Agent-based Modelling and Simulation of Airport Terminal

Seyed Sahand Mohammadi Ziabari
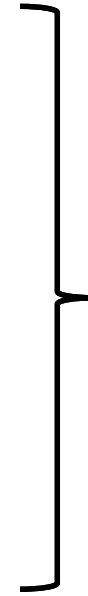
Projects

- **Systemic agent-based modelling and analysis of passenger discretionary activities in airport terminals (CTG)**

- **Agent-based modelling and simulation of airport terminal operations under COVID-19-related restrictions**

- **Surrogate modeling of agent-based airport terminal operations**

- **An improved Tabu Search for optimising the configuration of an agent-based simulation model of a novel security checkpoint**
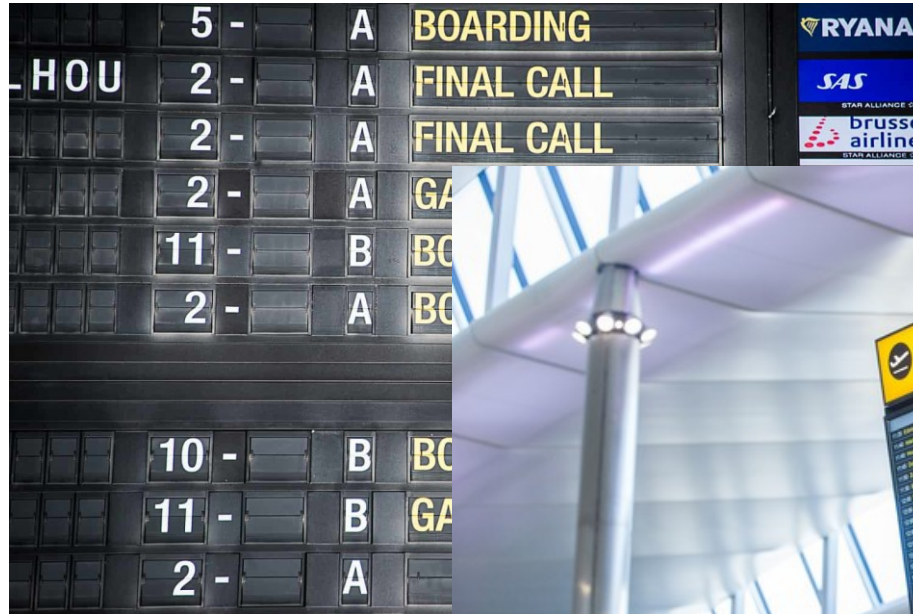
- **Remote luggage check-in (on goinig)**

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Call-to-Gate at airports

RTHA terminal overview

Introduction → Methodology → Case study → Discussion & Conclusion

Departures
- Gates
- Sanitary
- Retail

Arrivals
- Sanitary
- Baggage carousel

Passage
- Check-in & Baggage Drop
- Security check
- Service
- Lounge
- Sanitary
- Retail
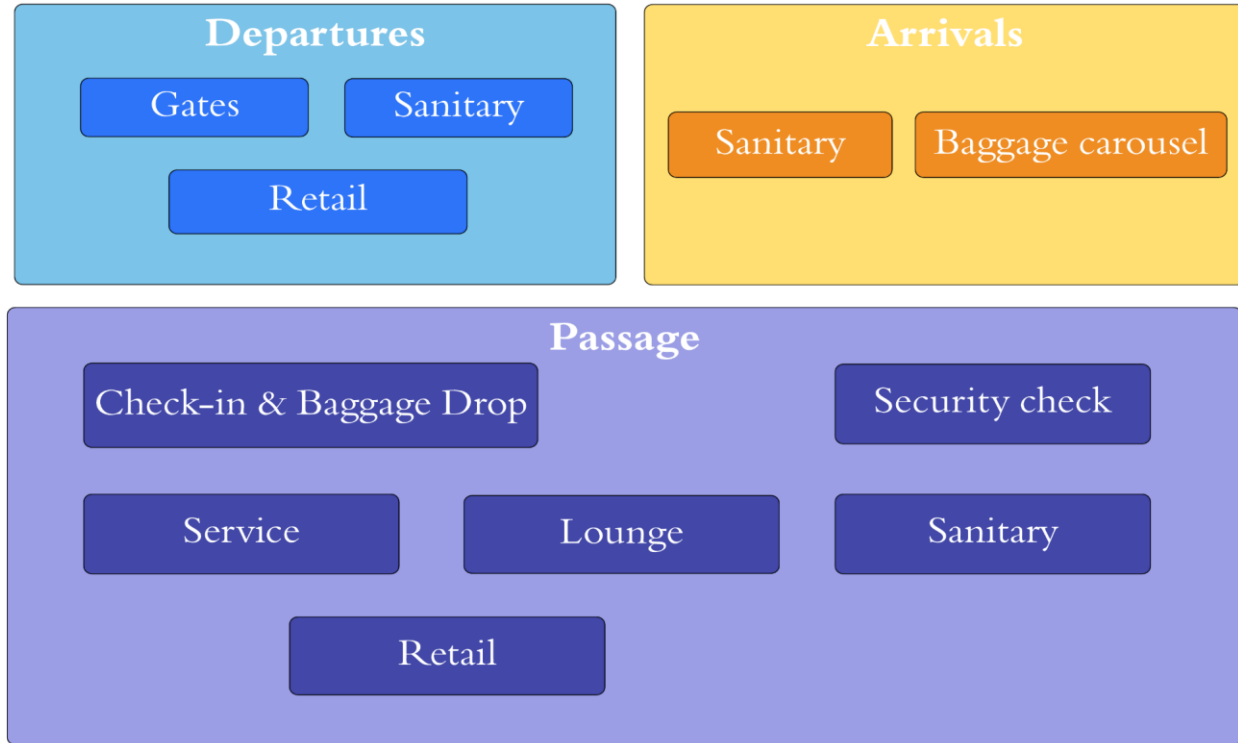
Stakeholders/Processes

