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Evaluating of Automated Guided Vehicles for Operating Theatres



Sean Lam Shao Wei, Health Services Research Center
 Ge Yao, Health Services Research Center
 Nguyen Ngoc Hoang Long, Health Services Research Center
 Marcus Eng Hock Ong, Health Services Research Center
 Henry Ho Sun Sien, Singapore General Hospital

Introduction

AGVs have been shown to be able to deliver medical supplies within the hospital in a wide variety of settings, demonstrating a robust solution for saving logistic-related costs and improving the efficiency and productivity of healthcare delivery.

Objective

To evaluate how the implementation of automated guided vehicles (AGVs) could assist OT circulating nurses in transporting surgical instruments in the OT complex to fulfil ad-hoc requests for surgical items for ongoing surgeries.

Data and Methodology

Data includes the **type of instruments** and the **ad-hoc request time** recorded for all elective and emergency surgeries done for five of the most common surgeries performed by the colorectal surgical department from January 2016 to June 2019.

Inventory orders can come from pre-ordered items determined by the OT schedules and **ad-hoc requests** by surgeons according to their preference and patient pre-operative indications.

A **discrete events simulation (DES)** model was developed to evaluate the impact of AGVs on annual manpower savings and costs of operations.

- **OT complex layout, conveyance time of nurses, frequency of requests and AGV specifications** were considered
- An **improved assortment algorithm** was developed for the selection of inventory loaded in the AGV.
- AGV scenarios with both **base assortment algorithm** and **improved assortment algorithm** were developed and compared under different restocking frequencies.
- Scenarios where demand rates were increased by 2X, 5X and 10X were evaluated

