MARMARA UNIVERSITY
FACULTY OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

IE3081 MODELING AND DISCRETE SIMULATION
PROJECT

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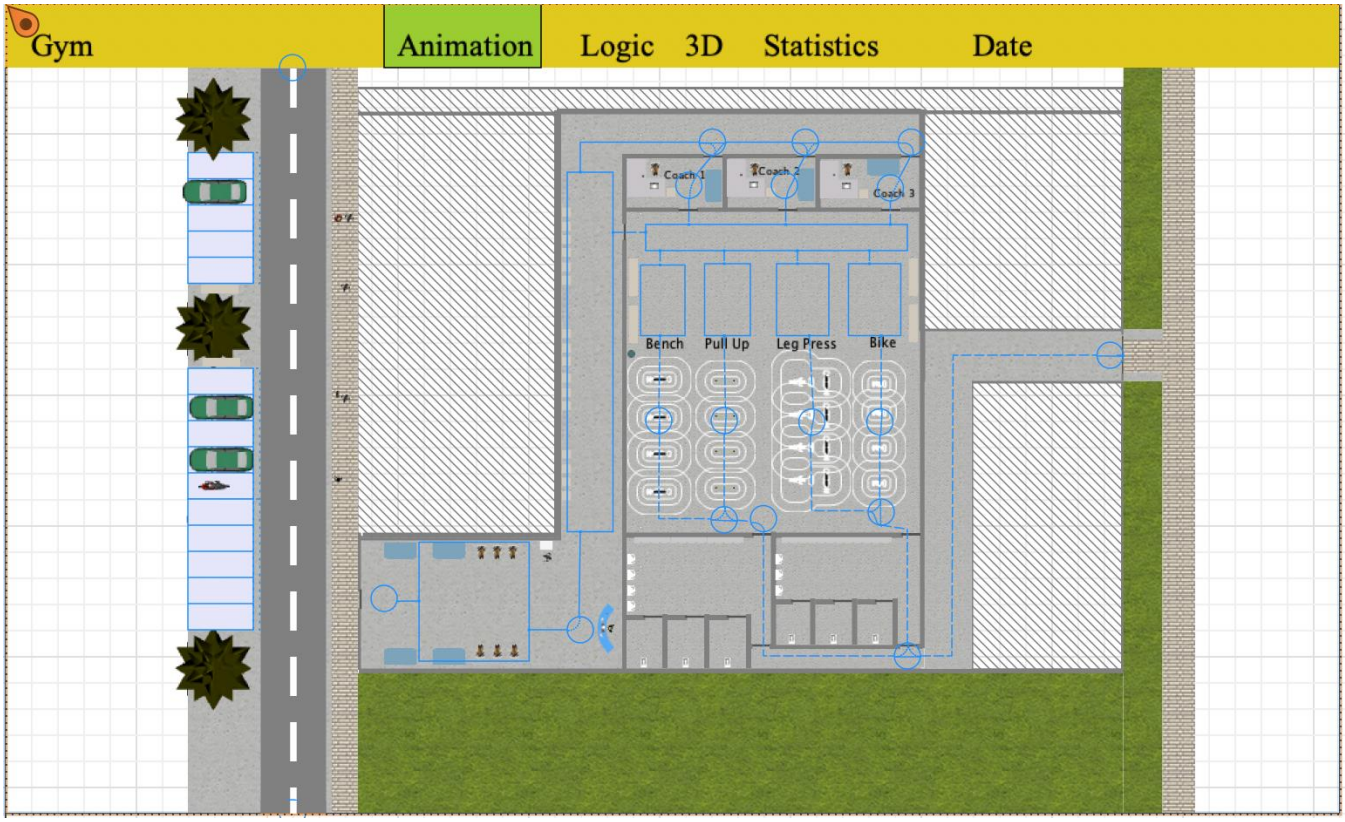
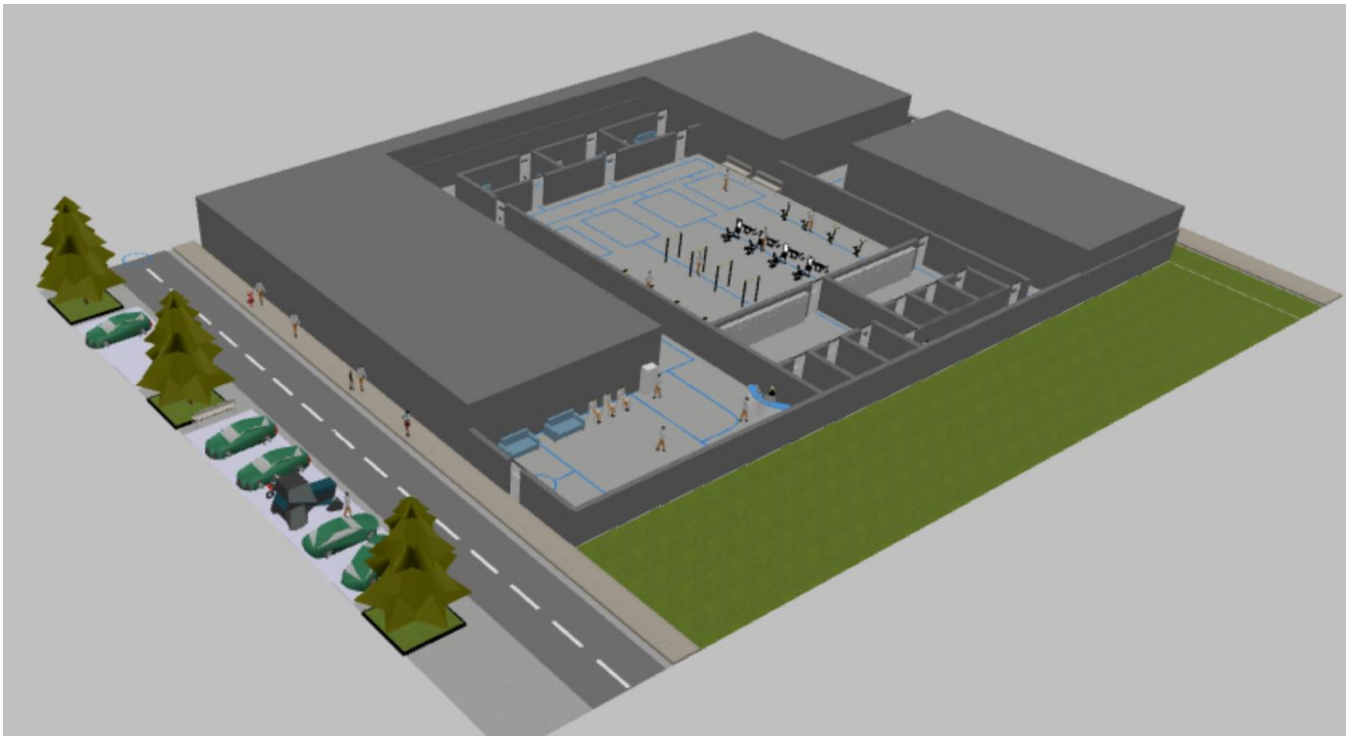
System Definition

