Project Report

CE-409: Simulation and Modelling

Fall Semester
SECTION: C

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Project Title

Use Arena software to design and run Cafe Processing Simulation

Abstract

Acknowledgement

We have made efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. We would like to extend my sincere thanks to all of them.

We are highly indebted to teachers for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project.

We would like to express our gratitude to the members of the project for their kind co-operation and encouragement which helped me in the completion of this project.

We would like to express my special gratitude and thanks to industry persons for giving me such attention and time.

Our thanks and appreciations also go to our Project partners in developing the project part from the efforts of myself, the success of any project depends largely on the encouragement and guidelines of many others. We take this opportunity to express our gratitude to the people who have been instrumental in the successful completion of this project. We would like to show our greatest appreciation to Miss Safina Soomro. We can't say thank you enough for your tremendous support and help. The guidance and support received from all the members who contributed and who are contributing to this project was vital for the success of the project. We are grateful for your constant support and help.

Abstract

This project utilizes Arena simulation software to model and analyze customer flow and resource utilization within a cafe. The model simulates customers arriving at random intervals, choosing between food and drinks, ordering, paying, and dining or taking their order to go. Data is collected throughout the process, including arrival times, wait times, and resource utilization of the barista station and cash registers.

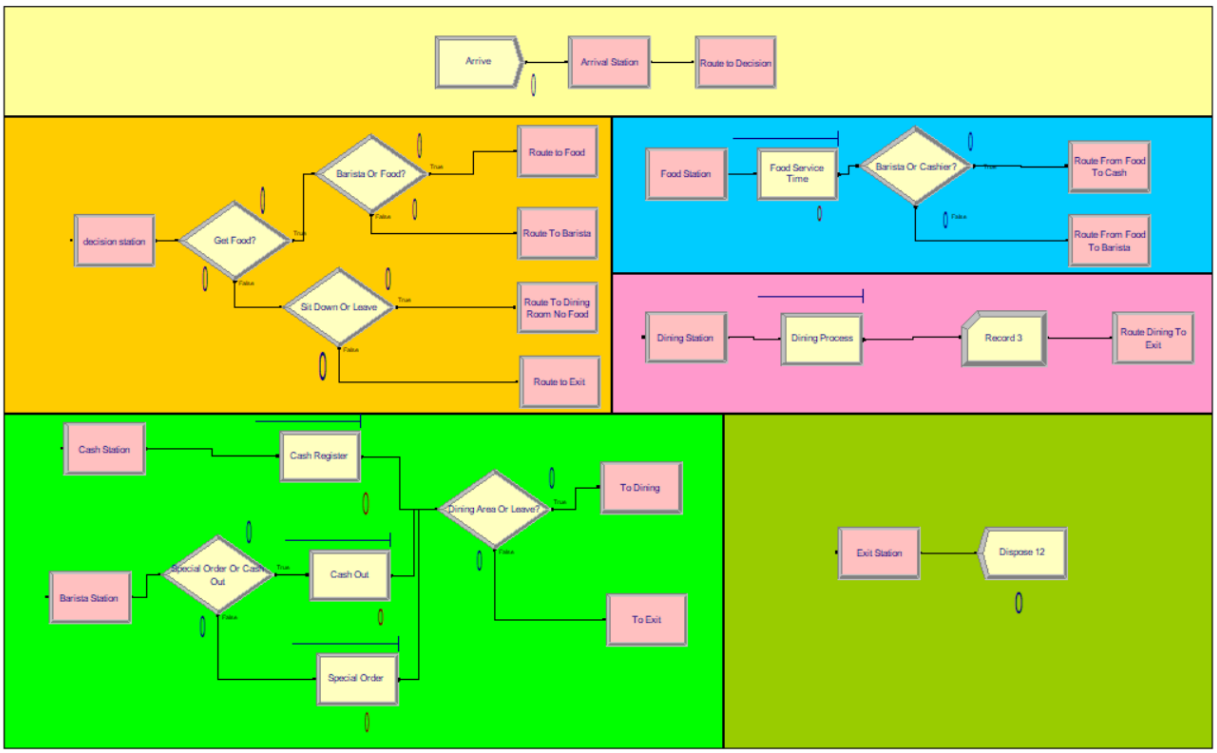
The analysis of this data focuses on identifying bottlenecks, optimizing resource allocation, and refining the menu. By evaluating wait times at different stages, we can pinpoint areas of congestion and implement solutions like adjusting staff scheduling or modifying the layout. Resource utilization analysis helps us determine if staff levels are appropriate during specific periods, allowing for efficient use of personnel. Sales data informs menu optimization, allowing us to focus on popular items and potentially remove underperforming ones.

The project demonstrates the effectiveness of using simulation modeling to improve cafe operations. By optimizing customer flow and resource utilization, we can enhance customer experience, reduce wait times, improve staff efficiency, and ultimately increase profitability. These abstract highlights the model's key features, analysis methods, and potential benefits, providing a concise overview of the project's goals and outcomes.

