Scheduling Model Design of Logistics Service Supply Chain

Project for Algorithm and Complexity

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Abstract. This project introduces the concept of logistics service supply chain. It includes the brief introduction of participants, service processes, constraints and objectives regarding scheduling model design of logistics service supply chain. Finally, it lists all the requirements and rules for each group. Please read this document carefully and complete the corresponding tasks.

Keywords: Logistics Service, Supply Chain, Scheduling

1 Logistics Service Supply Chain

With the growth of logistics demand, many logistics enterprises are united or integrated into logistics service supply chain to meet individualized demand and ensure adequate supply. In the logistics service supply chain, main participants include customers, functional logistics service providers and logistics service integrators. As we all know, completion time is an important index of logistics service performance and then the time scheduling problem becomes one of the key problems in logistics service scheduling. Therefore, logistics service integrators plays a very important role in making scheduling decisions based on the time windows of the functional logistics service providers and customer requirement. In this situation, the time windows are acceptable time, not a fixed standard time because of the uncertainty of service time and requirement time.

To be specific, for the functional logistics service providers, many uncertain factors including weather, traffic condition and vehicle troubles, possibly lead to difference between actual service time and standard time spending on completing a certain service. And for customers, the requirement time could possibly be compressed or postponed. Therefore, time windows are typical forms for them.

Assume for the service time of functional logistics service providers is considered and expressed as a uniform distribution function and the requirement time of customer time is presented by an interval. Based on the above, the time scheduling of logistics service supply chain is a multi-objective programming, including minimizing the total order operation cost of the logistics service supply chain, minimizing the difference between the total expected service time and customer requirement time and maximizing the satisfaction of customers.

2 Tasks

In this project, you are required to deal with the following tasks. The relevant data is shown in the attached file. Given the conditions, you should provide the scheduling scheme to minimize the difference between the total expected service time and customer requirement time, while minimizing the total order operation cost of the logistics service supply chain and maximizing the satisfaction of customers.

2.1 Scheduling Model Design without the Relationship between Time Windows of Supplier Operation and Customer Requirement

In this task, suppose there is a two-echelon logistics service supply chain composed of one logistics service integrator and several functional logistics service providers. The logistics service integrator can receive multiple service orders from customers at the same time. And each logistics service order consists of multiple service processes, which could be divided into two types, the customization service process and the mass service process. The service process of customer could be operated independently as customization service or integrated with the service process of customer as mass service. When the logistics service integrator knows the time requests of customers (an interval), it will require the functional logistics service providers to provide service time distribution. Basic data that you can analyze includes:

1. The normal service cost per unit time of the i-th process in offering customization operation for the j-th customer in customization process;
2. The extra cost per unit time paid by logistics service integrator to the functional logistics service providers of the i-th process in mass service process;
3. The penalty cost per unit time of the i-th process of the j-th customer order paid by functional logistics service providers to logistics service integrator, if the actual order completion time is different from the expected completion time in customization service process;
4. The service time distribution of functional logistics service providers;
5. The satisfaction of the i-th customization process of the j-th customer order;
6. The upper limit of the time postponed incurred in the i-th service process which could be endured by the $(i+1)$-th service process for the j-th customer order. They are all determined by the rigid requirement caused by upstream and downstream operations of logistics service supply chain;
7. The upper limit of the time ahead of schedule incurred in the i-th service process which could be endured by the $(i+1)$-th service process for the jth customer order. They are all determined by the rigid requirement caused by upstream and downstream operations of LSSC.

2.2 Scheduling Model Design with the Relationship between Time Windows of Supplier Operation and Customer Requirement

In fact, the investigation of this relationship is valuable to supply chain scheduling. Considering the relationship between time windows of supplier operation and customer requirement, how to change the scheduling model?

3 Requirements

In this project, you are required to solve all the problems mentioned in section 2. For each problem, please finish the following tasks.

3.1 Problem Formulation

Please formulate the problem formally as a mathematical programming. You need to define variables carefully and model the description of every requirement and constraint mathematically. Moreover, can you convert your programming as an LP (Linear Programming) or ILP (Integer LP)?

3.2 Problem Analysis and Algorithm Design

Firstly, please judge the difficulty of your defined problem. Whether it is in P, NP, NP-Complete, or NP-Hard? Prove or clarify your conclusion.

Next, please design an efficient algorithm to solve the detection problem in polynomial time with respect to the input size. You need to describe your design first, introduce the necessary concepts, symbols, definitions, etc., and write the pseudo code of your design.

3.3 Theoretical Analysis and Performance Evaluation

For each variation of detection problem, you need to complete the following tasks:

Theoretical Analysis: For this part you are aiming to distinguish the theoretical properties of your problem and algorithm designs, including the following items:

1. Analyze the time complexity of your designed algorithm.
2. If the problem you are dealing with is in P, then prove the correctness of your design. Otherwise discuss the feasibility or the approximation property of your algorithm.

Performance Evaluation: it includes the following requirements:

1. Based on the provided data together with some necessary synthetic data, evaluate the effectiveness and efficiency of your design by simulations.
2. Analyze the influence of each essential parameter in your model through extensive simulations on a larger self-provided dataset (real or synthetic).

3.4 Report Requirements

You need to submit a report for this project, with the following requirements:

1. Your report should have the title, the author names, IDs, email addresses, the page header, the page numbers, figure for your simulations, tables for discussions and comparisons, with the corresponding figure titles and table titles.
2. Your report is English only, with a clear structure, divided by sections, and may contain organizational architecture like itemizations, definitions, or theorems and proofs.
3. Please include reference section and acknowledgement section. You may also include your feelings, suggestion, and comments in the acknowledgement section.
4. Please define your variables clearly. If needed, a symbol table is strongly recommended to help readers catch your design.
5. Please also include your latex source and simulation codes upon submission.