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Supply Chain Engineering and Research Intern

Optilogic Inc.
Ann Arbor, MI

May - August 2022

Python for automated creation of Network Optimization Supply Chain Models

Skills – Python (NumPy, Pandas), Git, Bitbucket, Optimization

- Wrote Python code scripts in the backend of the company's Neo- SC Optimization Product
- Built algorithms capable of creating supply chain models with given set of conditions and requirements
- Used the models created to run Quality Assurance and testing if corresponding features of the software are working as expected

Supply Chain Engineering and Research Intern

Optilogic Inc.
Ann Arbor, MI

May - August 2022

Cost to Serve

Skills – Python (NumPy, Pandas, Matplotlib, NetworkX), Network creation, Graph Cost Propagation, Supply Chain, Git, Bitbucket, Optimization

- Cost to Serve is an accountancy tool used to calculate cost required by a company to provide service to a customer account taking into account actual business activities, including procurement, production, inventory and transportation costs incurred.
- Inputs- CSV files of Neo Output: Product flows, Inventories, Company Sites/ locations, Productions
- Outputs/ Results-
  - Graph/ Network showing end-to-end path of products through the company's supply chain from suppliers to customers
  - Table showing landing cost at each node of the network derived from costs incurred until that node

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Computational Science Research Intern

Karlsruhe Institute of Technology
Karlsruhe, Germany

May – July 2020

Karlsruher Institut für Technologie

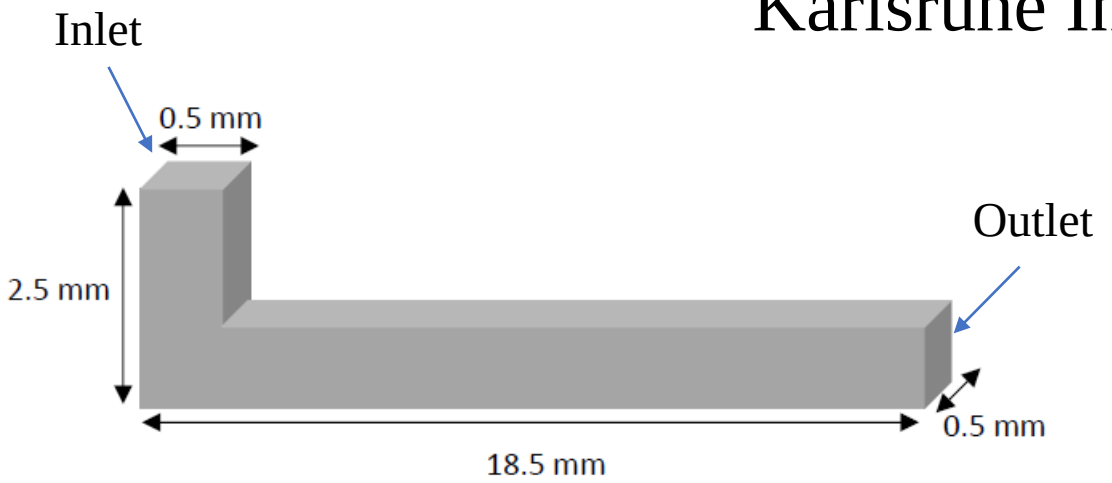
Simulation of Liquid-Particle flow in Microchannels

Skills – C++ Programming, Algorithm development, Computational Fluid Dynamics, OpenFOAM

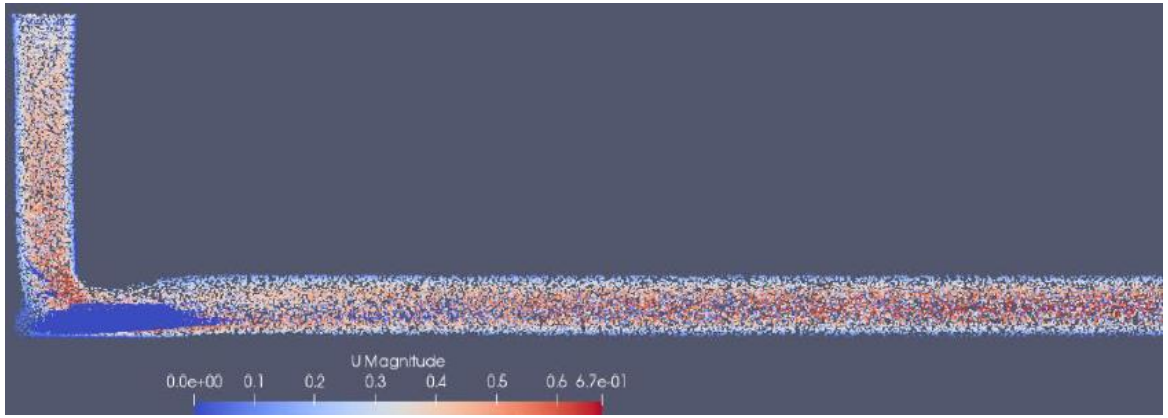
- Aim – This intern work dealt with predicting the fouling trend in microstructure devices using numerical CFD simulation-based in OpenFOAM software. The goal of this work was to combine particle drag and fluid dynamics to model complex fouling mechanisms in idealized micro-structured metallic devices whilst achieving numerical accuracy and consistency. The work involved using C++ based OpenFOAM software to code simulation environment including an L-Shaped microstructure device, liquid flowing through the device and particles entering the device from inlet.
- Inputs – Device design and dimensions, particles entering the device at the rate of over 10^5 per second along with liquid from device inlet, and started getting deposited at the bed of the device (Figure shown next slide)
- Analysis – Postprocessing achieved using Python to plot the deposition rate of particles based on various input parameters including inlet liquid speed.

