Optimizing Port Processes to Solve Supply Chain Complications

ME 635/IPD 611

Final Project Presentation

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Group 1

Background

- Global supply chain issue
  - Customer/industry demand
  - E-commerce growth
  - Transportation costs/capacity
  - Labor and equip shortages
- The Port of Los Angeles
  - “America’s Port”
  - Located in San Pedro Bay, 25 miles south of downtown Los Angeles
  - 7,500 acres of land and water along 43 miles of waterfront
  - Premiere gateway for international commerce
  - Busiest seaport in the Western Hemisphere

Background

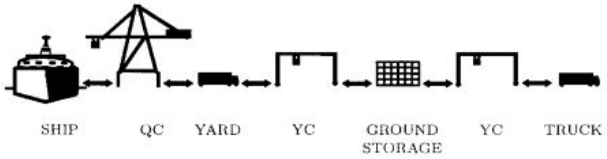


Figure 7.6. Container flows in a transfer-crane-relay system

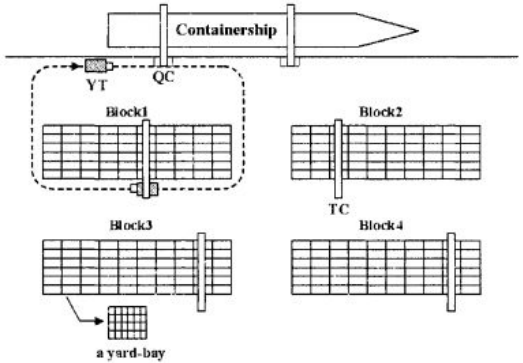


Figure 7.7. An example of a container terminal with a transfer-crane-relay system

The Port process:

- Shipping vessels are berthed for unloading/loading containers
- Gantry cranes dismount processed cargo containers to yard trucks at the terminal
- Rubber Tyre Gantry Crane (RTGs) lift containers off the yard trucks to storage areas then to designated trucks/trains upon arrival

Objective

The purpose of this project is to identify shortcomings in the operations of The Port of Los Angeles that can be addressed in order to improve throughput.

- ➢ Create Arena model simulation to analyze operational shortcomings to solve both incoming and outgoing complexities
- ➢ Find the required number of months of 24-hour port operation to completely eliminate backlog,if possible

Data Collection

There were gaps in available data online for this model, which include

- Recording of operation shifts over time
- Truck throughput
- Container Loading Times at the Storage Area
- Time distributions for how long each part of truck loading took

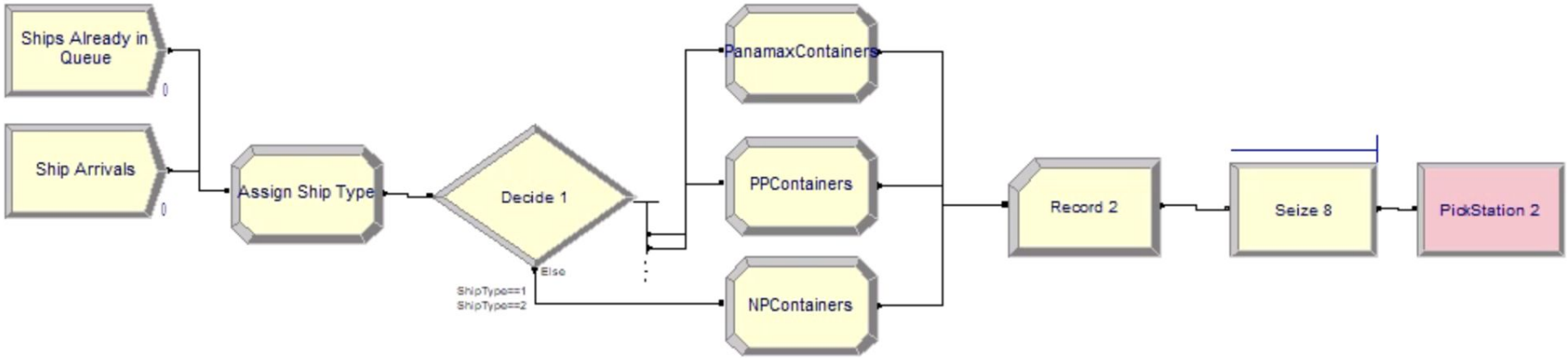
The model had to be shifted to include the data we did have

