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Research on Passengers' Preference for High-Speed Railways (HSRs) and High-Speed Trains (HSTs)

Di Wu and Juan Carlos Martín *

Department of Applied Economic Analysis, Faculty of Economics, University of Las Palmas de Gran, 35017 Las Palmas de Gran Canaria, Spain; di.wu101@alu.ulpgc.es
* Correspondence: jcarlos.martin@ulpgc.es; Tel.: +34-928-458189

Abstract: This paper aims to study passengers' preference for High-Speed Railways (HSRs) and High-Speed Trains (HSTs) through a systematic literature review. The existing relevant literature was examined by using the Scopus application, and the Latent Dirichlet Allocation (LDA) method is applied to extract the topics of the selected documents. By comparing the contents of the relevant literature, the general overview of research in this field can be further understood, and the key factors that have been studied so far that affect passengers' preference can be analyzed. As a green, safe, and sustainable transport mode, HSRs do not only play an essential role in serving passengers but could also be a novel option for freight transport as long as HSRs are able to adjust their technology to the requirements of the rapid growth of the modern logistics industry. The evaluation of passengers' preference for HSRs/HSTs presents some gaps that need to be addressed in future studies: (1) the speed of the HST line ought to be introduced clearly; (2) more competing alternatives, such as maglev, autonomous vehicles, and other access–egress transport modes to terminals, such as subways and aero taxis, need to be included; (3) the analysis of passengers' preferences needs to be extended to the new role that HSRs can play in the logistics industry as new cargo services have been developed with the participation of HSRs; and (4) some attributes related to environmental costs and carbon emissions for the transport modes, as well as segmentation variables that are proxies for different passengers' attitudes towards climate change concerns, need to be included in the design of the choice experiment.

Keywords: passengers' preference; high-speed rail; high-speed train; systematic literature review; LDA model; high-speed express train; logistics industry; sustainability

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1. Introduction

The term "transportation" can be interpreted with two different meanings according to the Cambridge English Dictionary: vehicles and people vs. vehicles and goods. These two different meanings are the origin of passenger and goods transport. Governments, experts, policymakers, and researchers need to study both transport markets in order to: (1) provide efficient transportation services; (2) develop more effective transportation policies; and (3) estimate the demand of consumers accurately. However, most of the existing and relevant research on High-Speed Railways (HSRs) has been mainly focused on passenger transport, and the analysis of goods transport is practically negligible.

It is well known that after their introduction, HSRs have mainly substituted for traditional or conventional railway services on developed routes as passengers' preferences for reducing the travel time are aligned with the railway service's improvement [1]. It is the safest transport system that has been developed in the world [2]. The transport mode is also seen as green, safe, and sustainable, and the network also has important economic and social effects at the regional level [3]. The fast development of HSRs has brought about a novel option for freight transport, but this has not gained researchers' attention. It is time to analyze whether HSRs can be used to move express freight transport goods. Thus, the

HSR capacity could be used more intensively, and the rapid growth of the modern logistics industry will be better serviced [4].

The HSR industry can be considered a remarkable exception to the obsolescence of transport technologies as railways have evolved during the last few decades from being a Victorian anachronism destined to a secondary role in interurban transport to one of the basic transport technologies of the twenty-first century [5]. Since the first HST launched on the Tokaido line in Japan between the cities of Tokyo and Osaka, the HST network has been expanded worldwide [1]. The emphasis on building new HST systems is a consequence of dealing with the relationships between climate change, transport, and space, in which the logic of speeding up and increasing efficiency through new road construction and expansion is losing support [6]. In addition, HSRs present a number of comparative advantages with respect to other interurban transport modes, such as being more environmentally friendly [7]. HSRs can contribute to environmental protection, have a low price, and provide a speedy transportation service for the express transportation market, which has extensive benefits both in the economy and society [8]. The environmental costs, traffic congestion, and carbon emissions have dramatically increased in most of the countries of the world [9].