Check-in
- Airline and/or ground handling

Security
- Airport and/or security provider
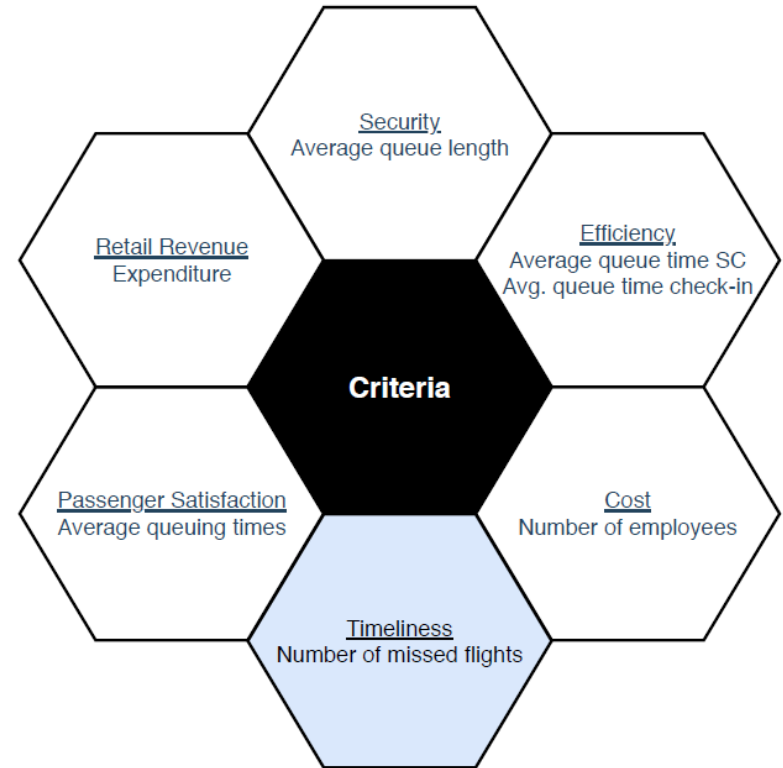
Retail
