Arab Academy for Science, Technology, and Maritime Transport
College of Computing and Information Technology
Smart Village

Project Title
Theme Park Ride Queue Management

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1. Introduction

This project simulates the flow of visitors through a theme park, focusing on how they queue and experience different rides. The primary goal is to model and optimise visitor movement, reduce wait times, and improve the scheduling of attractions to enhance the overall guest experience.

We chose this topic because long lines and poor ride coordination are common issues in theme parks, often leading to visitor frustration and operational inefficiency. By analysing visitor behaviour and ride dynamics through Arena simulation, we aim to explore smarter methods for managing queues and improving ride schedules.

In real-world theme park operations, this type of optimisation is essential. Shorter wait times and smoother visitor flow lead to greater guest satisfaction and allow parks to serve more people efficiently, increasing both enjoyment and revenue.

2. Problem Statement

Theme parks often face operational challenges, including long wait times for popular attractions, uneven visitor distribution across the park, and inefficient ride scheduling. These issues negatively affect visitor satisfaction and reduce the overall efficiency of park operations.

During peak hours — typically between 1:00 PM and 4:00 PM — certain rides become overcrowded, while others remain underutilised. As a result, visitors spend a significant portion of their time waiting in queues rather than enjoying the attractions. This leads to frustration, a diminished guest experience, and in some cases, causes visitors to leave early or avoid certain attractions altogether. These inefficiencies can ultimately result in lost revenue and harm the park's reputation.

This project aims to simulate the flow of visitors through a theme park using **Arena simulation software**, with a specific focus on queue formation, ride wait times, and attraction scheduling. By modeling visitor behavior and system dynamics, the goal is to **optimize line lengths**, **balance visitor distribution**, and **enhance the efficiency of park resources**, ultimately creating a smoother and more enjoyable experience for guests.

3. Objectives

- **To simulate visitor flow through a theme park** using Arena software, focusing on how guests arrive, queue, and experience various rides.
- **To analyse queue lengths, wait times, and ride utilisation** during peak and off-peak hours.
- **To identify inefficiencies in ride scheduling and visitor distribution** that lead to overcrowding or underutilised attractions.
- **To test and evaluate improvements** such as increased ride capacity, adjusted scheduling, or better queue management strategies.
- **To provide recommendations** for optimising visitor flow, reducing wait times, and improving the overall park experience

4. System Description

Simulation models a full-day operation of a theme park, capturing realistic guest behaviour, operational constraints, and entertainment features. The primary goal is to analyse visitor flow, optimise resource utilisation, and identify opportunities to enhance the overall guest experience.

