Simio 2022 May Student Competition

Platform Supply Vessel Logistics

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Overview

Simio Supply Logistics (SSL) is an organization that charters offshore vessels to and from various offshore drilling locations. SSL can choose from a variety of watercraft to rent monthly. The collection of platform supply vessels (PSVs) is selected and dispatched out of ports. These vessels service four deep-water rigs. The system is presently under scrutiny due to high costs, unmet demand, and excessive standby time. Management at SSL would like your team to improve vessel scheduling and determine a better way to meet the drilling company's demands while minimizing incurred costs.

SSL is requesting an analysis of the current vessel operations. Using the historical data collected by the data management team, model the current system's performance and fulfillment of cargo demand. The team will need to consider the specifications of different vessel types and capacity limitation for cargo as they plan which vessel is loaded and dispatched. Additionally, the North Sea, in which the rigs are located, can prove to be complex for sea-faring ships trying to pass through its waters. Factors such as wave height and general weather conditions greatly impact each vessel's ability to transport its cargo from port to rig, and once at the rig, unload its contents. Modeling the current system will provide a baseline for evaluating improvement strategies for the future.

Management requests that your team develops and evaluates alternative business and procedure strategies. New strategies should decrease the overall operating cost while improving productivity and uptime. Your team will deliver a video presentation to SSL management with your findings and proposal for a future system.

Location Description

Simio Supply Logistics (SSL) dispatches a collection of vessels out of two ports in countries that have coastal waters in the North Sea. The latitude and longitude of each port are provided in Table 1.

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Table 1: Port Locations

Port	Latitude	Longitude
HamburgPort	53.55562000000004	9.9874500000000221
RotterdamPort	51.895662488954009	4.3525686715774814

SSL services four rigs that are located in the North Sea. The latitude and longitude of each rig are provided in Table 2.

Table 2: Rig Coordinates

Rig	Latitude	Longitude
AlphaRig	54.450670964174314	2.372745502131739
BetaRig	57.0217880586188	-0.6731362970155863
CharlieRig	57.841553532247708	0.84980460255806645
DeltaRig	59.426617646130111	-5.2419589957365638

Due to restrictions in the North Sea, all seafaring vessels must travel along specific routes when travelling among rigs and/or ports. The latitude and longitude of each waypoint are provided in Table 3. The sequences vessels must travel among rigs and/or ports are provided in Table 4.

Table 3: Waypoint Coordinates

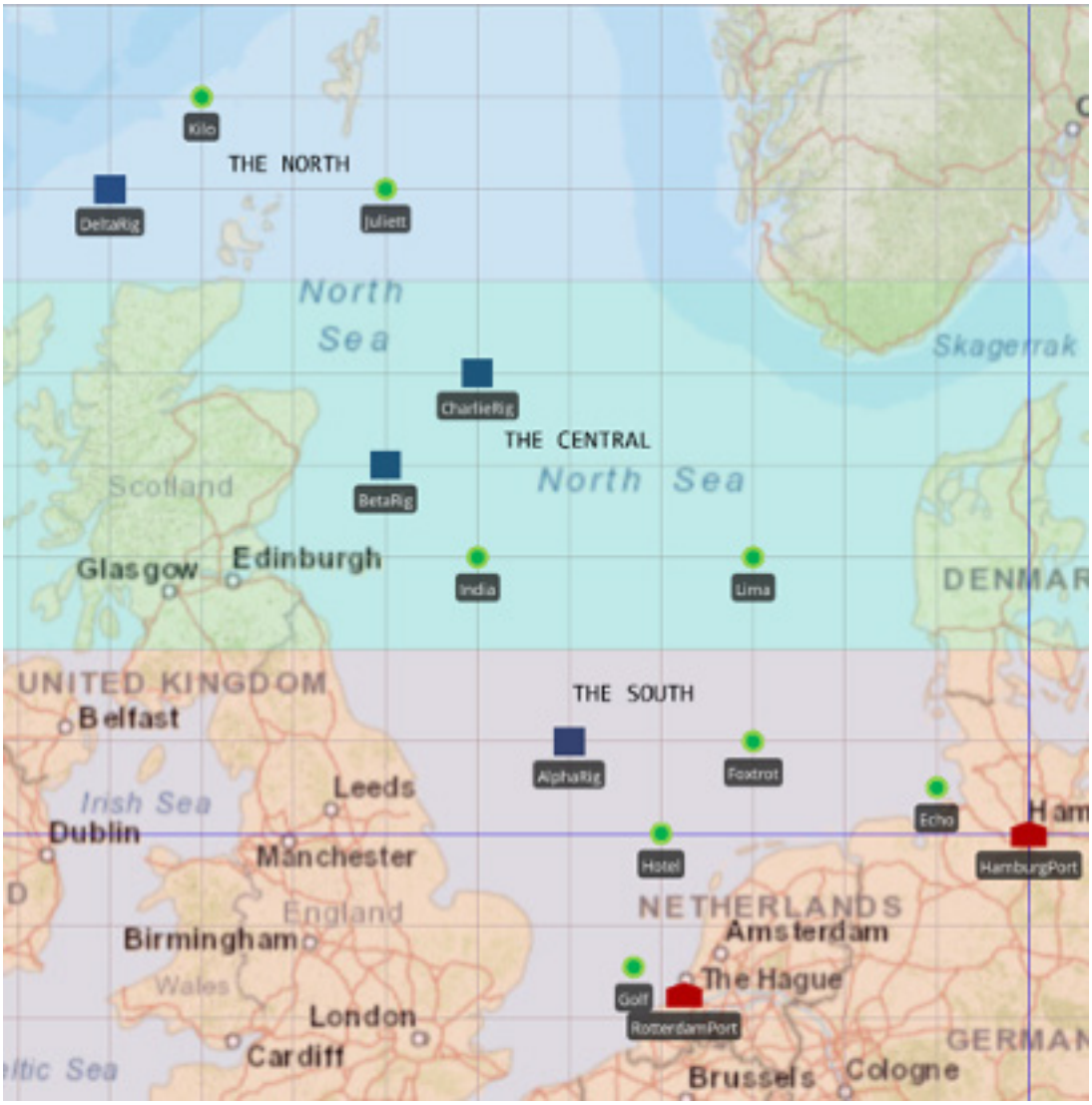
Waypoints	Latitude	Longitude
Echo	54.0055514819669	8.46450910042635
Foxtrot	54.450670964174314	5.4186273012790434
Golf	52.176718627930491	3.5149511768119535
Hotel	53.55562000000004	3.8956864017053716
India	56.183539411725448	0.84980460255806645
Juliett	59.426617646130111	-0.6731362970155863
Kilo	60.192429120879204	-3.7190180961629111
Lima	56.183539411725448	5.4186273012790434

