Shipping Truck Simulation

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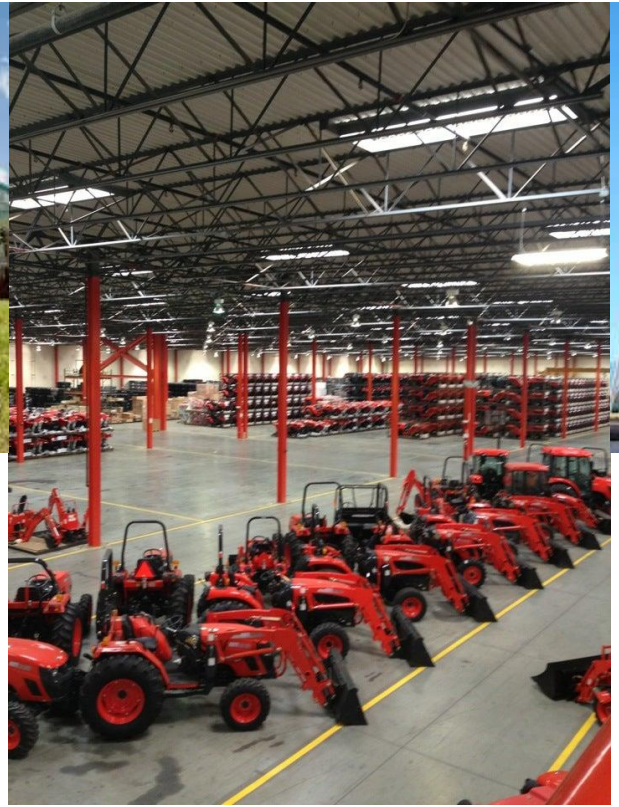
Context, Problem, and Significance

Context: Simulating the shipping processes at Kioti (Daedong-USA, Inc.)

- Volume of truck shipments per day is highly variable, resources and processes allocated need to be appropriate for both low and high volume days
- Truck waiting time incurs expenses for ‘Holding Fees’, this needs to be minimized
- Kioti is a less-optimized, but rapidly growing company
- Goods shipped consist of tractors (heavy machinery) and attachments
- This does not include parts or receiving processes