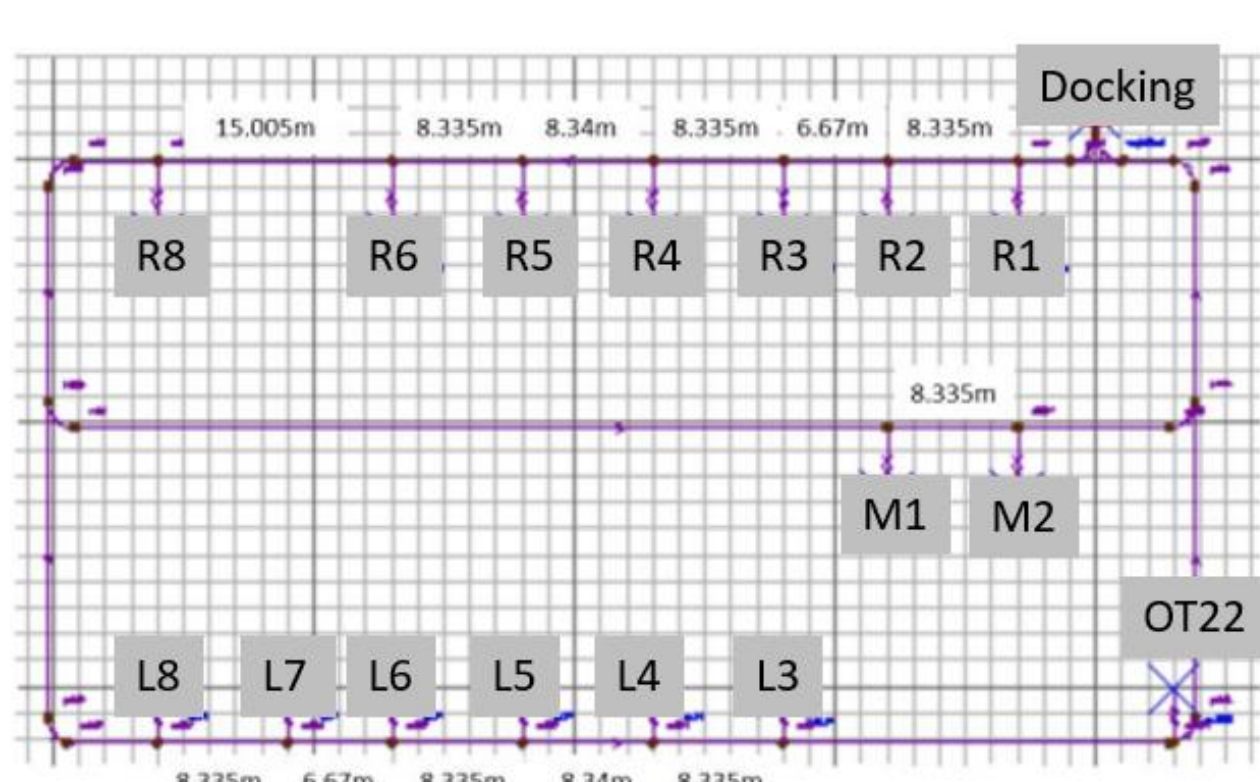


Fig 1. Simplified OT complex layout

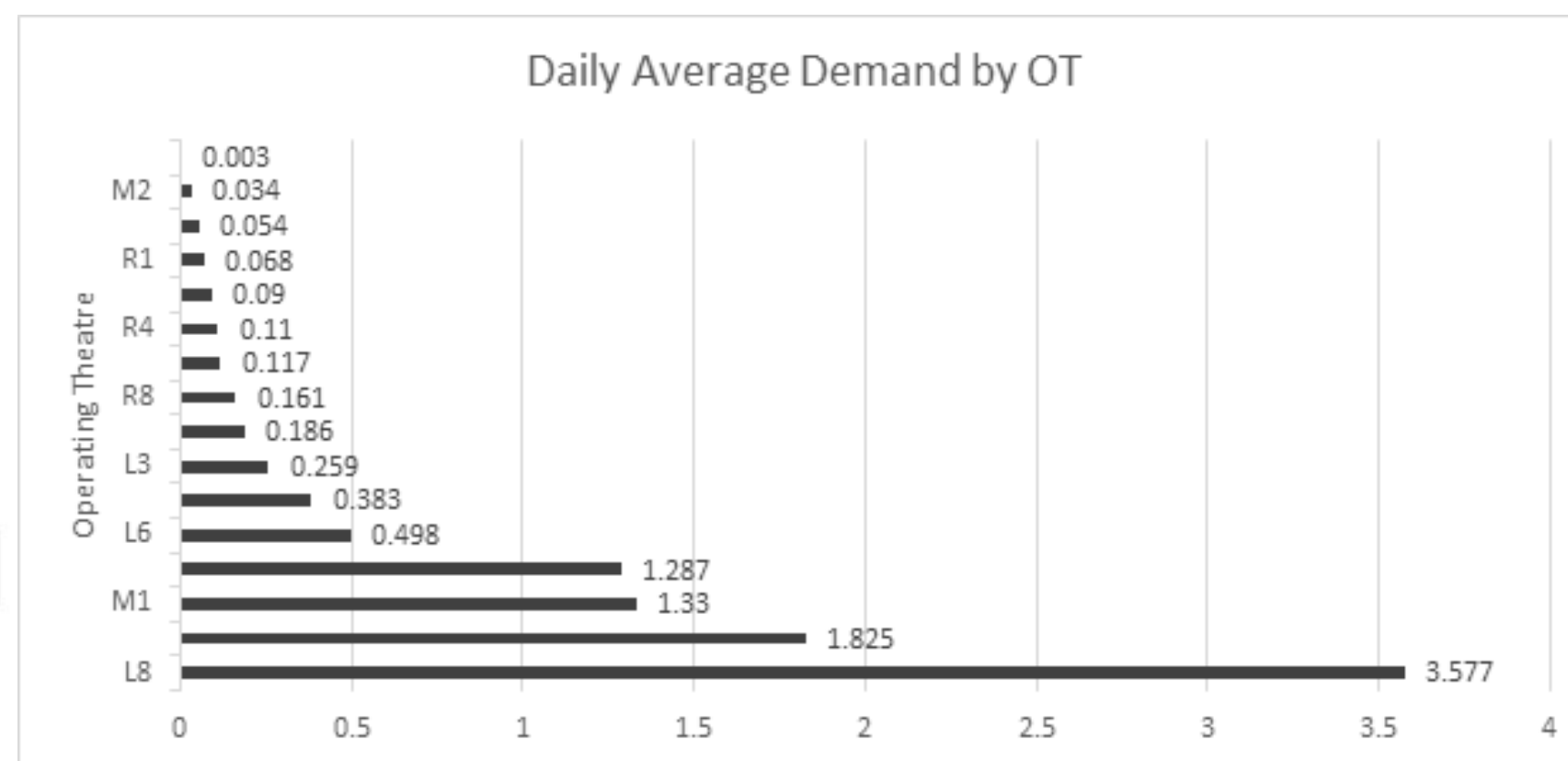


Fig 2. Relative Daily Demand Across OTs

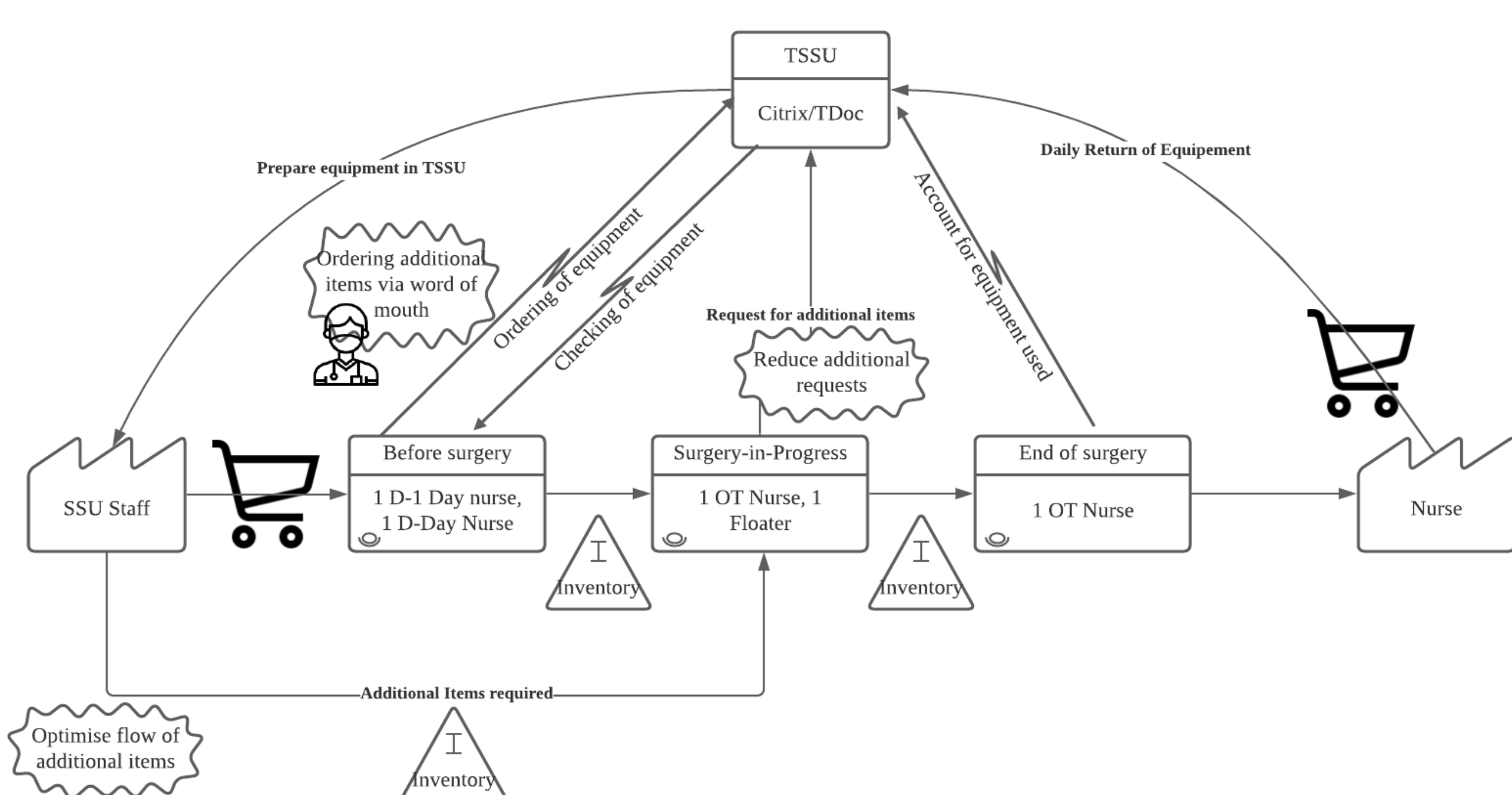


Fig 3. Value Stream Map for the order and fulfilment process in the OT

Results

1. Annual number of requests fulfilled by AGV

- Maximum annual number of requests fulfilled by AGV was reached with 3 AGV and improved assortment policy.
- Annual number of requests fulfilled by 2 AGV with improved assortment exceeds the number fulfilled by 3 AGV with basic assortment for all scenarios tested

