Tesla Transshipment Model

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Team Introduction

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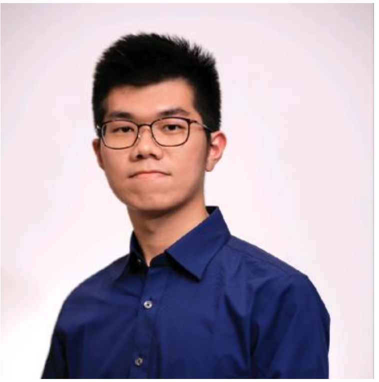

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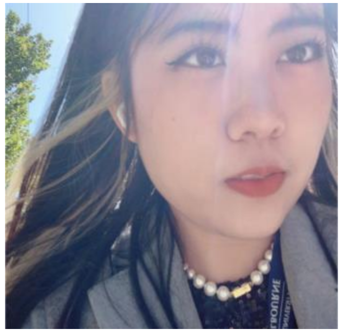

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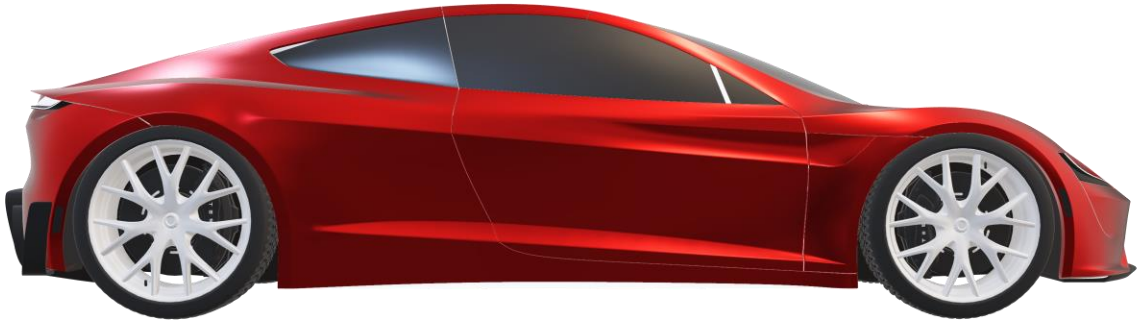
Content

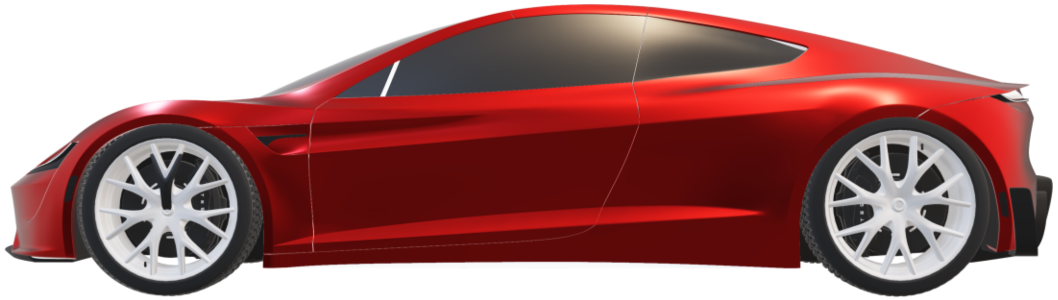
Introduction to Tesla

- Top-notch automakers
- Headquartered in Austin,Texas.
- It manufactures and sells electric cars and trucks including models like the Model Y, Model 3, Model X, Model S, Cybertruck, Tesla Semi and Tesla



Optimization problem of Tesla

- Organizational objective： cost-efficient, time-saving
- Challenges facing by Tesla： 4600 tesla model 3 vehicles were hampered in Australia port in January 2023 due to supply chain
- The goal of the solution： Minimizing transshipment cost and finding the optimal transshipment route while meeting all the store demands



Literature review

Strengths:

- Improve the efficiency of optimising the logistics through coordinated transportation and inventory management.

