2020 LEAN & SIX SIGMA WORLD CONFERENCE

Six Sigma for Operating Profit Maximization in Ship Assist at the West Coast of USA

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Ship Assist and Escort (SAE) : Background

What is Assist and Escort?:

1. The use of escorting Tugs to assist and ensure a vessel's safe passage from a port to open sea or vice versa.

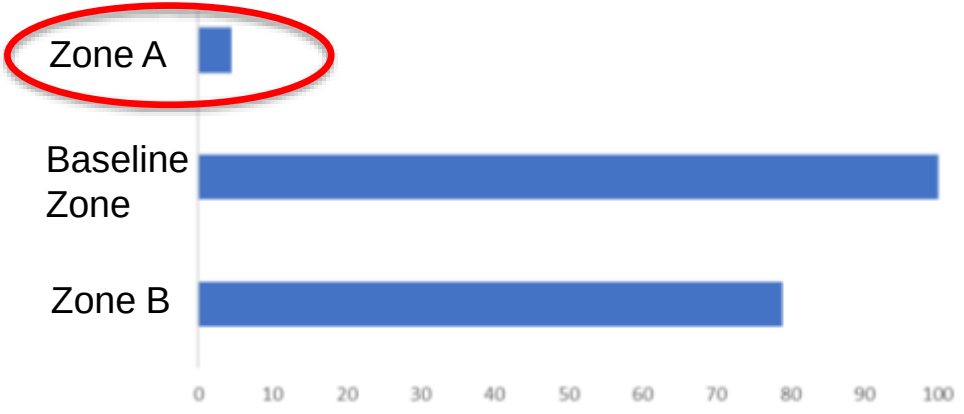
2. To reduce the risk of pollution in port areas and port approaches due to groundings or collisions caused by technical or human failures on board a vessel.

The escorting tugs should be able to control the ship over a relatively large speed range, let us say from 10 knots down to zero.

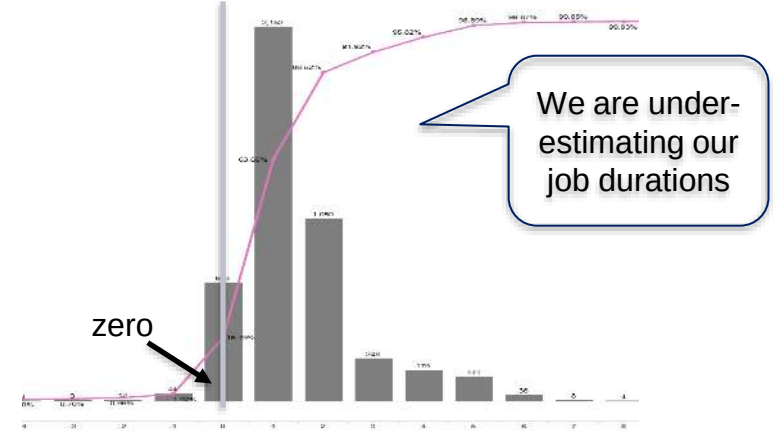
SAE Business Questions: Can we increase Operating Income? How?

After scoping, walking the process, and analyzing data with the SAE team, the following recommendations (among others) were made:

- Deep dive analysis into Zone A operations. Zone A has the lowest operating income, and roughly same volume, when comparing to the operating income of the Baseline Zone.
- There was a recurring discrepancy between expected job duration and actual job duration in our scheduling and dispatching system. This measurement issue was corrected.



(Op Inc of Zone/Op Inc of Baseline Zone)*100



Actual Job Duration – Expected Job Duration

Deep dive into Zone A: What is the operational question (OQ1) to answer?

Hourly Demand Pattern: Tug Jobs per hour

Percent of “Sub-Out” Tug Jobs per Hour

Sub-In: A competitor has a contracted client in need of escort/assist service. The competitor does not have the capacity to service the client and reaches out to the SAE company. Our company usually charges more than the contract rate negotiated by the competitor.

Sub-Out: Our SAE company does not have capacity to satisfy the contract and reaches out to a competitor. The competitor usually charges more than the contractual rate the SAE company has established with the client.

OQ1: *What is the portfolio of customers to have such that we can Maximize Sub-Ins and Minimize Sub-outs?*

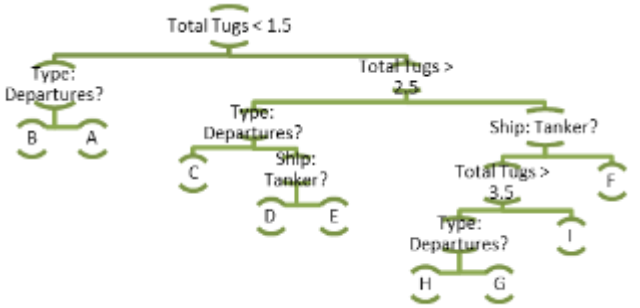
OQ2: Do we have the data to create a model and answer OQ1?