2. Annual manpower hour saved

- The annual manhours saved reach maximum at restocking frequency 2 and 4 for 5x and 10x data with 3 AGV and improved assortment respectively

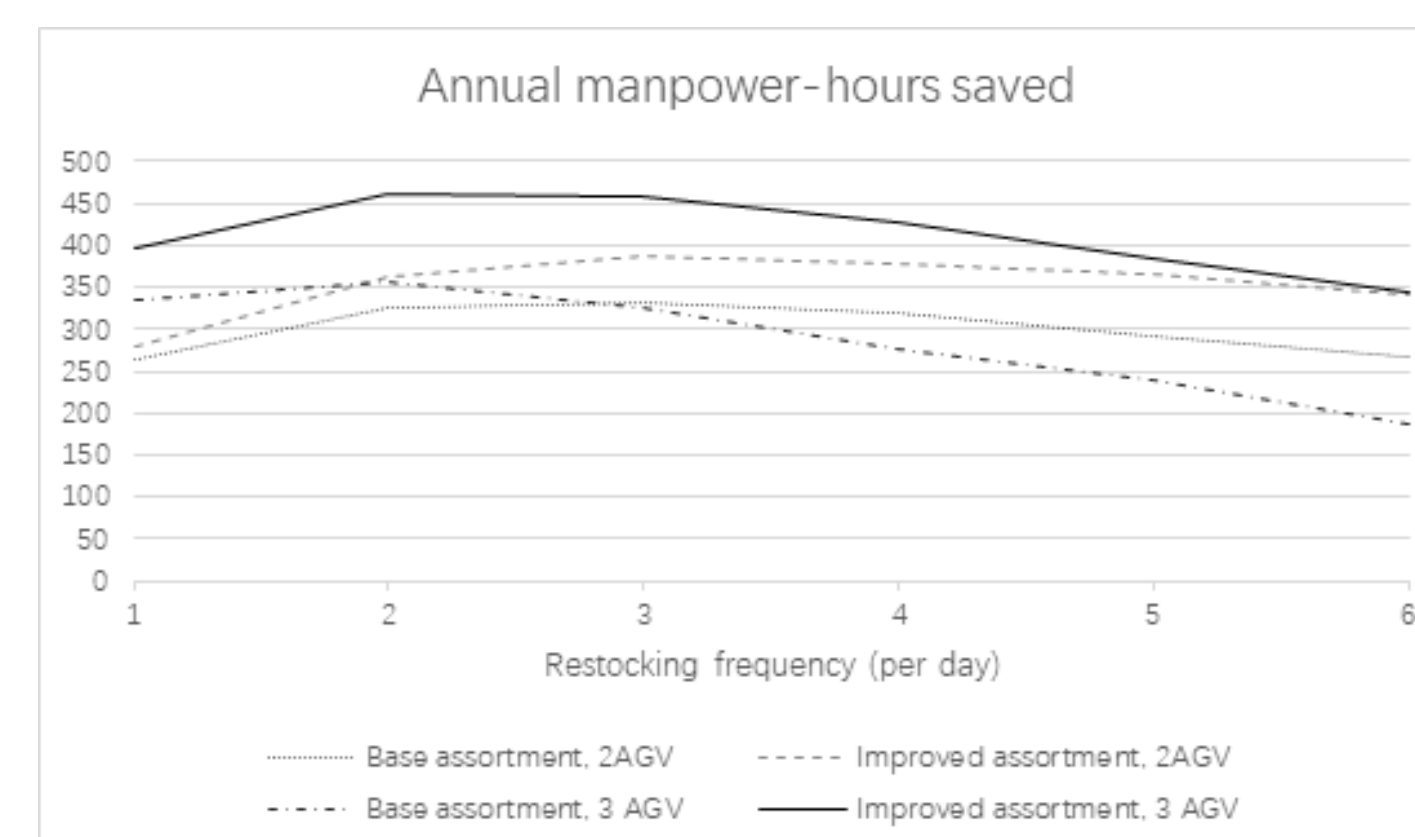


Fig 4. Annual Manhours Saved (5X scenario)