- Airport
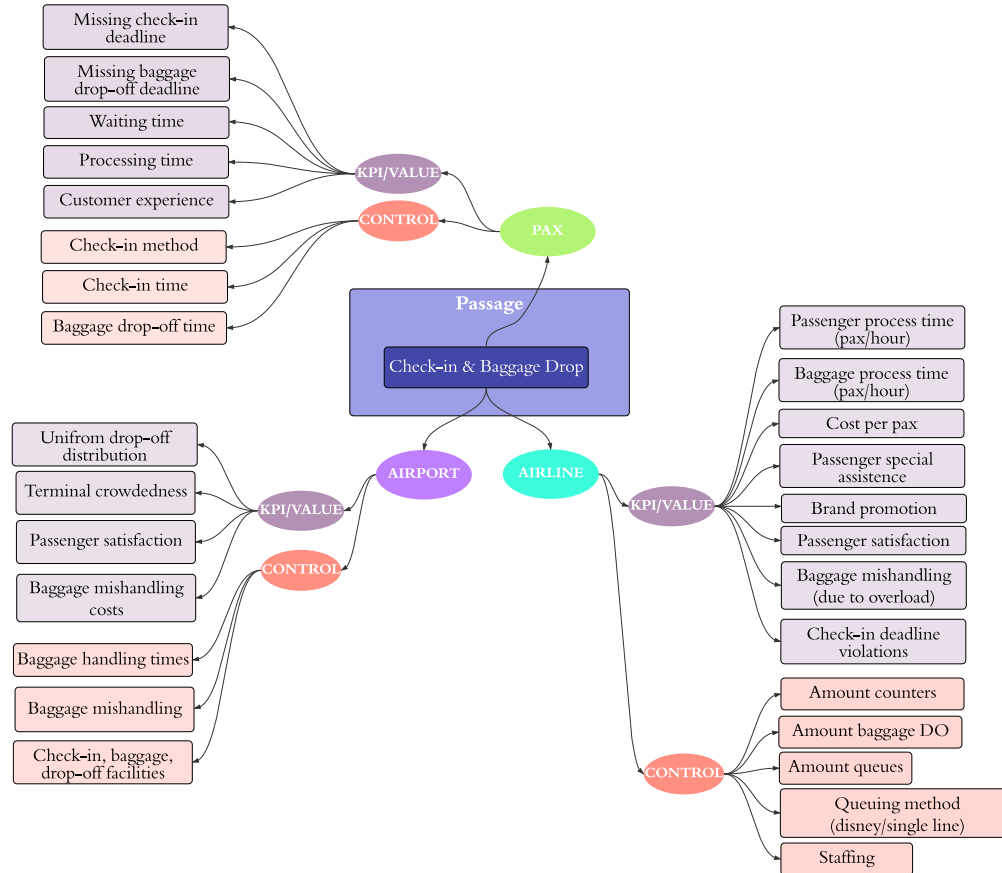
Food & Beverage
- Airport
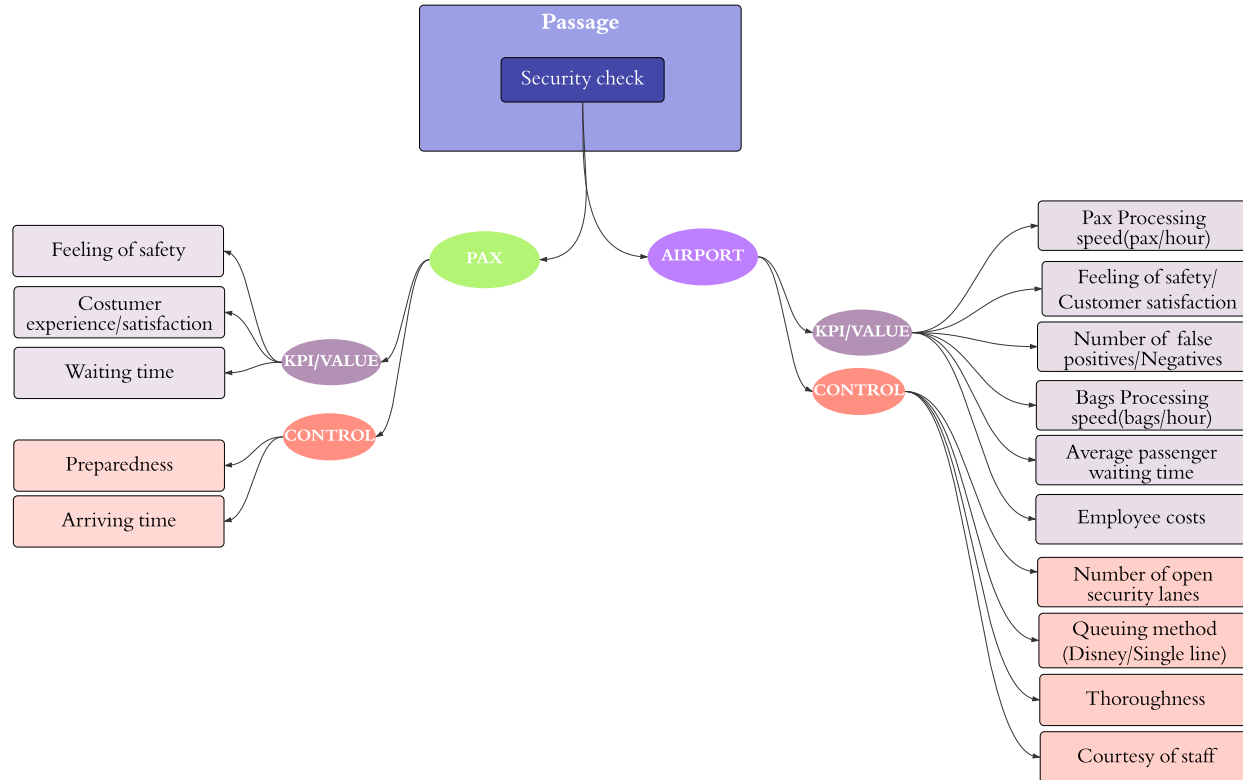
Lounge area
- Airport

