FOOD SUPPLY CHAIN PROJECT REPORT

Noel Joseph V01068714

Kenneth Joseph V01068766

EXECUTIVE SUMMARY:

Interchange Group Inc., a third-party logistics company, faces a challenge in optimizing poultry deliveries to a blast freezer. The company must determine the optimal number of trucks to schedule weekly, balancing efficient freezer use and operational costs. This project, part of the INFO 645 Prescriptive Analytics course at Virginia Commonwealth University, employs a data-driven approach to solve this logistical issue.

The blast freezer has a capacity of 288 cells, with a total freezing time of 34,560 hours per week, and each truck carries 24 pallets. The core problem is to schedule the right number of trucks to maximize freezer capacity without incurring excess costs or inefficiencies. Our approach combined data analysis and Monte Carlo simulation, using historical shipment data from "final_data.xlsx" and a simulation model in "Copy_of_Final_Report (1).ipynb". The simulation estimated total freezing times for truck schedules ranging from 10 to 40 trucks, considering the variability in pallet processing times.

The results showed that scheduling 25 to 30 trucks weekly is optimal, balancing freezer capacity and demand. This range keeps the median total freezing time within the freezer's capacity and minimizes the risk of overburdening resources. Scheduling over 30 trucks risks exceeding freezer capacity, as indicated by the 95th percentile of total freezing time.

In conclusion, it's recommended that Interchange Group Inc. schedules 25 to 30 trucks weekly for optimal freezer utilization. This strategy ensures efficient resource use, cost minimization, and consistent product quality. The key finding is that this truck scheduling range optimizes the balance between meeting demand and resource utilization, ensuring operational efficiency.

PROBLEM STATEMENT:

Interchange Group, Inc., a third-party logistics company based in Harrisonburg, Virginia, specializes in blast-freezing poultry products. With the construction of a new blast freezer funded by a grant, the company aims to optimize the throughput of meat processed from Virginia. To accomplish this, Interchange seeks to determine the optimal number of trucks they should schedule for poultry delivery each week.

OBJECTIVE:

Through this undertaking, we are looking to determine the following:

- How many trucks should be scheduled weekly to ensure a maximum 50% probability that the total processing time does not surpass 34,560 hours?
- How many trucks should be scheduled weekly to ensure a maximum 5% probability that the total processing time surpasses 34,560 hours?

DEFINING VARIABLES:

1. **Decision Variable:**

Y = Number of Trucks Scheduled per Week

This is the primary decision variable. The goal is to determine the optimal number of trucks to

schedule each week based on the constraints and uncertainties described.

2. **Random Variable:**

X = Processing Time for Each Pallet

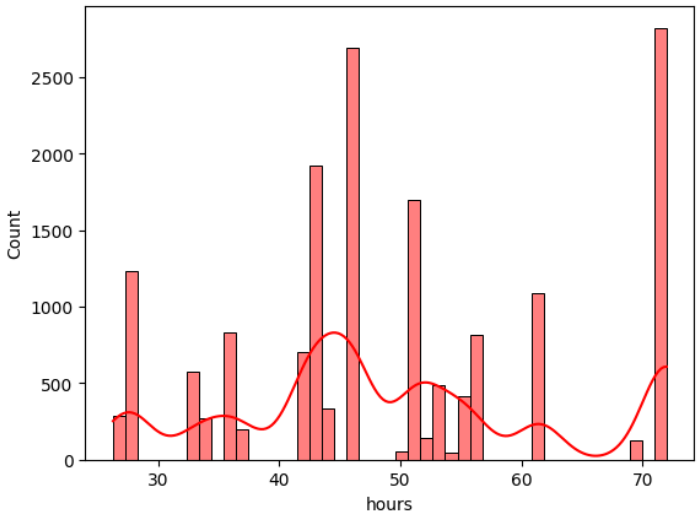
The amount of time it takes to freeze each pallet of poultry product. This time is uncertain and can vary based on the type of product. Given that the type of product in each truck is unknown at the time of scheduling, the processing time for each pallet becomes a random variable. It is mentioned that this is the "only source of uncertainty," which means this is the primary random variable in the question.

3. **Constant Variables (Parameters):**

- Total Freezing Time Available Each Week: 34,560 hours. This is calculated based on the number of cells in the freezer, the number of hours in a day, and the number of days in a week.
- Number of Cells in the Freezer: 288 cells.
- Number of Pallets a Truck Can Carry: 24 pallets.
- Number of Hours in a Day: 24 hours.
- Number of Days in a Week: 5 days.