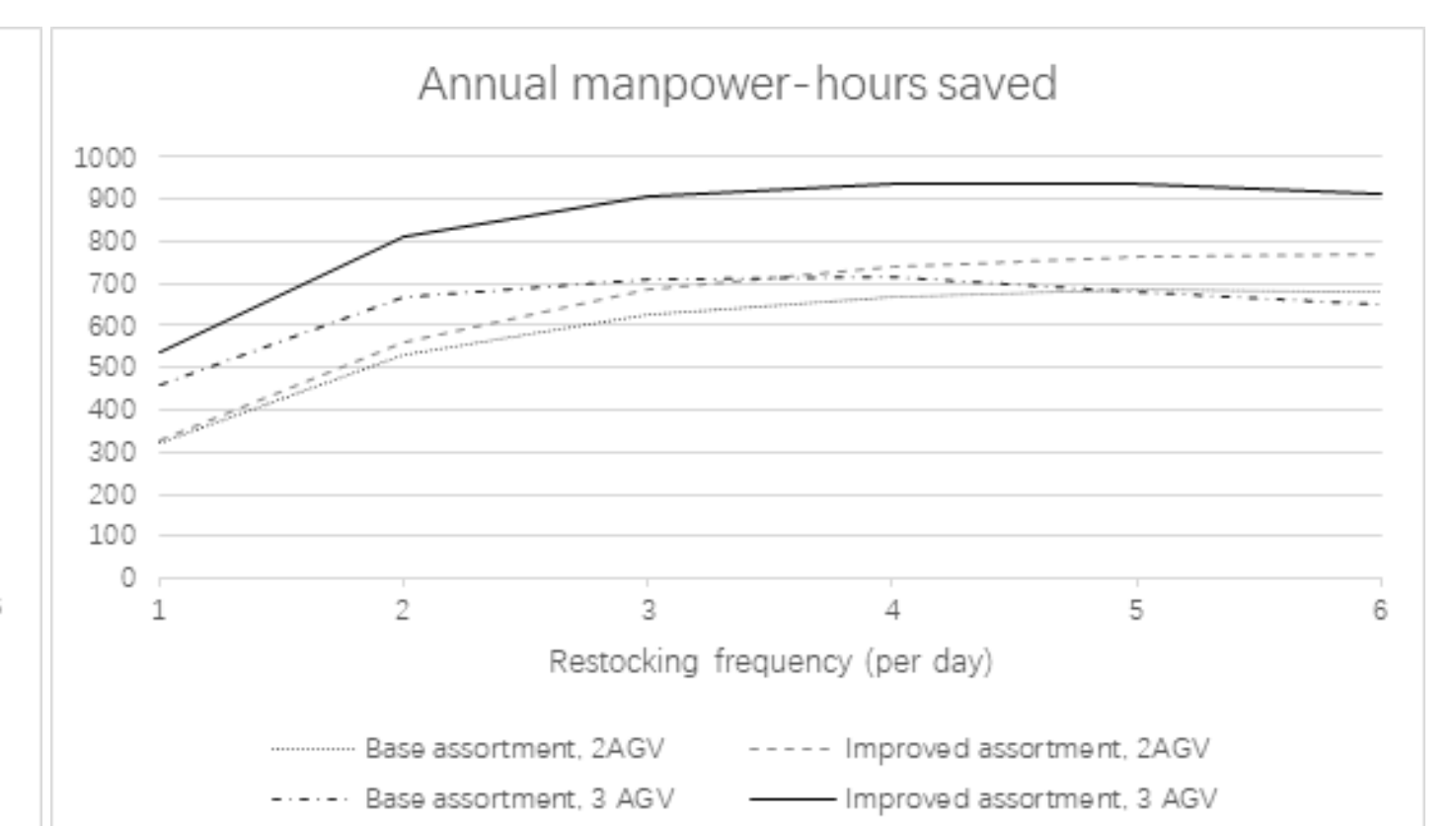


Fig 5. Annual Manhours Saved (10X scenario)

3. Utilization rate:

- The maximum utilization rate for all datasets is less than 3 AGV, improved assortment at the optimal restocking frequency