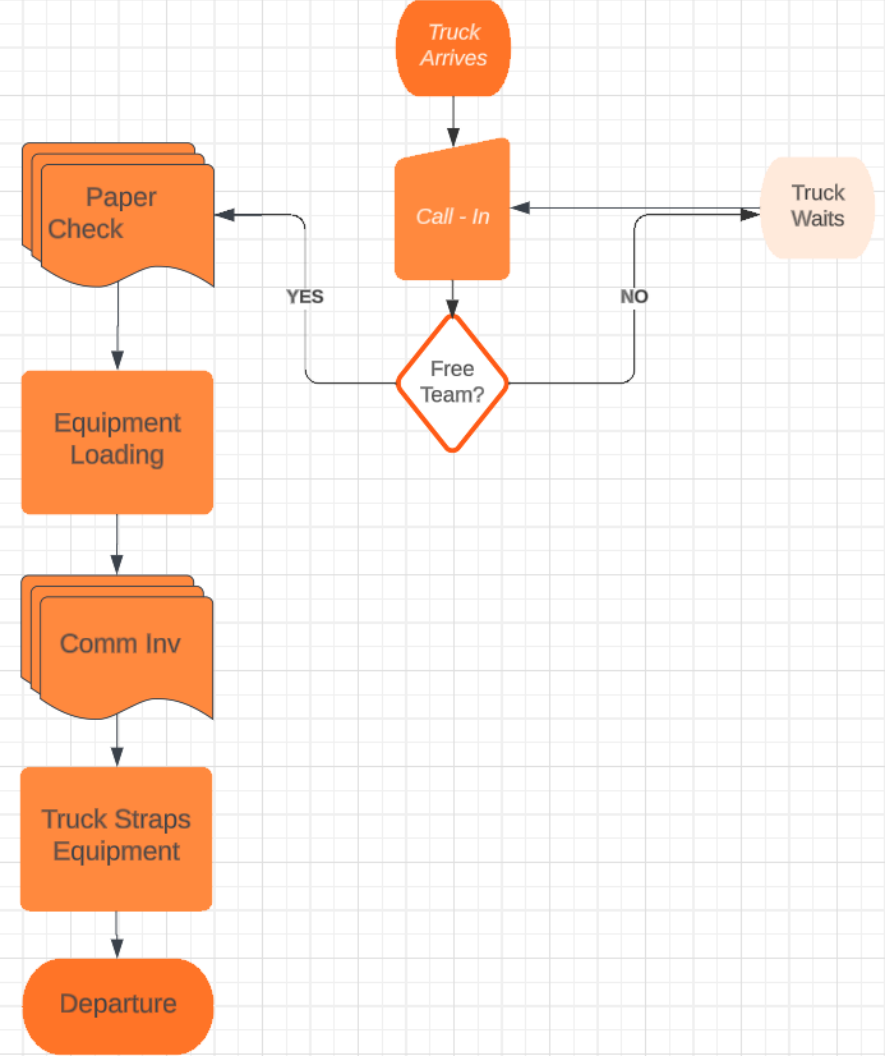
Kioti Warehouse + Area



Problem and Significance

Problem: Simulating the shipping processes at Kioti (Daedong-USA, Inc.)

- Problem: How well can Kioti processes accommodate the variable load of shipping trucks to support anticipated sales?
- Significance: As Kioti pushes for higher yearly sales, simulating future daily shipping volumes will inform management of what department changes need to be made. This may be process changes, different business relations contracts, changes in workforce



Truck arrives and calls in. During call-in a team is checked for availability.

If no team is available the truck is given a waiting number and is called once a team becomes available with an estimated waiting time.

Papers to confirm which load are checked.

Equipment is loaded.

Commercial Invoice and Bill of Lading is exchanged.

Truck straps equipment on outside of bay and departs

Process Flow

Simulating the Process

Primary Parameters: Number of Teams, Number of Trucks

- Intended to change via user selection

Constants: Each constant below is technically a range of values where one value is randomly selected from the range

- Check-In Duration (5 - 15 min)
- Paper Duration Check (5 - 15 min)
- Commercial Invc/BOL Exchange (5 - 15 min)
- Loading Equipment (30 - 60 min)
- Truck Strapping (30 - 60 min)

Constants were chosen by collaborating with Shipping Manager and Team Leads

How It Simulates

The program is simulating an entire day in which trucks arrive at random times between 8am - 5pm.

- Trucks are “scheduled”, but rarely come even within 2 hours of their time
- Arrival times are generated between 8am - 5pm
- Arrival time and team availability are the two determinants that the process simulates over
- One day of simulation ranges from 10 to 25 trucks.
- Reasons for adding time of day:
  - Creates waiting time scenario if multiple trucks arrive at once
  - Allows for future parameterization of the program (i.e. what if all the trucks arrived after 10am?)

Why Simulate This Way?

Due to a combination of desires from the Shipping Manager and the intended extension of the program, the program needed to be setup so that future parameters could be accommodated:

- Number of bays
- Number of teams
- Include receiving trucks & teams
- Number of strap-down stations
- Operational hour changes

There were also specific natures/scenarios that needed to be answered:

- If 3 trucks arrive at 4:30pm, when does our team get to leave?
- At exactly what time can I expect a truck to depart if it arrives at this time?
- How well does our process handle 4 trucks at the same time?

Simulations Chosen & Validation

Two sets of simulations were chosen for class

- 10 to 30 Trucks & 2 Teams
- 10 to 30 Trucks & 3 Teams

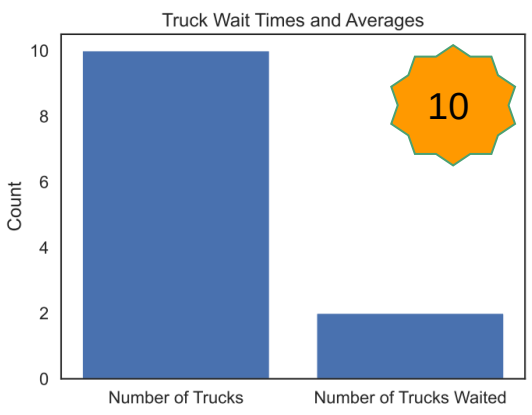
In total, that is simulating 200 trucks. These parameters were chosen to show impact of potentially increasing manpower to accommodate more trucks in lieu of growing sales goals.

