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Pricing policy of floating ticket fare for riding high speed rail based on time-space compression

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ABSTRACT

The Taiwan high-speed rail (HSR) markedly reduces the travel time from the north of Taiwan to the south, or vice versa, relative to other modes of public overland transportation. The HSR is faster than those modes, but also more expensive to ride. The pricing of HSR tickets has gained limited public acceptance because it lacks justification, indicating the need for a theoretical method for objectively justifying the ticket prices. With continuing improvements in data analytics, the computational capacity of computers, and visualization techniques, constructing a time–space model of a long-distance transportation system has become increasingly feasible, and such a model can be used to examine the time–space compression of the HSR. The first part of this investigation uses multidimensional scaling to obtain fitting coordinates based on travel times for various combinations of departure/destination HSR stations, and a geographic information system to generate time–space maps of the relative locations of those stations. Through these maps, we can directly estimate the traveling time between pairs of stations. The second part constructs a floating ticket-pricing model that accounts for the riding costs of the HSR. The model's power to explain the prices of HSR tickets is evaluated. Based on the analytical results, suggestions to the current HSR ticket fare were proposed to set the feasible rate concerning the operating, passenger-perceived, and time-space compression costs. Recommendations for future research are made.

1. Introduction

The implementation of the “one fixed day off and one flexible rest day” working-day reform policy has had profound effects on domestic economic development, individual attitudes toward leisure, and company leave benefits. Partially as a result of the policy, the Taiwanese public has become increasingly eager to improve their standard of living and engage in leisure activities; the perceived value of time and the quality of transportation services has also been growing. Accordingly, the service quality, convenience, safety, comfort, punctuality, travel time, and ticket fares of transportation services warrant investigation (Andersson et al., 2010; Jen and Hu, 2003; Sumaedi et al., 2012).

The service portfolio of the Taiwanese middle- and long-distance transportation industry started with buses and trains, and it has recently incorporated the high-speed rail (HSR). Although the HSR considerably reduces overland travel time, its construction and operation have entailed substantial costs, so its ticket fares make it more expensive than other modes of public overland transportation (Huang et al., 2018). In October 2013, HSR fares were raised for the first time since the operation of the rail system began in 2005 (by 9.69%), causing public disdain. In the knowledge economy of the 21th century, HSR operation managers should develop business strategies that satisfy the needs of their customers.

With multiple transportation services to choose from, travelers place a growing emphasis on service quality, safety, and punctuality (Lam and Huang, 2003). The HSR has the unrivalled advantage of reducing travel time, but it may attract merely passengers seeking to experience the rail service as a novelty if its managers fail adequately to respond to customer needs. In addition to exploiting the advantages of its trains and meeting customer needs, the HSR operator must sufficiently address public concerns about its rail service, enabling its operation.

HSR trains expedite travel among regions of Taiwan, altering the socioeconomics of space (Banister and Givoni, 2013; Bullock et al., 2009; Givoni, 2006; Hall and Pain, 2006). Therefore, the HSR in Taiwan has caused time–space compression of varying uniformity in the geographical areas along its route. A map can compare the effects of time–space compression before and after the construction of the HSR. Increasing the ridership of the HSR necessitates an investigation into the behavioral intentions of passengers.

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Many empirical investigations have shown that service quality directly influences customers' behavioral intentions (Brown et al., 1993; Zeithaml et al., 1996). However, some researchers have argued that perceived value is a more relevant predictor than service quality, suggesting that perceived value and customer satisfaction indirectly affect customers' behavioral intentions (Cronin et al., 2000).

Ticket fare has been demonstrated to influence passengers' choice behavior (Wu, 2007). Zeithaml (1988) proposed that perceived value is directly determined by service quality and an antecedent factor in purchase decision-making, suggesting that it affects purchase intention (Chen and Chang, 2008; Zeithaml, 1988). Based on these findings, the HSR operating company in all instances should ensure that its service coverage meets passengers' needs and that its service quality meets their expectations, building customer trust and loyalty. It should also revisit the prices of its tickets, which affects passengers' perceived value of its service, to promote profitability.

