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Block time reliability and scheduled block time setting

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ABSTRACT

While in ground transportation the concept of reliability has been extensively studied, there is little literature in air transportation. Scheduled block time (SBT) setting is a crucial part in airlines' scheduling. Interviews with an airline and relevant work in ground transportation have shown that SBT and the historical block time distribution, reflecting block time reliability, have a close relationship. This paper investigates how the change in actual block time distribution will affect SBT and system performance. Firstly this relationship is studied with empirical data and multiple regression models. The distribution of the historical block time for a flight is depicted by the difference between every 10th percentiles. We found that gate delay plays a minor role in setting SBT and that SBTs have decreasing sensitivity to historical flight times toward the right tail of the distribution. To specifically link SBT setting with the flight's on-time performance, a SBT adjustment model is further developed. Poor on-time performance leads to increased SBT in the next year. With the behavior model results showing that both the median block time and the "inner right tail" of the distribution affect SBT setting, an impact study is conducted to validate these impacts with historical data. The impact of historical block time distribution on SBT is validated with real data in year 2006–2008 and 2009–2011. Furthermore, by studying the flight performance difference based on different changes in SBT, we conclude that ignoring the impact on SBT changes when considering potential benefits of improved block time distribution could lead to inaccurate results.

1. Introduction

The idea of reliability or (inversely) variability is not new in the field of ground transportation, where (un)reliability mainly refers to the unpredictable variations in travel time and is thus directly related to uncertainty of travel time (Carrion and Levinson, 2012). A rapidly growing body of literature addresses measurement and valuation of travel time variability, and the goal of enhancing reliability seems to be an increasing priority for policy makers (Börjesson et al., 2012). It is now standard that transit operators regularly publish statistics on reliability (Börjesson et al., 2012). In the realm of commercial air transportation, the percentage of flights arriving within 15 min of their scheduled times is tracked by DOT and widely published on online flight booking sites. However, there is limited knowledge of how flight time variability affects airline schedule setting. The block time for a flight is the analogue for travel time in ground transportation. It is defined as the time between when an aircraft moves under its own power for the purpose of flight and when the aircraft comes to rest after landing (Code of Federal Regulations, 2012). Typically the airline scheduler sets scheduled block time, or SBT, for a certain

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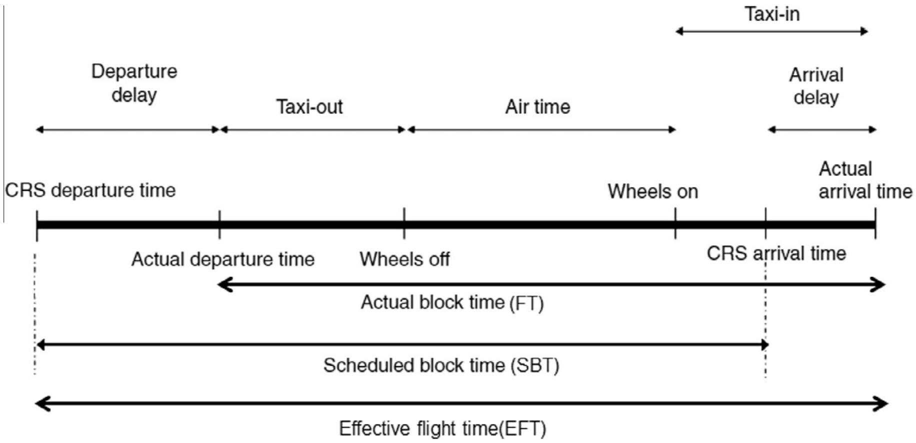

Fig. 1. Scheduled block time (SBT) in the context of flight time decomposition (Deshpande and Arikan, 2012).

flight more than six months ahead of time (Deshpande and Arikan, 2012). Fig. 1 illustrates SBT in the context of flight time decomposition. SBT is the time duration between the scheduled (computer reservation system, or CRS) departure and scheduled arrival time. The actual block time (FT) is the time between actual departure and arrival time and varies from day to day for the same flight. The block time can be further decomposed into taxi-out, airborne and taxi-in time. The time between scheduled and actual departure time is defined as departure delay, or gate delay.

Airlines face a difficult set of trade-offs in setting SBT. They must balance their cost saving motive against their desire for good schedule adherence. The choice of SBT is somewhat similar to travelers' choice of departure time when they have a preferred arrival time, except the decision must be made much further in advance. While traveler choice is made based on considerations including time saving and the disutility of a late arrival, SBT setting is mainly driven by market forces and the profit motive. Various researches in ground transportation have shown that travel time variability significantly affects travelers' departure time decisions. Therefore, despite the difference in motivation, it is natural to assume an analogous relationship between SBT and block-time variability in air transportation.

Understanding this relationship is critical to assessing the consequences of improvements to the National Airspace System (NAS), such as those contemplated under NEXTGEN. Such improvements will affect the distributions of realized block times for individual flights. This change in distribution may affect both the SBT and deviations of actual block times from the SBT. It is important to consider both effects, since they have different economic implications. Changes in SBT influence a host of related costs including crew time and aircraft ownership, as well as the earliness and lateness of flights relative to the schedule. In current practice, however, the impact of a NAS improvement on SBT is not explicitly considered. In essence, it is assumed that any reduction in realized block time has the same economic value regardless of its impact on SBT.

In this paper, the potential for changes in the block time distribution to change SBT will be the major focus. To understand this, firstly we need to understand the relationship between SBT and actual block times. This leads to our major contribution, which is to analyze the impact of the historical distributions of actual block times on SBT. We also analyze cross-year adjustments in SBTs based on the distributions of earliness and lateness relative to schedule, as well as on-time performance. With the efforts to fully understand the complete cycle of SBT setting, this paper explicitly links the relationship between the changes in actual block time distribution and SBT. This fills a missing piece of the NEXTGEN benefit analysis by relating changes in flight time distributions with changes in SBT.

Beyond this specific focus, our study provides a perspective on how the phenomenon of transport system reliability is manifested in the specific mode of scheduled air transport. As suggested above, setting SBT is somewhat analogous to scheduling the morning commute. However, there are important differences because the SBT must be set well in advance, and also in the perceived penalties of earliness and lateness. As we shall see, these differences cause airlines to focus on a particular part of the block time distribution when setting SBT. The innovative methodology required to reveal this behavior is a further contribution of our work.

The remainder of this paper is organized as follows. Section 2 provides background on relevant concepts in ground travel time reliability as well as the current airline scheduling methodologies and practice. In Section 3 a behavioral analysis incorporating block time reliability is conducted to model the SBT setting behavior using historical data. Section 4 estimates a different SBT setting model in which the adjustments to SBT from one year to the next are modeled and the effect of on-time performance is captured. Section 5 conducts an impact analysis where multiple years of historical data are analyzed to demonstrate the impact of block time distribution changes on SBT setting, and the influence of SBT changes on trends in schedule adherence metrics. Conclusions are presented in Section 6.