Model Assumptions

1. No stacking priority when unloading/loading containers
2. Every ship's size allocates the same number of cranes at berths(No crane blocking/ crane shifting)
3. All resources are utilized fully during the period of consideration
4. Each berth is reserved for one vessel at a time(Discrete Berth Scheduling)
5. Each berth can support the largest possible vessel's size
6. Storage yard has infinite capacity
7. Unlimited yard trucks

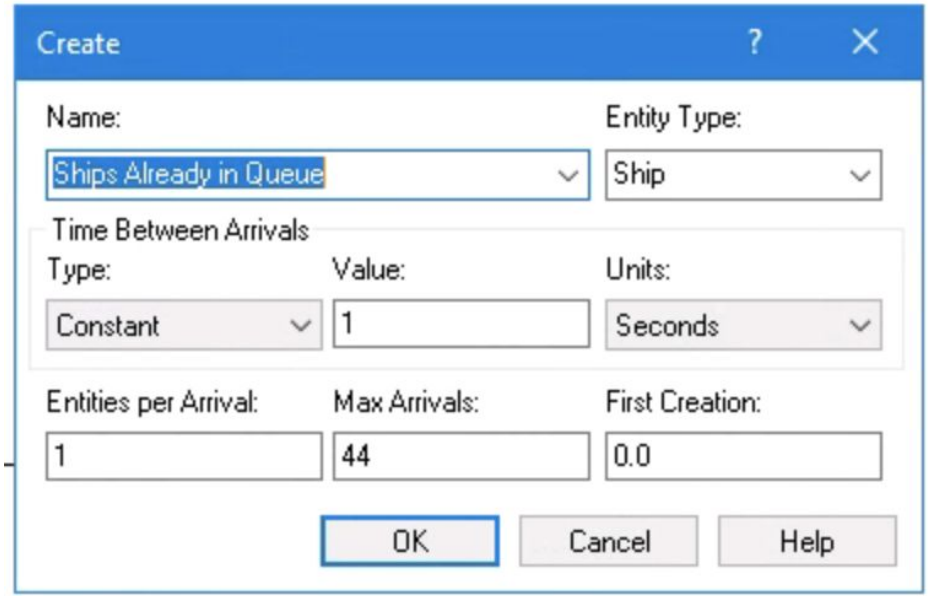
Model

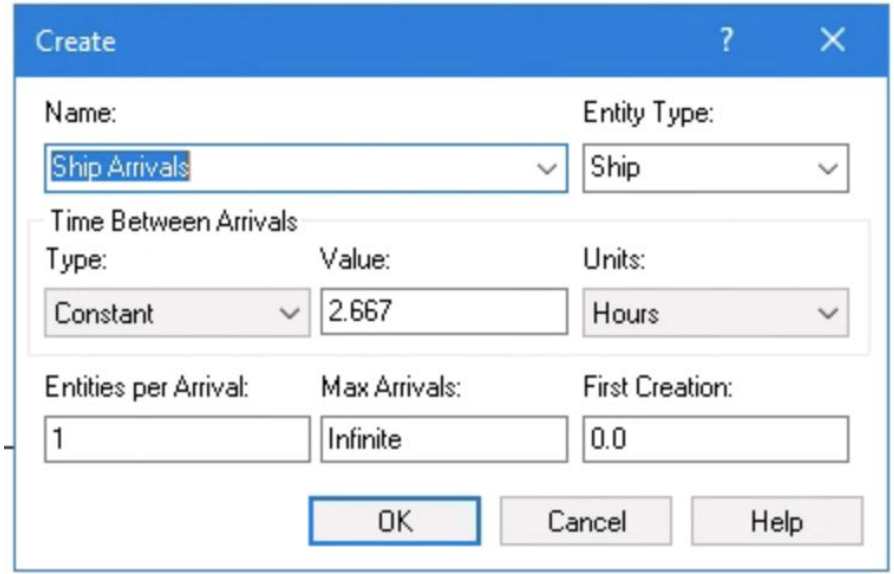
- Developed in Arena
- Entities created simulate ships arriving at port
- Ships are assigned:
  - Type (Attribute)
  - Quantity of containers (Variable)
- Placed in queue until a berth is available