Since the SAE team does not have access to the time duration of competitor's jobs, these were estimated using their own data.

First: All jobs were categorized (grouped) using a classification regression tree.

Regression trees enable the grouping of similar jobs together based on the various characteristics these jobs share.

Second: For each of the nine job groups established in the regression tree model, we created stochastic distributions for the estimated duration of each job in hours.



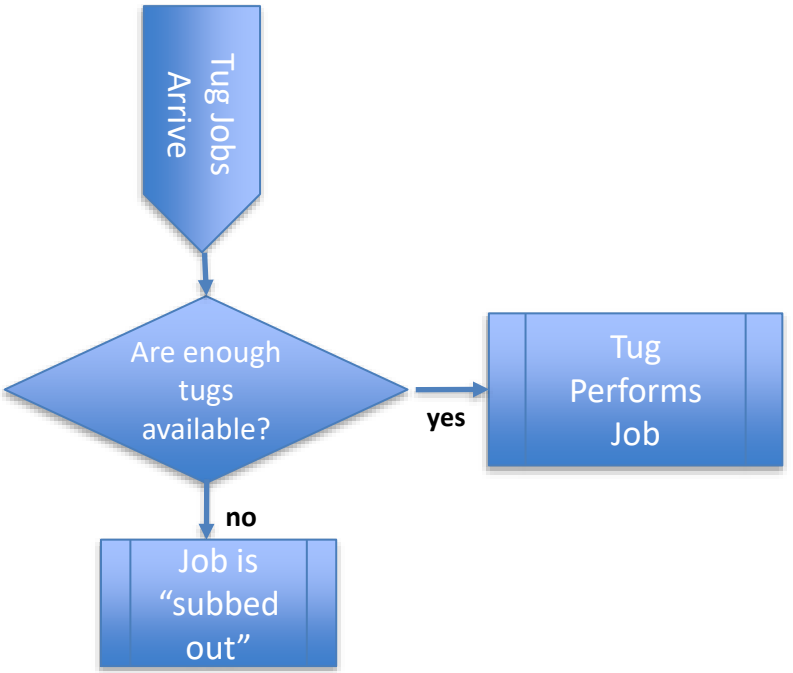
Category	Description	Job Length of Time Distribution
Type A	1 Tug Departures	Lognormal
Type B	1 Tug Arrivals or Shifts	Lognormal
Type C	2 Tug Departures	Weibull
Type D	2 Tug Container/Other Arrivals/Shifts	1 + Erlang
Type E	2 Tug Tanker Arrivals/Shifts	Normal
Type F	3 or 4 Tug Container/Other	2 + Weibull
Type G	3 Tug Tanker Departures	Normal
Type H	3 Tug Tanker Arrivals/Shifts	3 + 8*Beta
Type I	4 Tug Tanker	Triangular

Modeling “what-if” scenarios with the data generated

Because this is a complex real system of interactions where one tug company’s actions affect all competitors, a computer-based discrete event simulator was used to estimate and test different scenarios.

Example of “what-if” scenarios:

- **What is the effect of losing the contract from Client 1?**
- **What if Competitor 2 acquires the contract from Client 2, and what is our breakeven rate in case we sub-in this customer later?**
- **How does a change in the contract from Client 3 affect the sub-out, and sub-in of Competitor 2, as well as our operating income?**



