LaBoard's Bowling Alley Simulation

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Course: Data Modeling CSCI B450

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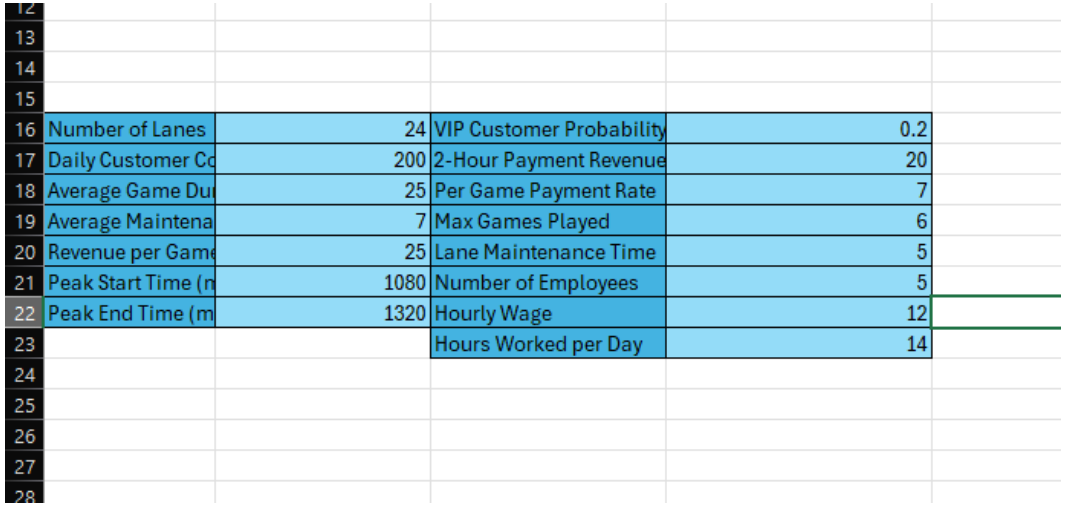
Introduction

+ Simulation models the operations of a bowling alley on Hilton Head Island!
+ Goal is to model the financials of the bowling alley including these key elements:
    - Customer Flow
    - Lane Utilization
    - Revenue Generation
    - Employee Labor Costs
    - Seasonal Variations
    - Maintenance Times

Model Description

- More realistic M/M/c
- M: Interarrival times follow Poisson distribution, M: Service times are exponentially distributed. C: Number of servers or lanes. Multi server queue with up to Number of Lanes. When a lane is occupied, the customer waits in a queue until a lane is available.
- Key variables include:
  - Lane Count: Number of available lanes
  - Customer Count: Average number of customers per day
  - Game Duration & Maintenance: Time spent on each game and maintenance time after each game
  - Revenue Variables: Games, Food, and Beverage's sales
  - Employee Parameters: Number of employees, hourly wage, working hours
  - Fixed Peak Season: June through August and December, demand prices increase
  - Payment Options: Fixed 2-hour payment vs. per game



16	Number of Lanes	24	VIP Customer Probability	0.2
17	Daily Customer Co	200	2-Hour Payment Revenue	20
18	Average Game Du	25	Per Game Payment Rate	7
19	Average Maintena	7	Max Games Played	6
20	Revenue per Game	25	Lane Maintenance Time	5
21	Peak Start Time (n	1080	Number of Employees	5
22	Peak End Time (m	1320	Hourly Wage	12
23			Hours Worked per Day	14

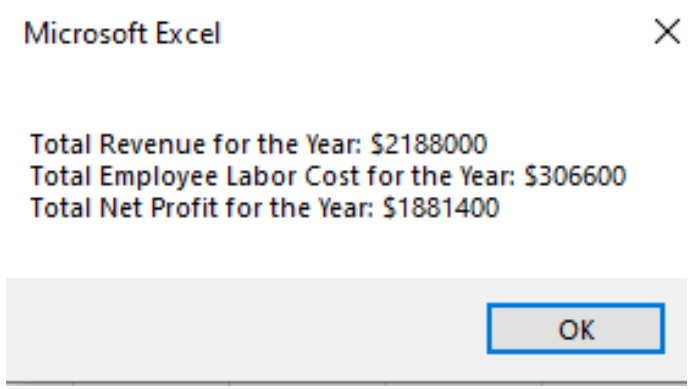
Assumptions

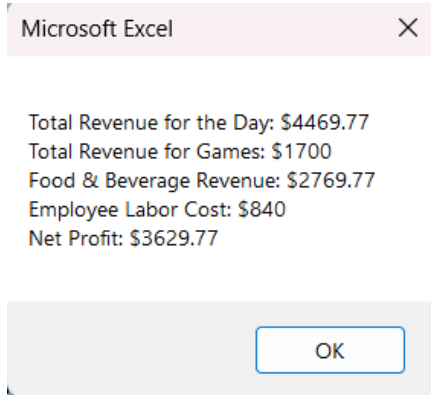
$$P(X = x) = \frac{\lambda^x e^{-\lambda}}{x!}$$