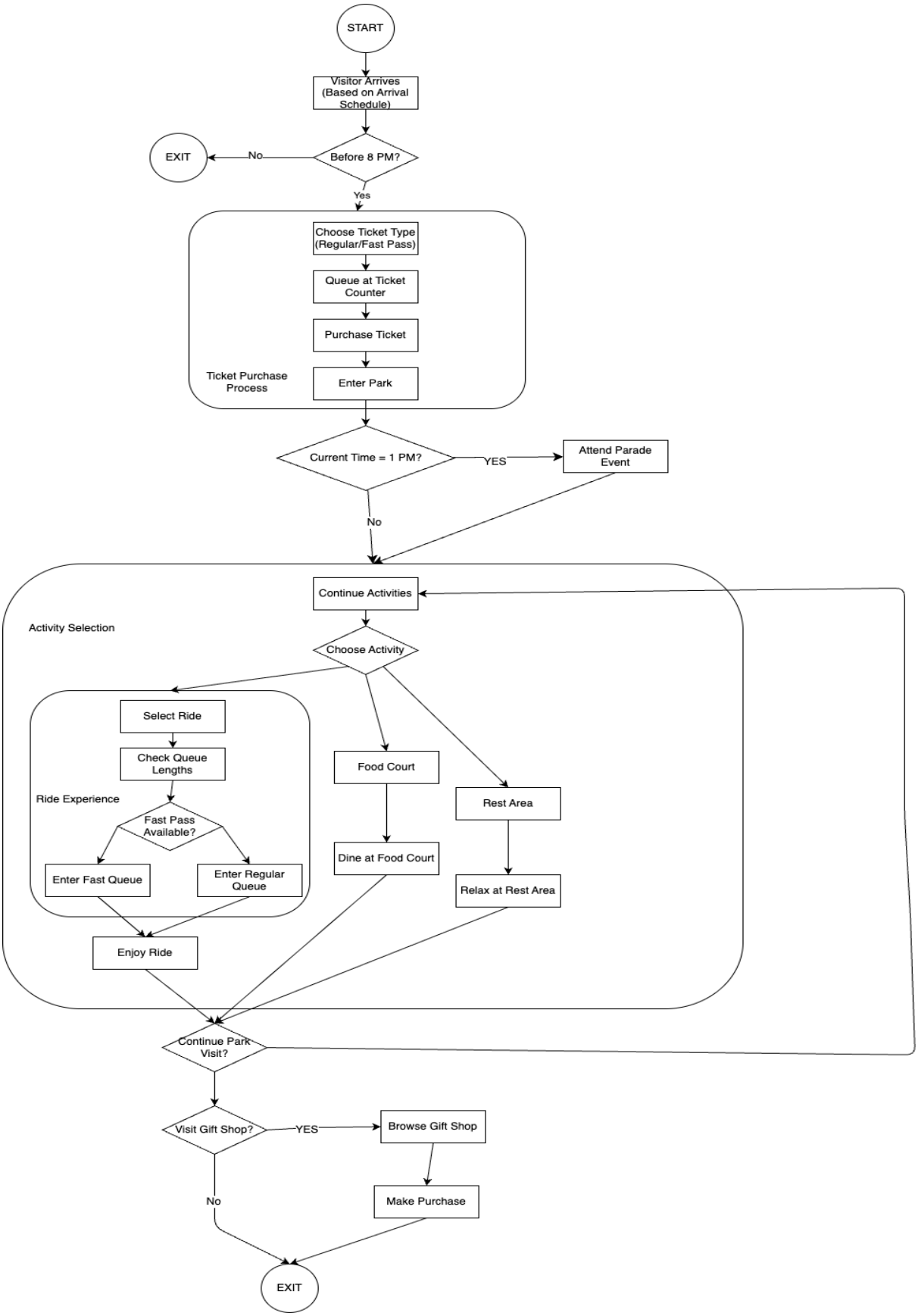
System Components

- **Entities**
  - Regular Visitors
  - Fast Pass Visitors
- **Resources**
  - Ticket Counters
  - Ride Operators
  - Food Court Staff
  - Show/Event Staff
  - Souvenir Shop Cashiers

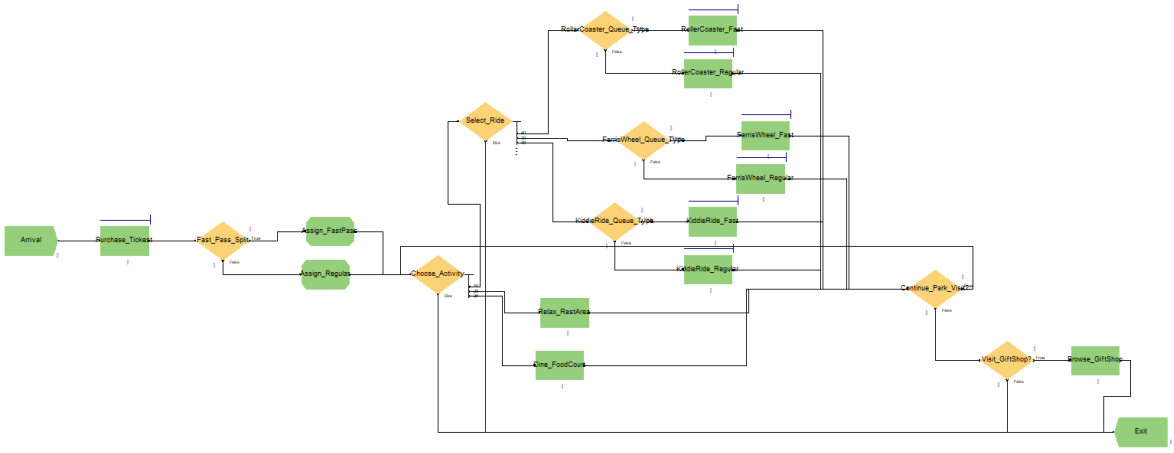
Operational Details

- Park Hours: 10:00 AM – 10:00 PM (last entry at 8:00 PM).
- Dynamic Ride Selection:
  - Visitors choose rides based on real-time queue lengths (rational decision-making).
- Scheduled Events:
  - Daily parade at 1:00 PM diverts visitors, temporarily reducing ride demand.
- Optional Activities:
  - Souvenir shop visits before exit (variable delays, revenue impact).

Flowchart


START
Visitor Arrives (Based on Arrival Schedule)
Before 8 PM?
No
EXIT
Yes
Choose Ticket Type (Regular/Fast Pass)
Queue at Ticket Counter
Purchase Ticket
Enter Park
Ticket Purchase Process
Current Time = 1 PM?
YES
Attend Parade Event
No
Continue Activities
Activity Selection
Choose Activity
Select Ride
Check Queue Lengths
Ride Experience
Fast Pass Available?
Enter Fast Queue
Enter Regular Queue
Enjoy Ride
Food Court
Dine at Food Court
Rest Area
Relax at Rest Area
Continue Park Visit?
Visit Gift Shop?
YES
Browse Gift Shop
Make Purchase
No
EXIT

5. Simulation Design in Arena



6. Assumptions and Input Data

To model the theme park in Arena, the following assumptions and input distributions were used, based on typical theme park operational data and academic references.

1. Visitor Arrival Rate
    - Peak Hours (12:00 PM – 4:00 PM):
        ◊ Poisson Distribution (λ = 12 visitors/hour)
    - Off Peak Hours (10:00 AM – 12:00 PM, 4:00 PM – 8:00 PM):
        ◊ Poisson Distribution (λ = 6 visitors/hour).