  -Leelertkij et al. (2021): vehicle routing from the warehouse to the retail store; warehouse to warehouse

  -Achamrach et al. (2022):tracked the inventory level

- Multiple objectives in objective function

  -Liu et al. (2013) & He et al. (2012): cost & the customer service level

- Discussion on environmental sustainability

  -Qu et al. (2016): designing sustainable supply chain networks

  -Januardi et al. (2020): the cost of carbon emissions as an objective function

Literature review

Weaknesses:

- Incomplete and unrealistic assumptions being used

  -Demand can vary with changing circumstances.

  -Most papers collected did not consider damages goods and COVID-19 impact.

- Applications of products failing to translate it to Tesla's problem

  -The mode of transportation is always limited.

- Multiple objectives inducing fuzzy optimisation solution, but can result in being ambiguous

Methodology

Decision Variables

Xij	Numbers of vehicles to be shipped from origin i to destination j	Transport routes - choose the closest, fastest, and most efficient transport routes
Tij	Delivery time from origin i to destination j Origin i = 1,2,3,4 Destination j = 2,3,4,5,6,7,8,9,10	Supplier’s delivery time
CLTij	Cost of land transportation personnel Origin i = 2,3,4 Destination = 2,3,4,5,6,7,8,9,10	Human resource constraints E.g. truck drivers
CSTij	Cost of sea transportation personnel Origin i = 1 Destination j = 2,3,4	Shipping company expenses to run the ship
Pij	Ports of selection from origin i to destination j Only i= 1 j = 2,3,4	Different entry ports determined by demand of stores
CELij	Amount of carbon footprint of land transportation from origin i to destination j Origin i = 2,3,4 Destination j = 2,3,4,5,6, 7, 8, 9, 10	

Methodology

CESij	Amount of carbon footprint of sea transportation from origin i to destination j Origin i = 1 Destination j = 2,3,4	Supplier’s carbon emission
CLij	Cost charged by supplier for land transportation from origin i and destination j Origin i = 2,3,4 Destination j = 2,3,4,5,6,7,8,9,10	Supplier’s cost
CSij	Cost charged by supplier for sea transportation from origin i and destination j Origin i = 1 Destination j = 2,3,4	
Ui	Ui=1 if total number of EVs transported from warehouse i is less than 10% of warehouse capacity Ui=0 if it is not For i=2,3,4	Determines which warehouses have allocated less than required amount
Vi	Vi=1 if warehouse is selected Vi=0 if not For i=2,3,4	Determines which warehouse is selected

Methodology

Wi	Warehouse of selection from the destination port i Wi=1 if both Ui and Vi equals to 1 Wi=0 if not For i=2,3,4	Determines which warehouse incurs penalty cost
RCi	Rental cost of warehouse i i = 2,3,4	Cost of warehouse facilities
SWMi	Salaries of warehouse manager(s)	Salaries of top-level management
OCij	Operational cost of warehouse from origin i to destination j Origin i = 2,3,4 Destination j = 2,3,4	Operational cost of warehouse facilities relative to number of EVs E.g. labour in warehouse, machinery/equipment operating cost
PCi	Penalty cost at $99999 if there is an underutilization of warehouse	Penalty cost

Methodology

Objective function

Z (Transshipment cost) = Variable costs + Fixed costs + Penalty cost

$$Z = \sum_{i=1}^{8} [\sum_{j=2}^{14} \text{Xij} * (\text{Tij} + \text{CELij} + \text{CESij} + \text{CLij} + \text{CSij} + \text{DCij} + \text{OCij} + \text{CLTij} + \text{CSTij} + \text{Pij})] + \sum_{i=6}^{8} \text{Vi} * (\text{RCi} + \text{SWMi}) + \sum_{i=6}^{8} \text{Vi} * \text{PCi}$$

$$Z = 23x12 + 25x13 + 28x14 + 10x23 + 6x25 + 12x26 + 11x27 + 25x210 + 5x32 + 18x34 + 12\,x\,35 + 6x36 + 7\,x\,37 + 18x\,43 + 8\,x\,48 + 5\,x\,49 + 12\,x\,410 + 50{,}000\,P1 + 15{,}000\,P/W2 + 30{,}000\,P/W3 + 30{,}000\,P/W4 + 99{,}999\,P/W2 + 99{,}999\,P/W3 + 99{,}999\,P/W4$$