Boarding
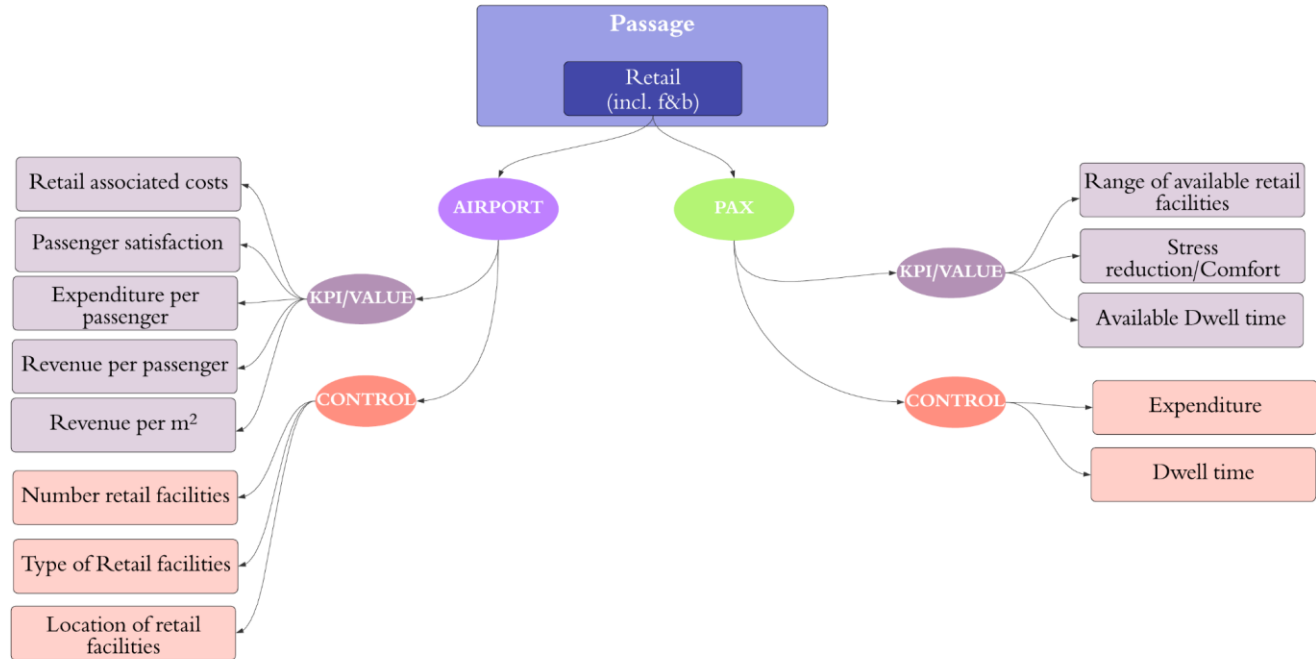- Airline and/or ground handling

Check-in and baggage drop KPI's and measures

Introduction → Methodology → Case study → Discussion & Conclusion

Missing check-in deadline
Missing baggage drop-off deadline
Waiting time
Processing time
Customer experience
Check-in method
Check-in time
Baggage drop-off time

KPI/VALUE
CONTROL
PAX

Passage
Check-in & Baggage Drop

AIRPORT
AIRLINE

Unifrom drop-off distribution
Terminal crowdedness
Passenger satisfaction
Baggage mishandling costs
Baggage handling times
Baggage mishandling
Check-in, baggage, drop-off facilities

KPI/VALUE
CONTROL

Passenger process time (pax/hour)
Baggage process time (pax/hour)
Cost per pax
Passenger special assistence
Brand promotion
Passenger satisfaction
Baggage mishandling (due to overload)
Check-in deadline violations