Objective: Use Arena software to design and run Cafe Processing Simulation.

1. Project Description:

1.1. Complete simulation model:



1.2. Model Overview:

- The model simulates the customer journey in your cafe, starting with their arrival and ending with their departure.
- Customers arrive at the "Arrive" module following a specific distribution (e.g., Poisson) to represent random arrival times.
- They then decide whether to order food or go straight to the barista at the "Arrival Station."
- The food and barista processes branch off, with customers selecting food items, potentially adding drinks, and finally proceeding to the cash register for payment.
- Customers can choose to dine in or take their orders to go.
- The dining area allows for additional orders ("Social Order") and final payment ("Cash Out") before exiting.
- Data recording modules ("Record 1" and "Dispose 12") capture crucial statistics for analysis.

1.3. Key Components and their Workings:

- Customer Arrival: The "Arrive" module generates customers at specific intervals or randomly based on a chosen distribution.
- Arrival Station: This decision point directs customers to either the "Food Station" or the "Barista Station" based on their preference for food or drinks.
- Food Station: Customers browse and select food items, with the processing time potentially represented by a specific module and distribution. They can then proceed to the cash register or the "Barista or Cover?" point.
- Barista Station: Customers who bypass the food station or choose to add drinks arrive here. They order their drinks, pay at the cash register, and then proceed to the dining area or exit.
- Dining Area: Customers can find a seat, place additional orders ("Social Order"), or pay their bill ("Cash Out") before exiting.

1.4. Data Collection and Analysis:

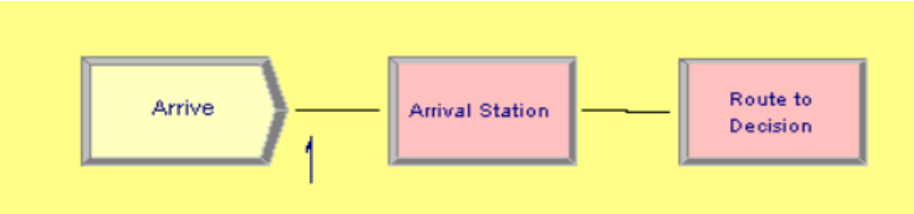
The "Record 1" and "Dispose 12" modules capture valuable data on various aspects of the process, such as:

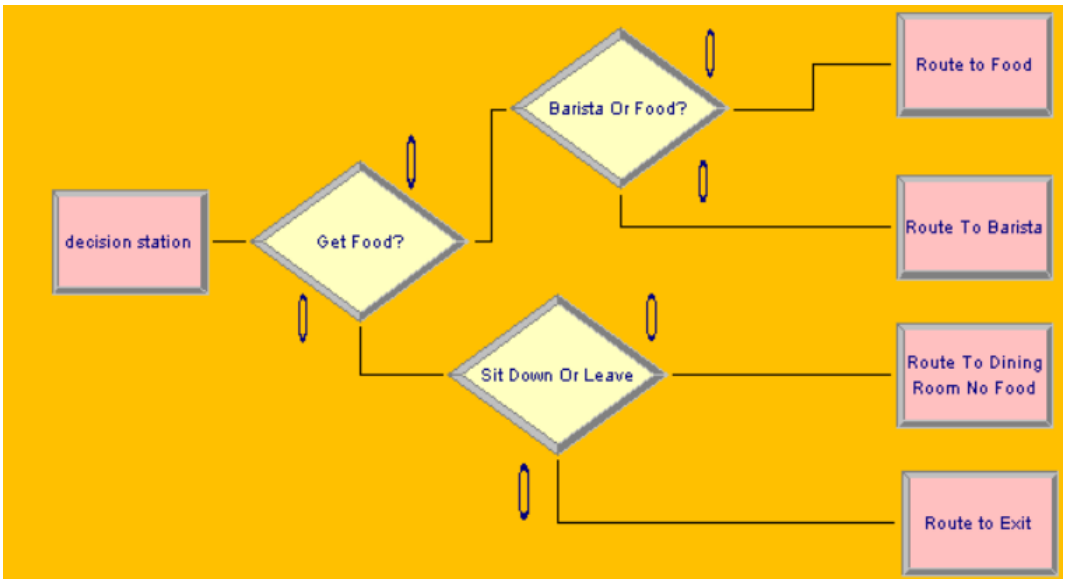
- Customer arrival times and wait times at different stages.
- Number of customers ordering food and drinks.
- Utilization of baristas and cash registers.
- Revenue generated from food and drinks.