Table 4: Travel Sequence Among Assets

Starting Location	Ending Location	Sequence
HamburgPort	RotterdamPort	Echo – Foxtrot – Hotel - Golf
HamburgPort	AlphaRig	Echo - Foxtrot
HamburgPort	BetaRig	Echo – Foxtrot - India
HamburgPort	CharlieRig	Echo - Lima
HamburgPort	DeltaRig	Echo – Lima – Juliett - Kilo
RotterdamPort	HamburgPort	Golf – Hotel – Foxtrot - Echo
RotterdamPort	AlphaRig	Golf - Hotel
RotterdamPort	BetaRig	Golf – Hotel - India
RotterdamPort	CharlieRig	Golf – Hotel
RotterdamPort	DeltaRig	Golf – Hotel – Juliett - Kilo
AlphaRig	HamburgPort	Foxtrot - Echo
AlphaRig	RotterdamPort	Hotel - Golf
AlphaRig	BetaRig	India
AlphaRig	CharlieRig	Direct Route
AlphaRig	DeltaRig	Juliett - Kilo
BetaRig	HamburgPort	India – Foxtrot - Echo
BetaRig	RotterdamPort	India – Hotel - Golf
BetaRig	AlphaRig	India
BetaRig	CharlieRig	Direct Route
BetaRig	DeltaRig	Juliett - Kilo
CharlieRig	HamburgPort	Lima - Echo
CharlieRig	RotterdamPort	Hotel - Golf
CharlieRig	AlphaRig	Direct Route
CharlieRig	BetaRig	Direct Route
CharlieRig	DeltaRig	Juliett - Kilo
DeltaRig	HamburgPort	Kilo – Juliett – Lima - Echo
DeltaRig	RotterdamPort	Kilo – Juliett – Hotel - Golf
DeltaRig	AlphaRig	Kilo - Juliett
DeltaRig	BetaRig	Kilo - Juliett
DeltaRig	CharlieRig	Kilo - Juliett

Figure 1 shows an approximation of where all ports, rigs, and waypoints are located.

Figure 1: Map of SSL Assets and Weather Regions



Weather

Weather is a major factor in vessel travel in the North Sea. Vessels can travel the waters in three different ways depending on the weather. If the weather is optimal, vessels will traverse the North Sea at their maximum travel rate. If the weather is moderate or severe, vessels may have to slow down or stop completely to ensure cargo is not lost and that the vessel does not incur damage.

