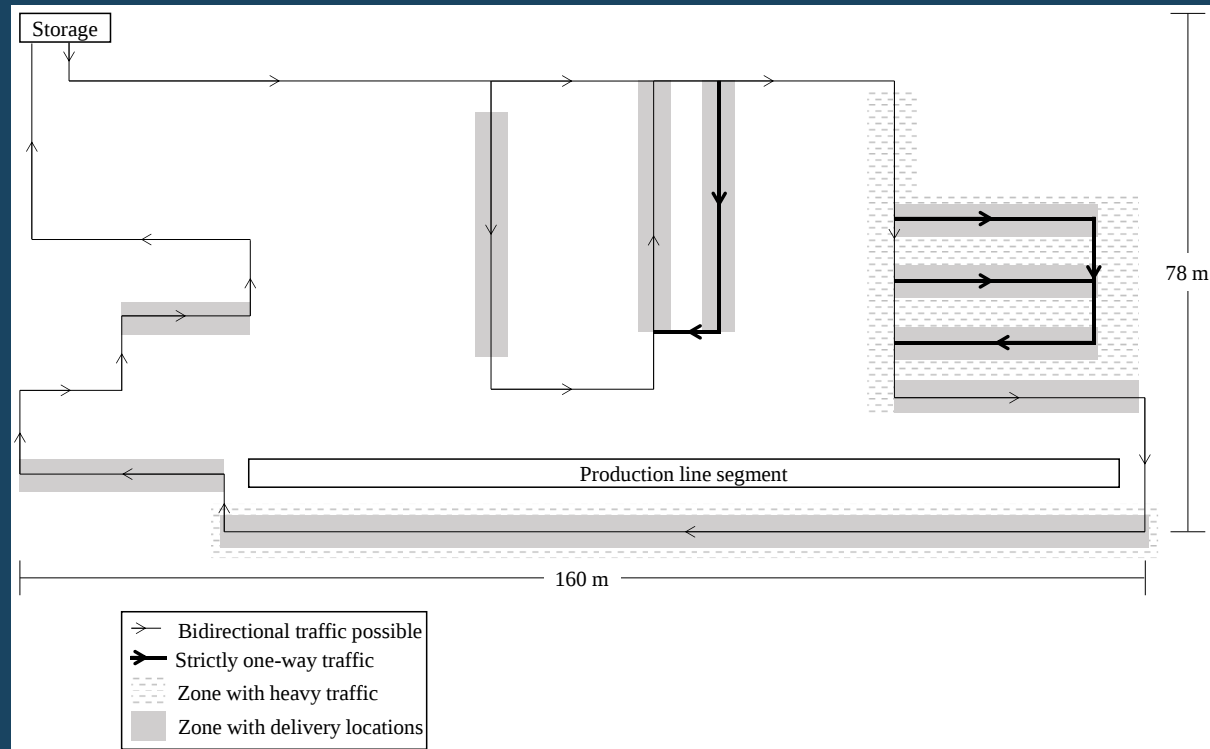
Literature review

- Single load AGVs in focus
- Research regarding multiple load AGVs (load capacity > 1)
 - Scheduling
 - Dispatching
 - Job shop environments
- Material flow conditions for test the performance of dispatching/scheduling
- Limited attention in mixed-model assembly environments

Simulation model

- Discrete event simulation model develop
- Starting point in industrial material flow
 - The material flow is performed manually today, tugger train
 - Demand and distribution of demand over time
 - Layout and localisation of load transfer positions
 - Traffic rules -> overtaking, unidirectional aisles
- Dispatching rule
 - Based on the experience of the driver in the material flow
 - Replenishment should be made within 2400 seconds
 - Dispatching rule developed to determine when to start a delivery round
 - A maximum waiting time for each available transport request is calculated