2. Working:

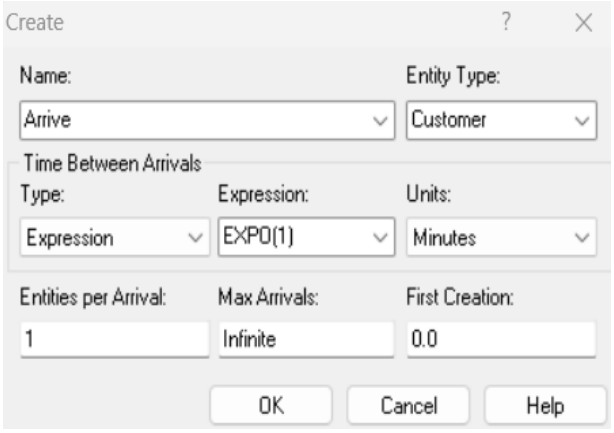
2.1. Arrival and Decision Point:

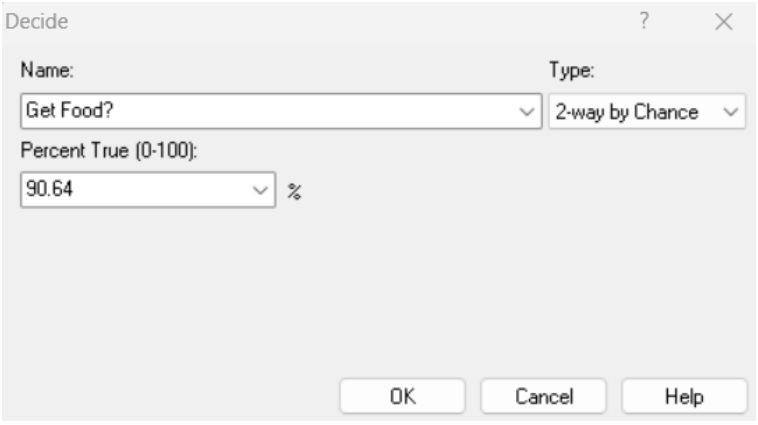
- Customers enter our simulation at the "Arrival" module, arriving at random intervals based on the defined Poisson distribution (e.g., every 2 minutes on average).
- At the "Arrival Station," each customer makes a crucial decision: head straight to the "Barista Station" for drinks or proceed to the "Food Selection" module for a delicious meal from our menu. This choice might be influenced by factors like time of day or random chance as per our model settings.