The paper aims to: (1) analyze through a systematic literature review passengers' preference for HSRs and HSTs; (2) examine the existing literature using the Scopus application; (3) understand the main alternatives and attributes that have been used; (4) obtain the main segmentation variables that have been used to analyze the heterogeneity in passengers' preferences; and (5) summarize the main findings that could expand future research.

To this end, first, the data were extracted from Scopus with the following keyords: TITLE-ABS-KEY (hst AND preferenc*) OR TITLE-ABS-KEY (hsr AND preferenc*). Consequently, a database that contains 143 related articles was obtained. Second, the Latent Dirichlet Allocation (LDA) method was applied to elicit the topics of the selected documents. Then, by summarizing the alphabetic abbreviations "HSR" and "HST", 65 documents were filtered in which "HSR" and "HST" mean "high-speed railway" and "high-speed train", respectively. Third, after reading the abstracts of the selected documents, a further refinement was made to select 24 articles that applied a Stated Preference method.

2. Bibliometric Analysis

2.1. Scopus Database

The information database about passengers' preference for HSRs and HSTs was obtained from Scopus, a citation platform launched by Elsevier Science in 2004 [10]. It is a navigation tool that provides the world's largest curated, peer-reviewed abstract and indexing database with over 24,000 active titles indexed in August 2020. Scopus offers new refining and sorting features for researchers with bibliometrics tools that can track, analyze, and visualize research, covering the fields of Sciences, Social Sciences, Medicine, Technology, and Arts and Humanities [11].

A total of 143 documents were obtained by using TITLE-ABS-KEY (hst AND preferenc*) OR TITLE-ABS-KEY (hsr AND preferenc*) as the search keywords on Scopus. This strategy guaranteed that all the 143 documents contained those terms, in either the title (TITLE), abstract (ABS), or keywords (KEY). In addition, the following information for each study was also extracted: author, author(s) ID, title, year of publication, source title, volume, issue, page start, page end, page count, abstract, keywords, and document type.

To further filter the 143 documents, each abstract was read carefully, and the meaning of the acronyms in each article was summarized. Thus, 65 documents that dealt with high-speed railways or high-speed trains were further filtered to make an additional selection. The selection was based on whether the study conducted or did not conduct a "Stated Preference" (SP) experiment. Thus, 24 papers were specified as the target references of this paper for further analysis.

Figure 1 shows the number of articles published annually from the extracted database. It illustrates that the publication of the documents began in 1966. Tracing back through

history, the world's first high-speed railway was the Tokaido Shinkansen from Tokyo, Japan, which opened for regular service in 1964 [12]. Thus, if the subject of the only article published in 1966 is about a high-speed railway, then it can be assumed that the study referred to the Japanese Shinkansen.

