Enhancing Automation Decisions using Power BI Analysis and Linear Programming

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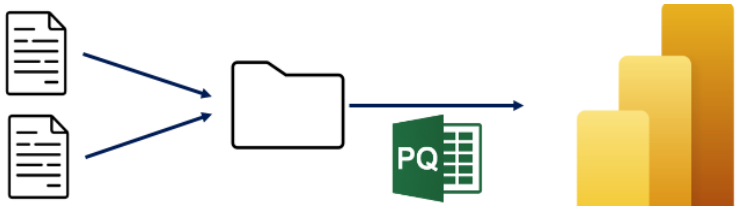
Tyson Foods

Tyson Foods is a modern, multi-national, protein-focused food company producing approximately 20% of the beef, pork, and chicken in the United States. In the 2022 fiscal year, Tyson generated $53 billion in revenue. Tyson is divided into three divisions: Poultry, Fresh Meats, and Prepared Foods. Throughout this year our team has been working with Tyson's automation and robotics team. The automation team investigates opportunities to invest in technological solutions to improve their manufacturing processes. They analyze the historical trends at their facilities to inform decisions such as the type of automation that will be most impactful, and the quantity of robotics required to handle a facility's demand. For their Fresh Meat facilities, decentralized and non-uniform data have resulted in a limited and time-intensive analysis process.

Poultry | Fresh Meats | Prepared Foods

Streamlining the Data Ingestion

To implement our automated dashboard solution, our first step was to design a process to easily import the data into Power BI in an organized and structured format. We created an entity relationship diagram (ERD) that normalized our data and identified the connections between different data sources. Next, we used Power Query, an ETL tool embedded within Power BI, to streamline the ingestion process. Our ingestion process extracts data files from computer folders using the folder file path and transforms the raw data in the folder to structured data within Power BI. After the ingestion process, the data is ready for analysis in Power BI.



Linear Programming Modeling

We created an optimization model that prescribes the cheapest combination of palletizers required to fulfill a facility's throughput. Data inputs, such as the variety and volume of SKUs, can be pulled directly from the Power BI dashboard. Data parameters, such as palletizer cost, were provided by Tyson's automation team. The model considers two alternatives, a compact, nimble collaborative palletizer and a sizable industrial palletizer. Each palletizer has unique capabilities. The model parameters and constraints can be adjusted to meet the specific requirements of each facility.

Parameters:
n = number of outfeeds
A = facility space available
W = maximum case weight
T_n = throughput at each outfeed
P_c (collaborative), P_I (industrial) = price
V_c, V_I = Volume capacity
F_c, F_I = Footprint
Z_c, Z_I = Weight capacity

Decision Variables:
X_n = {1 if outfeed n has collaborative palletizer; 0 otherwise}; integer
Y_n = {1 if outfeed n has an industrial palletizer; 0 otherwise}; integer

Constraints:
Available area greater than sum of footprints
Outfeed volume covered by palletizer capacity
If W > Z_c, at least one industrial palletizer

Objective: min $\sum_{i=1}^{n} P_c * X_i + P_I * Y_i$

Current Analysis Process

The automation team analyzes the performance of Fresh Meat facilities to inform automation decisions that enhance the manufacturing process. To understand a facility's performance, analysts import SKU data collected from scans on the facility lines into Excel to conduct statistical analysis on throughput and unique products over a specific period. This process takes about 45 minutes for each data file and is limited, excluding key metrics such as the number of incomplete pallets and average pallet height. Our automated dashboard solution provides the automation team with a comprehensive facility performance report, enabling them to make more informed decisions.

Data loaded to Microsoft Excel

Box Serial Number	Product Code	Timestamp
1234568	F1234ABCP	1/1/22 12:00 AM
1234569	F1235ABCP	1/1/22 12:01 AM
1234571	F1235ABCP	1/1/22 11:59 PM

Per Minute Metrics Calculated

Minute	Index	Boxes/ Minute	SKUs/ Minute
12:00 AM	1	3	2
12:01 AM	2	5	3
11:59 PM	1440	5	1

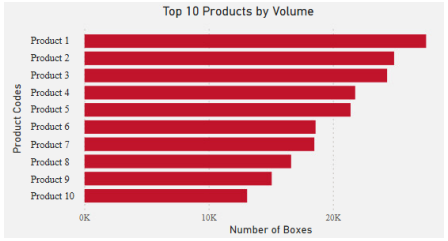
45 minutes

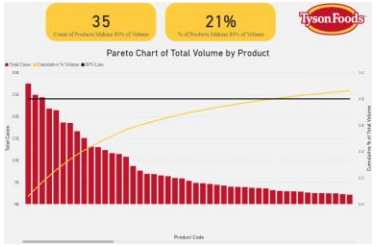
Summary Metrics Attained
Maximum boxes/minute: 5
Maximum SKUs/minute: 3
Number of incomplete pallets: ?
Average pallet weight: ?

Automation Team

Data Visualizations in Power BI

We collaborated with the automation team to pinpoint facility metrics that can guide their decisions regarding automation implementation. To create these metrics in our dashboard, we used Data Analysis Expressions (DAX), a querying language within Power BI, to create measures and calculated tables from our normalized data. We used these measures to create interactive visuals within Power BI to facilitate a more in-depth analysis of Fresh Meats facilities' historical trends and provide the automation team with insights that allow them to make more informed automation decisions.





Results and Impact

Tyson's automation team is responsible for guiding their automation effort to ensure they effectively apply their resources by making data-driven automation decisions. To address their issue of a time-intensive and limited data analysis process, our team enhanced the analysis process by streamlining their data cleaning process and delivering a comprehensive report in Power BI. We also created a linear programming tool to support their automation decisions by suggesting a combination of palletizers that minimize cost. Our new tool will reduce the analysis time, provide more metrics for the team to study, and will be available to multiple teams within Tyson.