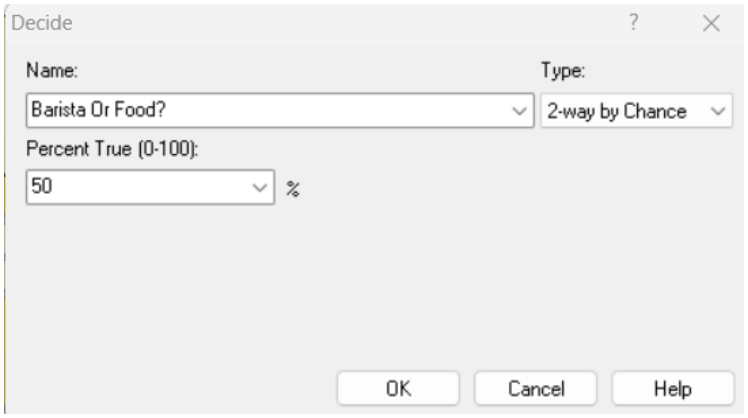


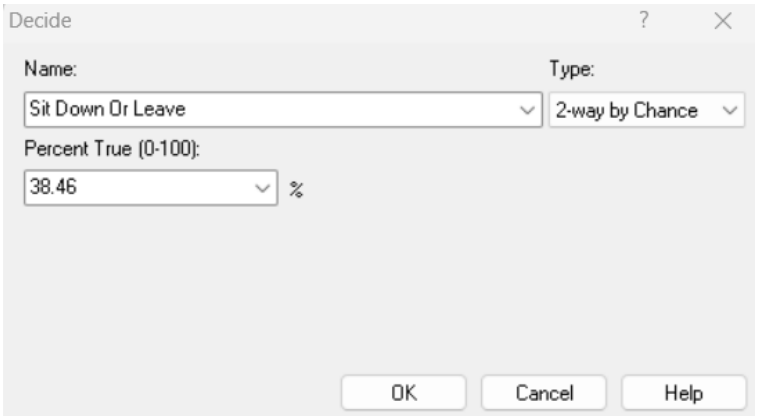


2.1.1 Modules configurations:



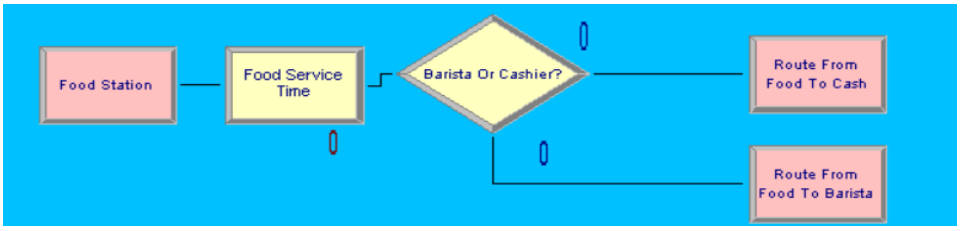




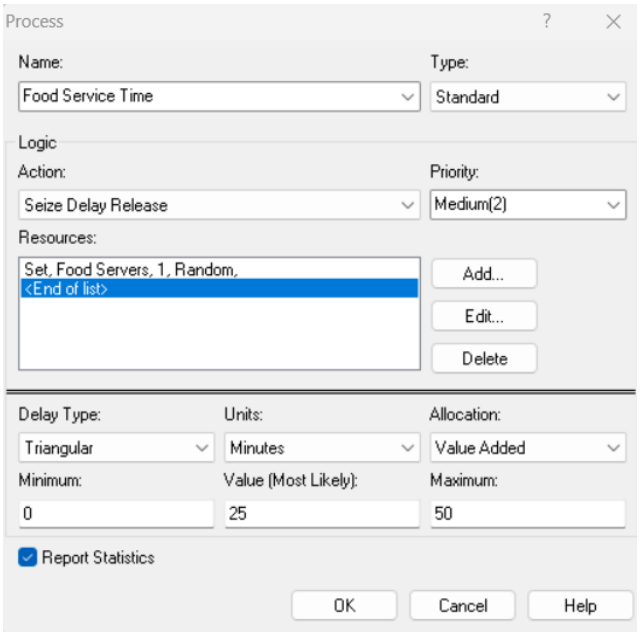


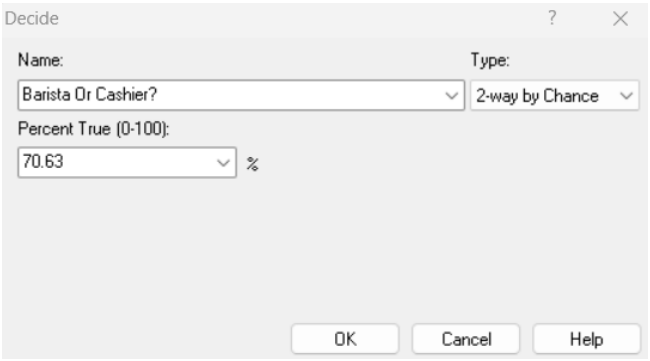
2.2. **Food Path:**

- Food enthusiasts who choose the "Food Selection" module browse through our enticing menu, selecting their desired items. The processing time at this stage is simulated by a delay module, perhaps following a normal distribution with an average of 2 minutes, accounting for browsing and ordering.
- After making their food selections, customers have two options:
  - **Direct payment:** They can proceed to either "Cash Register 1" or "Cash Register 2" to pay for their food and head directly to the "Dining Area" or "Exit Station" depending on their preference.
  - **Barista or table:** If they want to add drinks or need a table, they continue to the "Barista or Table?" decision point.



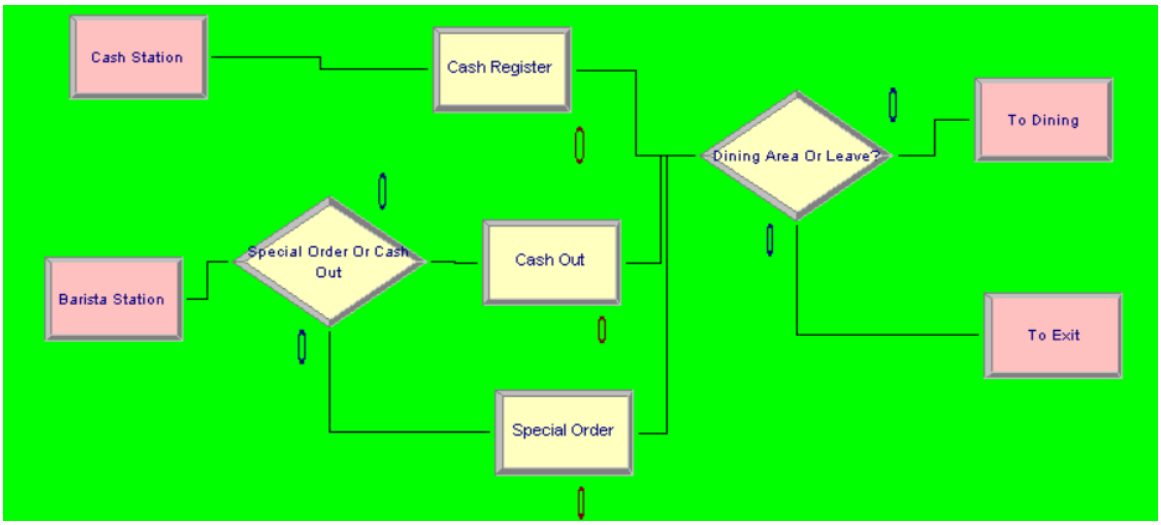
2.2.1 Modules configurations:



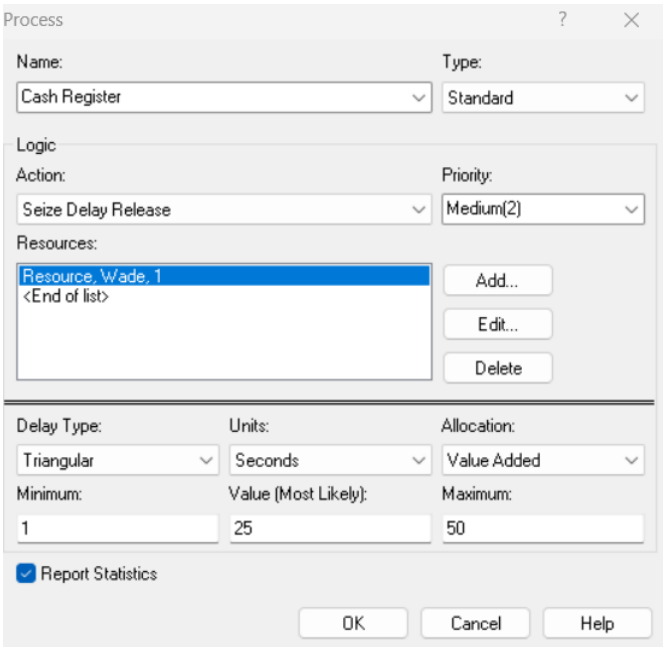


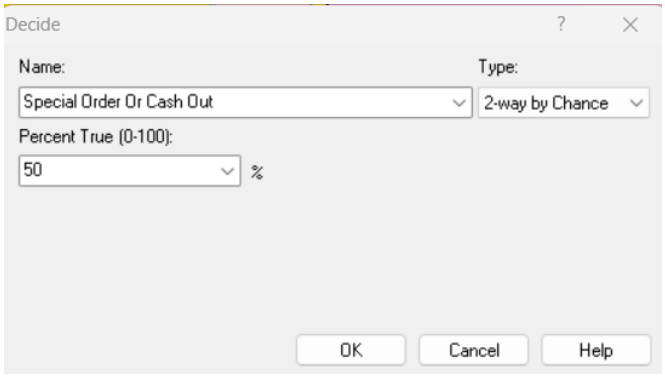
2.3. Barista Path:

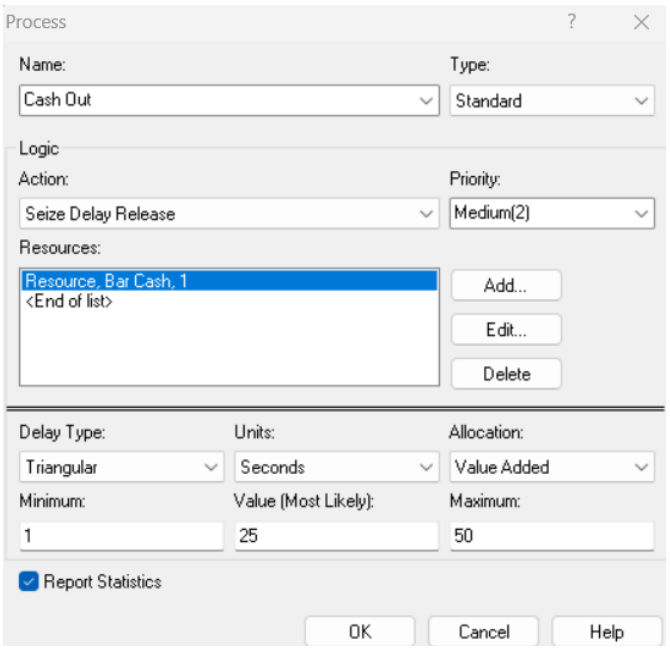
- Customers who bypass the food station or crave a caffeine kick reach our bustling "Barista Station." Here, they order their favorite beverages and proceed to either "Cash Register 1" or "Cash Register 2" to pay. The processing time for coffee preparation is simulated by a separate delay module with its own distribution, ensuring realistic wait times.
- After paying, customers can choose their next destination:
  - **Dining Area:** Head over to find a seat and relax, potentially placing additional orders ("Social Order") for their tablemates.
  - **Exit Station:** Skip the dining experience and take their order to go through the "Exit Station."