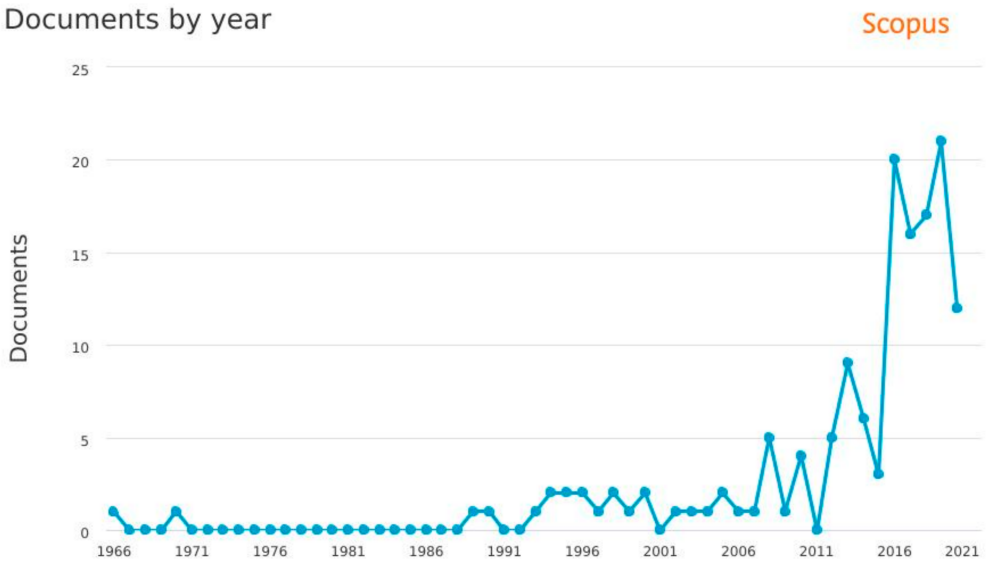

Figure 1. The total number of published documents.

Figure 1 shows that from the year 1966 until the year 1991, there were only four published documents. From 1986 to 2001, there were some slight fluctuations in the curve with some ups and downs. In 2001, no papers were published. Then, an increasing trend of the curve occurs from 2008, in which the highest peak point for the period is observed in 2020.

2.2. Latent Dirichlet Allocation (LDA) Model

To determine the main topics studied by the selected papers, the Latent Dirichlet allocation (LDA) model was applied. The LDA model has been applied successfully within the computer sciences for information retrieval and text mining [13]. The LDA model was the first probabilistic topic model and was presented by Blei et al. in 2003 [14]. More information can be obtained in other articles (e.g., Blei and Lafferty [15] and Griffiths and Steyvers [16]). The fundaments of the model are based on the assumption that a document can be considered a collection of words, with no order or sequential relationship between words. A document can contain random mixtures of latent topics, and each word in the document is generated by one of the topics. For reducing each document in a given corpus, the LDA method can be used to extract a topic from the topic distribution of each document and a word from the word distribution corresponding to the extracted topic [17].

Thus, the 143 abstracts were pre-processed by executing the Python programming language code on Google Colaboratory (Colab), which is a free-of-charge cloud service for disseminating data analysis, machine learning, and education [18]. Colab is an easy-to-use Chrome-browser-based collaboration tool that has two cell types (text cells and code cells), and the output appears below each cell directly [19].

Before training the LDA model, a Word Cloud image was made on Colab to provide an overview at first sight. Word Clouds depend on the frequency of words as follows: the more a specific word appears in a textual data source, the bigger and bolder it appears in the word cloud. A word cloud helps to determine whether a given text database is relevant in order to meet the specific information need [20]. As shown in Figure 2, the biggest words are hsr, preference, high, speed, and hst. In principle, it seems that many of the 143 selected papers are related to high-speed railways. However, some smaller words are health, food,

nutrient, and star. These words were unexpected and made the researchers cautious as other fields could have been part of the selected database; thus, the selected papers could have needed a further refinement.