Computational Science Research Intern

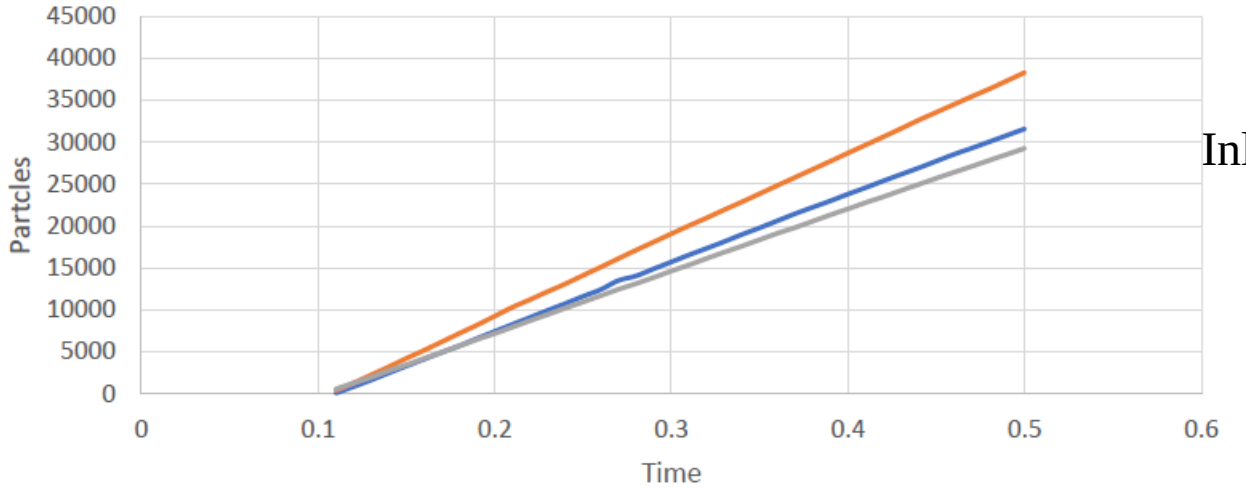
Karlsruhe Institute of Technology



Device Structure



Particle Speed plotting as they flow through the device



Particle Deposition vs Time

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Consumer Purchasing Behavior Analysis using Clustering Techniques

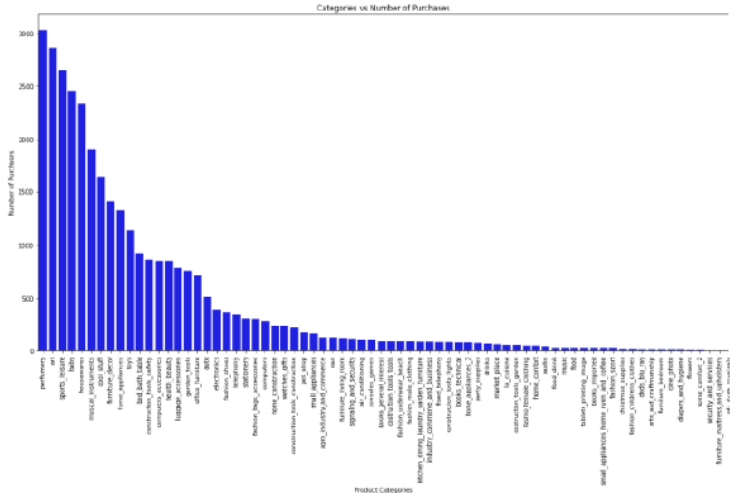
January – April 2022

Skills – Python libraries for Machine Learning, Data Analytics, Customer Segmentation, Jupyter Notebook

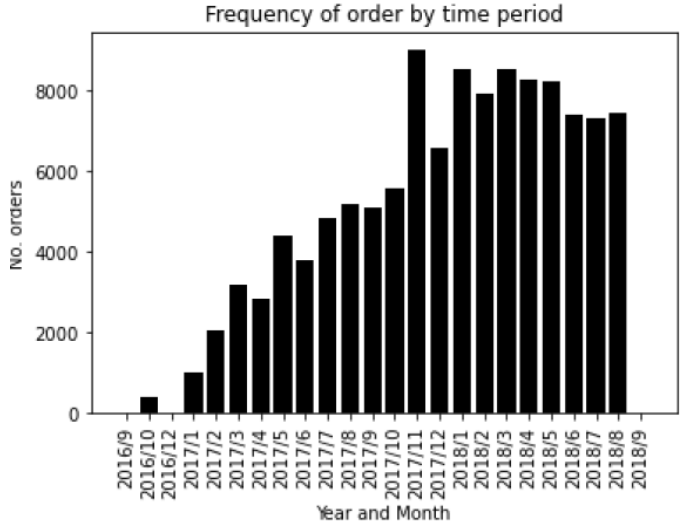
- Introduction – Utilized a publicly available dataset of the customers shopping on Olist Store's website to perform customer segmentation to be used for Olist for targeted marketing.
- Analysis – This was accomplished in the following steps
  - Exploratory Data Analysis – To identify the need for clustering
  - Feature Extraction – Identifying essential features to be used for segmentation
  - Dataset Creation - This included binary encoding of the features and dataset creation and using Principal Component Analysis (PCA) for features generation
  - Clustering - Employed K-Means and Gaussian Mixture Clustering model algorithms on Jupyter Notebook to perform high dimensional clustering
  - Result – This included insight generation from obtained clusters