KPI/VALUE

Amount counters
Amount baggage DO
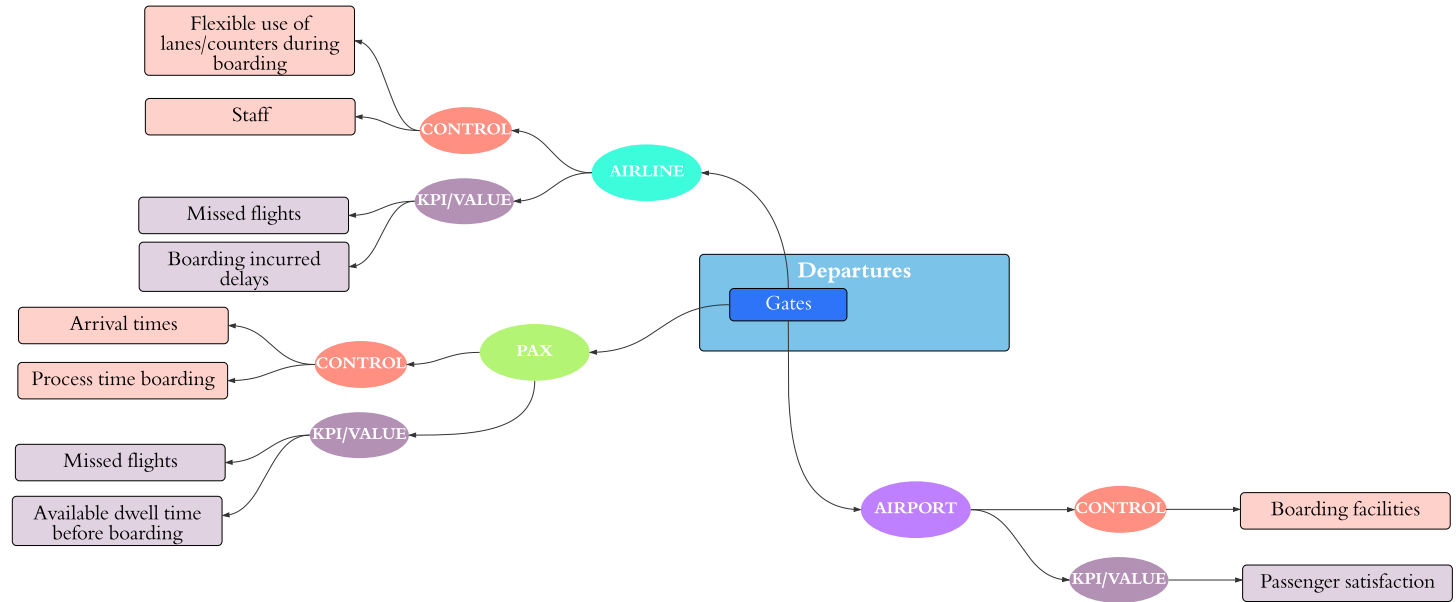Amount queues
Queuing method (disney/single line)
Staffing

CONTROL

7

Security check KPI's and control measures

Retail KPI's and control measures

Boarding KPI's and control measures

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Flexible use of lanes/counters during boarding

Staff

CONTROL

AIRLINE

Missed flights

Boarding incurred delays

KPI/VALUE

Departures

Gates

Arrival times

Process time boarding

CONTROL

PAX

Missed flights

Available dwell time before boarding

KPI/VALUE

AIRPORT

CONTROL

Boarding facilities

KPI/VALUE

Passenger satisfaction

# An airport terminal can be well represented by an agent-based model

- ABM: bottom-up modelling approach:
  - **Agents** are autonomous entities.
  - They are placed in the **environment** with an initial set of rules
    -> behaviour & interactions

Agents

Passenger   Check in operator   Security check operator

Environment

Check in   Security check   Gate
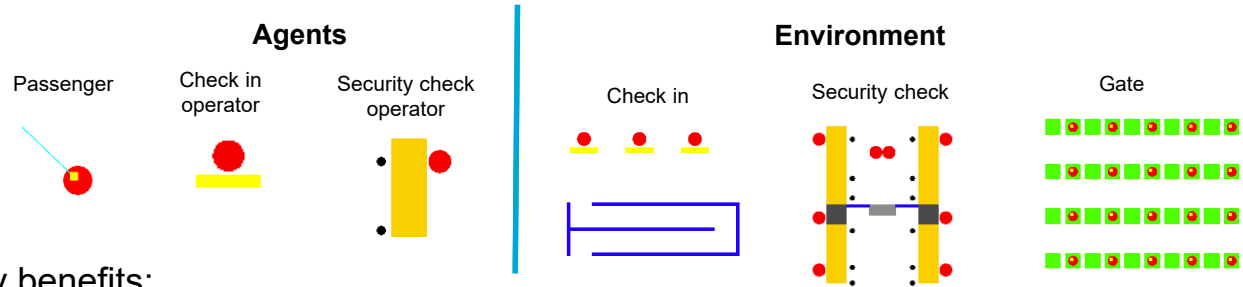
Key benefits:

+ Modular (different airports, measures)

+ Realism (human cognitive behaviour, local interactions -> global emergence)