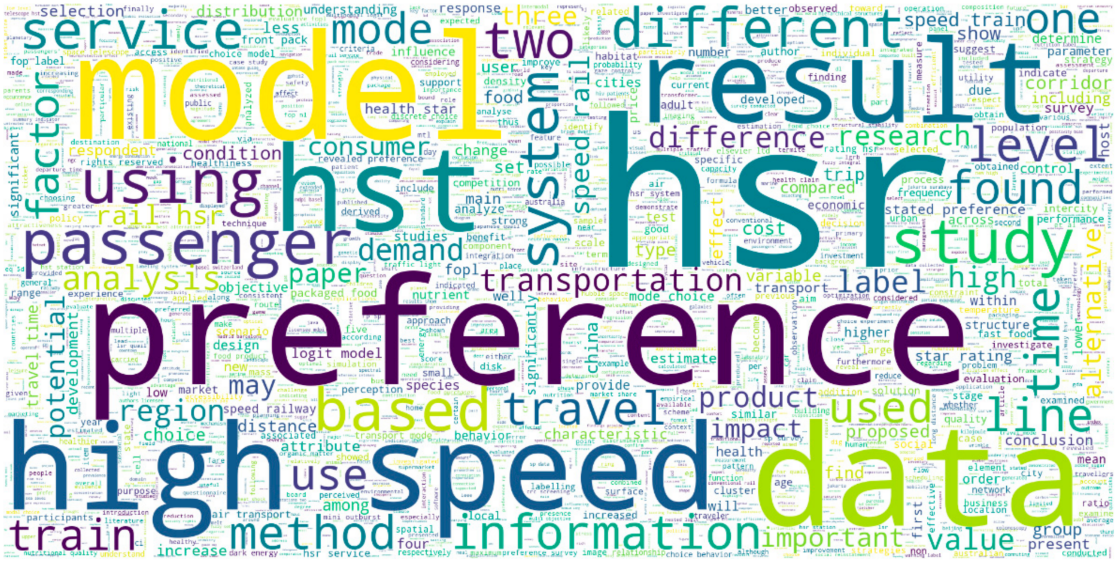

Figure 2. Word cloud image of the 143 abstracts.

3. Results

3.1. Results of the Database

The 143 articles were published in 106 publications. Figure 3 shows the five most prolific publications of these 106 sources. These five publications had published at least three articles during the period under analysis: *Appetite* (4); *Nutrients* (4); *Transportation Research Part A Policy and Practice* (5); *The Astrophysical Journal* (4); and *The Astronomical Journal* (3). Simultaneously, from Figure 3, we can see that the four documents published in *Appetite* were published from the year 2016 to the year 2018, the four documents published in *Nutrients* were published from the year 2017 to the year 2019, and the four documents published in *Transportation Research Part A Policy and Practice* were published from the year 2014 to the year 2019. The names of some journals provide a piece of evidence that not all the domains of the 143 articles were related to transportation.

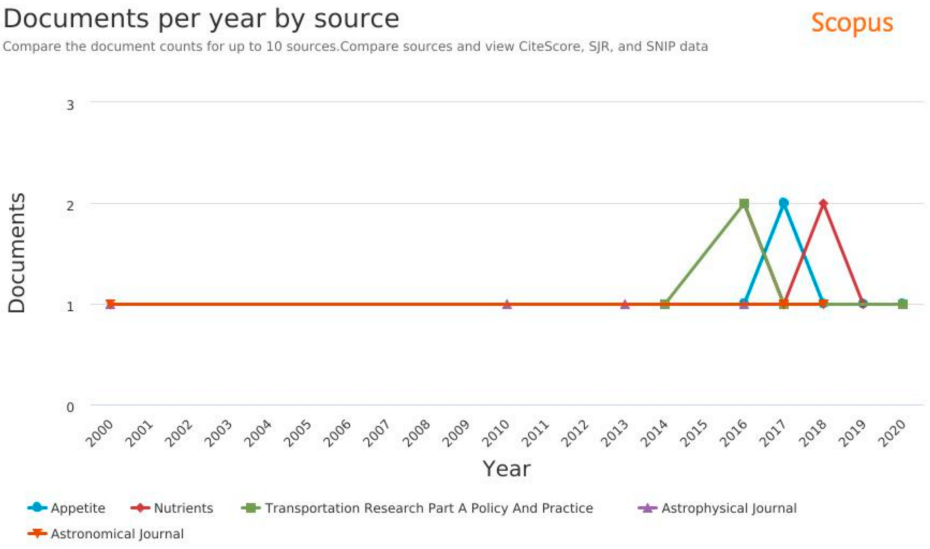

Figure 3. The most productive sources.

The classification of the articles can be clearly seen in Figure 4. The three largest proportion distributions of the number of published documents are in Engineering (17.1%), Social Sciences (15.9%), and Earth and Planetary Sciences (7.4%) and Physics and Astronomy (7.4%). The percentage distributions of the Medicine, Nursing, Computer Science, Agricultural and Biological Sciences, Mathematics, Biochemistry, and Other journal categories are 7.0%, 6.6%, 5.8%, 5.0%, 4.3%, 3.5%, and 20.2%, respectively.