Methodology

Constraints

Constraint 1: Number of EVs to be supplied

For i= 1,2,3,4

Supply for P1: x12 +x13+x14+x15+x16+x17+x18+x19+x110 -12000<=0

Supply for P2: x22+x23+x25+x26+x27+x28+x29+x210-12000<=0

Supply for P3: x33+x34+x35+x36+x37+x38+x39+x310 -12000<=0

Supply for P4: x44+x45+x46+x47+x48+x49+x410-12000<=0

Constraint 2: Number of EVs demanded by stores

For destination j = 2,3,4,5,6,7,8,9,10

Demand for P2: x12+x22+ x23+ x24-12000=0

Demand for P3: x13+x23+x33+x34-12000=0

Demand for P4: x14+x24+x34+x44-12000=0

Demand for S5: x15+x25+x35+x45-1000=0

Demand for S6: x16+x26+x36+x46-2500=0

Demand for S7: x17+x27+x37+x47 -2500=0

Demand for S8: x18+x28+x38+x48 -2000=0

Demand for S9: x19+x29+x39+x49 -2000=0

Demand for S10: x110+x210+x310+x410 -2000=0

Methodology

Constraints cont.

Constraint 3: Load capacity of Sea Transport

A maximum of 4000 EVs is allowed for each ship.

X12- 4000 ≤ 0

X13-4000 ≤ 0

X14-4000 ≤ 0

Constraint 4: Carbon footprint limitation for land transportation

The maximum carbon footprint limitation is set at 50,000gCO for land transportation.

6*x23+6*x25+6*x26+6*x27+6*x34+6*x35+6*x36+6*x37+6*x43+6*x48+6*x49+6*x410–500000 ≤ 0

Constraint 5: Carbon footprint limitation for sea transportation

From our assumption, 1TEU emits 500gCO of carbon footprint. 2000 TEU will be delivered from Shanghai port and so the maximum carbon footprint limitation is set at 1,000,000gCO.

50*x12+ 50*x13+ 50*x14–1,000,000 ≤ 0

Methodology

Constraints cont.

Constraint 6: Maximum operation cost of warehouse

The maximum operation cost of the warehouse allocated is 150,000.

$Xij *OCij \leq 150,000$

W2: $10x23+6x25+12x26+11x27-150,0000 \leq 0$

W3: $10x32+18x34+12x35+6x36+7x37-150,0000 \leq 0$

W4: $18x43+8x48+5x49+12x410-150,0000 \leq 0$

Constraint 7: Maximum number of EVs transported between warehouses

A maximum number of 2000 EVs is allowed to be transported between warehouses

$xij \leq 2000$

$x23-20000 \leq 0$

$x32-20000 \leq 0$

$x34-20000 \leq 0$

$x43-20000 \leq 0$

Methodology

Constraints cont.

Constraint 8: Maximum amount of time allocated for loading and unloading EVs in port i

3 min per teu and total of 2000 TEU = 3*2000 = 6000 mins

Max of 6000 mins

The maximum amount of time allocated for loading and unloading EVs in port i is as shown:

For P2: x23+x25+x26+x27 - 6500 ≤ 0

For P3: x32+x34+x35+x36 +x37- 7000 ≤ 0

For P4: x43+x48+x49+x4 10- 6000 ≤ 0

Constraint 9: Minimum number of cars to be stored/kept at warehouse (e.g. 25% of cars shipped in as backup)

We have allocated 10% of the total EVs shipped from Shanghai port to be kept at the warehouse.

W2: x23+x25+x26+x27 - 1200 ≤ 0

W3: x32+x34+x35+x36+x37 - 1200 ≤ 0

W4: x43+x48+x49+x4 10 - 1200 ≤ 0

Methodology

Constraints cont.

