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Coordinating overseas and local sourcing through a capacitated expediting transportation policy

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ABSTRACT

We consider an assembly system that adopts both overseas sourcing and local sourcing for different components. Local sourcing has a short and deterministic lead-time. Overseas sourcing can be divided into two stages and each stage has uncertain transportation duration. A capacitated expediting service could be adopted after first-stage transportation. In this study, we derive an optimal expediting policy for overseas sourcing and an optimal responsive sourcing policy for local sourcing. In addition, we discuss the impacts of lead-time volatility and the decision of safety lead-time, which are relevant in implementing the expediting service.

1. Introduction

In global sourcing, it is common to procure some components in assembly systems from overseas suppliers while others from local suppliers. Although, the iPhone is assembled in China, its components come from around the world. According to the location and number of Apple suppliers per country, illustrated in CompareCamp, we find that only 391 suppliers are from China, while the other 394 suppliers involve overseas sourcing.[1] Owing to the rapid growth of the consumer automotive market and low labor costs in China, many automotive companies from the United States and Western Europe develop joint-ventures with local Chinese automotive companies (Zhao et al., 2012). These joint ventures can benefit from the low purchasing costs of local suppliers; however, overseas sourcing is also necessary for some critical components with high technology requirements. According to a survey by Hermani (2008), Santana has the lowest overseas component content but still reaches 6%, and Audi and BMW Brilliance Automotive have 40% and 60% overseas content, respectively.

There exist significant differences between local sourcing and overseas sourcing. Local sourcing has a short and deterministic lead-time in order to achieve high responsiveness. It has the advantage of reacting efficiently to assembly requirements and can reduce inventory costs. In contrast, overseas sourcing that relies heavily on the ocean transport faces long and uncertain lead-times. For example, the transit time between South China and the US West Coast fluctuates between 15 days and 45 days (Tiwari and Trivedi, 2012). It is important to consider the impacts of lead-time uncertainty when making overseas sourcing decisions, and adopting effective policies to counter adverse impacts. Holding a high level of safety inventory is a natural way to mitigate ocean transport risks, which is used by Brown-Foreman Beverages in the United Kingdom, for example (Jain, 2018). However, the increase in lead-time volatility would significantly raise the inventory cost (Clark et al., 2012). Therefore, many firms adopt a more flexible

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[1] CompareCamp, (2014). How & Where iPhone is Made: Comparison of Apple's Manufacturing Process. http://comparecamp.com/how-where-iphone-is-made-comparison-of-apples-manufacturing-process/.

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policy of expediting the transportation of some components, materials, or products in an intermediate expediting hub to counter potential delay risk, such as changing to air freight, rerouting by bypassing intermediate consolidation and distribution points, and preferential treatment services by supply and logistics intermediaries (e.g., priority processing and unloading) (Kouvelis and Tang, 2012; Mamani and Moinzadeh, 2014). Firms such as Toyota, Columbia Sportswear and Quest Communications all use air freight to mitigate the adverse effects of ocean transport (Jain, 2018). Furthermore, Honda, Toyota, and Nissan in North America expedite the transportation of components by air freight in case of West Coast port delays that impact the supply chain.[2]

In an assembly system, the end product consists of different complementary components, and the product's delivery time depends on the availability of each component. Thus, each component's arrival time decision is dependent on the arrival times of other components. Especially, it is a critical challenge to coordinate component sourcing from the home country and an overseas country. Specifically, two basic questions emerge as follows: How does the assembler adopt the expediting service for overseas sourcing and responsive sourcing for local sourcing to achieve coordination? The rapid development of global sourcing and e-commerce creates significant increase in demand for freight transport, which results in capacity shortages, especially in case of air freight in an expediting operations environment (Chen and Miller-Hooks, 2012; Foreman et al., 2010; Liu and Papageorgiou, 2013). [3] Thus, this phenomenon yields a question: How does the capacity constraint impact the assembler's expediting policy? Furthermore, in some specific environments, the assembler can optimize relevant decisions to promote the implementation of the expediting service. How should the firm adjust the optimal expediting policy when facing more volatile transportation risk? How should the assembler determine the safety lead-time and what is the role of such optimizing? We examine these questions in this study.