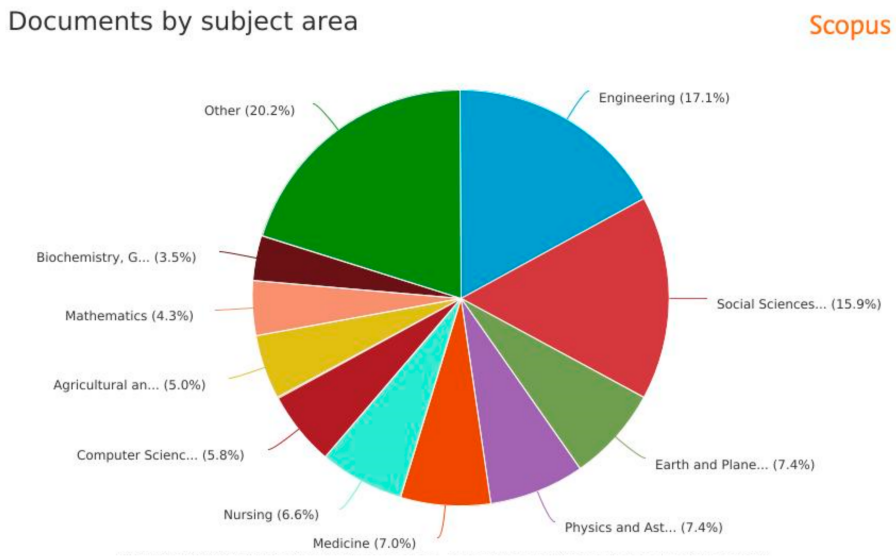

Figure 4. The category analysis.

Figure 5 shows the most prolific authors in this field. We can see that (i) Pettigrew, S. is ranked in first place, with seven published articles; (ii) Pagliara, F., Román, C., and Talati, Z. were ranked in second place, with six published articles; (iii) and, finally, Martín, J.C. and Neal, B. were ranked in third place, with five published articles. Figures 1–5 have been obtained using Scopus through the analyze search results button [21].

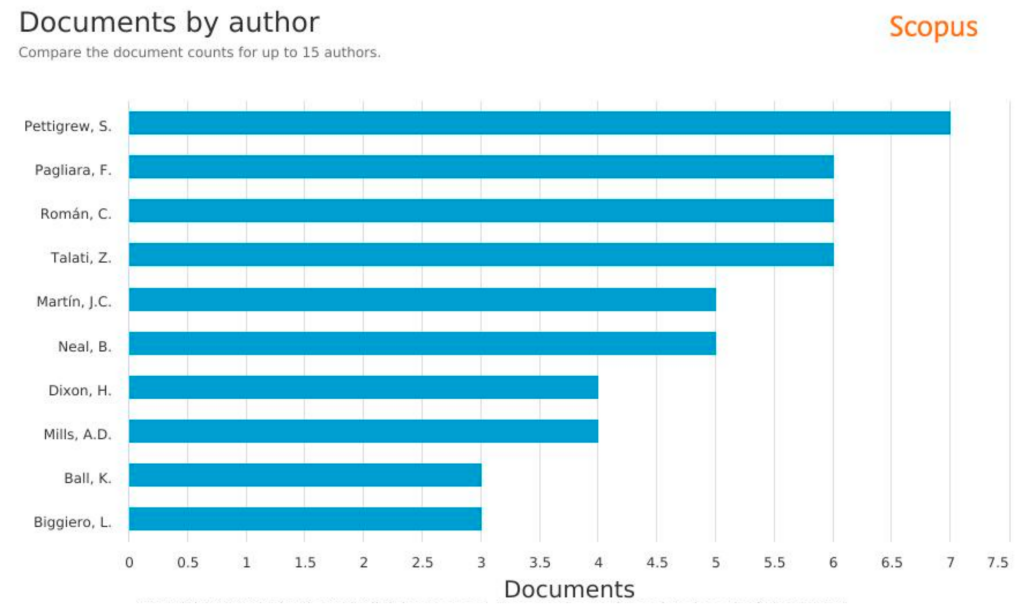

Figure 5. The most prolific authors.