We built a simulation to simulate a gym place. In the gym there are equipments, and each equipment has its own branch. Also, there are coaches who are responsible for the members sports program, nutrition schedule and diet. Gym members will arrive to the system and according to their program they will be directed to their coach or equipments. Coaches will check the program of the member. Coaches may direct members to the equipments like bench press of pull up. Members will go the coaches if they are required to. Then members will leave the system. Also, in the simulation there will be members who don't require a coach and they will immediately direct to equipments. Long term members will have priority when they are waiting in the equipment queue.

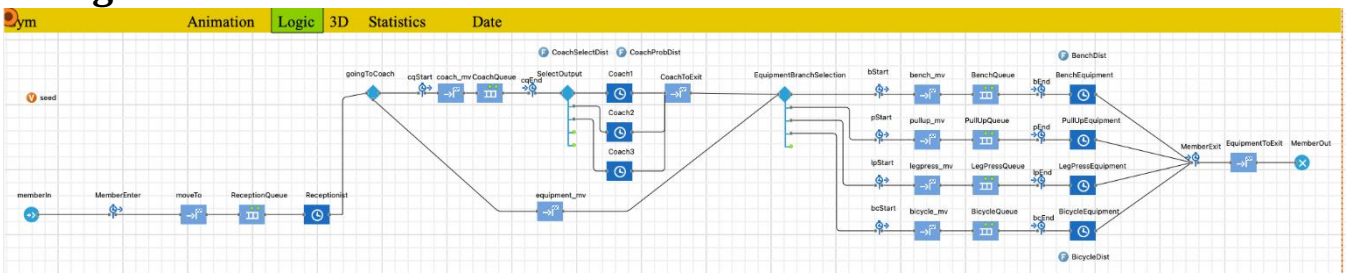
2D View of the Model



3D View of the Model



Logic



System Components

MemberIn: It is a source where members arrive to the gym.

Receptionist: A delay component to simulate member registration procedures. Member may need to wait in the queue.

equipmentBranchSelection : It is a selector component. Members will go to the different branches according to their program.

BenchEquipment: A delay component to simulate equipment tool.

PullUpEquipment: A delay component to simulate pull up equipment.

LegPressEquipment: A delay component to simulate leg press equipment.

BicycleEquipment: A delay component to simulate bicycle equipment.

Coach: A delay component to simulate coach inspection.

selectoutput **components:** It is a selector component. Coaches will direct some of members to the equipments.

Memberout: It is a sink where members leave the gym.

MoveTo components : It is direct to the member according to the arrival location.

Generation of Random Variates

In the simulation all random numbers are generated by Anylogic's default random number generator and java.util.Random class of java. These random number generators are trusted to have uniform distribution and no correlation among the generated random numbers.

Input Variables

- **Number of members arriving to the gym**: We will run the model for 100 members.

- **Proportion of longterm members**: 20% of the members will be longterm members.

- **Equipment branch selection**: 24% of the members will go the bench press equipment. 23% of the members will go the pull up euipment. 25% of the members will go the leg press equipment. 28% of the members will go the bicycle equipment.

- **Rate of Going coach**: 40% of members will go the coachs. 30% of members will go the coach1. 30% of members will go the coach2. 40% of members will go the coach3. 60% of members will go directly to the equipments.

- **Interarrival times of members**: Members interarrival times are uniformly distributed between 1 and 2 minutes.

Service Times

- **Receptionist Service Time:** Uniformly distributed between 1 and 2 minutes.
- **Bench Press Equipment usage time probability distribution**:

Usage Time (Minutes)	Probability	Cumulative Probability
4	0.40	0.40
5	0.40	0.80
6	0.20	1.00

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- **Pull Up usage time probability distribution**:

Usage Time (Minutes)	Probability	Cumulative Probability
5	0.60	0.60
6	0.20	0.80
8	0.20	1.00

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- **Leg press usage time** is uniformly distributed between 2 and 5 minutes.
- **Bicycle usage time** is uniformly distributed between 4 and 6 minutes.
- **Service time of coaches**:

Service Time (Minutes)	Probability	Cumulative Probability
4	0.30	0.30
5	0.10	0.40
6	0.25	0.65
7	0.35	1.00

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Output Variables

- Average time spent by a member in the gym
- Average queue waiting times for each coach
- Utilization of each equipment
- Utilization of coaches
- Utilization of receptionist

Output Values and Responses

We have collected these data from database after model run.

- **Queue Waiting Times for Each Equipment:**

Equipment Type	Average Queue Waiting Time (minutes)
Bench Press	2
Pull Up	1,61
Leg Press	1.48
Bicycle	1.79

- **Utilization of Equipments:**

Equipment Type	Utilization %
Bench Press	0.18
Pull Up	0.13
Leg Press	0.17
Bicycle	0.17

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Queue Waiting Time for Coaches:

Coaches	Average Queue Waiting Time (minutes)
Coach 1 – Coach 2 – Coach 3	1.42

Utilization of Coaches:

Coaches	Utilization %
Coach 1	0.41
Coach 2	0.25
Coach 3	0.05

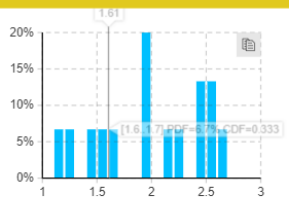
Utilization of Receptionist:

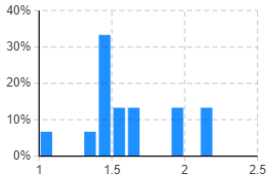
Receptionist	Utilization %
Receptionist	0.94

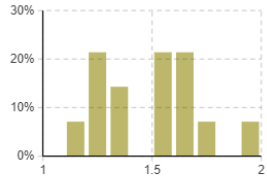
- **Average Time Spent by a Member:** It is measured as **14.26** minutes.

Graphics of Statistics:

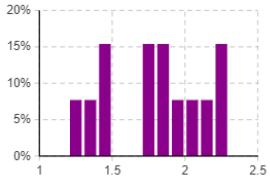
Gym Animation Logic 3D Statistics Jan 12, 2024, 9:42:44 AM



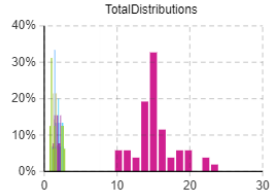


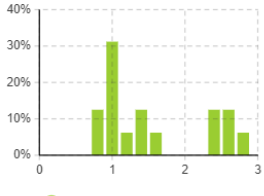


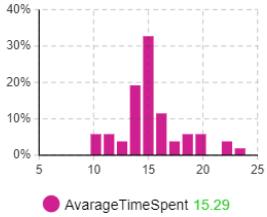
BenchQueueAvarageWaitingTimeDist 2 PullUpQueueAvarageWaitingTimeDist 1.61 LegPressQueueAvarageWaitingTimeDist 1.48