We consider an assembly system that purchases different components to assemble the end product. Some components are procured through overseas sourcing, while others through local sourcing. The lead-time of local sourcing is deterministic and short. In contrast, the lead-time of overseas sourcing is longer, more variable, and can be divided into two stages by an expediting hub. We restrict our study to a special case in which only one critical component or sub-assembly is purchased through overseas sourcing. This keeps the analysis tractable and does not hinder the investigation of sourcing coordination between overseas and local sourcing. After first-stage transportation, the assembler can adopt a capacitated expediting service for the overseas component at the expediting hub. Then, the assembler should determine the arrival times of components sourced from the home country. We derive the assembler's optimal expediting policy for overseas sourcing and the optimal responsive sourcing policy for local sourcing. Additionally, we discuss two relevant decisions in the implementation of an expediting service, that is, impacts of lead-time volatility and safety lead-time. We attempt to address the following question: what is the precise value of expediting in the coordination of sourcing from an overseas country and from the home country?.

Our research contributes to the extant literature in two main aspects. First, it studies the impacts of expediting capacity on the value of an optimal expediting policy, which although practically important, remains largely unexamined in the literature. Second, we explore the value of an expediting service for an assembly system in coordinating the sourcing of different complementary components from an overseas country and the home country, while the current literature focuses on the sourcing problems of a single product.

Our results provide several managerial insights for global sourcing practices in assembly systems. First, we find that expediting capacity has significant influence on the optimal expediting policy. When expediting is available, the assembler should use the entire expediting capacity, as long as it is beneficial to expedite the overseas component. It is never optimal to utilize a portion of the expediting capacity. In addition, if the overseas component arrives late at the expediting hub, the arrival times of the local components should be decided according to the expediting quantity of the overseas component. Specifically, the local components should arrive at the same time as the expedited overseas component when expediting capacity is large, whereas the local components should postpone their arrival to save inventory holding costs when the expediting capacity is small or the assembler does not adopt expediting.

Second, our study reveals the value of an expediting service for an assembly system in coordinating the sourcing of different complementary components from an overseas country and the home country. This value enhances when expediting cost decreases or expediting capacity increases. Although optimizing the safety lead-time is a normal method for mitigating lead-time uncertainty risk, its use is not always suggested when an expediting policy is adopted. Optimizing the safety lead-time can reduce the inventory cost of the overseas component but may increase both the inventory costs of local components and the delay cost of the final product. In particular, as the additional benefit is small when expediting cost is high or expediting capacity is less, the assembler does not need significant computational efforts to search for the optimal safety lead-time. In fact, the value of expediting can be sufficiently reflected even when the assembler chooses the original lead-time (i.e. lead-time adopted without the presence of expediting service) in this situation. Only when expediting cost is sufficiently low and expediting capacity is sufficiently large can optimizing the safety lead-time significantly improve the value of expediting, as the assembler would rely heavily on the expediting service. In this situation, the assembler can coordinate sourcing from both overseas and the home country and benefit from optimizing the safety lead-time.

Third, our study examines the impacts of lead-time uncertainty on the assembler's global sourcing decisions with a capacitated

[2] Dan Boaz, (2015). Honda, Toyota and Nissan turn to air freight as port issues impact supply chain. AirFreight.com. https://www.airfreight.com/blog/honda-toyota-nissan-turn-air-freight-port-issues-impact-supply-chain.

[3] AFP Global Logistics, (2018). Air Freight Capacity Shortage is Changing the Way We Move Freight. https://www.afplus.com/news/air-freight-capacity-shortage-changing-way-move-freight/ Allyn International, (2017). Air Freight Capacity Issues. http://www.allynintl.com/en/news-publications/entry/air-freight-capacity-issues.