Consumer Purchasing Behavior Analysis using Clustering Techniques - Results

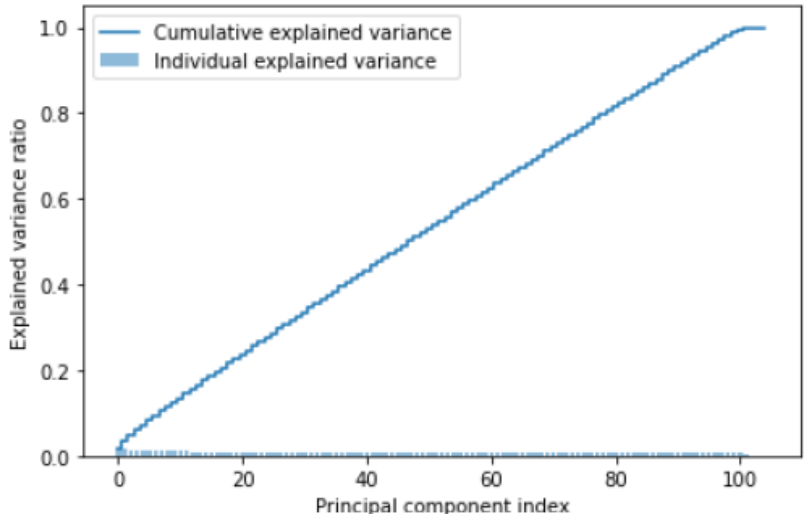
Purchases vs Product Category



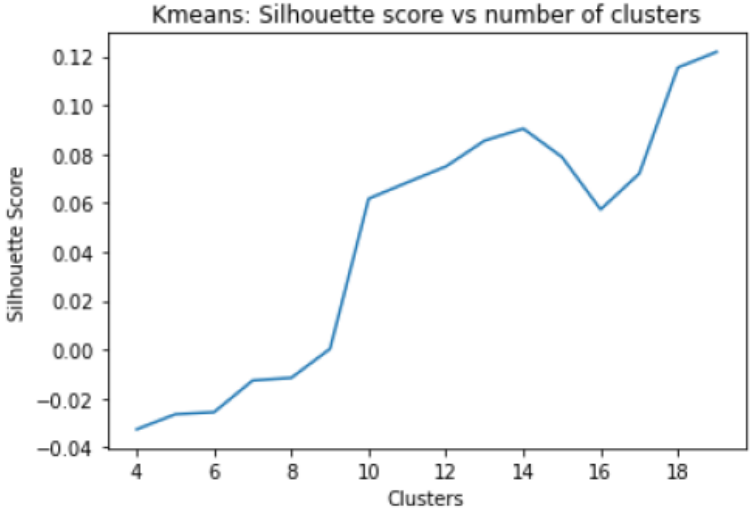
Frequency of order by time period



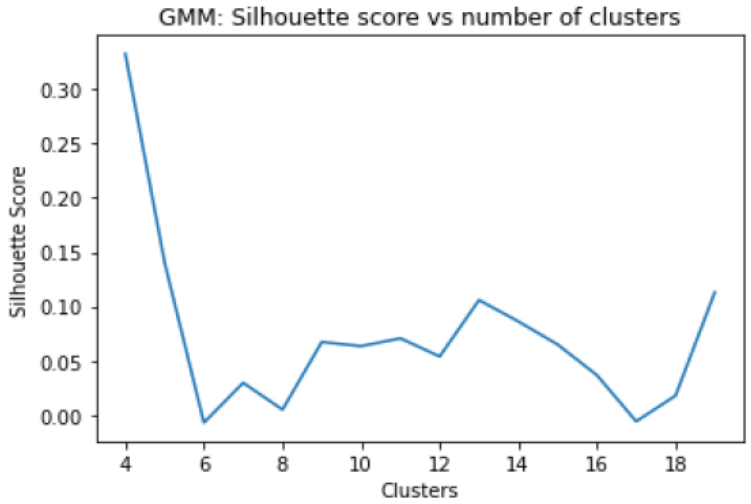
Variance explained vs PC index



Kmeans: Silhouette score vs number of clusters

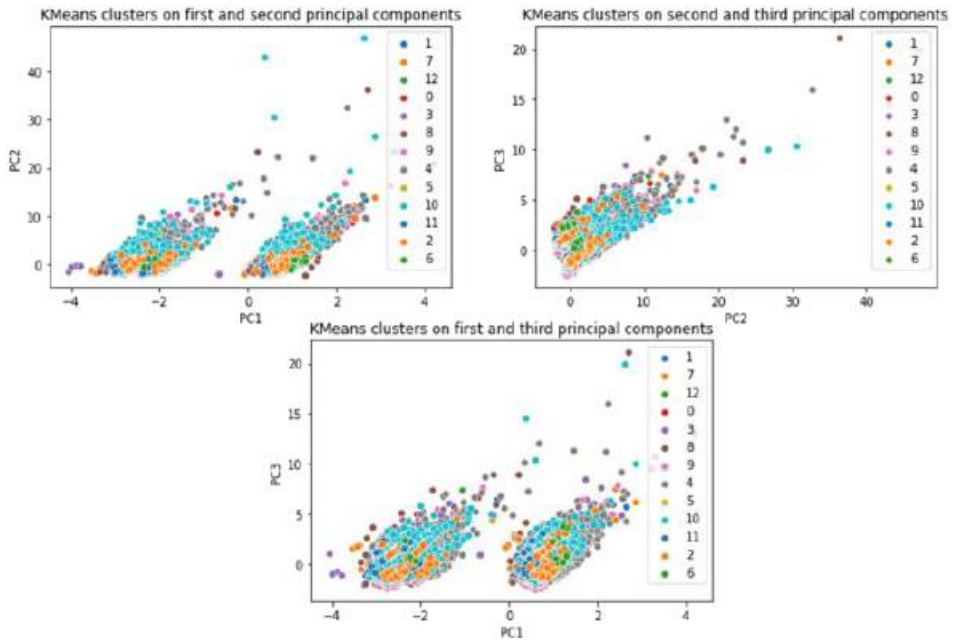


GMM: Silhouette score vs number of clusters

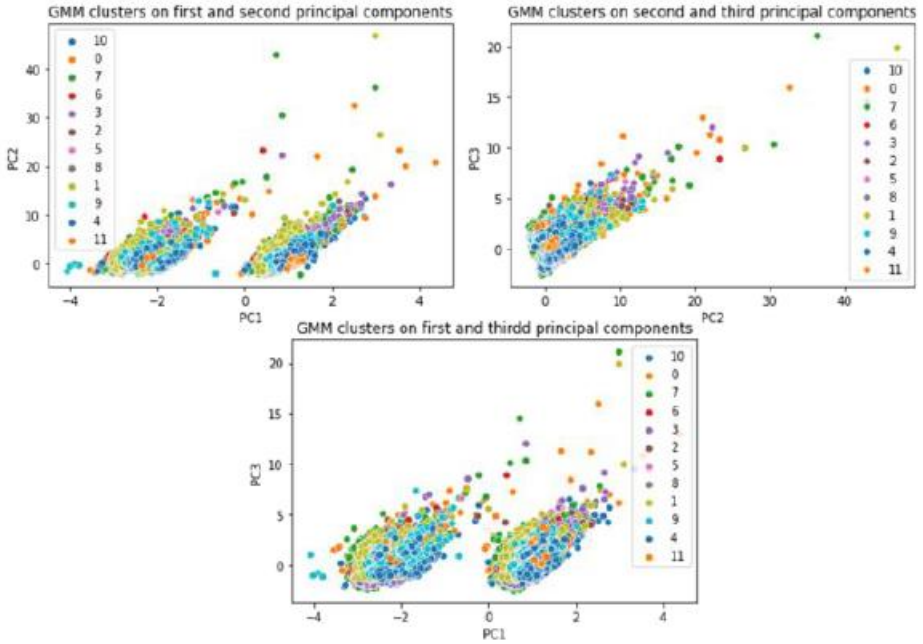


Consumer Purchasing Behavior Analysis using Clustering Techniques - Results

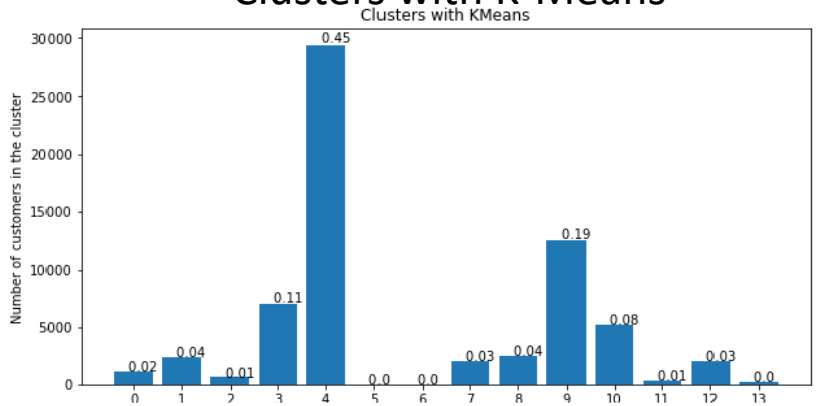
K-Means Cluster visualization with PCA



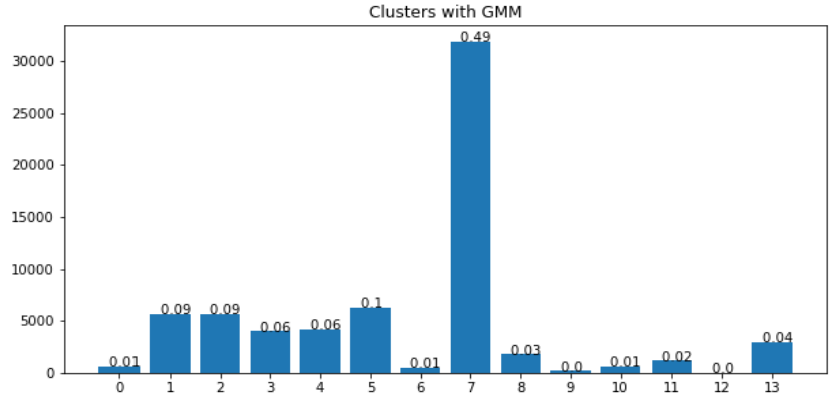
GMM Cluster visualization with PCA