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Simio Supply Logistics separates the North Sea into three major weather pattern regions: The North, The Central, and The South. Weather is consistent across the entire region, as shown in Figure 1. Table 5 defines these regions and where the locations reside.

Table 5: North Sea Weather Regions

Region	Location	Latitude
The North	DeltaRig, Juliett, Kilo	North of 58.643079247126963
The Central	BetaRig, CharlieRig, India, Lima	North of 55.326574342881408 and South of 58.643079247126963
The South	HamburgPort, RotterdamPort, AlphaRig, Echo, Foxtrot, Golf, Hotel	South of 55.326574342881408

Weather is defined by the current wave height and current wind speed and are evaluated every hour and those conditions are considered the current conditions for the next hour. Table 6 defines the weather in each major region.

Table 6: Weather Regions in North Sea

Region	Wave Height (meters)	Windspeed (meters/second)
The North	Random.Exponential(3.5)	Random.Exponential(7.4)
The Central	Random.Exponential(2.5)	Random.Exponential(6.8)
The South	Random.Exponential(0.7)	Random.Exponential(6.1)

Vessels are rated differently for the weather. Each has a unique wind or wave resistance level. This is provided in Table 7.

Table 7: Vessel Weather Specifications

Vessel Type	Wave Height Resistance	Wind Resistance
150	2	8
175	1.2	5
9000	0.8	4.6

The weather will impact the rate at which a vessel will traverse the North Sea. The speed of a vessel can be estimated by Equation 1. The speed of a vessel will never be negative: if Equation 1 results in a negative value, it can be assumed the vessel has stopped moving.

Equation 1: Estimated Vessel Speed After Weather Impact

$$\text{Current Vessel Speed} = \text{Vessel Maximum Speed} - \frac{(\text{Current Wind Speed} + \text{Current Wave Height})}{(\text{Wind Speed Resistance} + \text{Wave Height Resistance})}$$

Vessel Loading and Information

Presently, two ports are being used to service all the material requests: HamburgPort and RotterdamPort. Each port has 50 slips available. When a slip is being used (rented) by SSL, the fixed cost is $350,000 per month. Slips are rented to a lessee by month: if a slip is used by SSL for any part of the month, the entire fixed cost is incurred. When cargo is requested by a rig, the cargo is loaded on to vessel at the appropriate slip. If a vessel is not loading, transporting, or unloading cargo, it is held at a slip. Travel capacity of the waterways is not a limit of the system.

While at the slip, cargo is loaded onto the vessel and other activities occur, like fueling. Cargo loading and fueling a vessel can occur in series or simultaneously. When loading and fueling occur simultaneously, the cost for the use of the vessel has a one-time increase (per trip) of 10% the daily rate. This increase in price accounts for the additional personnel required, in addition to financially mitigating the more-risk behavior of simultaneous activities. The time to fuel a vessel is shown in Table 8.

There are distinct types of vessels available to SSL. Each vessel type has a different amount of cargo space, as shown in Table 8, in addition to other pertinent information. Vessels, like slips, are leased monthly: the daily cost of the vessel is incurred every day of the month if the vessel is used for at least one day in the month. Vessel usage cost is only incurred, by day, if a vessel is utilized for loading, transport, and unloading.

Table 8: Vessel Information

Vessel Type	Maximum Speed (knots)	Cargo Space (m^3)	Daily Cost (in thousands)	Usage Cost (in thousands)	Fuel Time (in hours)
150	10	23,000	33	5	4
175	13	17,000	35	7	2.5
9000	17	14,000	41	11	2

Each material has a vessel loading/unloading rate, shown in Table 9.

Table 9: Material Loading/Unloading Rates

Material	Rate
DeckCargo (units)	10 minutes per unit
DryBulk (m^3)	2,500 m^3 per hour
Fuel (m^3)	2,000 m^3 per hour
LiquidBulk (m^3)	3,000 m^3 per hour
Pipe (bundle)	15 minutes per bundle
Casing (bundle)	13 minutes per bundle

Material Requirements at Rigs

A deep-water well in the North Sea can take months to drill. A well consists of multiple concentric strings of casing (pipe) beginning with the outermost string. A drilling unit or "rig" drills through the bottom of each successive casing to a new depth, then cements a new inner string into the last section of hole drilled. These steps are planned, although variations in the time to complete each step are quite common. The casing, cement, drilling fluids, supporting equipment, et cetera are assembled in advance and staged at the servicing docks (slips) for transport to the rigs by vessel. Rig materials are generalized into groups: DeckCargo (in units), DryBulk (m^3), Fuel (m^3), LiquidBulk (m^3), Pipe (in bundles), and Casing (in bundles).