Model

- 2 Create blocks:
  - Vessels already at port
  - New vessels arriving at port





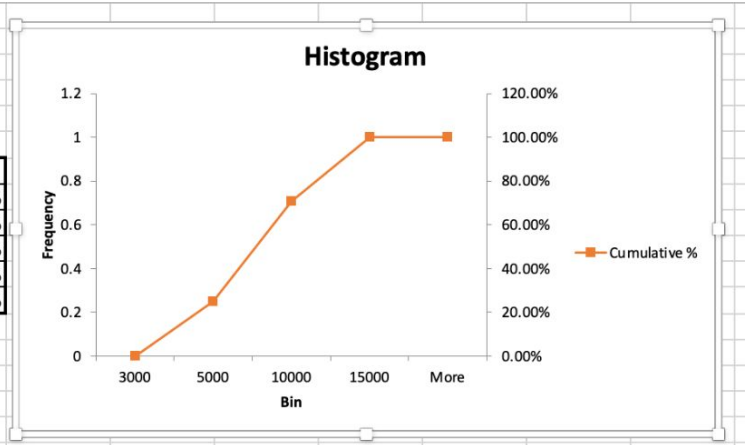
Model

- Sample of ships currently at port were used to develop a distribution of ship types

Ship	TEU's	Port
SEASPAN MANILA	4248	WBCT
ZIM IBERIA	4250	WBCT
AITOLIKOS	4300	TraPac
REN JIAN	4308	YTI
REN JIAN 26	4400	TraPac
HYUNDAI GRACE	4571	YTI
UTE	5041	APMT
CMA CGM VIRGINIA	5078	FMS
CMA CGM GEORGIA	5100	FMS
GEORGE WASHINGTON BRIDGE	5642	APMT
GERD MAERSK	6600	APMT
ONE HAMMERSMITH	8212	YTI
EVER LOVELY	8488	Everport
MSC SHAY	8566	WBCT
YM UNICORN	8626	WBCT
YM UNANIMITY	8626	WBCT
EVER LYRIC	9532	Everport

Median Values	
Panamax	4304
Post-Panamax	8212
NeoPanamax	13092

	Bin	*Cumulative %*
Feeders	3000	0.00%
Panamax	5000	25.00%
Post-Panamax	10000	70.83%
NeoPanamax	15000	100.00%
Ultra Large (ULC	More	100.00%

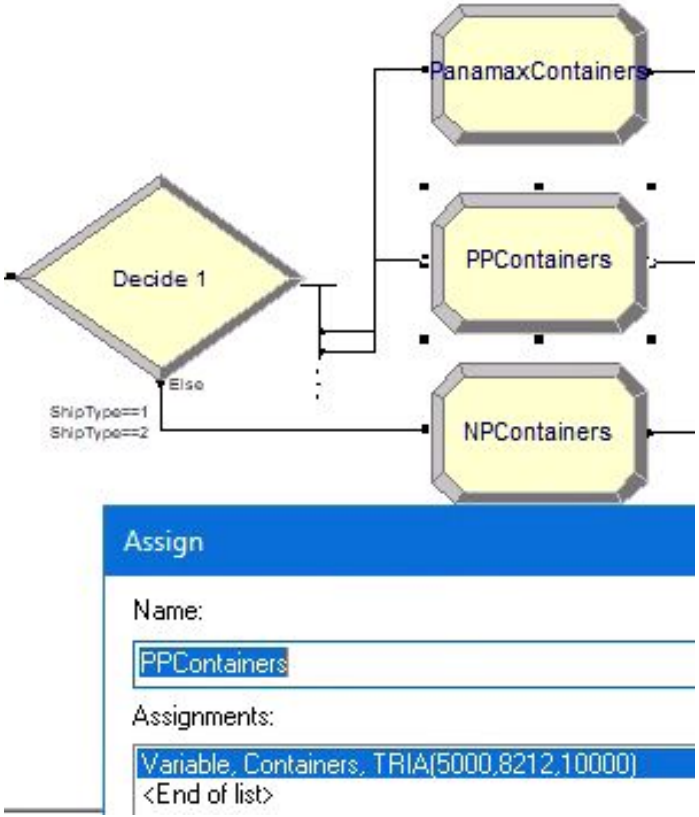


Assignments:

```
Attribute, ShipType, Disc(0.25,1,0.7083,2,1,3)
<End of list>
```