- FCFS Queue Discipline
- Exponential Distribution for service times
- Poisson Arrival Process
- Employees work 14 hours without breaks

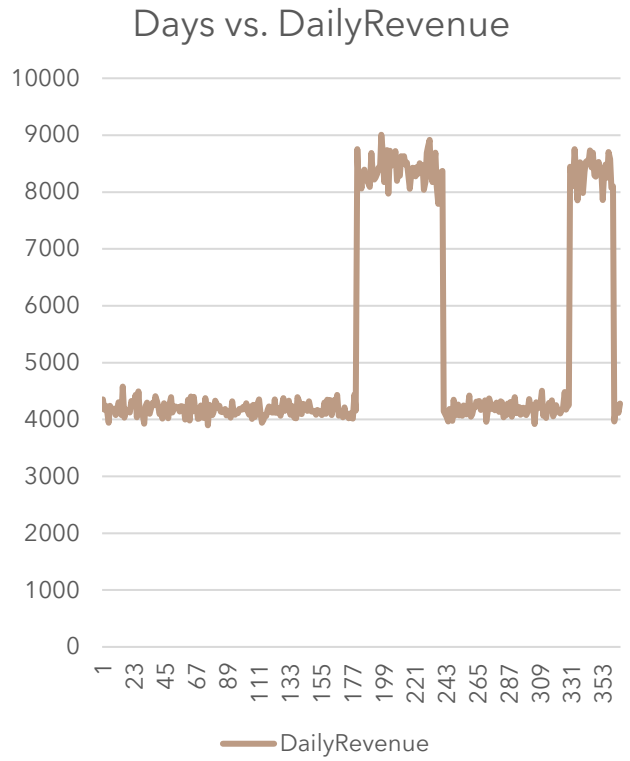
Simulation Process

- Problem: Identified key business variables such as customer flow and lane maintenance
- Writing the code: Used VBA for flexible simulation and inputs can be altered dynamically
- Customer Flow Simulation: Random number generator used for customer arrivals, adjusted for peak seasons
- Lane Management: Simulated lane availability, considering both maintenance and customer wait time
- Revenue and Cost Calculations: Tracked Revenue from games and food, and employee labor costs
- Reporting: Calculated daily net profit and accumulated totals for yearly revenue and costs





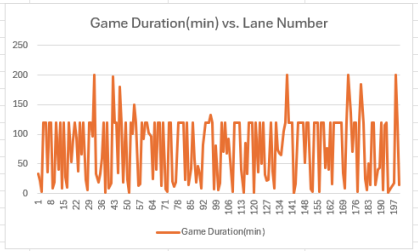
Results and Visualisation

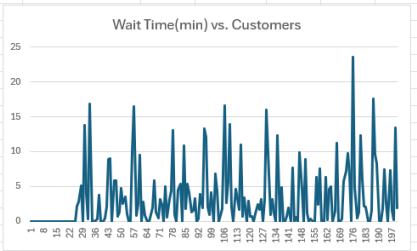


Seasonal Impact on Revenue

- Peak Season from June to August and December which increased Revenue 200%
- More customers arrive and the average revenue per game increases