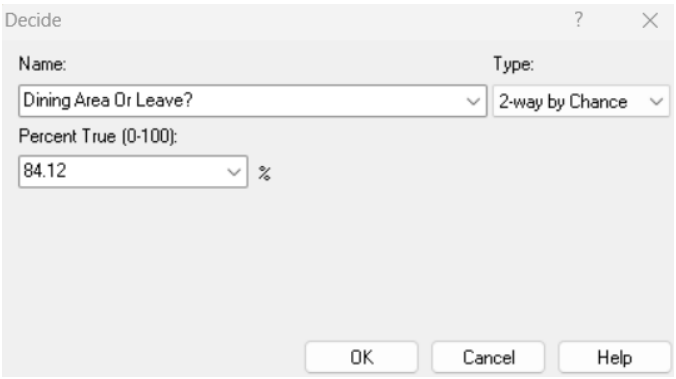


2.3.1 Modules configurations:





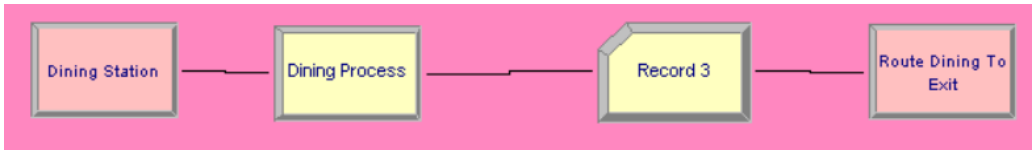




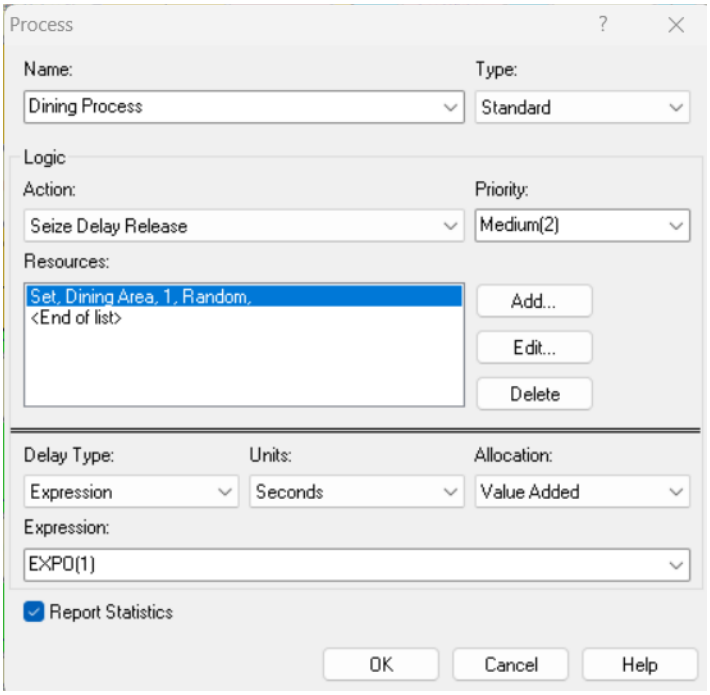
2.4. Dining Area:

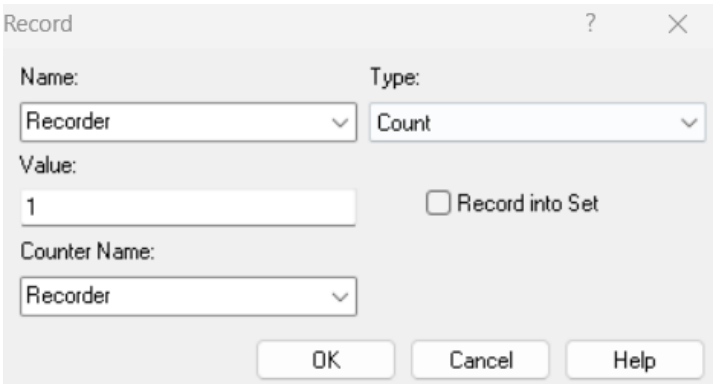
- Our "Dining Area" welcomes customers with a warm ambiance and the chance to savor their meal. They can either:

  - **Social Order:** Place additional orders for others at their table, adding to the overall bill.
  - **Cash Out:** Once finished, they pay their complete bill at the "Cash Out" module before exiting through the "Exit Station."