Model

- Decision tree separates entities by ship type attribute
- Assign blocks “load” ships with a triangular distribution of containers
- Containers could not be treated as entities due to the 150 limit of student version
- Type Variable is used so it can be manipulated by crane processes later
- Total incoming ships and containers are recorded

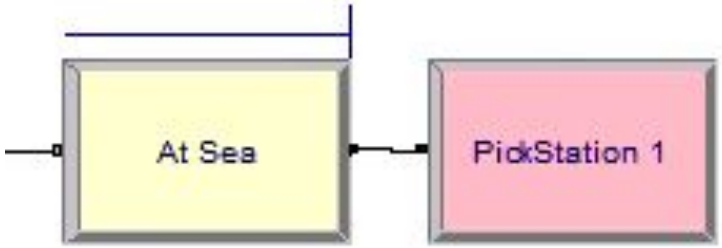


Model

- Berths are represented in the model as resources
- Each berth has a different number of cranes
- “AllBerths” is a total of the berths that allows for queueing at sea

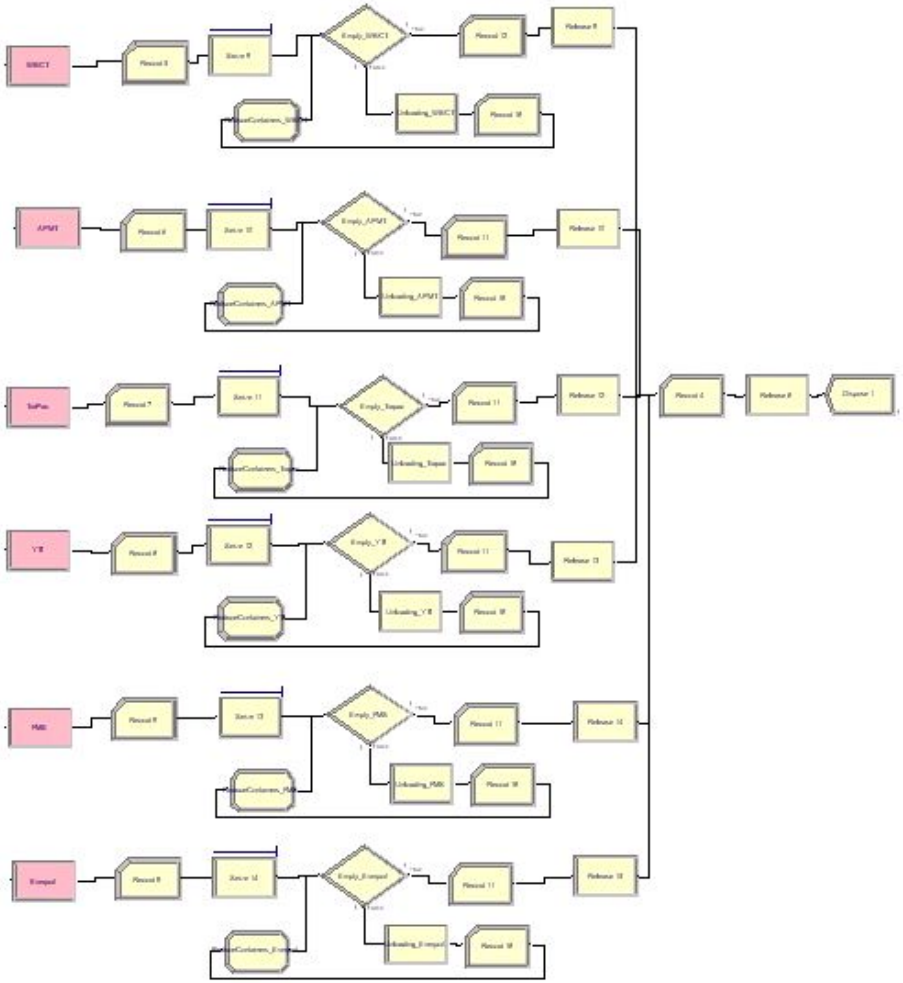
Resource - Basic Process