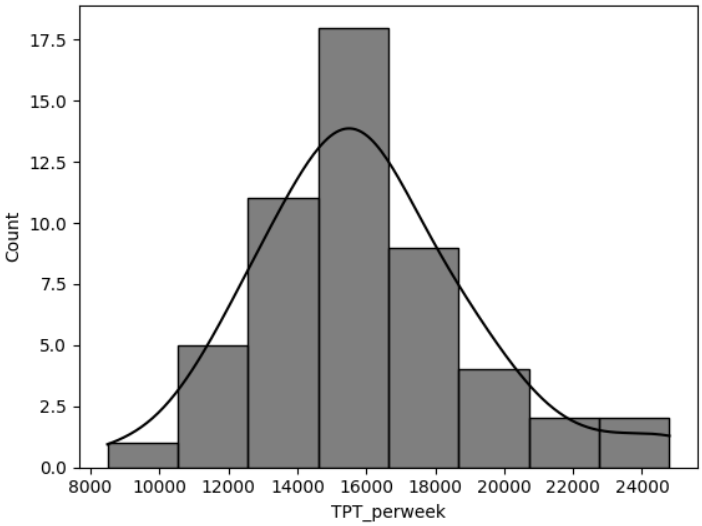
IDENTIFYING THE DISTRIBUTIONS:

Hours:



The visualization of the hourly data shows that it follows a normal distribution. Upon running Chi-Squared tests the results were inconclusive so we will be assuming the data follows a normal distribution.

Total Processing time per week:



The visualization of the total Processing time per week data shows that it follows a normal distribution. However, upon running Chi-Squared tests the results showed that the Gamma distribution's p-value was much higher than the normal distribution p-value. Hence, we will be assuming a gamma distribution for our total Processing time per week data.

Chi-squared results: For a gamma distribution, the alpha estimate is 25.321580 and the beta estimate is 0.001587. The test statistic for a gamma distribution is 3.244821 and the p-value is 0.861469.

MODELLING METHODOLOGY:

In the Food Supply Chain Project, we employed a Monte Carlo simulation methodology using Python, which offers extensive libraries like NumPy for numerical computations and pandas for data manipulation, enabling us to model and analyze complex scenarios efficiently. The simulation was executed on Google Collab. It involved generating random samples to represent the variability in pallet freezing times, thereby estimating the total freezing time required each week for different truck schedules.

IMPLEMENTATION:

The simulation model has been implemented using a Python code which is available in the attached Python Notebook file, Copy of Final_Report.ipynb. The code can also be found at the Google Colab link below:

https://colab.research.google.com/drive/1QNs5tkhYiyHc5sXtndyaOQIUB4l2MZnt?usp=sharing

RESULTS:

We have estimated the number of trucks that can be scheduled to make sure there's a 50% chance that the total processing time won't exceed 34,560 hours and a 95% chance as well. We have predicted that 25-30 trucks should be scheduled each week. This will ensure:

For 25 trucks-

- The total freezing time per week is equal to 29734.808854
- 50th percentile for total freezing time per week is equal to 29740.458363
- 95th percentile for total freezing time per week is equal to 30286.939851

For 30 trucks-

- The total freezing time per week is equal to 35690.758062
- 50th percentile for total freezing time per week is equal to 35689.590771
- 95th percentile for total freezing time per week is equal to 36296.473405

RECOMMENDATIONS:

Based on the analysis, it is recommended that Interchange Group Inc. schedules between 25 and 30 trucks per week for optimal freezer utilization. This range ensures efficient use of the blast freezer's capacity, minimizing the likelihood of exceeding its time constraints while also avoiding underutilization.

The company should also continuously monitor and adjust the number of trucks based on real-time data and seasonal variations in demand. Implementing a flexible scheduling system could

further enhance efficiency, allowing for adjustments in truck schedules in response to fluctuating supply and demand, thereby maintaining operational flexibility and cost-effectiveness.

CONCLUSION:

The conclusion of the Food Supply Chain Project indicates that for Interchange Group Inc., the optimal scheduling of 25 to 30 trucks per week strikes the best balance between maximizing freezer capacity and operational efficiency. This range minimizes the risk of exceeding the freezer's time capacity while ensuring efficient resource utilization. Scheduling within this range is crucial to avoid the costs and inefficiencies associated with both under- and over-scheduling.

APPENDIX

Use of Generative AI:

Our experience with ChatGPT for code generation was disappointing as it struggled to grasp the complete problem. However, the AI proved valuable in enhancing sentence structures and elevating the overall quality of the final report.

Link to ChatGPT conversations:

https://chat.openai.com/share/9859de91-8ab2-41eb-bad8-b2dc598f9b66

https://chat.openai.com/share/24a70946-fae7-40ce-ab63-351850c242ea