2.4.1 Modules configurations:



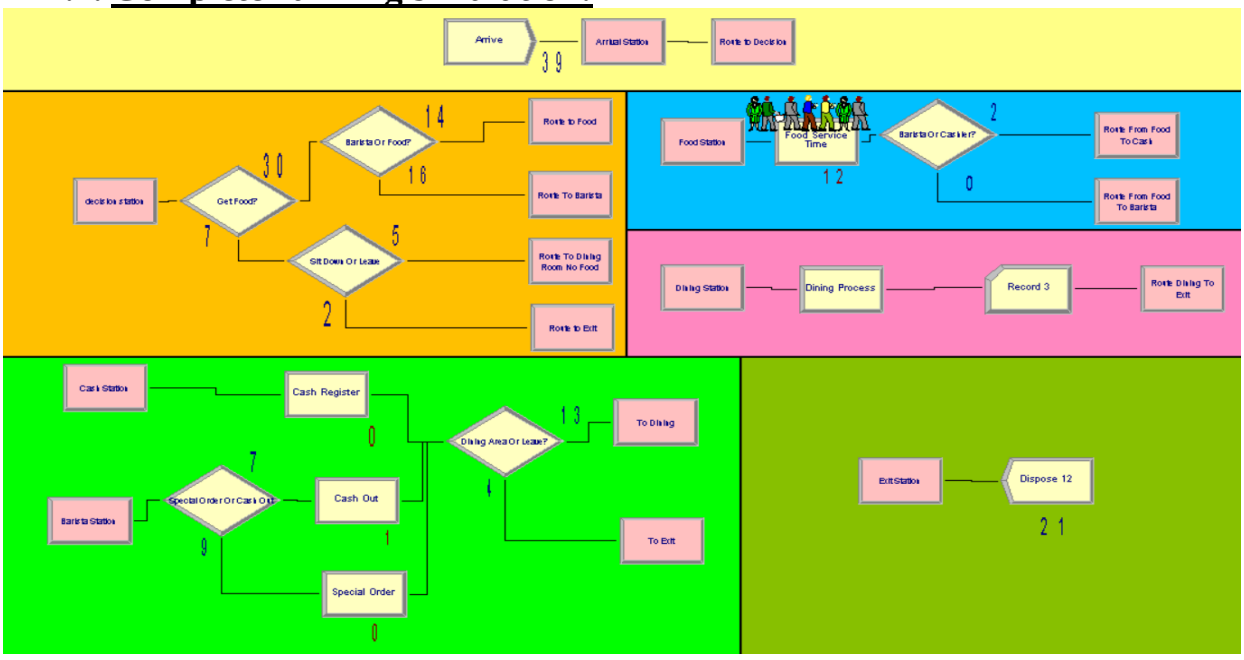


3. Advantages:

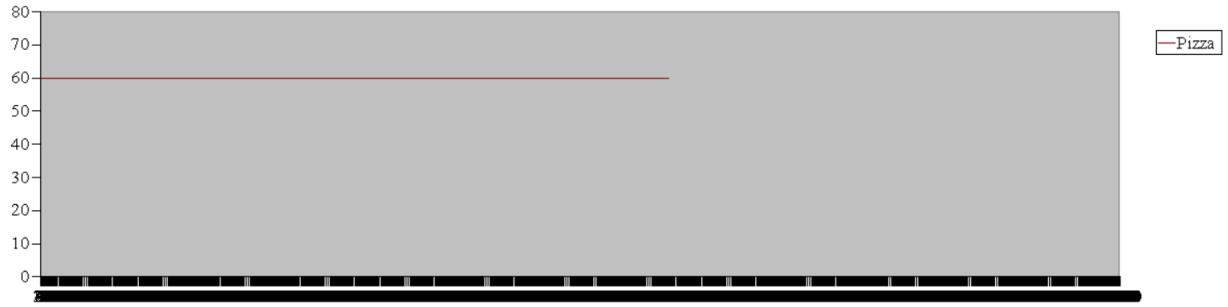
- **Identifying Bottlenecks:** Pinpoint areas of congestion like queues at cash registers or the barista station, allowing you to prioritize improvements for smoother customer flow.
- **Resource Optimization:** Analyze barista and cashier utilization, ensuring efficient staffing by adjusting schedules, cross-training employees, or minimizing unnecessary labor costs.
- **Data-driven Menu Refinement:** Focus on popular items based on sales data, maximizing profit potential and customer satisfaction by removing underperformers or experimenting with new offerings.
- **Dynamic Pricing Strategies:** Explore adjusting prices based on demand or time of day, potentially increasing revenue without deterring customers, and optimizing resource allocation during slower periods.
- **Reduced Experimentation Risks:** Test new menu items, layout changes, or staffing strategies within the simulation before committing resources in the real world, minimizing risk and maximizing positive outcomes.
- **Improved Decision Making:** Base your decisions on concrete data and objective analysis, reducing guesswork and ensuring that changes are grounded in customer preferences and operational efficiency.
- **Continuous Improvement:** Use the model as a platform for ongoing optimization, constantly monitoring real-world performance, adapting strategies, and experimenting with new ideas for lasting success.

4. Output:

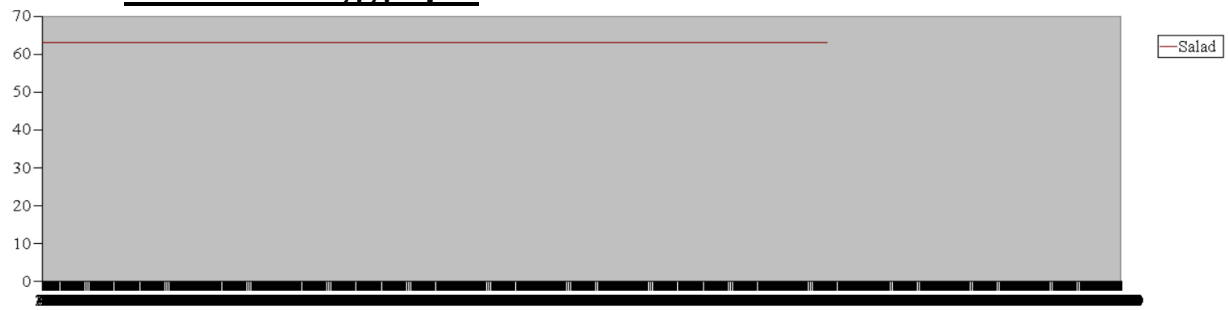
4.1. Complete running simulation:



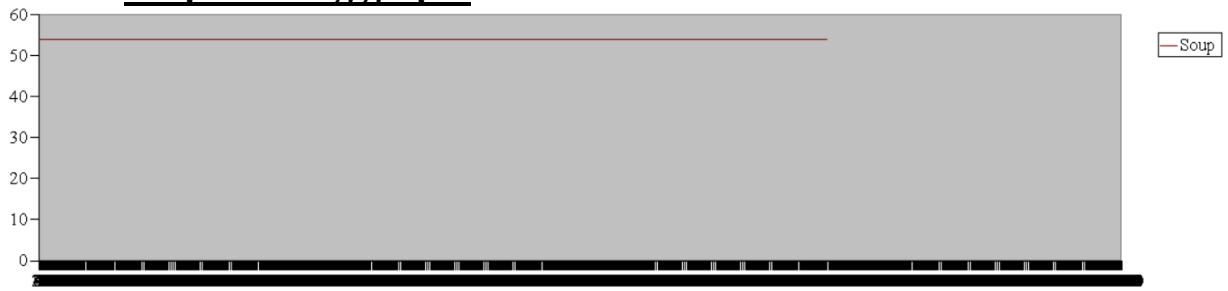
4.4.1 Pizza order graph:



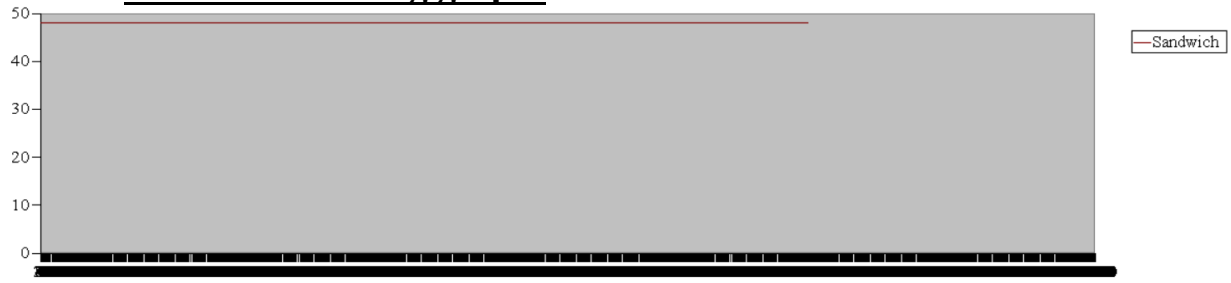
4.4.2 Salad ordering graph:



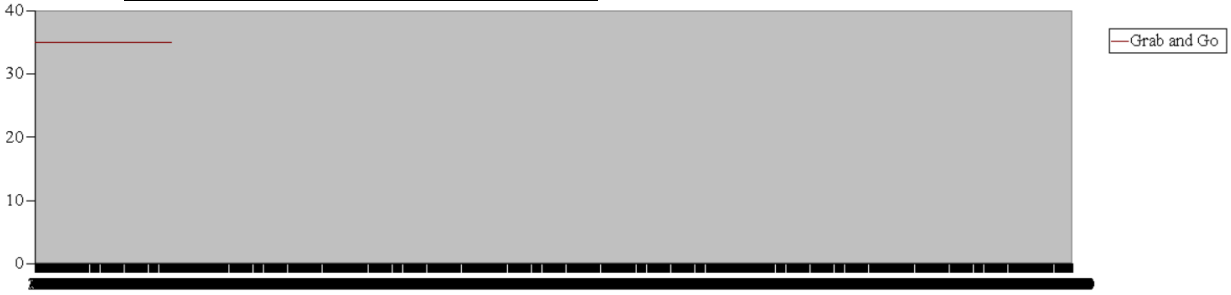
4.4.3 Soup ordering graph:



4.4.4 Sandwich ordering graph:



4.4.1 Take away/Grab & go graph:



Conclusion

The simulation of our cafe's customer flow and resource utilization has revealed valuable insights for optimization. By identifying bottlenecks, optimizing resource allocation, and refining the menu, we can enhance customer experience, reduce wait times, improve staff efficiency, and ultimately increase profitability.

Specifically, the simulation showed that there are periods of congestion at the barista station and cash registers during peak hours. This suggests that we could improve customer flow by adjusting staff scheduling, refining the layout, or implementing technology. The simulation also showed that there are periods of underutilization of barista and cashier resources. This suggests that we could optimize staff schedules or cross-train employees. Finally, the simulation showed that some menu items are more popular than others. This suggests that we could focus on popular items, refine underperforming items, or experiment with new offerings.

These insights provide a roadmap for improving our cafe's operations. By implementing these optimizations, we can create a more efficient, customer-friendly, and profitable business.