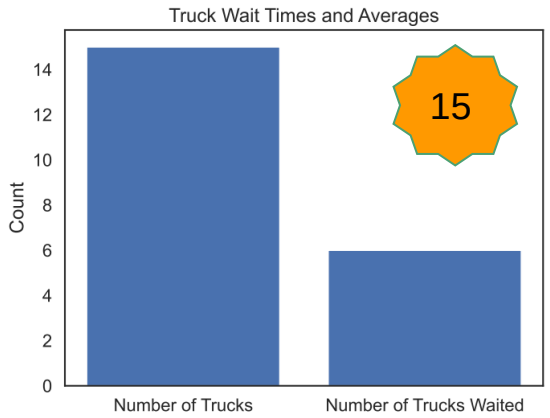
Validation was performed by

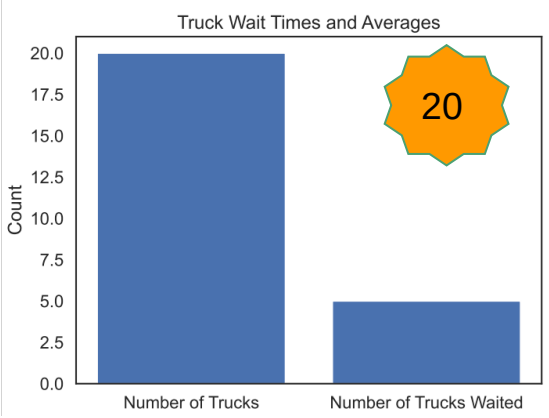
- Gathering ‘tribal’ knowledge from Team Leads
- Discussing estimates on truck visit duration (this metric isn’t being tracked in the real world)

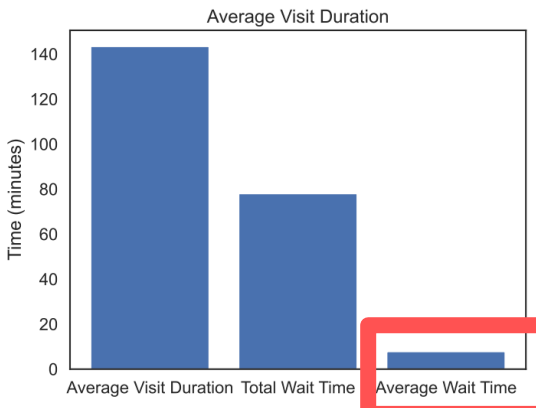
After showing results from simulations, both groups felt like duration of activities and total processing time was accurate. What is not clear is whether truck arrival times are accurately represented since the department does not track this in a readily accessible manner.