Clusters with K-Means



Clusters with GMM



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Demand Variation Analysis of Bluebikes rentals

February 2022

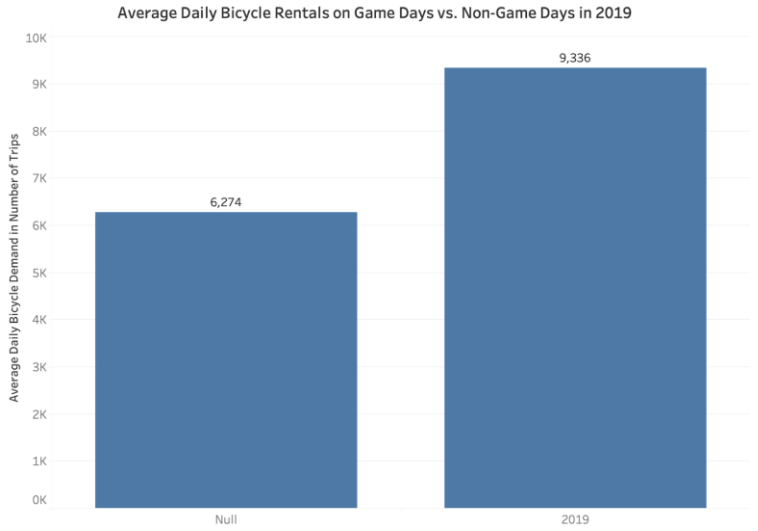
Skills – Python, SQL, Tableau

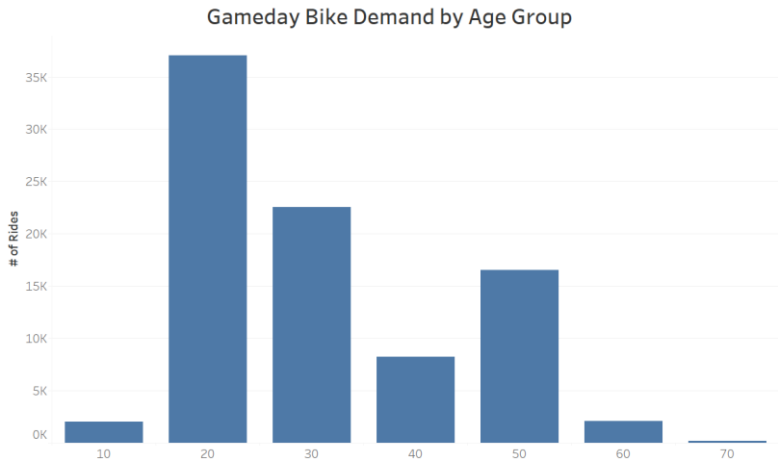
- Aim – To determine demand variation of Bluebike rentals during Boston Red Sox home game days vs non game days
- Introduction – Data used in this project was sourced from Sportradar API and Blue Bikes Boston data
- Analysis – Python was used to have an API call to Sportradar API to import data which was then manipulated using pandas to generate usable CSV files to be fed into SQL and subsequently Tableau for visualisation.

