

Consumption Motivation at High-Speed Rail Stations

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Exploring passengers' consumption motivation can provide the basis for arranging commercial activities in high-speed rail (HSR) stations to generate more revenue for operations. The passenger traffic at five major HSR stations in Taiwan were evaluated. Based on the results of decision-making trial and evaluation laboratory (DEMATEL) and DEMATEL-based on the analytical network process methods, it is shown that station attributes and consumption environment attributes are key factors that impact product attributes. Moreover, store location, commercial activities offered, product diversity, time pressure, and service convenience have a "cause" characteristic and, therefore, should be focused on when deploying commercial services at HSR stations.

Keywords: high-speed rail stations ; consumption motivation ; MADM model ; DEMATEL ; DANP ; modified VIKOR

1. Introduction

High-speed rail (HSR) are a popular transportation facility in many countries around the world, including Japan, France, Germany, Spain, Belgium, the United Kingdom, Switzerland, the United States, South Korea, Italy, Taiwan, China, Saudi Arabia, and the Netherlands. It is characterized by safety, comfort and efficiency. Emerging countries, such as Iran, Morocco, and Mexico, are also actively building high-speed rail networks ^{[1][2]}. The construction of a HSR network increases accessibility between different cities, causing a change in population distribution and industrial structure ^[3]. From the perspective of urban design, transportation facilities are seen as transcending the functional elements that ensure efficient traffic flow. Streets, railway stations, and bus stops can all be regarded as important components of an area ^[4]. However, the development of HSR network is more expensive than building a traditional railway network due to the higher-quality infrastructure required ^[1]. Failure to properly manage this infrastructure will result in HSR stations remaining idle and could lead to bankruptcy. Policymakers are trying to devise ways to generate revenue from sources other than fares to promote sustainable operation of HSRs. Among them, providing business activities or services is an important strategy ^[5].

A railway station is an attractive location for commercial purposes, providing shopping, business, and leisure opportunities to both passengers and residents. Therefore, rail companies can generate additional revenue by operating commercial and retail areas. Currently, HSR operations are mainly funded by fare income, followed by income from ancillary commercial facilities. For example, the JR West line in Japan had a total operating income of about 158.2 billion Japanese Yen in 2020, to which affiliated commercial facilities contributed 574.8 billion yen (about 38% of the total operating income) ^[6]. To achieve sustainable operations, the positioning and installation of commercial facilities in the train stations are important ^[7]. Exploring rail passengers' consumption behavior at HSR stations is an important means to provide services based on user perceptions and expectations ^[8]. There is an abundance of studies on commercial facilities and consumer behavior at airports ^{[9][10][11][12][13][14][15]}, but there are few that explore passengers' consumption behavior at HSR stations, despite it being an important research issue. This study aims to fill this gap on the consumption motivations of passengers at HSR stations.

Previous studies on passengers' consumption behavior in transportation facilities have mostly used statistical regression analysis ^{[12][13][15][16]}, Pearson correlation test ^[9], or modified grey correlation analysis ^[10]. However, as consumption motivations are affected by various qualitative or quantitative factors, multiple-attribute decision making (MADM) models are increasingly being used ^[17]. Among the many MADM models, analytic hierarchy process (AHP), developed by Saaty ^[18], is a popular method for analyzing issues in transport infrastructure projects ^[19]; it has been utilized to explore passenger satisfaction in urban multi-mode public transportation in Ningbo, China ^[20], and factors of customer happiness in authorized workshops ^[21]. However, traditional AHP cannot solve the problem of complex influential relationships among the different motivations ^[22]. Although the analytical network process (ANP), improved by Saaty ^[23], relaxes the assumption on the construction of a relationship network, the influential matrix still lacks a reliable foundation ^[24]. Of late, more and more studies have utilized the advanced decision-making trial and evaluation laboratory (DEMATEL) to explore

the complex influence relationships in issues related to determinants of consumption, including online consumption [25], airline passenger satisfaction [26], green marketing [27], and second-hand clothing purchase motivation [28].

2. Constructing a Framework for Exploring Passengers' Consumption Motivations at HSR Stations

Public transportation nodes, especially railway stations, have become the focus in urban land planning. A rail station is a special facility for passengers to embark and disembark, wait, or transfer using several means, such as platforms, floors, escalators, automatic ticketing systems, and transportation equipment [29]. A rail station can be said to have five functions: connect catchment areas and transportation networks, support the transfer of passengers or cargo between transportation modes, promote commercial use of real estate, provide a public space, and contribute to the identity of the surrounding area [30]. Through public transport operators, it can increase the utilization rate of its services by improving the quality of services provided [31]. Ghosh et al. [32] pointed out that platforms are also an important part of a rail station. Individuals use a variety of platform-based convenience facilities, such as refreshment stalls, ATMs, toilets, cloakrooms, and waiting rooms. Retail activities also play a vital role at the station and can help utilize the space effectively by providing shopping facilities to passengers [33][34].

As a representative example of a HSR, the West Japan Railway Company (JR west) integrates commercial facilities into its rail stations for optimizing the station layout, thereby increasing passenger convenience and providing additional value [35]. Kim et al. [36] proposed that a HSR station is not only a transportation hub, but also integrates shopping, dining, business, and leisure activity centers for attracting more passengers. From the passengers' perspective, Ojha [37] indicated that the most important amenities on India's railway stations are the food and beverage facilities. Be it a traditional railway station or a HSR station, its functions have expanded from simply giving a ride to diversified functions such as shopping or dining for more convenience [30].