Constraint 10: Penalty cost Wi – underutilisation of warehouse

Below 5% usage will incur penalty cost

$x_{ij} + 99999w_i \geq q_i$

Where wi is the warehouse selection and qi is the penalty level

For W2: $x_{23}+x_{25}+x_{26}+x_{27}+99999W_2-1200 \geq 0$

For W3: $x_{32}+x_{34}+x_{35}+x_{36}+x_{37}+99999W_3-1200 \geq 0$

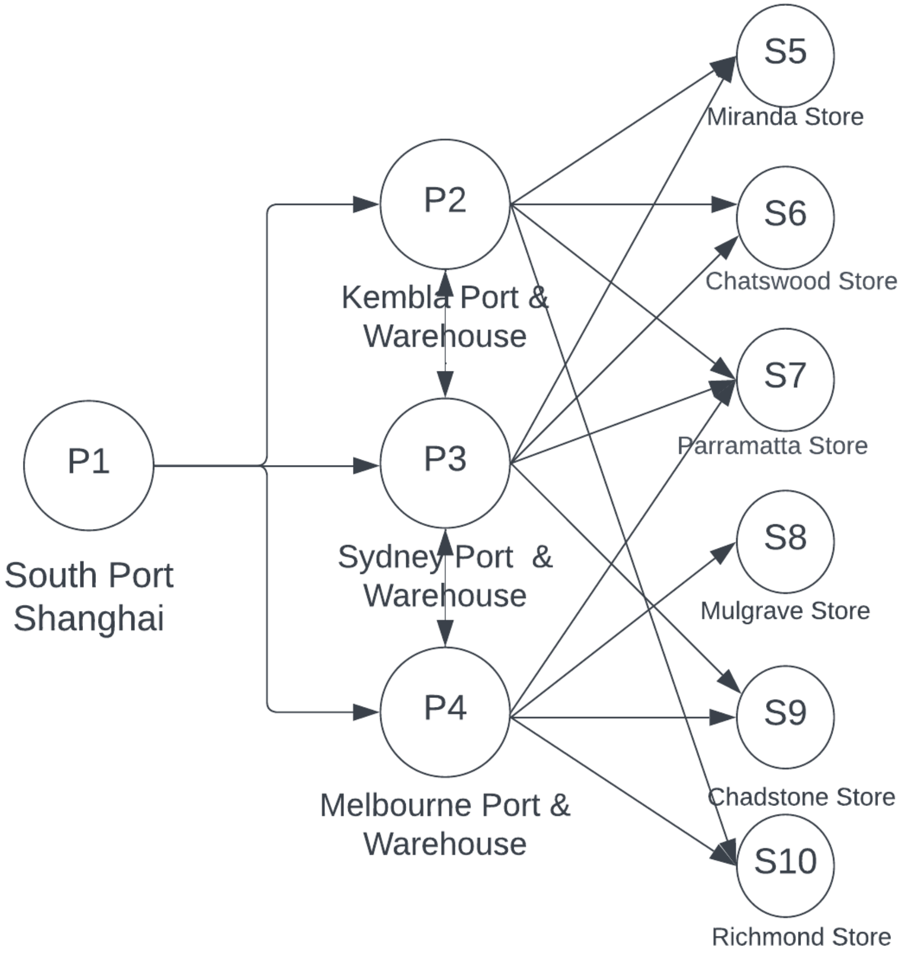
For W4: $x_{43}+x_{48}+x_{49}+x_{4\ 10}+99999W_4-1200 \geq 0$