3.2. Results of the Latent Dirichlet Allocation (LDA) Model

So far, the results discussed above are all based on the Scopus database. The next step was to pre-process those abstracts to further extract the main topics of HSTs or HSRs. Tokenization and stop words removal are two basic procedures. The original text can be seen as a sequence of characters and, before doing any analysis of this corpus, sentences ought to be isolated. In order to isolate sentences, words have to be isolated from the original sequence of characters. This isolation of word-like units from a raw text is called tokenization. By performing tokenization, the character structure of units is recognizable, for instance, numbers, dates, and punctuation, and units will be subject to a morphological analysis [22]. Stop words, such as "and", "but", "if", and "the", have a grammatical function and the same likelihood of occurring in textual materials, but are not relevant to the content of documents. It is a common practice to remove stop words for retrieval since they are not useful indicators of content [23].

After pre-processing the 143 abstracts extracted from Scopus, a dictionary and a corpus are created as inputs to the Latent Dirichlet Allocation (LDA) model. The LDA model is an unsupervised method for capturing context-specific valences. The general and basic idea is that textual materials are represented as random latent topics, where each topic is composed of distributed words, and each word is a basic unit [17]. In this research, each abstract refers to a "document" in the literature, which is formed by a sequence of N words, w = (w1, w2, . . . , wN), where wN is the Nth word in the sequence. M documents form a corpus D = (d1, d2, . . . , dM), where dM is the Mth document of the collection. The LDA model is highly efficient because it can handle not only big data but also dis-aggregate periods with sparse data. It is more suitable because there is no need to make assumptions about the text structure, the language's grammatical properties, or the distribution of and relationships between words [24].

Python is a high-level programming language that supports modules and packages and has become very popular in recent bibliometric analyses. In the study, Colab, a code written following the standards and rules of Python, was used together with both NLTK and Gensim, two packages of Python.

The NLTK package of Python was adopted to remove the stop words at the pre-processing stage. NLTK is one of the commonly used Python packages for Natural Language Processing and one of the oldest packages. The default list of all the English stop words supported by NLTK was used with a list of added words that were specifically prepared for the study. Table 1 shows the 179 default English stop words of NLTK.

Table 1. The 179 default English stop words supported by NLTK.

i, me, my, myself, we, our, ours, ourselves, you, you're, you've, you'll, you'd, your, yours, yourself, yourselves, he, him, his, himself, she, she's, her, hers, herself, it, it's, its, itself, they, them, their, theirs, themselves, what, which, who, whom, this, that, that'll, these, those, am, is, are, was, were, be, been, being, have, has, had, having, do, does, did, doing, a, an, the, and, but, if, or, because, as, until, while, of, at, by, for, with, about, against, between, into, though, during, before, after, above, below, to, from, up, down, in, out, on, off, over, under, again, further, then, once, here, there, when, where, why, how, all, any, both, each, few, more, most, other, some, such, no, nor, not, only, own, same, so, than, too, very, s, t, can, will, just, don, don't, should, should've, now, d, ll, m, o, re, ve, y, ain, aren, aren't, couldn, couldn't, didn, didn't, doesn', doesn't, hadn, hadn't, hasn, hasn't, haven, haven't, isn, isn't, ma, mightn, mightn't, mustn, mustn't, needn, needn't, shan, shan't, shouldn, shouldn't, wasn, wasn't, weren, weren't, won, won't, wouldn', wouldn't.

Since there are no rules for identifying stop words, and any word can be chosen as a stop word for a specific purpose, more stop words can be added. On a sequence process, stop words could be added if researchers think that some words do not provide enough added value to the object of the study. As said, there are no magical recipes and the general trend is to move from the standard use of a large number of stop lists with 200–300 terms to small stop lists with 7–12 terms to no stop list [25]. To identify more stop words, we first performed the whole procedure of the LDA model by removing the 179 default English

stop words and setting the output to obtain 50 topics with 30 frequent terms each. From the frequency of the 1500 terms, 300 of them were hand-filtered as stop words in order to obtain more accurate results in subsequent LDA runs (Table 2).