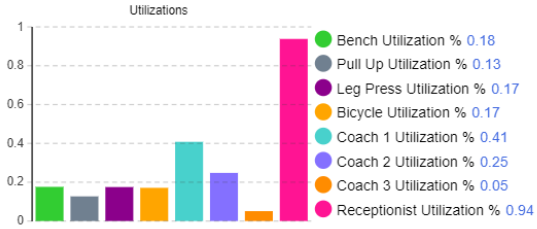
BicycleQueueAvarageWaitingTimeDist 1.79







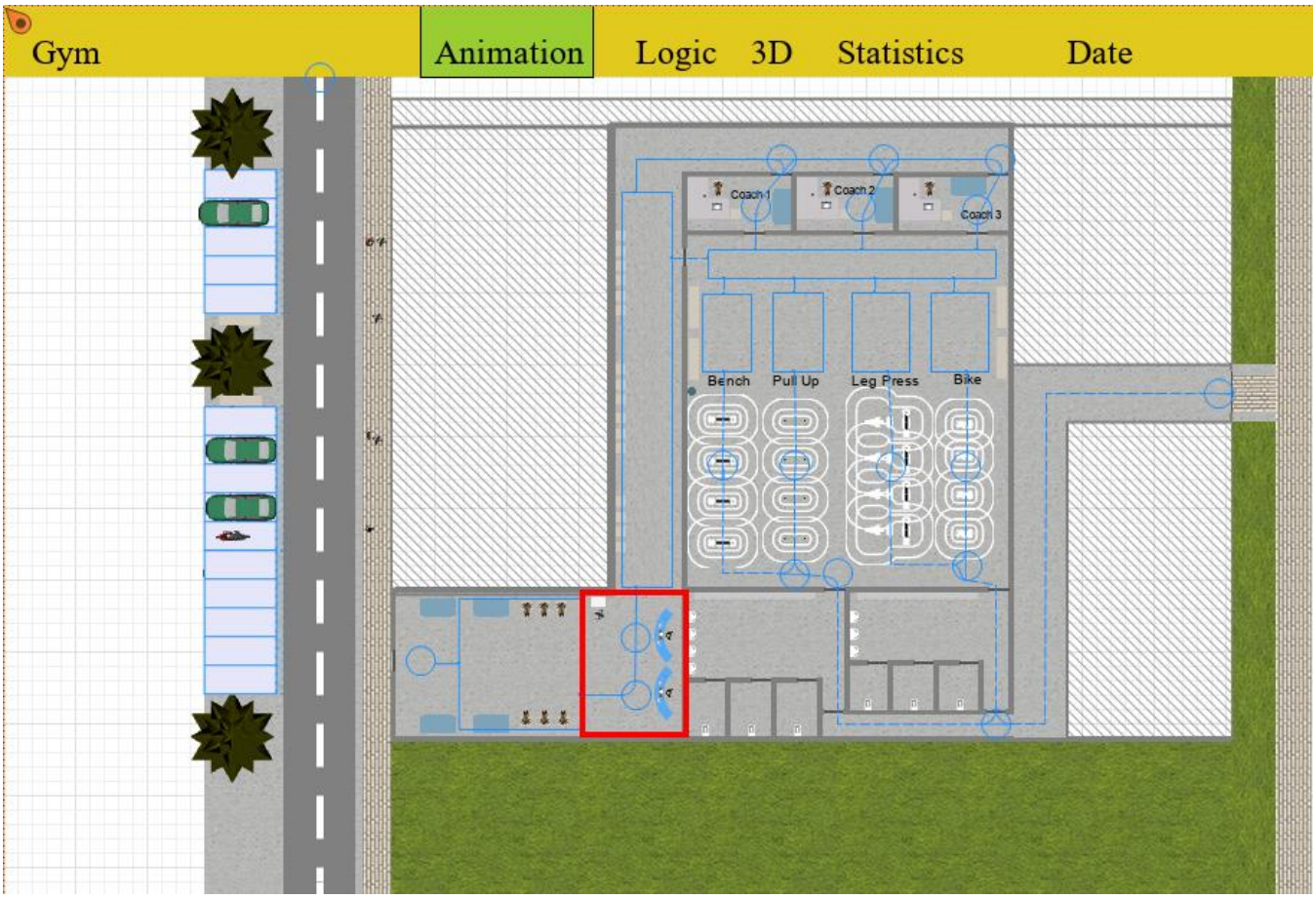
CoachQueueAvarageWaitingTime 1.56 AvarageTimeSpent 15.29