+ Key Performance Indicators
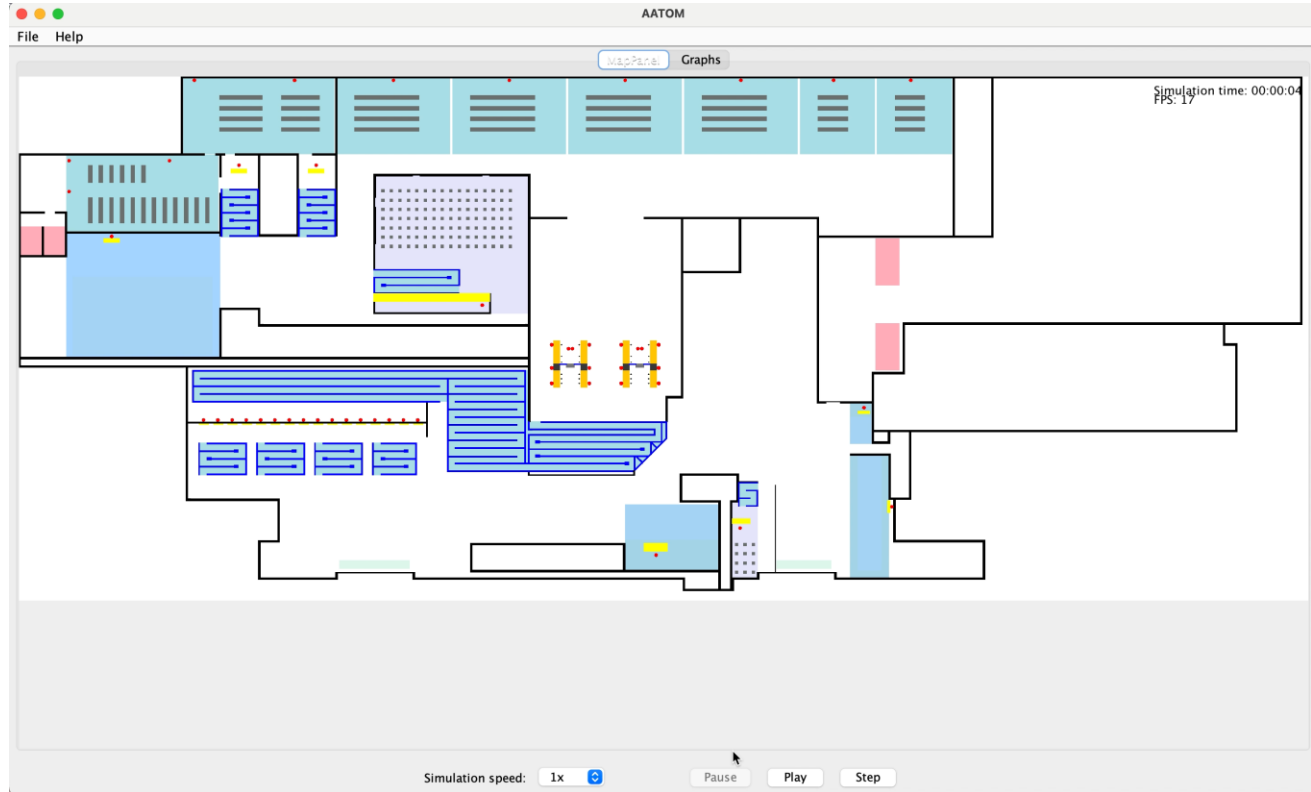
+ Modular -> Hypothesis testing

AATOM Full Architecture
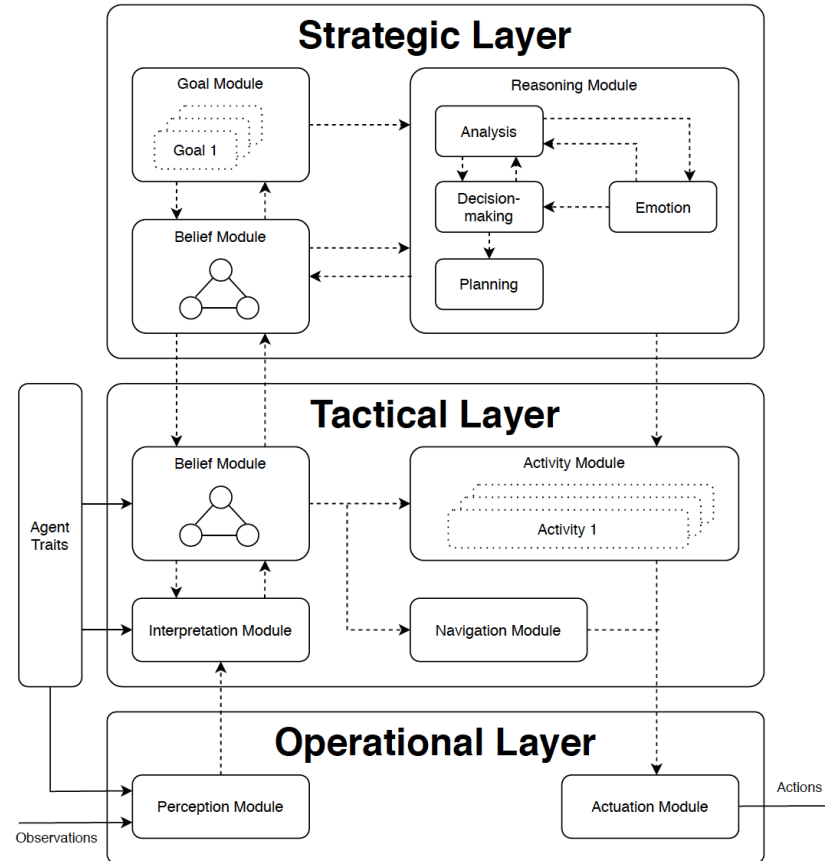
Simulation & Graphs in AATOM