Selecting a suitable location within the HSR station to configure commercial services is an issue in the design of a rail station. Three dimensions—station attributes (D_1), product attributes (D_2), and environment attributes (D_3)—are used for evaluating the framework to explore passengers' consumption motivations at a HSR station (Table 1).

Table 1. Framework for passenger consumption motivation at HSR stations.

Dimension	Criteria	Definitions	Cited Literature
Station attributes (D_1)	Station scale (C_1)	The scale of HSR stations	[14][38][39]
	Store location (C_2)	Location of stores in HSR stations	[12][14][38][39]
	Commercial activities offered (C_3)	Commercial activities provided in HSR stations, such as dining, shopping, and entertainment facilities	[13][40][41]
	Product diversity (C_4)	The variety of products offered by the shops in the HSR station	[12][42][43][44]
Product attributes (D_2)	Product quality (C_5)	The quality of the products provided by the stores in the HSR station	[42][44][45]
	Product retail price (C_6)	The prices of the products sold by the shops in the HSR stations are reasonable	[16][42][44][46]
	Brand name (C_7)	Whether the brands sold in the HSR stations are well-known to passengers	[10][42][44]
Consumption environment attributes (D_3)	Environment (C_8)	The ambient atmosphere of the shops in the HSR stations, such as cleanliness, lighting, or temperature	[11][45][47][48]
	Time pressure (C_9)	The free time available from the time a passenger enters the HSR station till the time of embarking. If there is too little free time, there will be a time pressure.	[15][16][49][50]
	Service quality (C_{10})	The service quality of the service staff in the stores in HSR stations and whether the quality is high or low	[11][12][44][49][51]
	Service convenience (C_{11})	Convenience of consumption by passengers in HSR stations, such as the convenience of obtaining products, making payments, and deciding the type of business activities to consume	[44][47][52][53]

The location of the stores provides unique competitive advantages for the stores and has important implications for business revenue [54]. Unlike large shopping malls or department stores, special consideration has to be given to the relationship among available scale space, accessibility, and types of commercial activities provided at rail stations due to the limited space available [55]. Hence, station attributes (D_1) are selected as one dimension. Moreover, the attributes related to product and consumption environment must also be carefully considered. While designing a mall atmosphere, product and service classification based on customer preferences is very important, especially as satisfying consumers' hedonic and utilitarian values will promote spending [42]. Wagner and Rudolph [56] pointed out that non-food shopping focuses more on retailers' store atmosphere and service convenience, while food shopping focuses more on the product itself. Hence, increasing the consumption efficiency can increase spending whether it is food or non-food shopping. With the rapid developments in technology, customers now interact with technology to create more service results while non-aviation-related activities such as shopping and dining in the airport have increased at the same time [47]. Hence, product attributes (D_2) and environment attributes (D_3) come into the picture. The selected criteria in each dimension are described as follows.

2.1. Station Attributes (D_1)

An appropriate scale of transportation facilities allows the setting up of a certain number of commercial facilities, which gives passengers the illusion that they are in a shopping center so they increase their spending and improve the retail revenue of the facility [14][38]. Apart from the routine eating and shopping facilities, entertainment activities can also be added [13]. An abundance of commercial facilities, such as hotels, department stores, theaters, and museums can also be provided to increase the consumption of tourists [40]. Stores should be located in the most accessible part for passengers according to the level of turnover. If a store is located in a corner or a passageway that is used less frequently, it will reduce the consumption motivation of passengers [12][14]. In transportation facilities such as airports, the provision of a wider range of retail and catering options has also proven to be an important factor in increasing passenger satisfaction and airport service quality [57]. Based on the above, this study includes three criteria in the dimension of station characteristics (D_1): station scale (C_1), store location (C_2), and commercial activities provided (C_3).

2.2. Product Attributes (D_2)

In consumer behavior, providing multiple brands and high-quality products at competitive prices increases the satisfaction of shoppers and promotes shopping and exploration [42]. Geuens et al. [43] mentioned that diverse types of products sold in transportation facilities that include both internationally-known and locally-known brands can trigger the consumption motivation of passengers. Some studies also indicate that brand name has a significant impact on the consumption satisfaction of passengers [10]. Product discounts also increase passengers' consumption motivation [46]. Lu [44] has shown that product quality, price, and brand reputation are critical in affecting consumption motivation in transportation facilities. Based on the above, this study includes four criteria in the dimension of product attribute (D_2): product diversity (C_4), product quality (C_5), product retail price (C_6), and brand name (C_7).

2.3. Consumption Environment Attributes (D_3)

Time and emotion affect passenger consumption in transportation facilities. Passengers are more concerned about convenience attributes, which involves how to easily and comfortably access the service environment and the availability and quality of convenience facilities and services provided [58]. Quality attributes in the physical environment are more important to operators [47]. Kesari and Atulkar [42] found that the use of bright attractive colors, lighting, cooling, cleanliness, fragrance, and luxurious seating produces a pleasant and exciting environment that allows consumers to relax. Rail stations can be designed in a way that reduces stress for passengers through the use of colors, lighting, temperature control, and decorative objects (real plants or art installations), thereby enhancing passengers' consumption motivation [11][45][46][48]. Some studies have also shown that time pressure has a significantly negative impact on passengers' consumption motivation [15][16][49][50], as they would be in a rush to catch their trains. Transportation facilities should provide more service personnel who provide high quality services to reduce the time pressure of passengers [44][52][53]. Good service quality by service personnel can also increase passengers' excitement [49], which echoes the viewpoint that good service quality increases passenger satisfaction and motivation [9][11][44][51]. Based on the above, this study includes four criteria in this dimension: environment (C_8), time pressure (C_9), service quality (C_{10}), and service convenience (C_{11}).

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