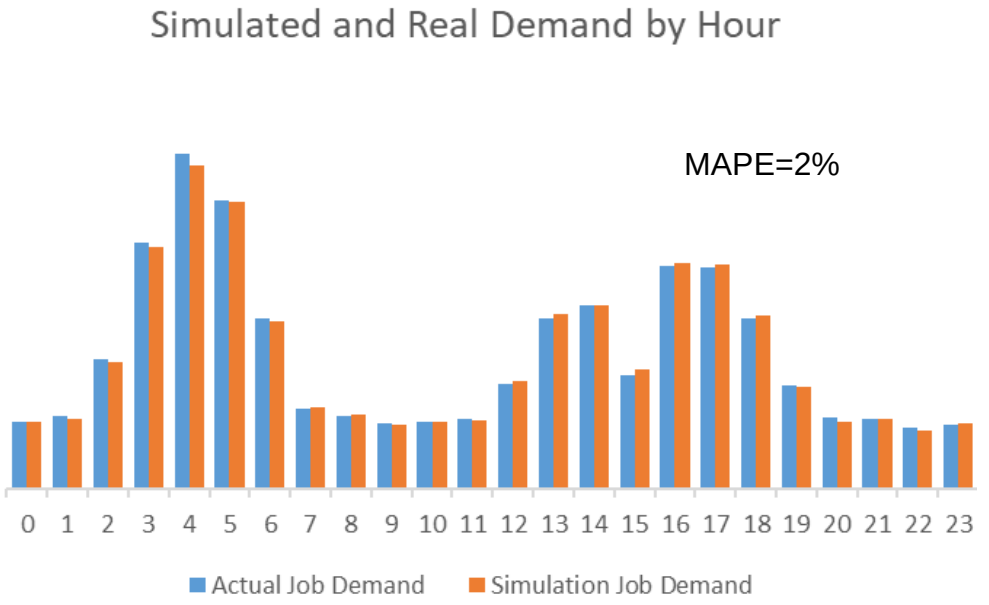
Model Validation

Prior to making any conclusions the model must be validated against actual test data.

As illustration, the charts show actual arrival jobs for Year X, by hour of day.

The simulated arrivals closely resemble the patterns and quantities of actual Year X tug-jobs.

Similar validations were done for demands over day of the week and seasonality within a year.



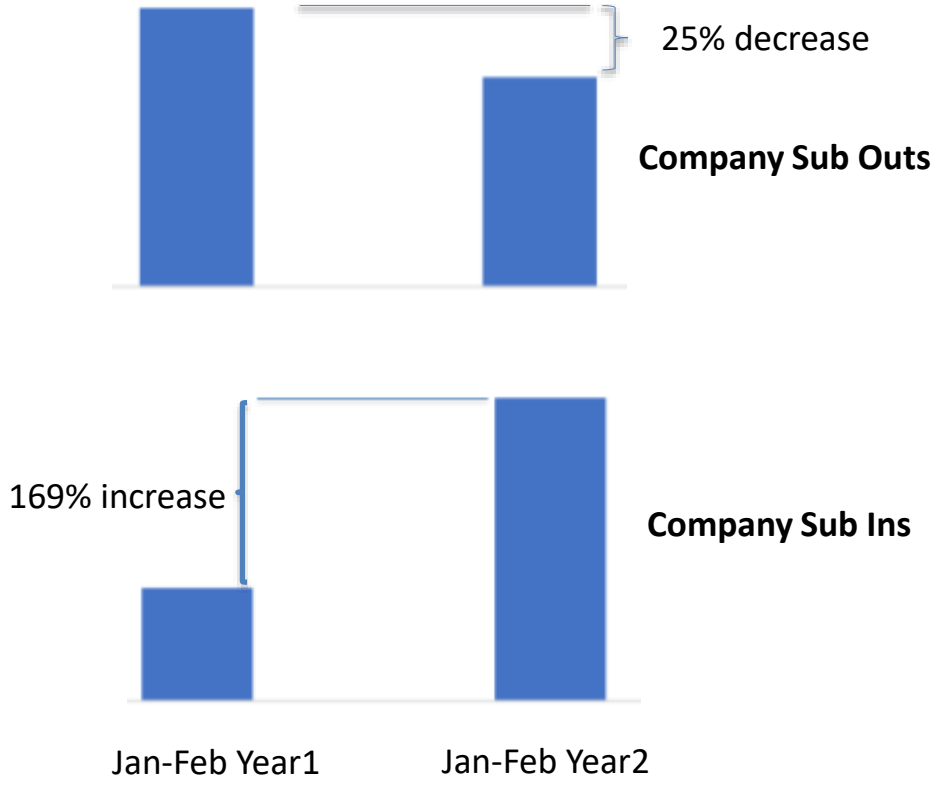
The model also predicted the sub-ins from our company and competitors with MAPE's ranging from 1/2 to 2 percent

The simulation closely resembled our company and competition sub-out data as well: MAPES ranging from 2 to 3 percent.

OQ3: Can we apply the recommendations provided by our models?

Operational results were visible during the first two months of Year 2 (we used Year 1 as baseline). The charts show a positive flip in sub-ins and sub-outs for Zone A.

Financially, SAE achieved a positive shift of 11 percent points in operating margin for Zone A from Year 1 to Year 3.



Conclusions: Remembering Woolsey & separating hype from problem solving

1. A manager would rather live with a problem (s)he cannot solve than accept a solution (s)he cannot understand.
2. A manager does not want, and will not pay for, an optimal solution. (S)he wants to be better-off now, as quickly and as cheaply as possible.
3. Finding the supposedly “optimal” solution is often not nearly as important as putting the solution values into a form that the client is accustomed of seeing.

“Always focus on problem solving…Solving problems requires creativity and acute ability to listen and observe”

- Gene Woolsey

No Hype=Answer Operating Q1, Q2, and Q3. Then, answer Business Q.