The HSR has refined the transportation network of Taiwan, increasing the accessibility of the regions it serves. It is faster than other modes of public land transportation but more expensive to ride (Banister and Berechman, 2001; Cheng, 2010). In particular, the varying pricing of HSR tickets lacks a solid, convincing rationale, indicating a need to assess objectively the time value of the pricing of the tickets. A theoretical method is required to justify their prices. Fig. 1 depicts the current HSR map of Taiwan.

For the above reason, a time–space map is constructed in this work to emphasize the advantage of social and economic effects by the construction of HSR. A floating ticket-pricing model (TPM) (Voss, 2015) is proposed, which may inform the adjustment and customization of HSR ticket fares in the future (Fearnley, 2013; Jansson, 1993). It can be used to review existing ticket fares for other forms of rail transportation by replacing the input data. Overall, this study emphasizes the advantage and the influence of time–space compression that is associated with the HSR, by proposing the time-space maps for diverse Taiwan HSR transportation strategies, and developing a floating TPM that is tailored to it.

The rest of this paper is organized as follows. Section 2 reviews HSR ticket pricing in other countries, as well as theories and methods that are applied in the construction of time–space maps and TPM; it also considers factors that affect a floating TPM. Section 3 describes the methodology that is utilized herein to establish a time–space map and determines the structure of the proposed floating TPM. Section 4 demonstrates the application of the TPM and the time-space map to the HSR and the results thereof. Section 5 draws conclusions and suggests avenues for future research.

Fig. 1. Current HSR map of Taiwan (adapted from https://www.google.com.tw/maps/).

2. Literature review

Ticket pricing is a critical factor in the competitiveness of transportation operations because it determines the extent to which the operators can leverage the technical and economic strengths of their transportation services to improve their operating efficiency. Reasonable ticket pricing may help to balance the market shares of various modes of transportation, satisfy the transportation needs of travelers, and allow operators to improve service quality.

This section discusses HSRs in different countries. It considers the relationship between the pricing of tickets and the business performance of the operators, studies of ticket-pricing models, the conceptual framework and variables of the ticket-pricing model that is reviewed in this study, the economic implications of time–space compression, and theories and methods that are used in time–space map construction.

2.1. Theoretical basis and construction of HSRs ticket-pricing models

HSRs around the world serve mostly metropolitan areas, helping to reduce unnecessary investments in public transportation infrastructure (Bullock et al., 2009; Little et al., 2011; Xu et al., 2012). Often, railway tracks are adapted for use by HSR trains. However, HSRs in countries such as Taiwan, South Korea, and Spain are intended to facilitate the development of less well connected, under-resourced parts of those nations (Cheng, 2010; Kim and Sultana, 2015; Monzón et al., 2013; Moyano and Coronado, 2018).

The Asian countries with HSR systems are China, Japan, South Korea, and Taiwan. Ticket fares for the HSR in China and Taiwan depend on the number of kilometers traveled (Cheng, 2010; Zheng and Liu, 2016). Fares for the high-speed railway in Japan, called the Shinkansen, are not only based on the number of kilometers traveled but also include a surcharge for express service, which depends on the distance traveled, based on a series of bands (Taniguchi, 1992). Fares for South Korea's HSR or Korea Train Express, decrease as the number of kilometers traveled increases.

The European countries that have HSR systems are France, Germany, Spain, Italy, Sweden, and Switzerland (Campos and de Rus, 2009; Fu et al., 2012). Ticket fares for the TGV (French: Train à Grande Vitesse, “high-speed train”) in France and AVE (Spanish: Alta Velocidad Española, “high-speed rail”) in Spain differ from those for HSRs in Asian countries because they vary with the time of purchase, distance traveled, the type of train car, and the time of riding. Fares for the ICE