4. Cost per fulfillment:

- Cost per fulfillment increases with restocking frequency for original dataset and 2X scenario.
- Minimum with 2 times of restocking per day for improved assortment with 2 and 3 AGV in 5X scenario
- Minimum with 2 times of restocking per day with 3 AGVs and 3 times restocking with 2 AGVs in 10X scenario

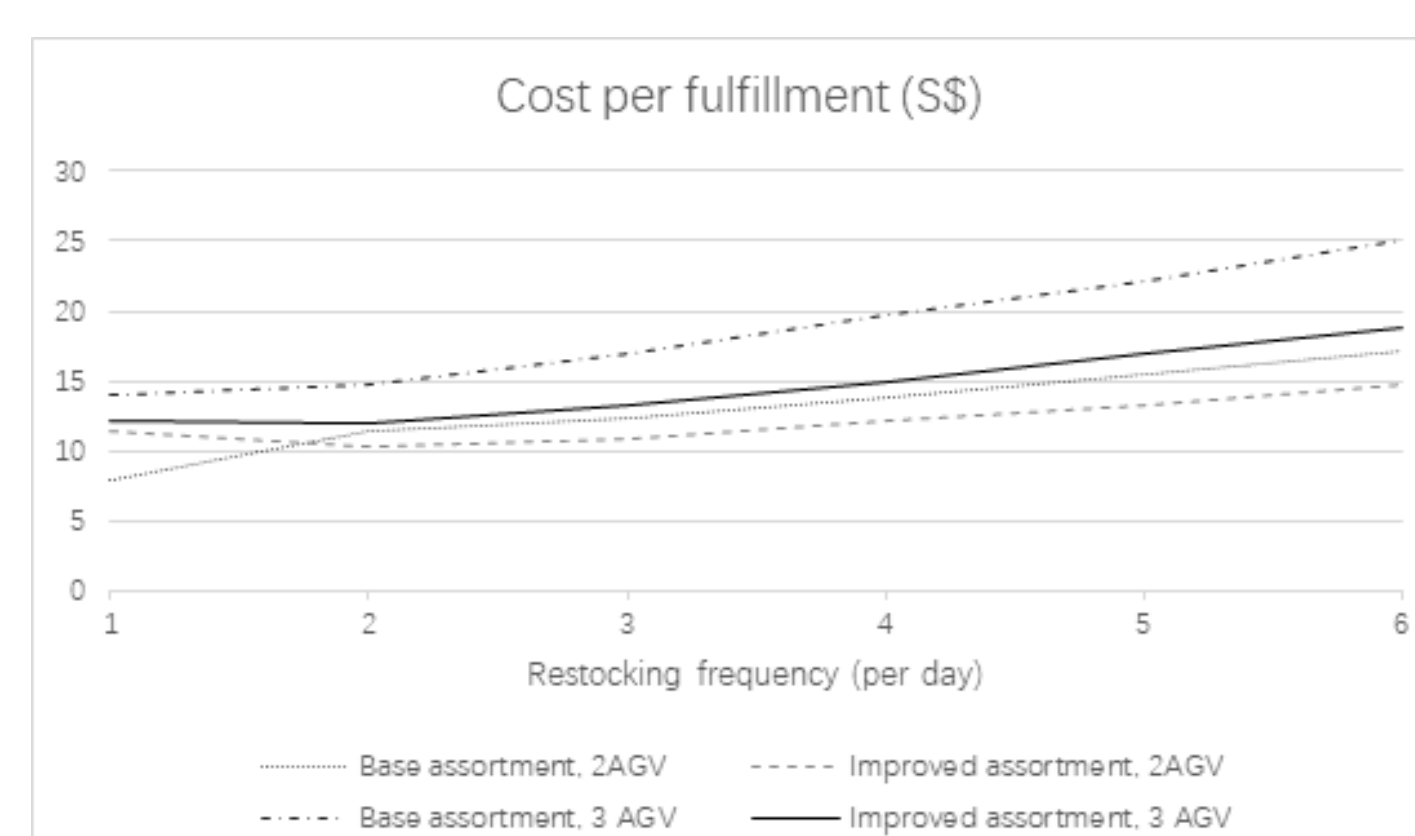


Fig 6. Cost per Fulfillment (5X scenario)

