Lead Time Reduction of Laboratory Testing Services

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Summary: Services that await arrival of customer inputs prior to commencing suffer from long lead times. Our research determined if performing process steps in a group of services concurrently with the transportation lead time can reduce overall lead times. This research clustered services per their co-occurrence frequency then developed a model to perform as many steps in those services as possible prior to samples arriving at the testing laboratory. The results showed the model is effective only when groups of services ordered on single inputs can be performed concurrently with the transportation lead time. When the tests under consideration for lead time reduction through the proposed model contained a large proportion of independent process time, there was a much greater potential for lead time reduction to be effective. Additionally, customer communication can give service providers a better opportunity to collaboratively reduce lead time.

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KEY INSIGHTS

1. **Concurrent process step strategies in a service supply chain require a minimum threshold of independent process time to be effective in reducing total cycle time**
2. **Customer collaboration is most effective in reducing total cycle time in scenarios that meet the minimum threshold of independent process time and where the customer fulfils its duty to provide advanced order information**
3. **In instances where both independent and dependent process times are low, the realization of benefits to a process step concurrent strategy will only be seen in large volumes of demand**

Introduction

Chemical companies that supply the aerospace industry require testing of their products prior to sale. Currently, the laboratory testing facilities used by these companies fail to consistently provide desired levels of quality, accurate results that conform to requirements on safety standards, method validation, and calibration verification. At the same time, independent laboratory testing facilities must divert valuable resources to “test method qualification” tasks on tests that may or may not actually experience demand before the qualifications expire. The lack of information regarding downstream drivers of demand cause testing facilities to set up, qualify, and run tests in an inefficient manner.

To manage demand uncertainty, testing facilities can postpone setup and qualification tasks until test samples arrives. A major consideration with this option however, is the increase in lead time it causes. Although some customers may allow for longer lead times, many others do not have such flexibility. Alternatively, customers would likely benefit from shorter lead times attained by the laboratory performing more setup tasks before the sample physically arrives.

The objective of our research was to reduce laboratory lead times through a concurrent process step strategy. In this strategy, process steps that can be performed in absence of customer inputs were done so concurrent with the transportation lead time of those customer inputs.

The Challenge, The Process, & The Question

The complexity of this scenario is derived from customers' inability to consistently provide detailed purchase orders ahead of shipping samples to be tested. This lack of detailed information (i.e. customer input) creates unnecessary delays in the commencement of laboratory testing activities which ultimately has downstream impacts in the sale of products.

Our research on this problem examines how testing services can be configured to more efficiently meet demand when customers share more information about their supply chains. It accomplishes this by first determining how partnering with customers to increase the service provider's visibility into the customer's supply chain can reduce demand uncertainty. Then it shows how the total cycle time of the supply chain's services can be adjusted to handle demand.

We partnered with a research laboratory and analytical testing company that provides testing services on fuels, lubricants, and greases. It's customer base consists of chemical and manufacturing companies in the aerospace industry. The firm operates an agile service supply chain offering hundreds of made-to-order as well as standardized test methods along with engineered-to-order laboratory research. The firm's customers supply it with physical samples, request specific test methods be run on the samples, and receive the results of testing services.

In a chemical testing supply chain, the interactions between customer and service provider that result in the production of a test result can be generalized into an eight-step process.

The customer is responsible for completing two of the steps:

- Customer Sends Purchase Order (PO)
- Customer Sends Sample

The laboratory service provider is responsible for performing the other six steps:

- Sample Arrival and Log-In
- Calibration Steps
- Preparation Steps
- Sample Testing Steps
- Equipment Clean Up
- Reporting Results

Performing the steps sequentially results in a longer total process duration thereby extending cycle time. When the customer and service provider steps are performed concurrently, the total duration is shorter, thereby reducing cycle time.

The question we sought to answer was:

Can service lead times be reduced by following a concurrent strategy where the service provider starts with the process at the same time that the customer sends the purchase order and the sample?

Our goal was to propose a new methodology to help service supply chains (laboratory testing services in the chemical industry) reduce their service lead time.

Methodology

Our methodology followed a four-step process:

1. Data Collection and Pre-Analysis
    - During Data Collection and Pre-Analysis, the data sources were identified and then used to further determine Key Performance Indicators (KPIs).
2. Cluster Analysis
    - Cluster Analysis was used to create subsets of the services, which reflected the one-to-many relationship between customer inputs (samples) and commonly associated services (co-ordered test methods).

