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GROUNDWORK FOR SIMULATION-BASED PROCESS IMPROVEMENT

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ABSTRACT

An organization interested in applying simulation for process improvement has to go through a learning process. The organization has to understand the effort involved in applying simulation and the value it will provide before investing in a simulation-based process improvement project. The learning may need to go through a few iterations before a decision to formally proceed with such a project can be taken. This case study describes the groundwork required before embarking on a simulation-based process improvement project. A recent process assessment project, that did not utilize simulation, is revisited to extract data for simulation and a basic model is developed for exploring the potential. The exercise was also intended to help define additional data that will need to be captured in the next process assessment project for the next iteration. The challenges in such post hoc extraction are discussed together with the limitations of the resulting first model.

1 INTRODUCTION

Multilateral development institutions work on a range of process improvement problems surrounding trade facilitation and logistics focusing on enhancing the efficiency of trade and transport systems related to international trade. They conduct in-depth studies of ports, airports, border crossing points, and container freight stations, which often encounter challenges with processing, handling, and coordination, leading to elevated costs and inefficiencies. Through analyzing and improving these processes, these institutions aim to reduce time, cut costs, and lower greenhouse gas emissions.

A commonly used methodology to study border process efficiencies is based on tracking the flows. This approach captures key milestones and process times involved in the trade and transport systems. By analyzing these data, border agencies can identify operational bottlenecks and implement improvements. This methodology has standardized definitions for key processes and events, and it has been applied to various trade nodes around the world. However, this methodology is limited to post hoc analysis and cannot predict or estimate the results of process improvements. The unit is hence looking at enhancing the approach. The application of discrete event simulation (DES) could potentially be a way to an enhanced approach especially for making ex ante prediction of the result of alternative improvement scenarios.

2 APPROACH

Interested personnel at the unit began by examining DES applications to border crossing systems reported in literature. Encouraged by such articles, the next step was to informally engage with academics with DES expertise at a local university. It was decided to attempt to build DES models using sanitized data from a recent time release study with the following objectives:

- Understand the additional data that will be required to build the DES models beyond what is collected for time release studies.
- Assess the additional analysis capabilities and associated benefits offered by DES models.

3 POST HOC DATA EXTRACTION

To assess the quality and nature of data gathered in current studies, sanitized data from a recent study was examined. The data captured the flow of individual shipments and associated information through the customs clearance process at a border crossing over a period of about one week. It included time stamps as the shipment completed steps in the process. The process flow was drawn at a high level while the time stamps were captured at a bit more detailed level. The data collection approach met the defined goals for the study, but lacked some of the key items needed for building and exploiting a DES model for process improvement including the following: Activity times at each process step; Resources deployed at each process step; Process flows at the level at which data was captured.

The activity times and resources deployed at each process step are intertwined. If there is only one resource working at a process step, the gap between successive step completion time stamps can be used to capture the activity time distribution with the assumption that the resource is devoted full time to the process step. However, if there are 3 resources working in parallel for a process step, one would need to take the gap between every fourth time stamp to capture the activity time distribution. In addition to assuming that the resources are fully devoted to this step, this requires the assumption that the successive completions are in sequence. Of course, one would also need to consider the gap between the completion at preceding time step and current time step for the shipment for another estimate. There are additional issues such as start and end time for the resources and their break times that have to be determined from the data. There are various additional processing steps that may be required based on inspection of the shipment that were not captured in the high-level process flows but have to be figured out from the detailed time stamp data.

The scope of the DES model was reduced to modeling a subset of the flow that had fewer variations and with more complete data. The activity times were generated by iterating through one to three resources at each of the steps and selecting a level that provided an initially "reasonable" average time. This initial "reasonability" of the estimates was to be evaluated later based on the agreement between the flow times generated by the DES model and those identified in the time release study.

4 DES MODEL BUILD AND APPLICATION

A DES model of a subset of the process has been built using ExtendSim. A few iterations were required to determine the resource deployments at various steps for the model to generate flow times that are sufficiently in agreement with those captured in the study for the modeled subset of the process.

The model allowed quantitative evaluation of some of the recommendations of the time release study. More importantly it allowed exploring the potential performance improvements through changes in resource deployments. For the first basic model of a subset of the process with a few assumptions on process times, strategic deployment of resources showed a significant reduction in cycle time. Such explorations went beyond those addressed in the time release study and provided an indication of the enhanced support that DES would provide for the process improvement efforts. The next step is to request collection of additional data required for building a DES model during the next time release study at a recipient agency. It is anticipated that the sponsors of the study and its potential partners would have a higher confidence in the results of the next version of the model as it will be based on actual data for items such as resource deployment and activity times.

The approach used in this case is one way for laying the groundwork for employing simulation for applications in an organization. The groundwork avoids the "leap of faith" that an organization has to take to bring in external expertise to develop and apply simulation for specific projects. For longer term, a robust program of work will need to be defined for simulation-based process improvement.

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