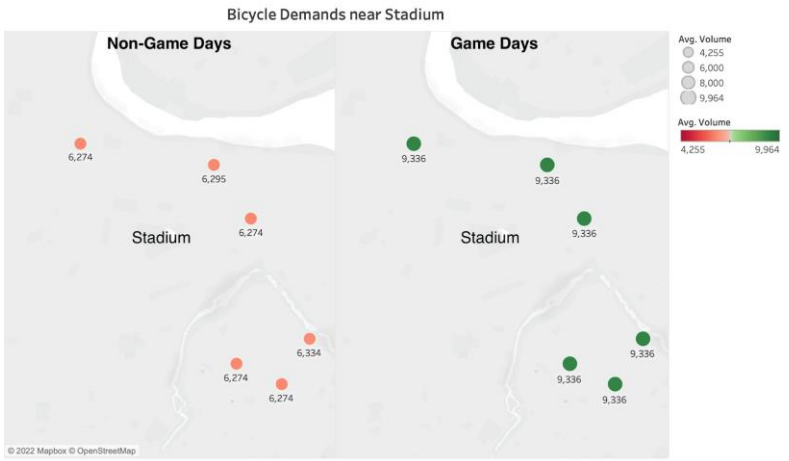
Results and Insights generated –

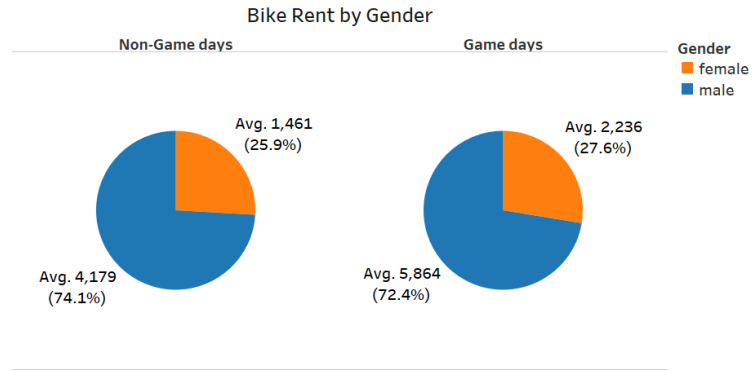
- Bike demand is 49% higher during game days as compared to non-game days
- Bike demand is higher in locations around Fenway Park during game day vs non-game day
- Males account for majority of bike rentals on both game day and non-game day
- Younger individuals ren higher than older people on game days

Demand Variation Analysis of Bluebikes rentals









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S&OP and Workforce Management Optimization

November 2021

Skills – Advanced MS- Excel, Integer Programming

- Aim – Use given company shipment forecast data (per month spread over an year) to plan production considering low workforce fluctuation, production capacity constraints and end of horizon effects
- Constraints –
  - Plant Capacity – 13,000 production units per month
  - Effective shipments in each month = Shipment forecast
- Objective – Devise an optimal plan of hiring, layoffs, and production in each month to minimize Total Cost to company

S&OP Planning and Workforce Management Optimization

Optimization Model Formulation

Objective

MIN: Total Cost = SUM(Labor Costs, Holding Costs)

Decision Variables

- Hirings per Month
- Layoffs per Month
- Overtime

Constraints

- Plant capacity exceeds the production in each month.
- Sum of production and inventory in each month exceeds the demand for that month.
- Hiring, Layoffs and Overtime are integers.
- CDOL limits for overtime - 10% in base scenario

Optimization Model in Excel

Production

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Demand		4,400	4,400	6,000	8,000	6,600	11,800	13,000	11,200	10,800	7,600	6,000	5,600
Regular Production		5,840	5,840	5,840	5,840	10,200	10,200	10,200	10,200	10,200	7,600	6,000	5,600
Overtime Production		0	0	0	0	0	0	0	1,000	600	0	0	0
Production In the month		5,840	5,840	5,840	5,840	10,200	10,200	10,200	11,200	10,800	7,600	6,000	5,600
Cum. Demand		4,400	8,800	14,800	22,800	29,400	41,200	54,200	65,400	76,200	83,800	89,800	95,400
Cum. Production		5,840	11,680	17,520	23,360	33,560	43,760	53,960	65,160	75,960	83,560	89,560	95,160
Inventory	240	1,680	3,120	2,960	800	4,400	2,800	0	0	0	0	0	0