	Name	Type	Capacity
1	AllBerths	Fixed Capacity	23
2	WBCT_Berth	Fixed Capacity	4
3	APMT_Berth	Fixed Capacity	6
4	TraPac_Berth	Fixed Capacity	4
5	YTI_Berth	Fixed Capacity	3
6	FMS_Berth	Fixed Capacity	3
7	Everport_Berth	Fixed Capacity	3

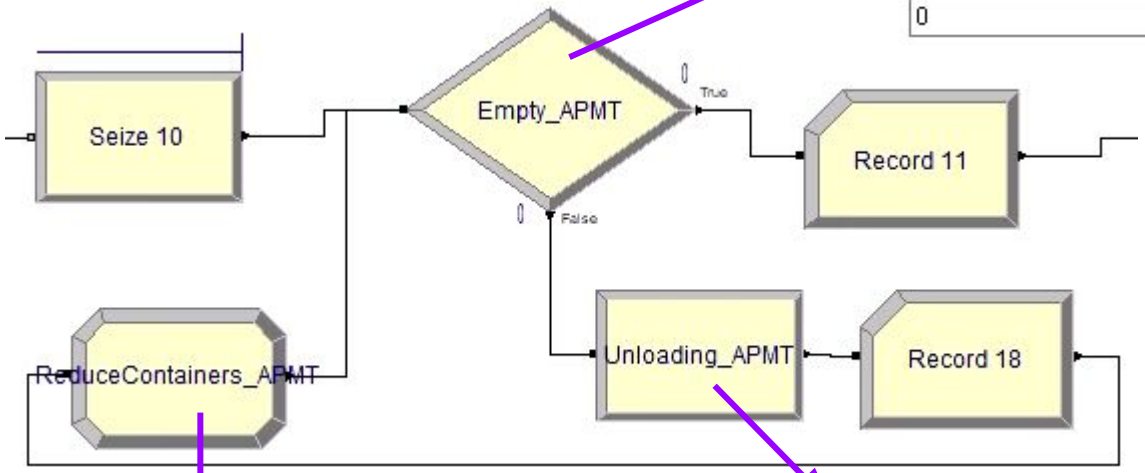


Model

- 6 stations used to represent 6 berth areas
- Each berth has different parameters in process loop reflecting number of cranes
- Record keeping performed for number of ships and containers processed



Model

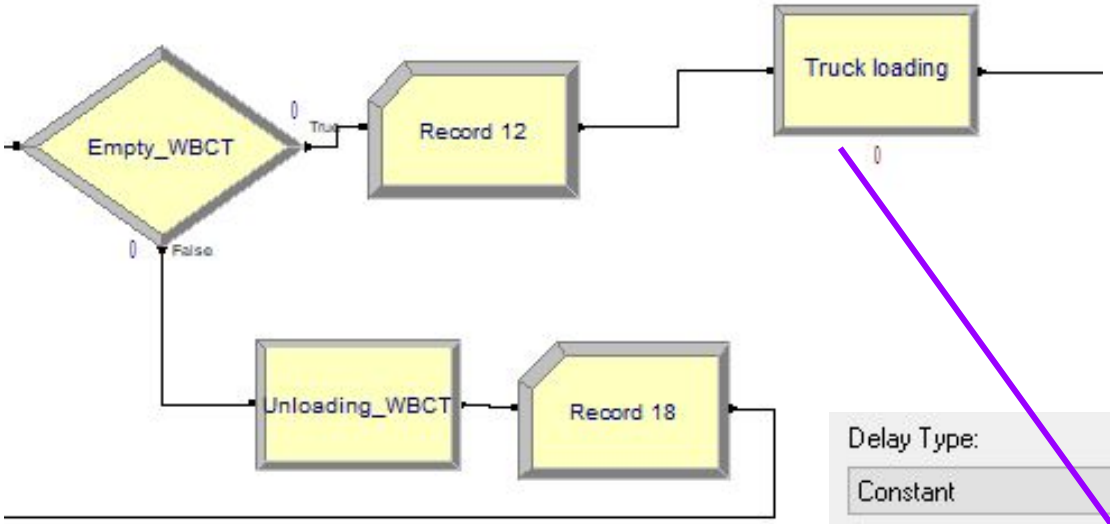


Name: Empty_APMT
Type: 2-way by Condition
If: Variable
Named: Containers
Is: <=
Value: 0