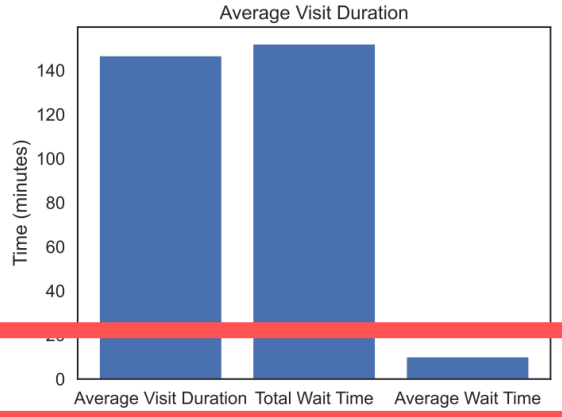
Findings: 2 Teams

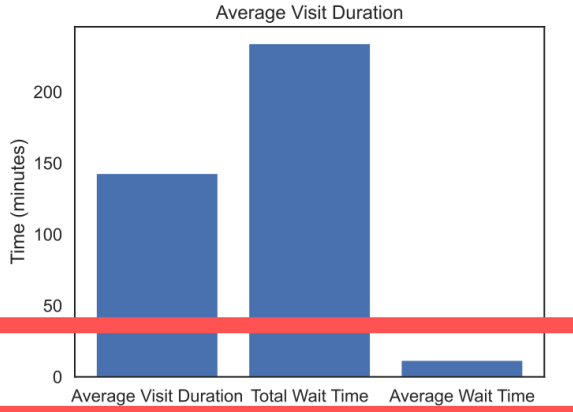












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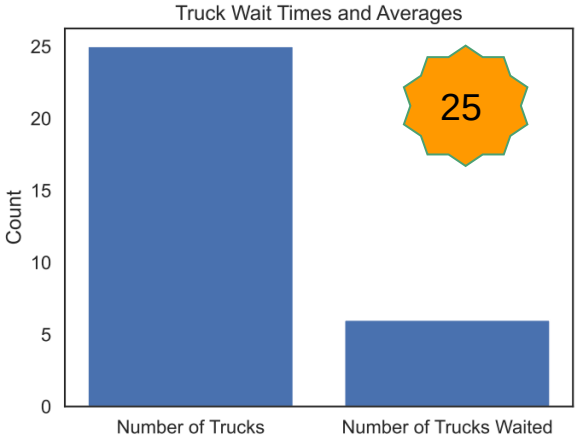
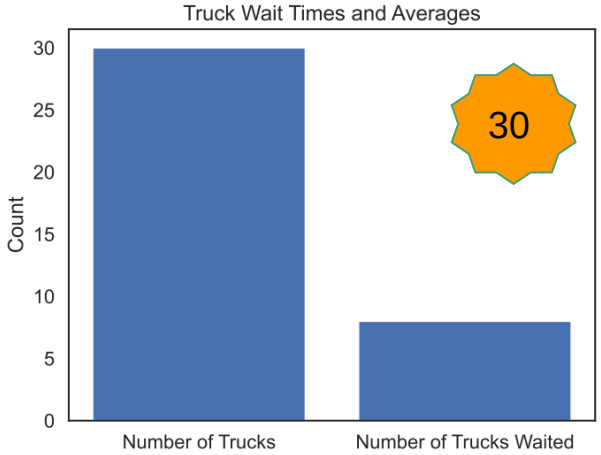
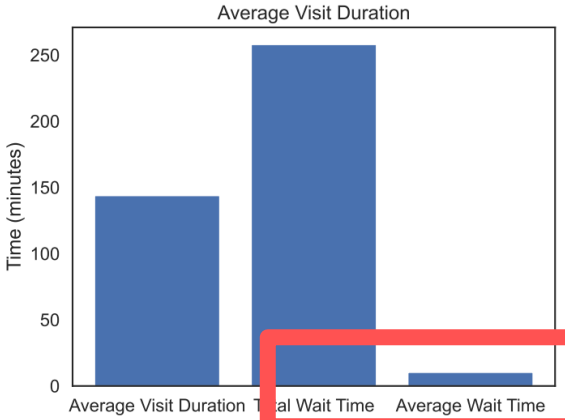
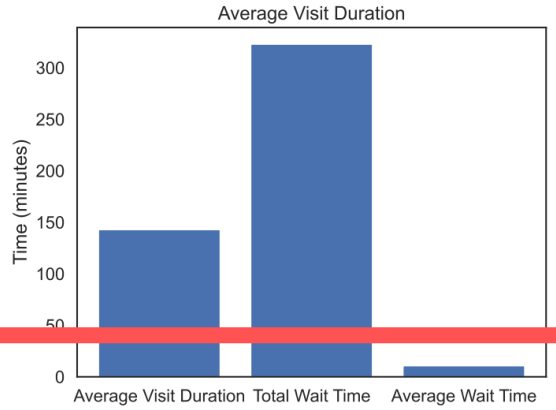
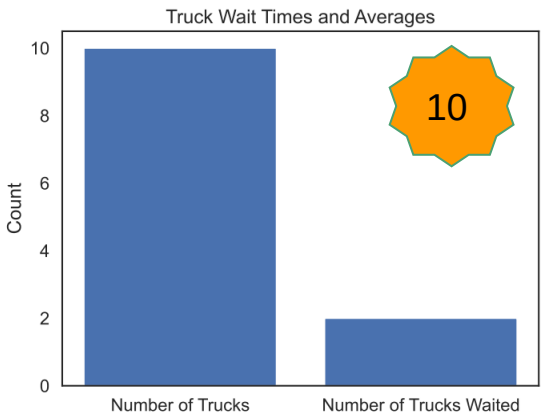