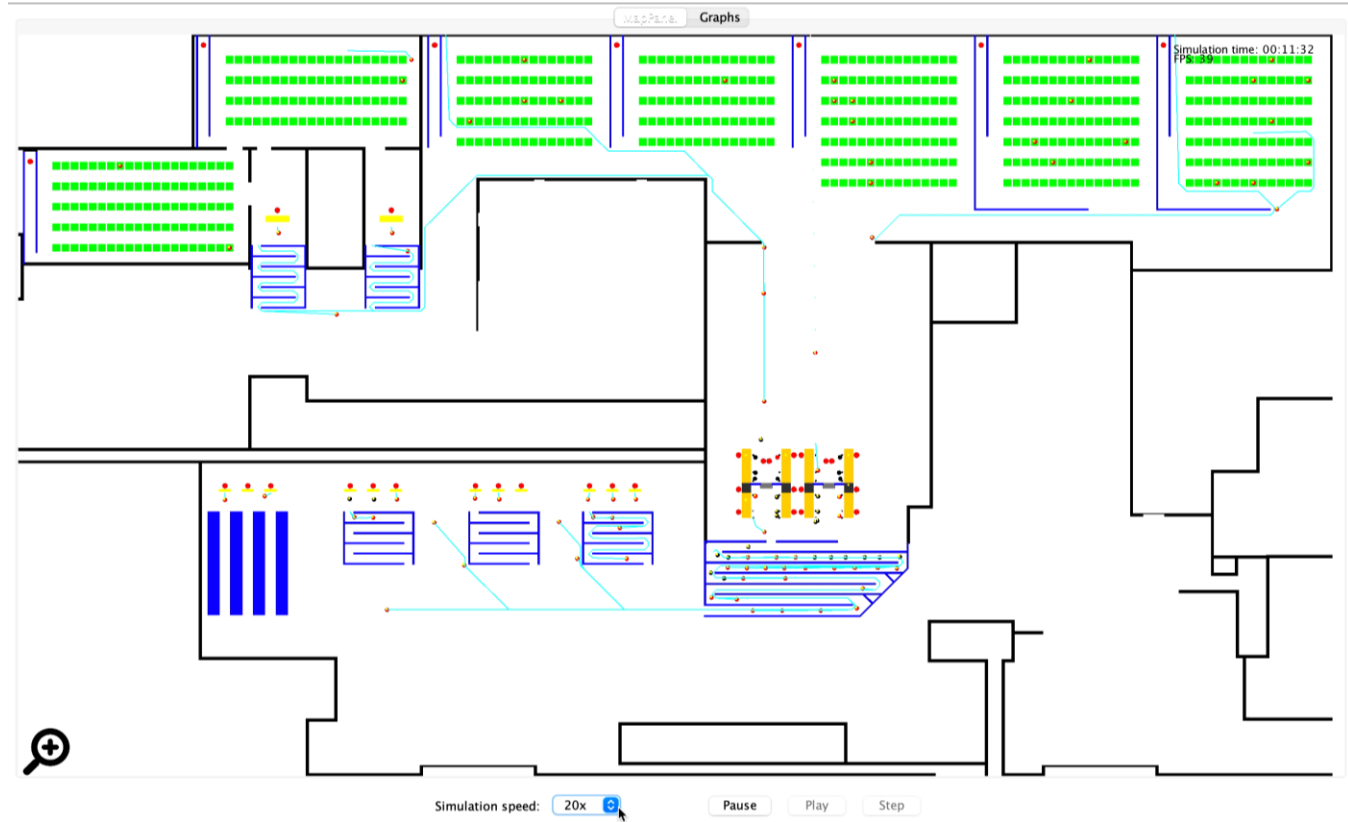Introduction → Methodology → Case study → Discussion & Conclusion

Graphs

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Experiments

- Experiment 1: effects of time at which passengers are called to the gate For experiment 1, 10 call-to-gate strategies are used in which the time ranges from 30 minutes to 120 minutes with steps of 10 minutes. The call-to-gate below 30 minutes was not considered because the boarding process starts 30 minutes before flight departure.

- Experiment 2: effects of security lane allocation. It indicates how many security lanes are open per time interval. The choices for the strategies are based on the average number of passengers expected to arrive in each time interval. Between 14:30-15:30, more passengers are expected to arrive compared to what a single security lane is able to handle without accumulating queue time. A fixed call-to-gate strategy of 45 minutes is used for this experiment.