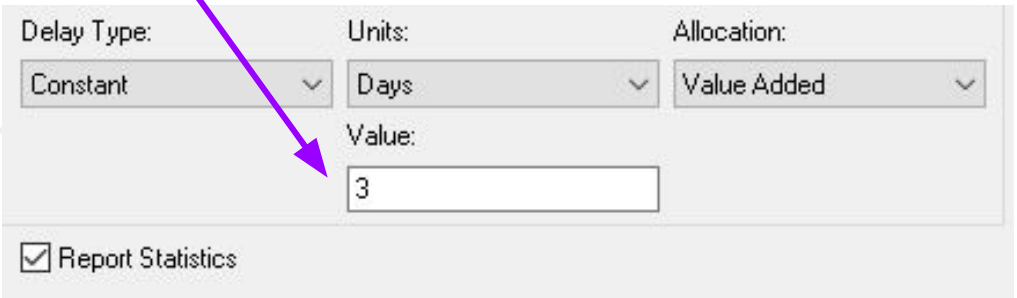
Name: ReduceContainers_APMT
Assignments:
Variable, Containers, Containers-3
<End of list>

Delay
Name: Unloading_APMT
Allocation: Value Added
Delay Time: TRIA(1,1.5,3)
Units: Minutes

Model



- Truck loading : a process for transporting containers in the port to trucks
- This delay time is what is optimized later to improve the throughput based on how berths are utilized



Inputs

The number of arrival ships in 10 days = 92 Ships -> 9 Ships/day (In average)

Ships arrival every 24 hours/ 9 Ships = 2.67 hour/ship

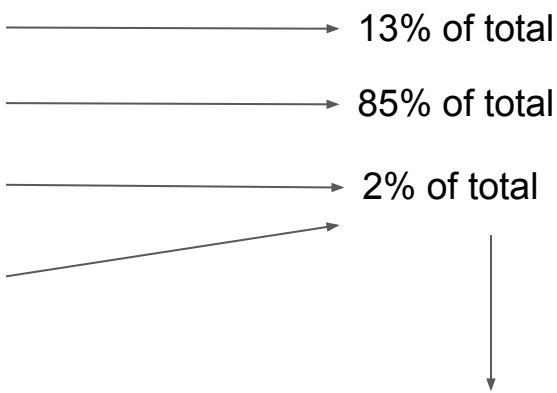
https://www.myshiptracking.com/ports/port-of-los-angeles-in-us-usa-id-279

Inputs

No.	Terminal Name	Berths	Gantry Cranes	Cranes / Berth(Approximated)
1	APMT	6	19	3
2	Everport	3	8	3
3	FMS	3	16	5
4	TraPac	4	10	3
5	YTI	3	11	4
6	WBCT	4	15	4
Total		23	79	

Inputs

	LOCAL DELIVERIES	ON-DOCK RAIL	OFF-DOCK RAIL
20 Feet	6,265	2,506	867
40 Feet	38,698	15,479	5,358
45 Feet	602	241	83
Other	507	203	70
Total	46,071	18,428	6,379



https://signal.portoptimizer.com/

37.47 Feet in average or 1.87 TEU

~ 2 TEU / Container

Simulation

- Adjust delay time at truck loading for each terminal
- Check the result of resource utilization -> try to have it fully utilized
- Run 24 hours a day, for 8 days with 15 replications

Terminal	Berths	Delay time for truck loading(Days)
APMT	6	4
Everport	3	2
FMS	3	2
TraPac	4	3
YTI	3	2
WBCT	4	3