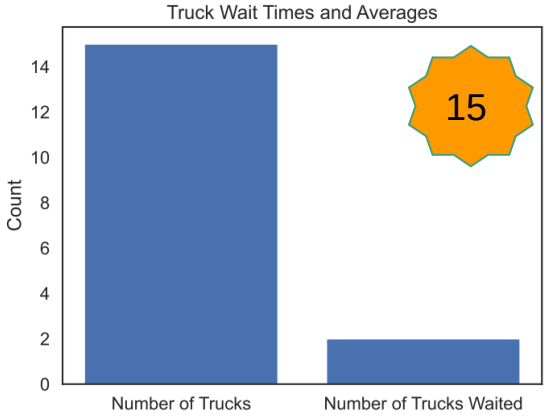


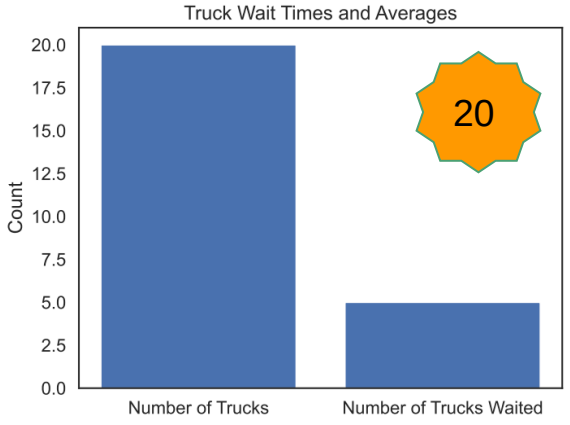


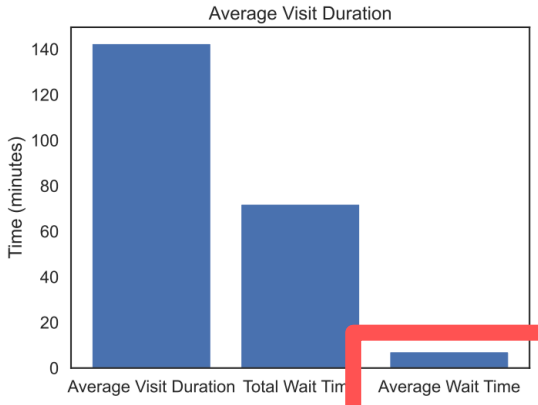


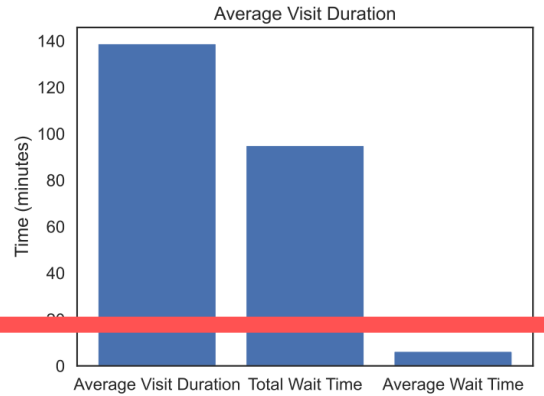
Findings: 3 Teams

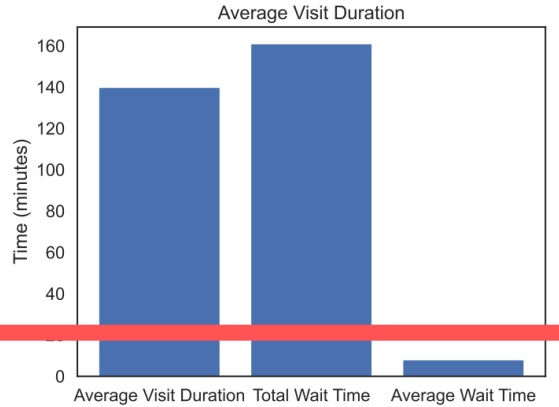












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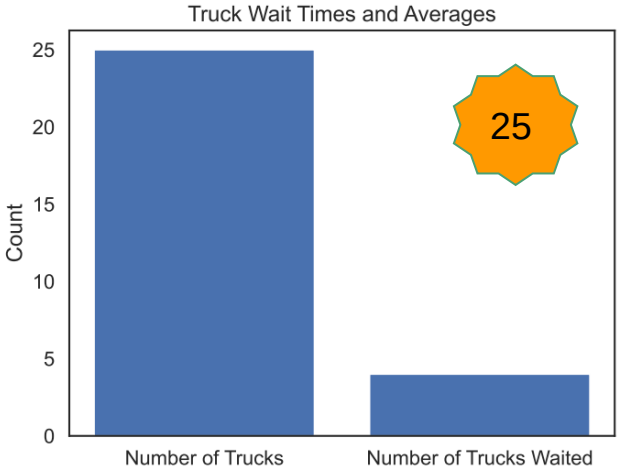