Table 2. The 300 hand-filtered stop words for this study.

according, achieved, across, addition, additional, additionally, adopted, adopting, affect, affected, aim, al, allows, along, alongside, also, among, analyses, analysis, analyze, analyzed, answered, apparent, approach, appropriate, around, assessed, associated, assumed, atp, attempt, au, author, back, based, behalf, believed, best, calculated, ce, choosing, ci, cl, claim, claims, clearly, cm, cmb, col, collect, collected, combined, compete, conclusions, conducted, consider, considered, consistently, costs, cpcs, cr, criteria, current, currently, dce, demonstrate, demonstrated, depending, designed, detected, determine, determined, developed, dig, discussed, dls, dr, due, effect, eg, employing, eos, eq, er, error, estimate, estimates, et, eu, evaluated, even, ever, examined, example, exist, expected, explain, fact, far, fb, find, finding, findings, fine, following, fopls, found, front, gda, general, generally, generate, generated, given, good, gp, gphst, highly, however, hra, hree, hsp, identified, identify, ie, ii, implications, importance, important, improve, improved, improvement, imt, included, including, incorporate, increase, increased, indeed, indicated, indicators, influence, influenced, information, interpretive, introduced, investigate, investigated, investigation, ix, jeju, joint, kd, kj, labels, lccs, less, level, lgrbs, like, log, low, lower, lree, lsr, lt, main, make, mean, meaning, measure, method, methods, mini, modal, mode, model, models, mpacts, mrna, mtl, multi, near, new, nft, ngc, nice, nip, nl, non, novel, npsc, nutri, objective, objectives, obscured, observed, obtain, obtained, occur, occurring, od, one, optically, order, osa, overall, part, particularly, perceived, pgy, plp, point, potential, potentially, preferred, presence, present, presented, produced, product, promote, proposed, provide, psg, published, ras, ratings, rc, recently, reduce, ree, reflect, regardless, related, relatively, relevant, represent, research, reserved, respectively, result, resulted, results, review, scoring, second, selected, show, showed, shown, significantly, similar, slight, small, smaller, snia, snls, sobf, sr, ssb, stage, strategies, strategy, strong, studies, study, suggest, suggests, supporting, ta, terms, testing, therefore, thsr, thus, tll, together, total, towards, typically, understand, understanding, us, used, using, uv, versus, viewed, visuals, vs, warning, web, well, whether, widely, without, would, wr, york.

Gensim was used to create a LDA topic model for the 143 documents. Table 3 represents the outcome with 20 topics and 10 keywords form each topic, with a decreasing weight order. Table 3 indicates that the scope of some of the terms does not seem to be related to the object of the paper (passengers' preference for HSRs or HSTs). The suspicious words are highlighted in bold: (i) food, organic, eggs, sugar, health, and nutrition; (ii) stars, telescope, space, galaxy, cosmological, hubble, and cosmic; and (iii) salmon, animal, habitat, deer, wild, landscape, species, plant, savanna, termite, woody, soil, and forest.

Table 3. The 20 topics (with 10 words each) of the 143 documents.