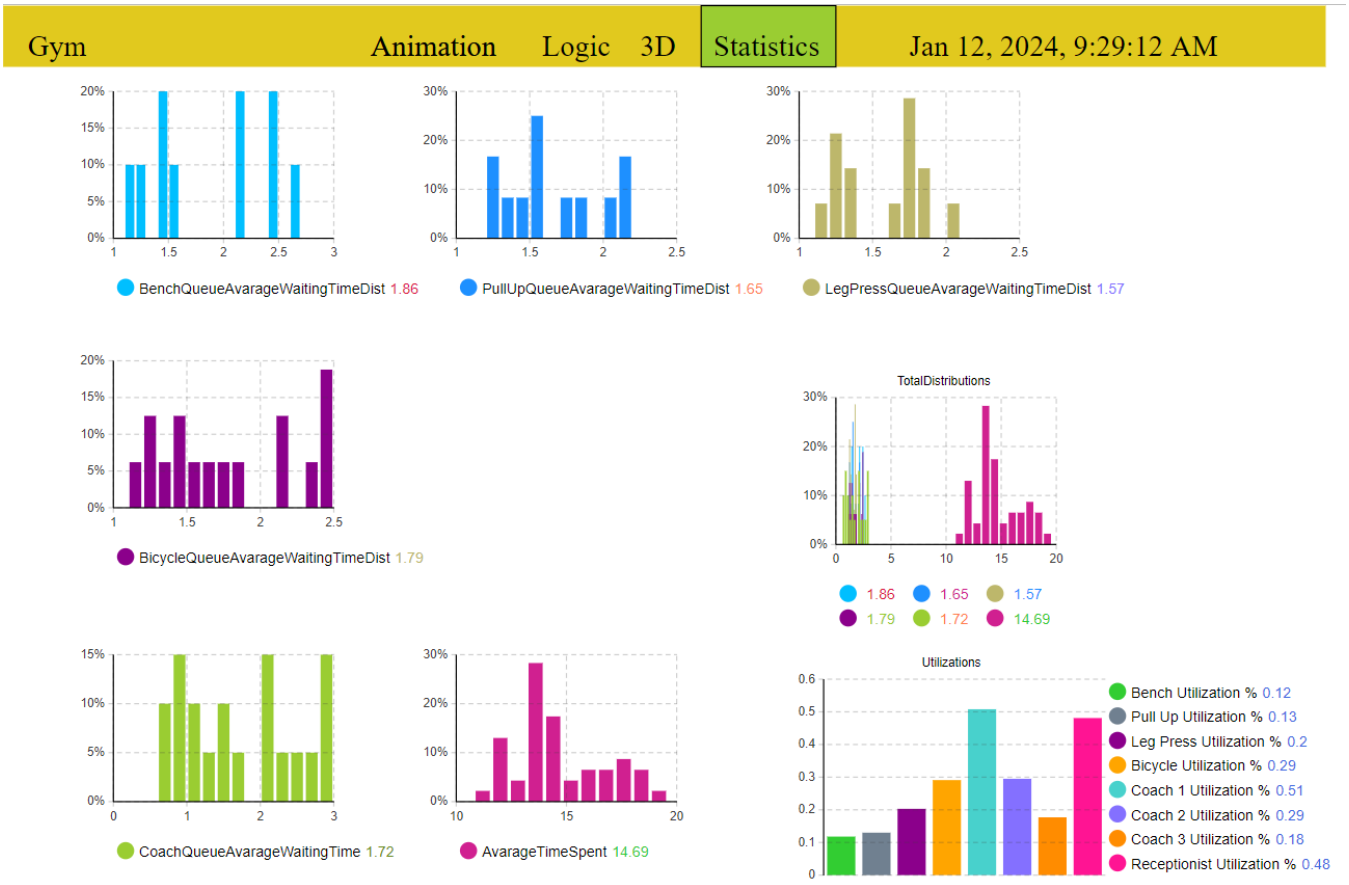
ALTERNATIVE DESIGN PART II

The reception have been updated. Since a lot of queues occurred in the first simulation, we increased the reception**.**

ALTERNATIVE DESIGN 2-D VIEW



Graphs of statistics for alternative design



Average Member Exit Time Comparison

Replication	First System	Alternative System	Observed Difference
1	18.11	16.22	1.89
2	19.17	16.14	3.03
3	19.53	15.66	3.87
4	20.44	16.53	3.91
5	16.99	16.48	0.51
6	20.43	18.36	2.07
7	19.87	17.88	1.99
8	17.20	14.73	2.47
9	21.14	18.12	3.02
10	19.31	15.32	3.99
Sample Mean	19.22	16.54	1,23
Sample Variance	1.94	1.49	2.68

Confidence Interval Calculation For 95% Confidence Level (Unequal Variances)

Estimator : **1.23** from the table

$$s.e.\left(\bar{Y}_{.1}-\bar{Y}_{.2}\right)=\sqrt{\frac{S_1^2}{R_1}+\frac{S_2^2}{R_2}}$$

Standard Error is calculated as **0.77** using formula above.

$$\upsilon=\frac{\left(S_1^2/R_1+S_2^2/R_2\right)^2}{\left[\left(S_1^2/R_1\right)^2/(R_1-1)\right]+\left[\left(S_2^2/R_2\right)^2/(R_2-1)\right]},$$

Degrees of Freedom is calculating as **17** using formula above

For a = 0.05

$t_{a/2,17}$ = 2.11 is found using T-table

$$\bar{Y}_{.1}-\bar{Y}_{.2}\pm t_{\alpha/2,\upsilon}s.e.(\bar{Y}_{.1}-\bar{Y}_{.2})$$

C.I found as **(-0.39,2.85)** using formula above.

Inference

Confidence interval includes 0 so there is no strong statistical evidence that alternative system is better than first system