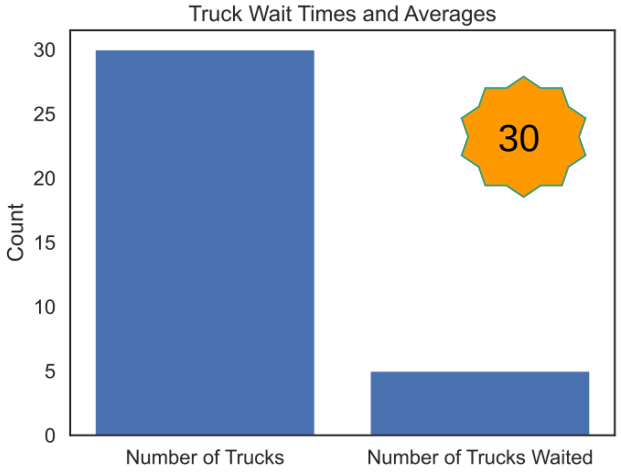

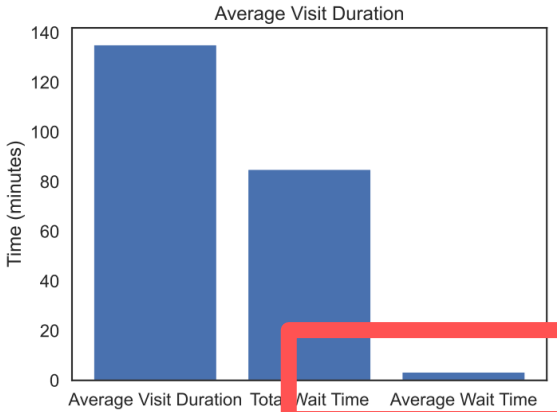

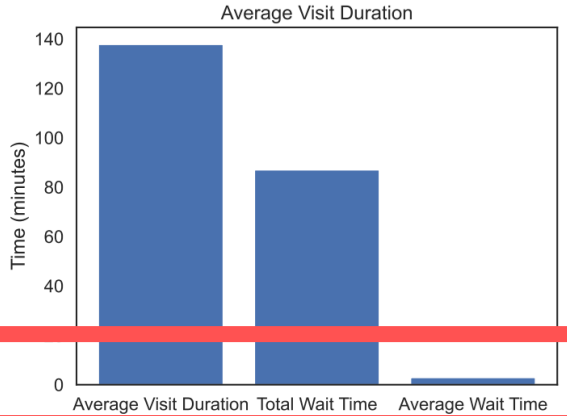

Conclusions

In the current state of the model, it is accounting for truck arrival time being highly variable to reflect the current real world state. Internal process are relatively static, which with more investigation may not be the case after more research. The model has been built to maintain ease of expansion.

- In both the 2 Team and 3 Team scenario, average wait time rarely increased
- In both the 2 Team and 3 Team scenario, average visit duration increased slightly as more trucks were scheduled that day

Although it seems simple, the importance of truck arrival time shines. If 4 trucks all arrive at the same time, waiting time and potential subsequent back-log increase. Tracking and enforcing truck arrival time with similar “holding fees” should decrease trucks outside of scheduled times.

Appendix

- Example of resulting dataframe with timestamps at each process to the right (times are in minutes, ie. 481 = 8:01am via 481/60
- Code: DATA604/Final Project at main · d-ev-craig/DATA604 (github.com)

Please use view the warehouse_sim_Clean.ipynb jupyter notebook for using code. The other version may be continuously developed.

	Arrival_Time	Type	CheckIn_Complete	Load_Complete	Strap_Complete	Departed	Waiting_on_Team_Duration	Total_Visit_Duration
0	481	Shipping	496	552	613	623	0	142
1	510	Shipping	517	575	635	645	0	135
2	512	Shipping	522	579	634	644	0	132
3	523	Shipping	529	614	668	678	34	155
4	554	Shipping	567	626	672	682	0	128
5	582	Shipping	594	660	733	743	0	161
6	737	Shipping	745	806	854	864	0	127
7	743	Shipping	754	819	875	885	0	142
8	746	Shipping	757	811	868	878	0	132
9	762	Shipping	775	867	904	914	49	152
10	825	Shipping	836	905	973	983	0	158
11	828	Shipping	836	894	938	948	0	120
12	833	Shipping	840	939	996	1006	39	173
13	854	Shipping	862	922	961	971	0	117
14	877	Shipping	888	963	1028	1038	22	161
15	893	Shipping	898	950	1003	1013	0	120
16	906	Shipping	916	986	1028	1038	0	132
17	923	Shipping	931	982	1042	1052	0	129
18	951	Shipping	965	1039	1101	1111	17	160
19	1011	Shipping	1021	1078	1123	1133	0	122