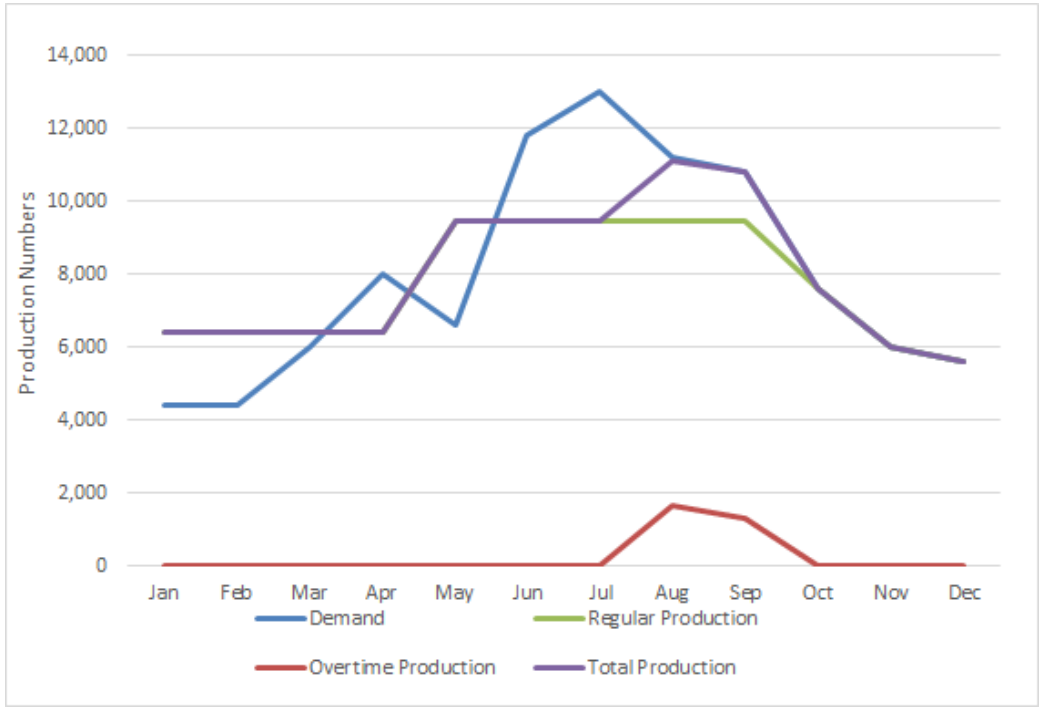
Labor

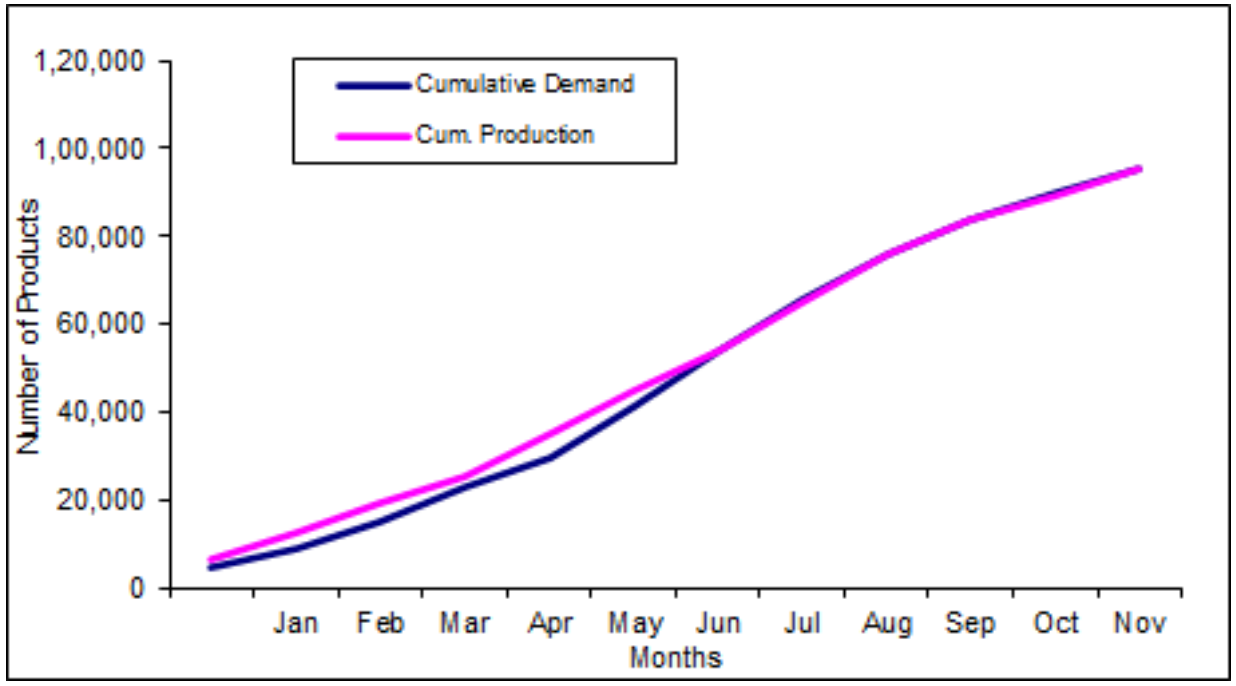
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
#Workers	160	146	146	146	146	255	255	255	255	255	190	150	140
Hirings		0	0	0	0	109	0	0	0	0	0	0	0
Layoffs		14	0	0	0	0	0	0	0	0	65	40	10
Overtime		0	0	0	0	0	0	0	25	15	0	0	0
CDOL Limit	10%	15	15	15	15	26	26	26	26	26	19	15	14

Accounting

		30	60	90	120	150	180	210	240	270	300	330	360	Total
Hiring Cost		0	0	0	0	196,200	0	0	0	0	0	0	0	$196,200
Layoff Costs		16,800	0	0	0	0	0	0	0	0	78,000	48,000	12,000	$154,800
Inventory holding costs		13,440	24,960	23,680	6,400	35,200	22,400	0	0	0	0	0	0	$126,080
Labour -Regular		350,400	350,400	350,400	350,400	612,000	612,000	612,000	612,000	612,000	456,000	360,000	336,000	$5,613,600
Labour -Overtime		0	0	0	0	0	0	0	82,500	49,500	0	0	0	$132,000
													Total Cost	$6,222,680

S&OP Planning and Workforce Management Optimization





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Strategizing UofM Bus route to minimize air-borne disease spread