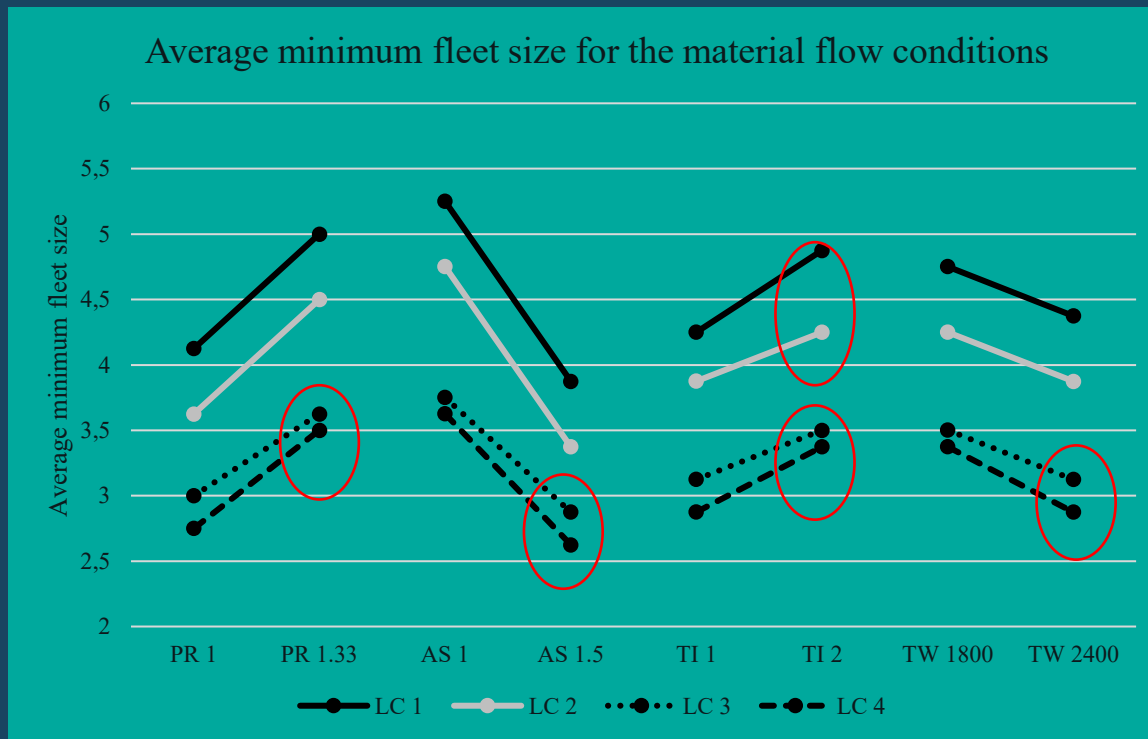
Simulation model



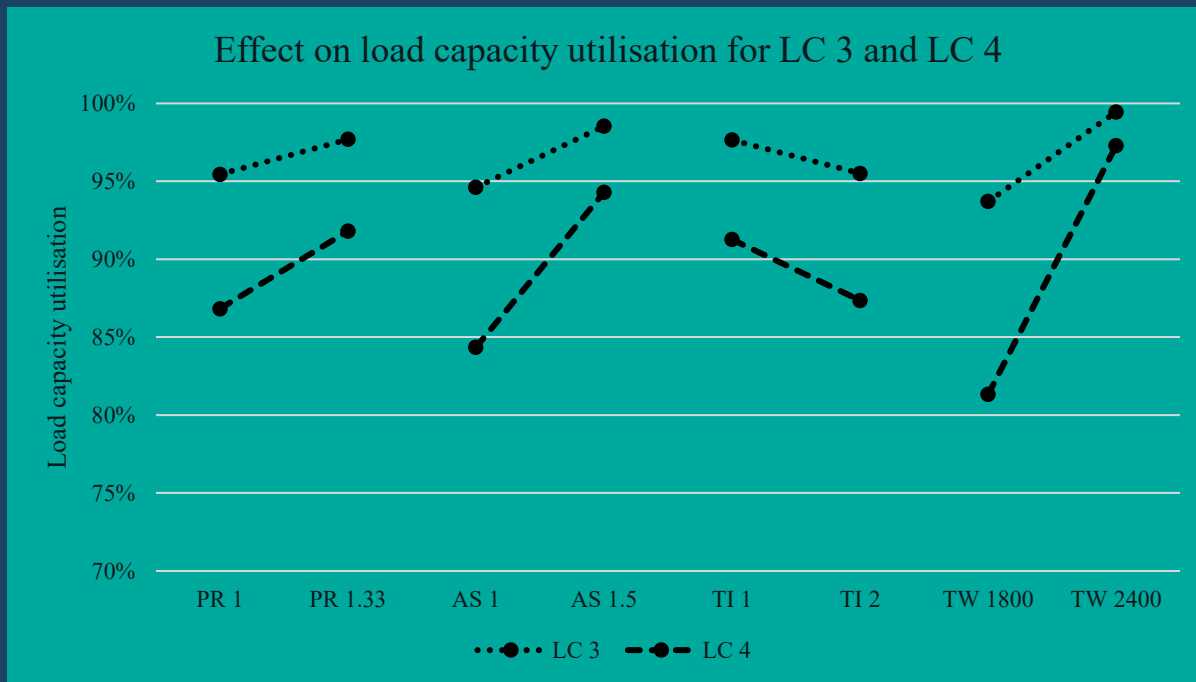
Simulation model

- Material flow conditions:
 - Production rate (PR): 100 % and 133 %
 - AGV speed (AS): 1 m/s and 1.5 m/s
 - Traffic interference (TI): low level and high level
 - Disturbances for the AGVs moving in the layout
 - Time windows (TW): 2400 seconds and 1800 seconds
- Performance
 - Minimum required fleet size
 - Determined based on reaching a predetermined mean tardiness level
 - Load carrying utilisation

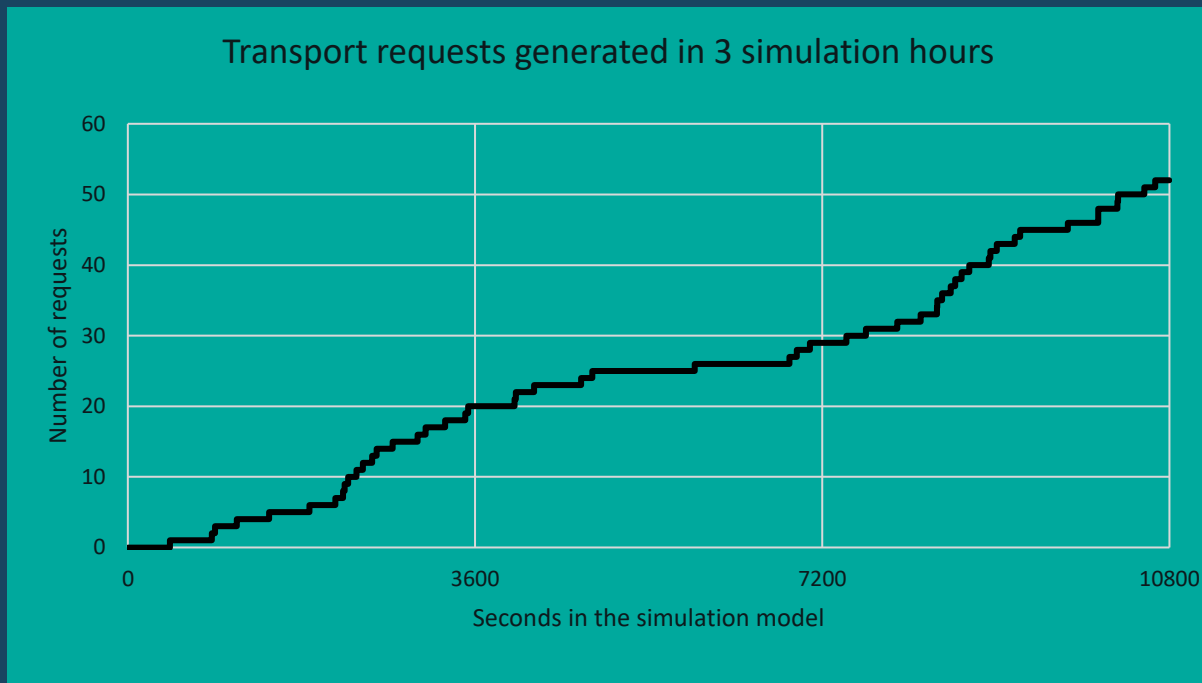
Results – minimum fleet size



Results – load capacity utilisation



Results – variation



Discussion

- Different load capacities may be suitable under different conditions
 - Load capacity 4 may be too large under certain conditions -> unable to utilise the capacity -> smaller Load capacity better
- Load capacity 1 could make it possible to utilise other routes, more flexible and direct transports, but causes more traffic and risk for congestions
- Practical challenges
 - Load transfer to and from the AGV tugger
 - Exchanging leftover material
- Further research:
 - Additional dispatching rules
 - Additional attention to analysing variations and its effect on fleet size



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