Each request a rig makes has a due date of five days from the request, i.e., the material needs to arrive at the rig no later than five days from the request. Should the request arrive after five days, there is a penalty of $10,000 per hour.

In the attached file (an excerpt shown in Table 10 below), the data for material request and fulfillment is provided. Presently, there is an operational policy that vessels do not leave the slip if they are less than 90% of their capacity. Material availability at the slips is not a concern of this project. Material cannot be unloaded from a vessel to a rig if it has not been requested.

Table 10: Sample Rig Material Requests

Requested Date Time	Rig	Material	Qty Requested	Received Date Time	Qty Received	Vessel	Origin Port
1/1/2021 8:00	AlphaRig	DeckCargo	5	1/6/2021 5:14	5	150A	RotterdamPort
1/1/2021 8:00	BetaRig	DeckCargo	7	1/4/2021 8:49	7	150B	RotterdamPort
1/1/2021 8:00	BetaRig	LiquidBulk	2000	1/4/2021 8:49	7	150B	RotterdamPort
...							
12/31/2021 8:00	DeltaRig	DryBulk	2600				

Analysis and Problem Deliverables

In accordance with the project charter, you should model the current state of the system so it can be investigated. At a high level, this mission includes data analysis, model construction, verification and validation, and evaluation. Once the model satisfactorily represents the current system, you should report on its performance. For example, how much is the current state costing SSL and how does that compare to a high-performing state; what costs are associated with normal business and what costs are associated with poor system performance; what is the system performance and/or productivity? Is the scrutiny of the system founded because there truly are high costs, unmet demand, and excessive standby time? Until this project, SSL has not made it a priority to analyze the system. You should provide a compelling and quantitative narrative regarding the current state to get stakeholders to agree about the status of the system and business operations, while providing evidence that your findings are reputable.

Once you document and describe the current state, you should consider what can be done to improve the system, if possible. You might examine the many different characteristics of the system and any sensible interactions among them. For example, what changes can be made to the way vessels, rigs, and ports interact: Should there be a business policy about what vessels service what rigs from what ports? The project stakeholders are open to any reasonable suggestion, so long as it improves the system by a rewarding savings in cost and/or increase in revenue. Should you suggest improvements that require assumptions, make sure to share them. Providing options for stakeholders to assess is important for the success of the project. Any suggested improvement should be presented as a compelling case, quantitatively justifying the suggestion. Furthermore, you might briefly discuss any improvements you explored but found them to be unreasonable or otherwise undesirable. You will present your findings in a video presentation and executive report. You can assume that those who will be viewing these materials are familiar enough with the project that they understand the mission (i.e., any details explicitly provided in the problem statement).

Challenge Problems

Challenge Problem 1

SSL has been investigating renting an additional port in Belfast for $350,000 per slip a month to more quickly service the North and Central rigs (see Table 11, below). Vessels that leave BelfastPort will always travel through the Mike node and then DeltaRig prior to servicing any other rigs following the same routes in Table 4, above. Vessels returning to BelfastPort will always travel through DeltaRig and then the Mike node before returning to port. BelfastPort is in the South and the Mike node is in the Central regions.

Table 11: Possible New Ports

Location	Latitude	Longitude
BelfastPort	54.636192163866447	-5.8815941735575139
Mike	56.183539411725448	-8.28784079488389

Challenge Problem 2

The vessel renting company has offered SSL an alternative pricing option, based on miles traveled by the vessel, instead of the costing information in Table 2 above. To help SSL decide about whether to stay with the current pricing plan or to switch to the new pricing plan, SSL would like to collect nautical mileage information about each vessel they use. The new mileage pricing model comprises a flat monthly cost, with an included monthly allotment of nautical miles, and an overage cost per mile, as shown in Table 12, below. While SSL has the freedom to maintain the legacy pricing or accept the new mileage pricing structure, whichever option is selected will be a commitment for the foreseeable future, for all vessels and vessel types. Should SSL keep the legacy pricing structure or accept the new mileage paradigm? (Hint: You might use Simio's Periodic Statistics to aid your investigation.)

Table 12: Vessel Nautical Mileage Costing Option

Vessel Type	Monthly Cost (in thousands)	Nautical Mile Allowance (in thousands)	Overage Cost per Nautical Mile (in thousands)
150	1049	2.61	50.2
175	1159	2.61	60.5
9000	1435	2.61	81.1

Data File

Included is a csv file named DemandAndFulfillmentLog.csv. The link to the file containing the data can be found below.

https://cdn.simio.com/StudentCompetition/2022_May_Data.zip

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