Outputs

Usage

Instantaneous Utilization	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
AllBerths	1.0000	0.00	1.0000	1.0000	0.00	1.0000
APMT_Berth	0.6667	0.00	0.6667	0.6667	0.00	0.6667
Everport_Berth	1.0000	0.00	1.0000	1.0000	0.00	1.0000
FMS_Berth	1.0000	0.00	1.0000	1.0000	0.00	1.0000
TraPac_Berth	0.7500	0.00	0.7500	0.7500	0.00	0.7500
WBCT_Berth	0.7500	0.00	0.7500	0.7500	0.00	0.7500
YTI_Berth	1.0000	0.00	1.0000	1.0000	0.00	1.0000

More than 66% of the resources are utilized

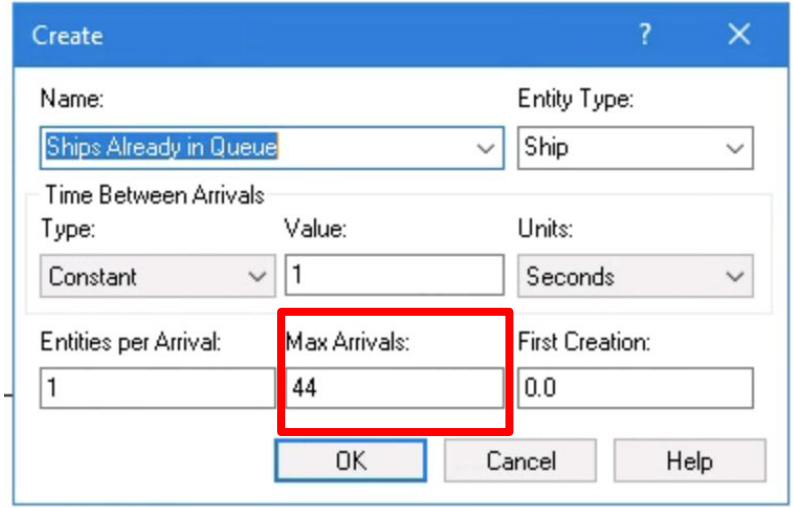
Replication Length: 8

Time Units: Days

Hours Per Day: 24

Base Time Units: Hours

Outputs



44 Ships already arrived at the port, causing the backlog

By fully utilized all berths for 24 hours/ 8 days, we can released almost all ships at the port

Validation & Verification

Real data

Data since 10/8/2021 - 10/20/2021

#Ships released : 28

Vessels departed

10/8/2021	26	18	1	9	25
10/12/2021	27	16	11	6.36	15.91
10/13/2021	27	18	0	0	0
10/14/2021	29	16	5	4.8	10.2
10/15/2021	29	16	3	6.33	15.33
10/18/2021	33	15	6	9.5	17.5
10/19/2021	36	18	2	4.5	14.5
10/20/2021	37	19	0	0	0