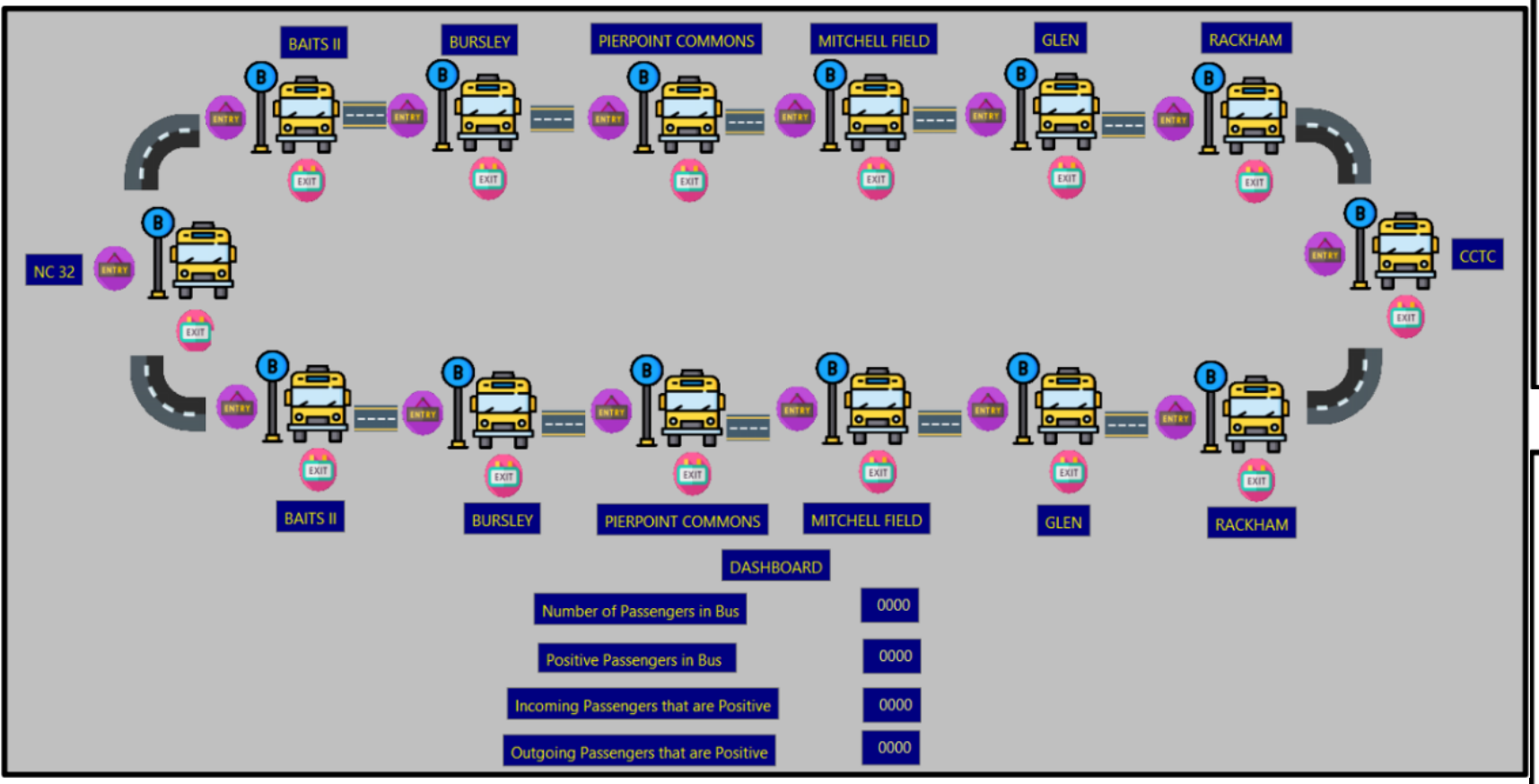
August – December 2021

Skills – ProModel, Discrete Event Simulation, Data Analysis

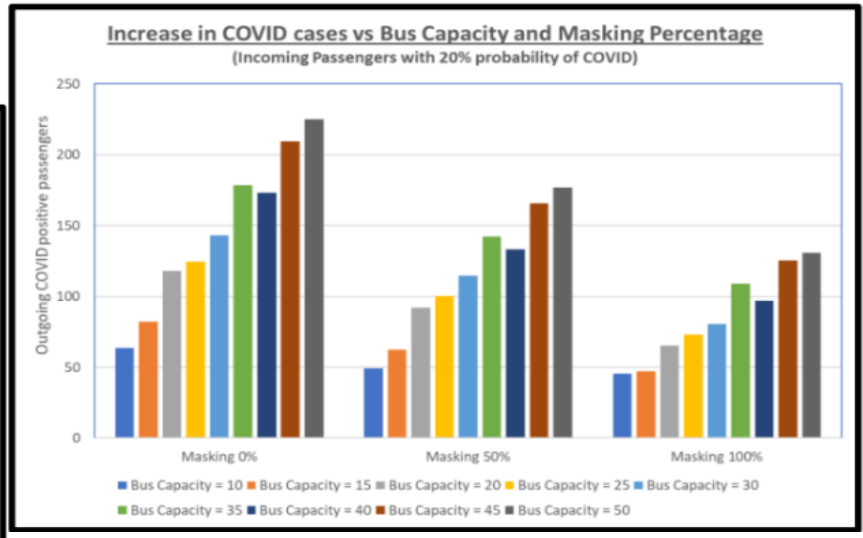
- Aim – To perform simulation of multiple scenarios of UM bus transit route to devise strategies for minimizing air-borne contagious disease spread
- Introduction – The project dealt with collecting passenger (including bus stop getting on & off, in-bus passenger count, and bus capacity) data across all bus stops along a UofM bus route, designing a simulation model in ProModel software that captures the bus route, feeding in the data collected to this model, and finally analysing outputs obtained to strategize bus capacities and mask mandates.
- Analysis – This included core questions to be answered:
  - What should be the optimal bus capacity?
  - What should be the optimal bus stop capacity?
  - Bus stop queue restrictions to be made?
- Results –
  - Increase in initial covid carriers results in higher number of new infections
  - 100% mask mandate results in 45% less infection spread
  - Reducing bus capacity by 10% causes a reduction in spread by 23%

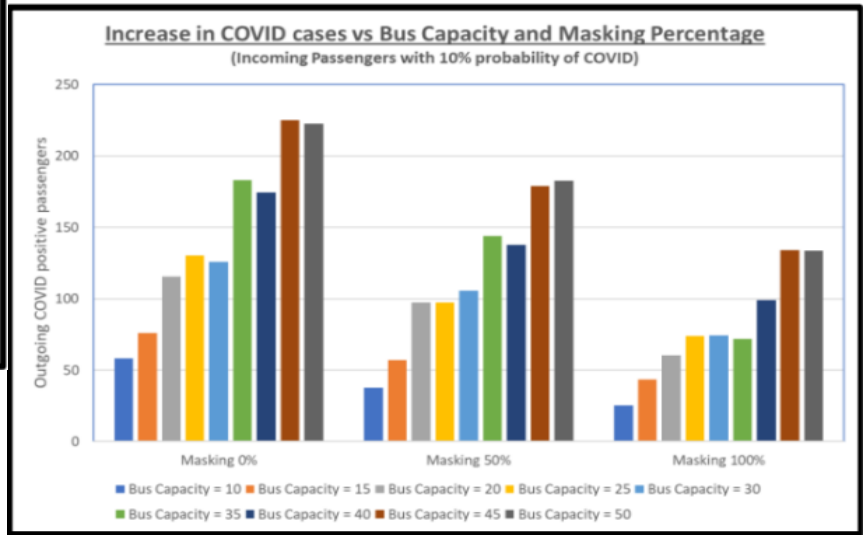
Strategizing UofM Bus route to minimize air-borne disease spread

