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**Project Report: Simulation of a Bowling Alley on Hilton Head Island**

**System Description**

The system I modeled in this simulation is a bowling alley on Hilton Head Island, which is a popular tourist destination. The simulation aims to model daily operations, revenue generation, and costs associated with running the business. This model incorporates several key components:

* **Customer Flow:** Simulating the number of customers visiting the bowling alley each day.
* **Lane Utilization:** Managing the availability and maintenance schedules of the lanes based on demand.
* **Revenue Generation:** Tracking revenue from bowling games, food, and beverages.
* **Employee Labor Costs:** Accounting for labor costs based on the number of employees and their working hours.
* **Seasonal Variations:** Modeling peak seasons when customer demand is higher.
* **Maintenance and Game Duration:** Calculating Lane maintenance times and game durations, which affect lane availability and customer throughput.
* **Financial Output:** Calculating daily revenue, employee labor costs, and net profit, as well as reporting the yearly totals.

This model aims to help the owner understand the financial aspects of running the bowling alley, including variations during peak and off-peak seasons.

**Formal Statement of the Model**

The simulation models the daily operations of a bowling alley over the course of a year (365 days). The key variables and parameters used in the simulation include:

* **Lane Count:** The number of lanes available for customer use.
* **Customer Count:** The average number of customers visiting the alley each day.
* **Game Duration:** The average time each customer spends bowling based off exponential distribution.
* **Lane Maintenance:** Time required for lane maintenance after each game.
* **Revenue Variables:** Revenue from each game, food, and beverages.
* **Employee Parameters:** Number of employees, their hourly wage, and working hours.
* **Peak Season:** The simulation includes peak seasons (days 180–240 and 330–360), where customer arrival rates and revenue per game increase.
* **Payment Options:** Customers may choose either a fixed 2-hour payment or pay per game, which impacts their total spending.

The model operates under the assumption that customers arrive throughout the day (14 hours) and that each game has associated revenue, with food and beverage purchases generating additional revenue. The simulation tracks daily revenue, employee labor costs, and net profit, reporting these values for each day of the year.

**Simulation Process and Development**

Here were the steps on creating the simulation:

1. **Defining the Problem:** I need to determine the key variables affecting the business, including customer count, game duration, lane maintenance time, and employee costs.
2. **Writing the Code:** I used VBA to write this code because we have done a lot of homework assignments that utilized this programming language. It was versatile and I was able to not only hardcode in some values but let the user manually change some of the inputs to get the desired outputs.
3. **Simulating Customer Flow:** A random number generator was used to simulate customer arrivals based on the average customer arrival rate and adjusted during peak seasons.
4. **Lane Management:** The availability of bowling lanes, accounting for maintenance time and customer wait times when no lanes are available.
5. **Game Costs and Duration:** I needed to figure out what is the duration of the game and how much does each game cost. The game durations follow an exponential distribution.
6. **Revenue and Cost Calculations:** For each customer, the simulation tracked revenue from games and food purchases, while also calculating employee labor costs based on their working hours. The working hours were based on a 14-hour day.
7. **Output Reporting:** At the end of each day, the total revenue, labor costs, and net profit were recorded. This was done for all 365 days to accumulate yearly totals.

**Challenges Encountered:**

* **Model Complexity:** One of the challenges was ensuring that the lane availability was properly managed, accounting for both the maintenance time and the customer wait time.
* **Dynamic Revenue:** Revenue variability was by far the most challenging, the food and beverage sales, and adjusted the pricing model based on customer choices of either paying per game or per 2 hours.
* **Peak Season Simulation:** Another challenge was adjusting the model to account for different peak seasons and ensuring that customer arrival rates and revenue per game changed dynamically during those periods.

**Verification and Validation**

The model was verified by testing it with different input parameters and confirming that the outputs made sense based on the real-world understanding of the business. Since I used to work at Station 300 for about 2 years, I was able to reiterate the customer flow and when peak times were per day and when Station 300 got the busiest. The model was validated through trial runs, ensuring that it produced logical results for both peak and off-peak periods. For instance, the revenue per day during peak season was significantly higher than during off-peak periods, as expected.

**Questions Addressed by the Simulation**

The primary question that this simulation aimed to answer was:

* **What is the total revenue, labor cost, and net profit for running the bowling alley over the course of a year?**

Additional questions included:

* How does the customer arrival rate change during peak seasons?
* How do changes in employee labor costs and game pricing impact the profitability of the business?
* How does lessening the number of lanes impact the profitability of the business?

**Final Answer:** After running the simulation, the total revenue for the year was calculated, factoring in both the peak and off-peak seasons. The total employee labor costs were also calculated, and the final net profit was determined.

Example output from a simulation run might look like:

* **Total Revenue for the Year:** $2,174,000
* **Total Employee Labor Cost for the Year:** $306,600
* **Total Net Profit for the Year:** $1,867,400

This result was justified by considering customer behavior during peak seasons (increased revenue and higher customer volume), as well as the fixed costs associated with employees, lane maintenance, and food and beverages. It is also justified from Station 300’s total net profit since they have an arcade as well as a bar which could contribute 2-3 times more of a net profit than just a bowling alley with lanes and a kitchen. If there are less lanes, say 10, there will be a lot more traffic and a buildup of wait times and you won’t make as much profit if a lot of people don’t bowl.

**Potential Areas for Further Development**

While this simulation provides valuable insights into the operation of the bowling alley, there are several areas where the model is refined:

* **Real-Time Data Integration:** The model could be enhanced by integrating real-time customer data, allowing for more accurate predictions of customer arrivals and revenue. So, if there was a bowling alley open today, we could make some more accurate predictions.
* **Dynamic Pricing Model:** A more dynamic pricing model could be introduced, where the price per game fluctuates depending on demand (e.g., higher prices during peak hours or seasons, higher pricing when there are more employees, fluctuating hourly pay).
* **Variable Employee Scheduling:** Employee work hours could be made more flexible, with additional employees working during peak hours and fewer during off-peak times.

**Charts and Tables**

The following charts and tables were used in the simulation to present input data and output results:

1. **Input Data Table**: Lists all the parameters used for the simulation, including customer count, lane availability, employee parameters, and revenue figures.

A screenshot of a spreadsheet

Description automatically generated

1. **Daily Revenue and Costs Table**: Shows a breakdown in daily revenue, employee labor costs, and net profit for each day of the year.

A screenshot of a computer screen

Description automatically generated

1. **Yearly Summary Table**: Summarizes the total revenue, labor costs, and net profit for the entire year.

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**Conclusion**

In conclusion, the simulation successfully modeled the operations of a bowling alley on Hilton Head Island. By simulating the flow of customers, lane utilization, revenue generation, and employee costs, the model provides valuable insights into the financial dynamics of the business. This simulation can be improved with employee schedules. For example, do employees get breaks, what breaks do they get paid for, how many employees were there. The simulation is a simplified model, which offers a solid foundation for future improvements, like dynamic pricing and real-time adjustments based on actual customer data.

**References**

* [Station 300](https://station300bluffton.com)
* [VBA Documentation](https://learn.microsoft.com/en-us/office/vba/api/overview/)