Constraint 11: Non-negativity, binary and integer

For all $X_{ij} \geq 0$, Xij and integer apply

For Wi, Ui, Vi, binary applies

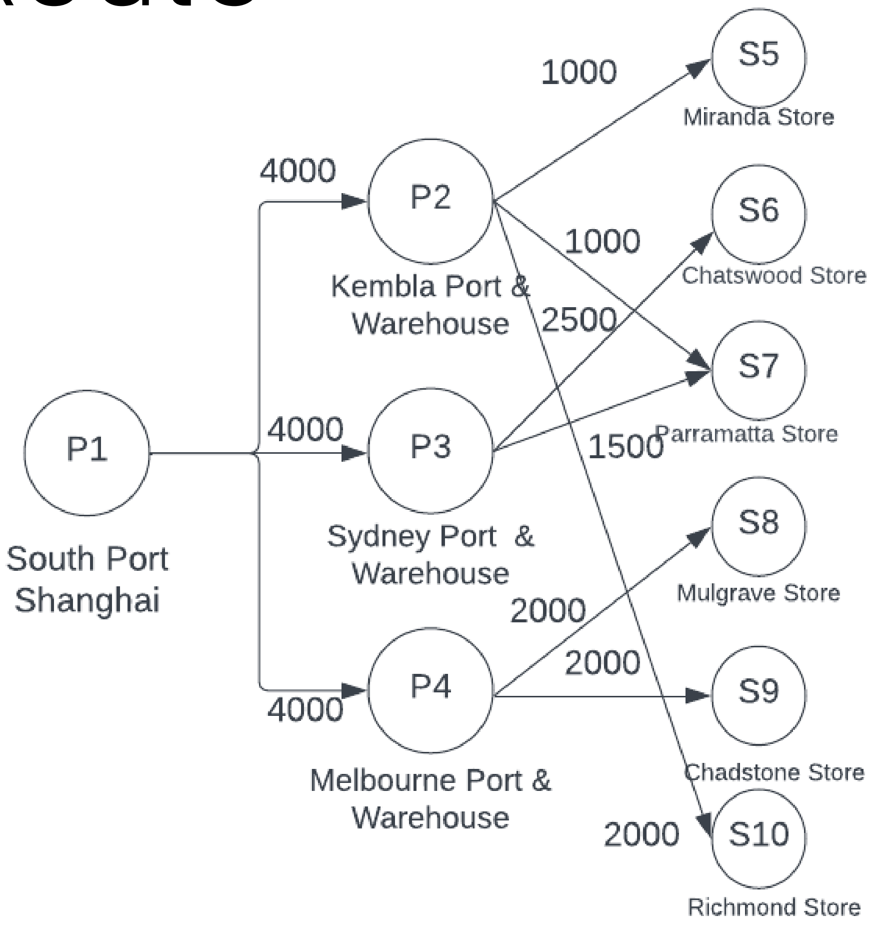
Route



P1
South Port Shanghai
P2
Kembla Port & Warehouse
P3
Sydney Port & Warehouse
P4
Melbourne Port & Warehouse
S5
Miranda Store
S6
Chatswood Store
S7
Parramatta Store
S8
Mulgrave Store
S9
Chadstone Store
S10
Richmond Store

Excel Pop-up

Optimal Route



Strengths

Ethical corporate
- Carbon emission costs considered
- Corporate social governance (CSR)
- Gaining competitive advantage & becoming EV industry leader

Up-to-date data
- Considering impact of COVID-19
- Model allows minimising shipment costs
- Considering modes of transshipment & multiple costs

Effective warehouse maintenance
- Constraints such as minimum storage requirement & underutilization penalties
- Reduce risk of understock
- Reduces time-to-customer
- Reduce possibility of a change of mind in purchase due to long waiting time
- Avoid warehouse penalties

Limitations

Natural disasters disruptions

- Delays in transportation process
- EVs not delivered in time, leading to dissatisfaction of customers
- Ultimately losing consumers and sales

Commodity War between China and Australia

- Sea transshipment disruption as an additional cost

Recommendations

Considering special circumstances on overall transshipment process

- Delays in transportation process
- EVs not delivered in time, leading to dissatisfaction of customers
- Ultimately losing consumers and sales

Commodity War between China and Australia

- Sea transshipment disruption as an additional cost

Conclusion

- Integer linear programming model: Used to minimize export costs of Tesla vehicles from China to Australia.
- Despite challenges such as complexity and sensitivity to disruptions, the model provides valuable insights for decision-making in supply chain management.
- It serves as a powerful tool for companies in the automotive industry and other sectors with complex distribution networks, enabling informed choices for routing and allocation.