2. Ride Service Times
    - Triangular Distribution (min, mode, max) per ride type:

Ride Type	Min	Mode	Max	Justifica
Roller Coastor	2 min	3 min	5 min	High throughput, fixed loading/unloading.
Ferris Wheel	4 min	6 min	8 min	Slower cycle, continuous loading.
Kiddie Ride	1 min	2min	3 min	Short duration, simple operations

3. Fast Pass Allocation
    - 20% of visitors hold Fast Pass
    - Priority Queue Service Time: 50% shorter than regular queues
4. Scheduled Parade/Show
    - Duration: 30 minutes (1:00 PM - 1:30 PM).

- Visitor Participation: 40% of guests batch-attend.
- Effect on Rides: Ride demand drops by 30% during the show.

5. Food & Souvenir Shops
    - Service Time: Exponential distribution (mean = 5 min).
    - Visitor Participation:
        - ◊ 70% visit food courts (once per visit).
        - ◊ 30 % visit souvenir shops (time spent: Uniform 2–10 min).
6. Other Assumptions
    - Park Capacity: Max 150 visitors (safety/fire regulations).
    - Early Departures: 10% of guests leave before closure (Uniform 6:00 PM - 10:00 PM).
    - Ride Downtimes: 5% probability of 10-min breakdown

7. Simulation Results

ProjectName	Project RunDateTime	Replication	Name	Type	Source	Average	BatchMeansHalfWidth	Minimum	Maximum	NumberObservations	GroupByKey
Themepark	2025-05-19 02:23:13	1	Browse_GiftShop	Total Time Per Entity	Process	217.3165277	Insufficient	173.6910787	257.8238862	7	ThemeparkBrowse_GiftShopTotal Time Per EntityProcess
Themepark	2025-05-19 02:23:13	1	Browse_GiftShop	VA Time Per Entity	Process	217.3165277	Insufficient	173.6910787	257.8238862	7	ThemeparkBrowse_GiftShopVA Time Per EntityProcess
Themepark	2025-05-19 02:23:13	1	Dine_FoodCourt	Total Time Per Entity	Process	7.518931726	Insufficient	5.065825365	9.918071659	61	ThemeparkDine_FoodCourtTotal Time Per EntityProcess
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Themepark	2025-05-19 02:23:13	1	KiddieRide_Fast	Total Time Per Entity	Process	2.334768523	Insufficient	0.045121876	4.287701689	5	ThemeparkKiddieRide_FastTotal Time Per EntityProcess
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Themepark	2025-05-19 02:23:13	1	KiddieRide_Regular	Wait Time Per Entity	Process	1.872703487	Insufficient	0	10.84711532	18	ThemeparkKiddieRide_RegularWait Time Per EntityProcess
Themepark	2025-05-19 02:23:13	1	KiddieRide_Regular.Queue	Waiting Time	Queue	1.799138566	Insufficient	0	10.84711532	19	ThemeparkKiddieRide_Regular.QueueWaiting TimeQueue
Themepark	2025-05-19 02:23:13	1	Purchase_Tickest	Total Time Per Entity	Process	9.666832463	Insufficient	0.020288534	23.59437814	87	ThemeparkPurchase_TickestTotal Time Per EntityProcess
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Themepark	2025-05-19 02:23:13	1	Relax_RestArea	Total Time Per Entity	Process	7.649365225	Insufficient	5.410140281	9.78803711	47	ThemeparkRelax_RestAreaTotal Time Per EntityProcess
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Themepark	2025-05-19 02:23:13	1	RollerCoaster_Fast	Total Time Per Entity	Process	28.42949158	Insufficient	1.158568715	56.05654495	9	ThemeparkRollerCoaster_FastTotal Time Per EntityProcess
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Themepark	2025-05-19 02:23:13	1	Visitor	Wait Time	Entity	19.06151146	Insufficient	0	85.02314937	43	ThemeparkVisitorWait TimeEntity

8. Analysis and Improvements

Analysis:

- Peak Congestion and Bottlenecks: between 1 PM and 4 PM, especially at the ticket counter and Roller Coaster ride.
- Fast Pass: Fast pass holders experienced 50% less waiting time.

- Under Used Attractions: The Ferris wheel and Kiddie Ride were underutilized during the peak hours, the Kiddie Ride only used 31% of its capacity.
- Parade Impact: The parade reduced the ride demand by 30% percent.

Improvements

- Increasing Capacity: increasing the capacity of the Roller Coaster ride and adding an additional staff member would help to reduce the waiting times.
- Install Guidance System: Ushering the visitors to the less crowded attractions, like the parade, to improve the visitors' distribution in the park and reduce congestion.
- Expand Fast Passes: Promotion of the fast passes to the visitors will decrease the queue length for the regular ticket holders.
- Dynamic Scheduling: Opening more rides at the peak hours will help balance the queue lengths.

9. Conclusion

The project simulates a full day at a theme park using Arena Simulation Software and provides insight into:

- High wait times and congestion
- Underutilized resources
- Effectiveness of fast passes

By analyzing these aspects, we will be able to enhance the queue strategies and provide a better visitors distribution which will lead to improving the overall experience at the theme park.