3. Project Evaluation and Review Techniques
    - Project Evaluation and Review Techniques (PERT) were used to model the lead times of services, considering the uncertainty of activity durations. Additionally, the individual steps of each service were listed in procedural outlines and used to survey an expert about service activity durations. Using

PERT analysis, each sample from historical data was evaluated as an individual project where test methods comprised the individual activities within the project.

4. Monte Carlo Simulation
    - Monte Carlo Simulations were used to analyze the effects of the concurrent process step strategy on the lead times of historical sample data.

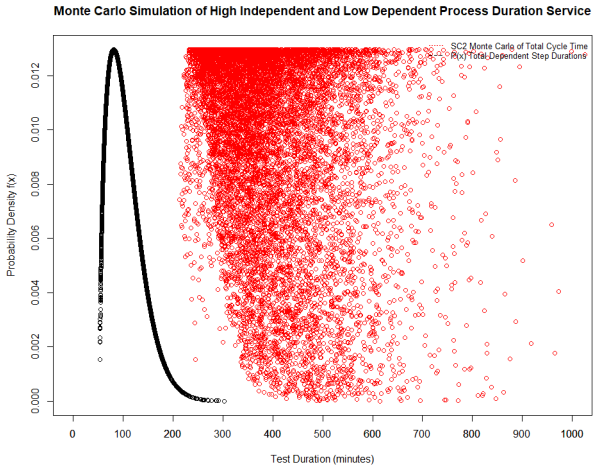

Figure above demonstrates potential reduction in lead time (black curve on the left) compared to actual (red data points) in tests containing high proportion of independent process steps

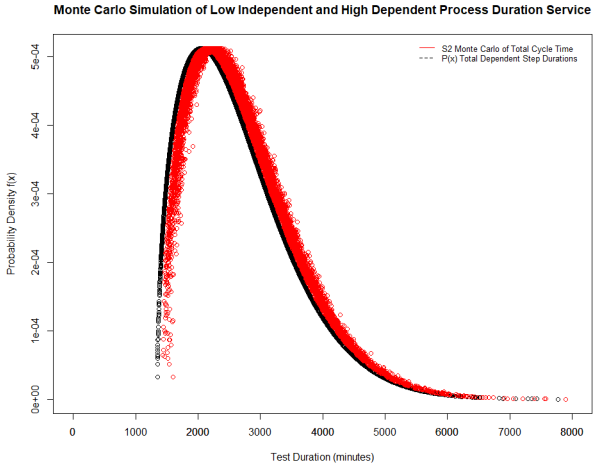

Figure above demonstrates no significant reduction in lead time (black curve) compared to actual (red data points) in tests containing low proportion of independent process steps

Conclusions and Findings

In the process step concurrent strategy, independent process steps were performed concurrently with the transportation lead time of customer inputs (samples). Monte Carlo simulations compared two sets of paired scenarios, one that represented the process step concurrent strategy when calibrations were not considered, and another set that represented when calibrations were considered. All scenarios used the Weibull Distribution, built from expert activity duration estimations of services in their Monte Carlo Simulations. Individual tests had different proportions of independent process times, some with none and others with a majority.

Concurrent Process Step Scenarios		
Scenario	Processes Steps Performed After Sample Arrival	Process Steps Performed During Sample Transit Time
Scenario 1	Dependent Process Steps	Independent Process Steps
Scenario 2	Independent and Dependent Process Steps	None
Scenario 3	Dependent Process Steps	Independent Process Steps and Calibration Steps
Scenario 4	Independent, Dependent, and Calibration Process Steps	None

Our first major finding was when the tests under consideration for lead time reduction through the proposed model contained a large proportion of independent process time, there was a much greater potential for lead time reduction to be effective. Examining a large cluster of tests showed that the lead time reduction on some tests would not create lead time reduction that could be distinguished from the variability in the cluster. When calibrations were considered, the effect of lead time reduction was greater, since calibrations represented an additional independent process. Focusing on an individual customer provided a greater potential for lead time reduction. This was our second finding.

Collaborating with specific customers that meet the criteria of our first finding will yield the most effective results in reducing total cycle time. However, every customer had a different subset of associated services that determine whether lead time reduction will work. Our third finding was that customers must be responsive enough to engage in the behavior. If the company promises lead times will be reduced but the customer does not provide enough information to facilitate lead time reduction, then it will harm both the customer and service provider's abilities to reduce total cycle time.

Lastly, if independent process time and dependent process time are low, then benefits will only be noticed if there is a large volume of demand. While the reduction of lead time on an individual service may be a short duration, it could sum to a long duration with enough demand volume.