	A	B	C	D	E	F	G	H	I	J	K
1	Event Date	Event Type	Arrival Time	CustomerID	Lane Number	Game Duration(min)	Wait Time(min)	Revenue	Food and Beverage Revenue	Service End time	Departure Time(min)
2	12/9/2024	Arrival	5	1	1	33.37329088	0	25	11.8668735	10	57.37329088
3	12/9/2024	Arrival	6	2	2	21.99559776	0	25	23.52724046	11	47.99559776
4	12/9/2024	Arrival	7	3	3	2.919875313	0	25	33.87478739	12	30.91987531
5	12/9/2024	Arrival	8	4	4	120	0	25	46.61079645	13	150
6	12/9/2024	Arrival	10	5	5	120	0	25	60.34606397	15	154
7	12/9/2024	Arrival	11	6	6	36.69386563	0	25	70.72885573	16	72.69386563
8	12/9/2024	Arrival	12	7	7	120	0	25	81.86681598	17	158
9	12/9/2024	Arrival	13	8	8	120	0	25	95.58962256	18	160
10	12/9/2024	Arrival	14	9	9	8.511589245	0	25	108.1009048	19	50.51158925
11	12/9/2024	Arrival	15	10	10	18.9600876	0	25	121.2641197	20	62.9600876
12	12/9/2024	Arrival	16	11	11	120	0	25	133.5698208	21	166
13	12/9/2024	Arrival	17	12	12	41.09235483	0	25	147.2748205	22	89.09235483
14	12/9/2024	Arrival	18	13	13	120	0	25	157.8303692	23	170
15	12/9/2024	Arrival	19	14	14	9.395574875	0	25	168.0815595	24	61.39557487
16	12/9/2024	Arrival	20	15	15	120	0	25	180.4805821	25	174
17	12/9/2024	Arrival	21	16	3	26.88456414	0	25	193.362247	26	82.88456414
18	12/9/2024	Arrival	22	17	16	10.41295391	0	25	206.0146615	27	68.41295391
19	12/9/2024	Arrival	23	18	17	120	0	25	216.1505193	28	180
20	12/9/2024	Arrival	24	19	18	52.70413096	0	25	226.4788494	29	114.704131
21	12/9/2024	Arrival	25	20	19	90.86268636	0	25	237.2105703	30	154.8626864
22	12/9/2024	Arrival	26	21	20	120	0	25	250.8989689	31	186
23	12/9/2024	Arrival	27	22	21	93.74457065	0	25	262.8897816	32	161.7445707
24	12/9/2024	Arrival	28	23	22	38.16144574	0	25	276.426785	33	108.1614457
25	12/9/2024	Arrival	29	24	23	120	0	25	288.2957301	34	192
26	12/9/2024	Arrival	30	25	24	66.25092679	0	25	303.0925396	35	140.2509268
27	12/9/2024	Arrival	31	26	-1	120	2.135649997	25	315.7783827	36	198.13565
28	12/9/2024	Arrival	32	27	-1	23.54381202	2.718500328	25	326.847485	37	104.2623123
29	12/9/2024	Arrival	33	28	-1	6.590693923	5.065241476	25	338.2824481	38	91.6559354
30	12/9/2024	Arrival	34	29	9	120	0	25	348.6732215	39	202
31	12/9/2024	Arrival	35	30	-1	120	13.82063218	25	360.649718	40	217.8206322
32	12/9/2024	Arrival	36	31	-1	95.90794185	3.983718949	25	370.8737907	41	185.8916608
33	12/9/2024	Arrival	37	32	-1	200	0.327984483	25	384.211936	42	288.3279845
34	12/9/2024	Arrival	38	33	-1	33.33845052	16.88941552	25	396.353856	43	140.227866
35	12/9/2024	Arrival	39	34	2	18.8155676	0	25	411.2564266	44	110.8155676
36	12/9/2024	Arrival	40	35	14	33.87015646	0	25	425.6493124	45	127.8701565
37	12/9/2024	Arrival	41	36	-1	59.1297699	0.103051969	25	437.6843357	46	155.2328219
38	12/9/2024	Arrival	42	37	-1	120	0.314643084	25	449.011071	47	218.3146431
39	12/9/2024	Arrival	43	38	-1	1.066154595	3.725243513	25	459.4940686	48	104.7913981
40	12/9/2024	Arrival	44	39	16	120	0	25	472.9601178	49	222
41	12/9/2024	Arrival	45	40	10	9.14972345	0	25	485.994561	50	113.1497235





Breakdown of Revenue

- Revenue can be affecting by time of day and season
- Revenue Sources:
  - Game Revenue: Direct revenue from games played or 2-hours
  - Food & Beverage Revenue $10 per customer

Challenges Encountered

- Lane Management: Properly simulating lane availability while considering maintenance and customer wait times
- Dynamic Revenue: Variability in revenue based on customer choices and peak season adjustments
- Peak Season Simulation: Adjusting the model to account for customer demand and price increases during peak times

Conclusion

- Simulation mostly models the operations of a bowling alley on Hilton Head Island
- Potential Areas for improvement:
  - Adjust dynamic pricing based on customer demand and employee availability
  - Create employee schedules
  - Could be down times where no lanes are running

Thank you

Questions?