Simulation Model in ProModel



Scenario Analysis





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Data Envelopment Analysis of teams in English Premier League

March to April 2022

- **Skills** – DEA, Efficiency Frontiers, Benchmarking
- Aim – To find most underperforming team among 4 EPL teams (Liverpool, Manchester City, Chelsea, and Manchester United), find low performing players in that team, and swap these by better performing players from other teams.
- Analysis –
  - Step 1: Identifying Lowest performing team was accomplished using Window DEA for the years 2016, 2017, 2018, 2019, 2020, and 2021.
  - Step 2: Transfer low performing players using categorical variables to separately analyse forwards, midfielders, and defenders
  - Step 3: Add better players to the identified lowest performing team with limited budget obtained from transfers in Step 2
- Results – Manchester United was found to be lowest performing team from step 1; 7 of its players were found to be replaceable in step 2 amounting to a budget of $387 M; these players were replaced with players from other teams using up $310 M.

Data Envelopment Analysis of teams English Premier League

	2016-2017-2018-2019-2020-2021
Liverpool	0.908633
Manchester City	0.895790
Chelsea	0.776830
Manchester United	0.771243

Step 1 Results

DEA Forward Players

Average through Window	
	2020-2021
Mohammad Salah(LV)	1
Sadio Mane(LV)	0.927844976
Luis Diaz(LV)	0.883722012
Roberto Firmino(LV)	0.758940994
Bernardo Silva(MC)	0.774996719
Marcus Rashford(MU)	0.701166122
Edinson Cavani(MU)	0.999990158
Jadon Sancho(MU)	0.984538145
Cristiano Ronaldo(MU)	1
Mason Greenwood(MU)	0.911325811
Daniel James(MU)	0.999988789
Anthony Martial(MU)	0.698752971
Andreas Pereira(MU)	0.761625513

DEA Midfielders

Average through Window	
	2020-2021
Fabinho(LV)	0.978158
Thiago(LV)	0.984258
Jordan Henderson(LV)	0.938955
Kevin De Bruyne(MC)	1
Rodri(MC)	1
Fernandinho(MC)	1
Bruno Fernandes(MU)	0.948212
Paul Pogba(MU)	1
Donny van de Beek(MU)	1
Jesse Lingard(MU)	0.44084
Fred(MU)	0.999613
Nemanja Matic(MU)	0.744119
Scott Mctominay(MU)	1
Juan Mata(MU)	0.571026

DEA Defenders

Average through Window	
	2020-2021
Virgil Van Dyjk(LV)	0.983547824
Aymeric Laporte(MC)	1
John Stones(MC)	0.889777618
Joel Matip(LV)	0.940238501
Trent Alexander(LV)	0.818586390
Kyle Walker(MC)	0.874425604
Ruben Dias(MC)	0.957410029
Joao Cancelo(MC)	0.836977472
Harry Maguire(MU)	0.550884057
Victor Lindelof(MU)	0.888636305
Phil Jones(MU)	0.724193883
Alex Telles(MU)	0.900468357
Luke Shaw(MU)	0.915894365
Raphael Varane(MU)	0.930004024
Diogo Dalot(MU)	0.999997934
Aaron Wan Bissakka(MU)	0.949690497

Step 2 Results

Players to be transferred out

Forward: Marcus Rashford ($77m), Anthony Martial ($30m)

Midfield: Jesse Lingard ($22m), Juan Mata ($3.3m), Nemanja Matic ($6.6m)

Defense: Harry Maguire ($44m), Phil Jones ($4.4m)

Data Envelopment Analysis of teams English Premier League

DEA Forward Players

Average through Window	
	2020-2021
Mohammad Salah(LV)	1
Sadio Mane(LV)	0.77843
Luis Diaz(LV)	0.904897
Roberto Firmino(LV)	0.760617
Bernardo Silva(MC)	0.862667
Harry Kane(Tottenham)	0.921663
Darwin Nunez(Benfica)	1
Victor Osimhen (Napoli)	0.968515
Dominic Calvert Lewin (Everton)	0.92357

DEA Midfielders

Average through Window	
	2020-2021
Fabinho(LV)	0.991257
Thiago(LV)	0.984794
Jordan Henderson(LV)	0.934515
Kevin De Bruyne(MC)	1
Rodri(MC)	1
Fernandinho(MC)	0.990982
Declan Rice(West Ham)	1
Jude Bellingham(Borussia Dortmund)	0.963554
Kalvin Phillips(Leeds United)	0.945511
Youri Tielemans (Leicester City)	0.999999
Antony (Ajax)	1
Christopher Nkunku(RB Leipzig)	1
Aurélien Tchouameni(AS Monaco)	1

DEA Defenders

Average through Window	
	2020-2021
Virgil Van Dyjk(LV)	1
Aymeric Laporte(MC)	1
John Stones(MC)	0.890655
Joel Matip(LV)	0.946887
Trent Alexander(LV)	0.854401
Kyle Walker(MC)	0.868891
Ruben Dias(MC)	0.956332
Joao Cancelo(MC)	0.873896
Pau Torres(Villareal)	0.744562
Jurrien Timber (Ajax)	1
Kyle Walker Peters (Southampton)	0.902528
Antonio Rudiger (Chelsea)	0.716545
Ronald Araujo(Barcelona)	1

Step 3

Data Envelopment Analysis of teams English Premier League

Players	Position	Transfer Value
Darwin Nunez(Benfica)	Forward	$40m
Victor Osimhen (Napoli)	Forward	$60m
Declan Rice(West Ham)	Midfield	$75m
Antony (Ajax)	Midfield	$38.5m
Aurélien Tchouameni(AS Monaco)	Midfield	$44m
Jurrien Timber (Ajax)	Defense	$33m
Kyle Walker Peters (Southampton)	Defense	$19.8m

Step 3 Results

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