- Experiment 3: combined effect of call-to-gate and security lane allocation Experiment 3 uses the call-to-gate strategies from experiment 1, and the security lane allocation strategies from experiment 2. Thus, for each explored call-to-gate time, four security checkpoint lane allocation strategies are explored.
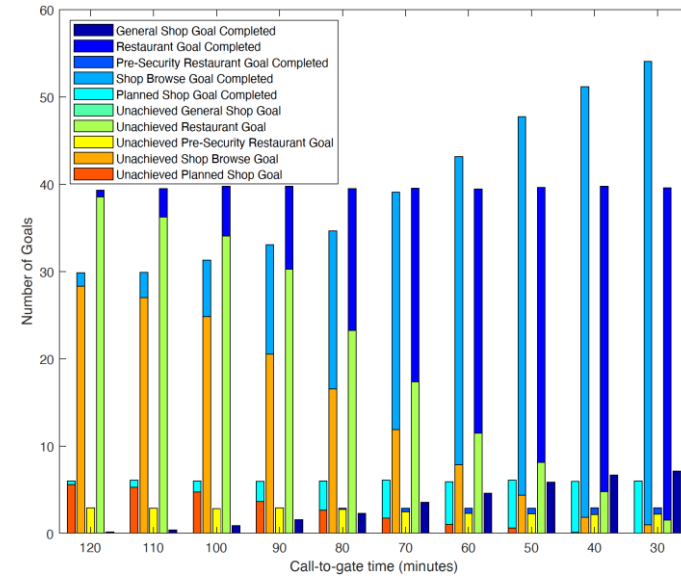
Security lane allocation strategies, indicating how many security lanes are open per time interval.

Strategy	14:00-14:30	14:30-15:00	15:00-15:30	15:30-16:00	16:00-16:30	16:30-17:00
1	1	1	1	1	1	1
2	1	2	1	1	1	1
3	1	1	2	1	1	1
4	1	2	2	1	1	1

Pax type vs Expenditure
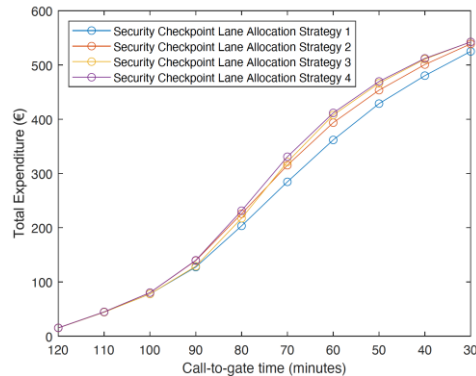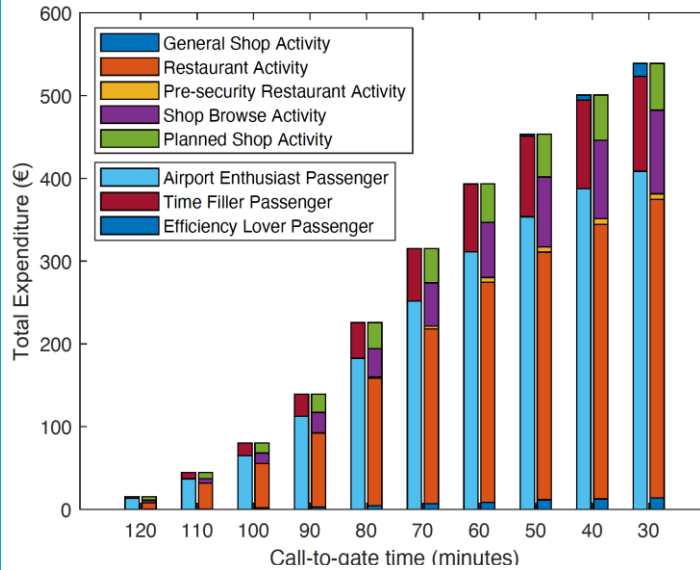
Goals completed vs CtG

Strategy	Average security checkpoint queue time (seconds)	Total expenditure (€)	Security checkpoint costs (€)
1	337.6	428.7	360
2	149.1	453.5	420
3	97.7	466.3	420
4	54.8	469.6	480

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Conclusion

- Expenditure can **significantly increase** if passengers are called to the gate later. Calling passengers later to the gate increases **dwelling time** of passengers, which causes passengers to complete more discretionary goals. **Airport enthusiast** passengers are particularly important for generating expenditure.

- Reducing **average queue time at security checkpoint** can also significantly increase expenditure, but the magnitude depends on the strategy. If the strategy reduces dwelling time of airport enthusiast passengers, less goals involving discretionary activities are completed. If this is not the case, keeping more lanes open does not necessary improve expenditure generation.

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Conclusion

- Call-to-gate strategies influence the **effectiveness** of security lane allocation strategies with respect to total generated expenditure. **Call-to-gate strategies** which result in **little free time** for passengers can benefit from **additional security resources at time intervals** at which early passengers arrive, since it can aid early passengers to complete some discretionary goals. However, call-to-gate strategies which result in more free time for passengers can benefit from additional security resources at time intervals when the majority of passengers arrive, since more passengers can complete discretionary goals.

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