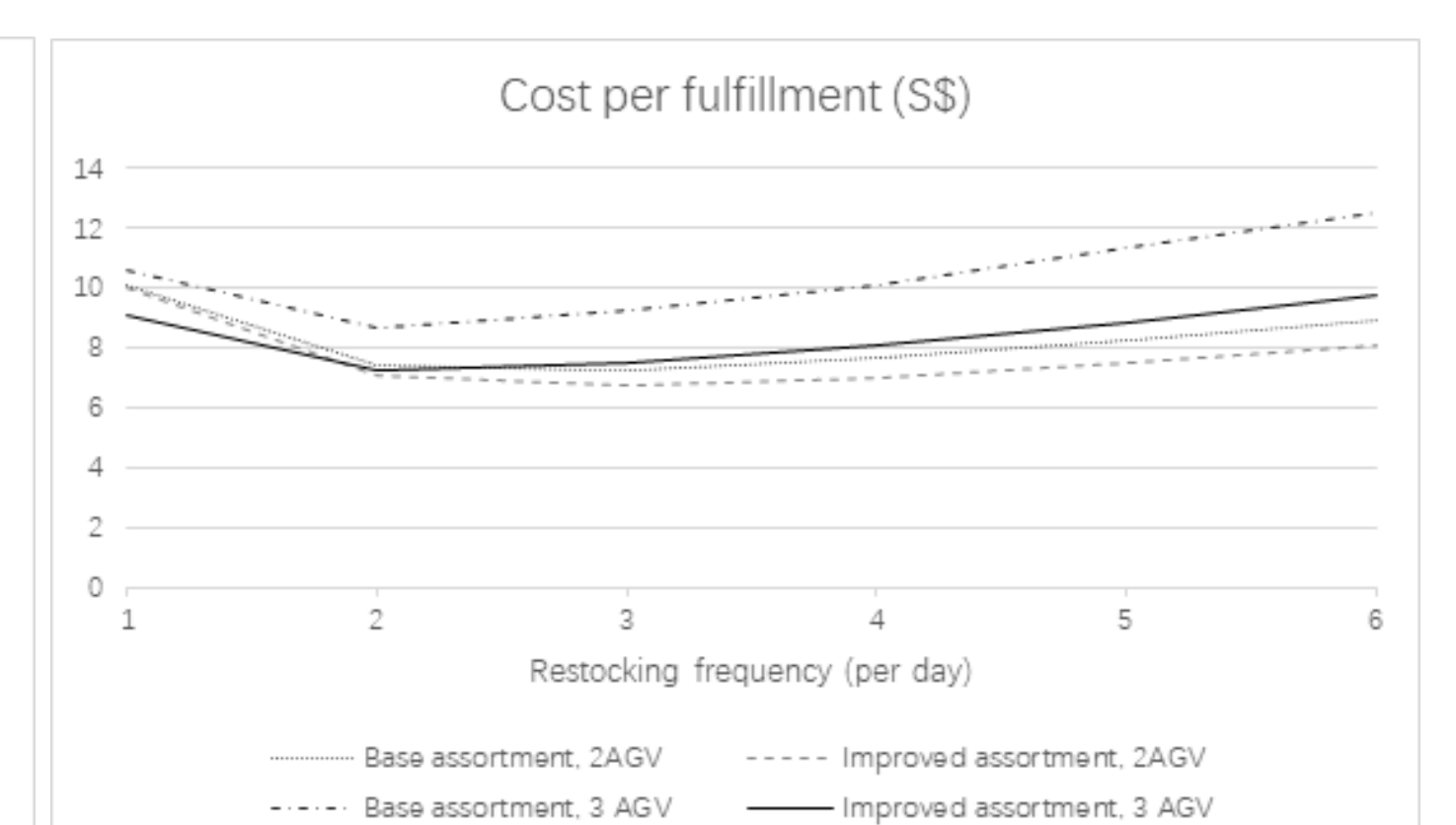


Fig 7. Cost per Fulfillment (10X scenario)

Conclusion

- Simulation modelling is a viable option for evaluating impact of AGVs on manual processes., AGVs can be effective under higher demand scenarios with optimal operational policies and configurations.
- Optimal AGV operational policies and configuration can be evaluated via virtual simulation platforms for the planning of AGV implementation

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