https://kentico.portoflosangeles.org/getmedia

Simulation

#Days : 8 days

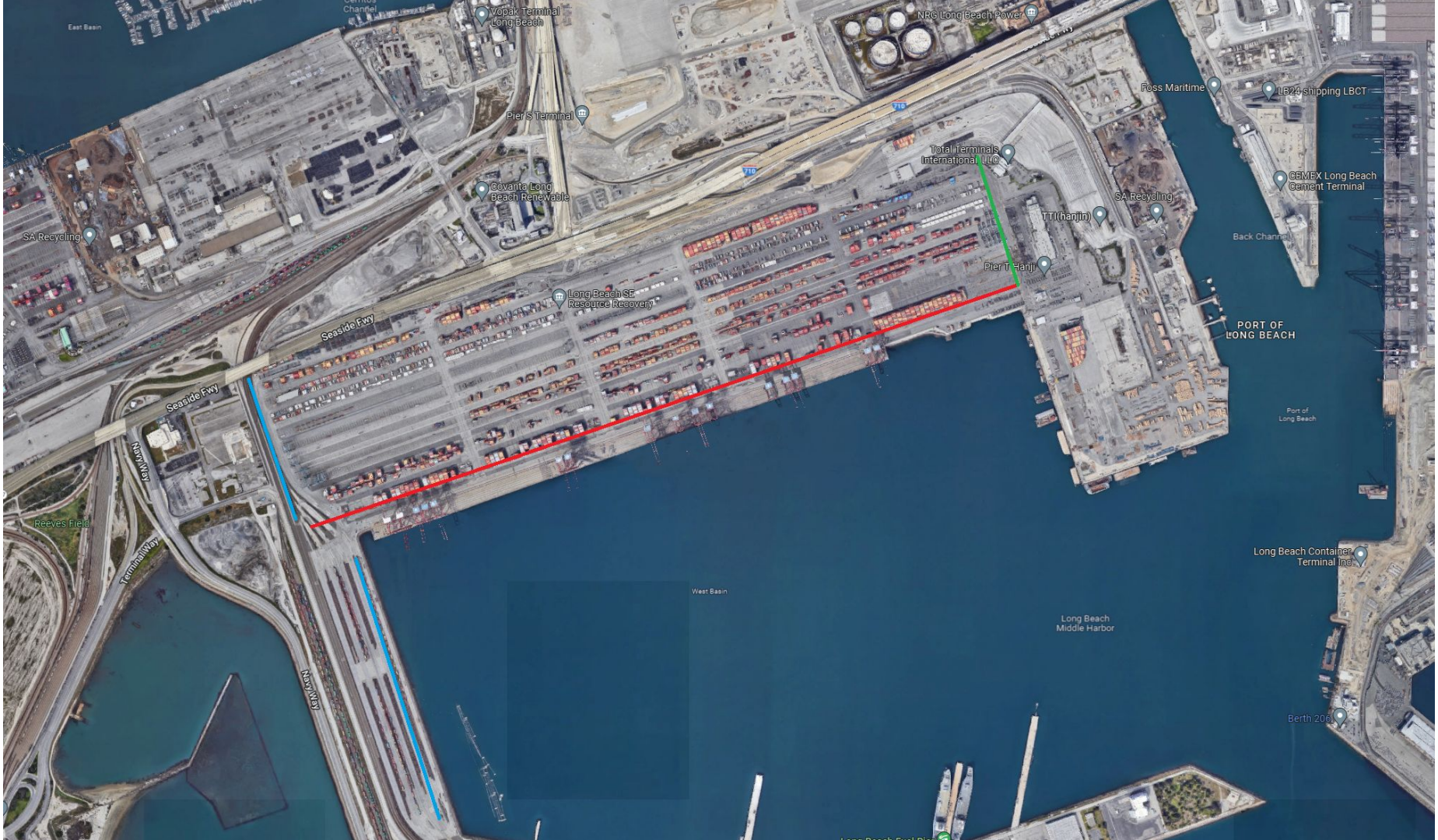
#Ships released : 43

Ship release improved by 53.57%

Total containers processed : 110851.6 TEU

Train Schedule

- Utilized MatLAB to validate train loading schedule
- Port of Los Angeles randomly sorts containers in storage areas across the yard
- Random time distribution for commuting to storage area, random distribution sorting containers in storage area
- Time distribution spread necessitates train schedules
- A couple ways to increase the capacity of train loading


East Basin
Vopak Terminal Long Beach
NRG Long Beach Power
Foss Maritime
LB24 shipping LBCT
Pier S Terminal
Total Terminals International, LLC
CEMEX Long Beach Cement Terminal
Covanta Long Beach Renewable
SA Recycling
TTI(hanjin)
SA Recycling
Back Channel
Pier T Hanji
Long Beach SE Resource Recovery
Seaside Fwy
PORT OF LONG BEACH
Seaside Fwy
Port of Long Beach
Navy Way
Reeves Field
Terminal Way
Long Beach Container Terminal Inc
West Basin
Long Beach Middle Harbor
Navy Way
Berth 206

Discussion

- As expected, utilizing the port for all hours is the best solution to shortening ships stuck at sea
- President Biden ordered ports to operate 24 hours to deal with the COVID-19 related supply chain issue
- In actuality most ports stopped operating at these numbers because of worker shortages and equipment bottlenecks

Resources

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9. Wikimedia Foundation. (2022, March 22). *Container ship*. Wikipedia. Retrieved April 5, 2022, from https://en.wikipedia.org/wiki/Container_ship