Topic	Keywords
1	hsr; fast; packaged; **food**; **organic**; hst; price; marine; sea; healthier
2	hsr; **eggs**; oviposition; foods; life; **sugar**; dose; fat; baby; age
3	railway; line; city; flows; transportation; net; speed; hst; gas; preference
4	hsr; utility; time; adult; trips; rail; travel; cost; line; commuting
5	hsr; fuzzy; humanoid; hst; genes; robots; navigation; cells; pyroptosis; functions
6	energy; hst; **stars**; **telescope**; luminosity; **space**; spectrum; **galaxy**; daylighting; hubble
7	temperature; **health**; hsr; heat; quails; **salmon**; arctic; tolerance; age; **animal**
8	hsr; social; line; choice; host; passengers; air; distribution; regions; discrimination
9	hsr; speed; high; travel; system; transportation; regions; workers; rail; distance
10	hsr; services; choice; rail; parents; transport; trip; demand; tourist; train
11	energy; neutrino; parameter; **cosmological**; number; **hubble**; **cosmic**; time; density; helium
12	elites; **habitat**; **deer**; passengers; ticket; crisis; Europeanness; **wild**; **landscape**; hsr
13	hsr; food; health; **nutrition**; consumers; products; star; quality; healthiness; daily
14	**species**; hsr; habitat; **plant**; **savanna**; **termite**; **woody**; sugar; **soil**; **forest**
15	hsr; high; rail; speed; travel; passengers; train; transport; conventional; intercity
16	stations; hst; train; hsr; surface; location; speed; urban; fast; transformer
17	hsr; hst; stability; structural; speed; intercity; rp; sp; corridor; train
18	travel; choice; train; hsr; passengers; distance; service; frequency; demand; pathway
19	travel; speed; choice; high; hsr; hst; transportation; time; passengers; train
20	hsr; transport; preference; speed; passengers; exclusion; rail; travel; air; access

3.3. A further Refinement of the Topics

All the 143 abstracts were meticulously read by one of the researchers to disentangle the strange words that appeared in bold in Table 3. Finally, it was possible to find that the well-known and profusely used acronyms HSR and HST in the literature on high-speed railways are also used in other fields. We found that, except for the 65 documents in which "HSR" and "HST" are related to high-speed railways, for the remaining 78 articles the acronyms referred to other different concepts. It was a surprise that the acronyms were used in 43 different contexts related to health, social, and science issues. Table 4 shows that the three main categories other than high-speed railways are: (1) Health Star Rating (18 documents); (2) Hubble Space Telescope (10 documents); and (3) High levels of Social Reinstatement behavior (5 documents). Furthermore, interestingly, three abstracts did not clearly state the meaning of HSR or HST, but they certainly were not related to passengers' preference for HSRs. The dubious words that appear in the list of 20 topics were found to be clearly related to different concepts that used the same acronym.

Table 4. Meanings of the "HSR" and "HST" acronyms in the extracted Scopus abstracts.

Meanings of "HSR" or "HST"	Number of Documents
High-speed railway or high-speed train	65
Health Star Rating (HSR)	18
Hubble Space Telescope (HST)	10
High levels of Social Reinstatement behavior (HSR)	5
HanSaRam-IX (HSR-IX)	3
Hottest Spot Temperature (HST)	2
highstand systems tract (HST)	2
hydrostatic transmission	1
hump-shaped oviposition regulation (HSR)	1
human speech recognition (HSR)	1
human Serine racemase (hSR)	1
Hubble constant (HST)	1
HST/STIS	1
HST/GOODS	1
HST WFPC2 observations	1
HST solar cells	1
HST Guide Star Catalog	1
HSD and HST	1
host star	1
homogeneously staining region (HSR)	1
homogeneous shear turbulence (HST)	1
home stool test (HST)	1
home sleep testing (HST)	1
home safety toolkit (HST)	1
High-silica rhyolites (HSR)	1
highly specialized technology (HST)	1
Higher Specialist Training (HST)	1
high structural stability regions (HSRs)	1
high school class (HSR)	1
hierarchical structures for recommender systems	1
Herbaceous Species Richness (HSR)	1
Hemorrhagic shock and resuscitation (HSR)	1
heat storage tanks (HSTs)	1
heat shock response (HSR)	1
Health system responsiveness (HSR)	1
health services research (HSR)	1
Harvard Step Test (HST)	1
Handover Served Ratio (HSR)	1
Habitat Sharing Ratio (HSR)	1
H. syriacus (HSR)	1
local measurements (HST)	1
guinea pig adrenal hydroxysteroid sulfotransferase (gpHST2)	1
Others	3
Total number of documents	143

For this reason, a new LDA model was applied to only the 65 documents that really deal with high-speed railways. Table 5 presents the 20 topics with 10 words each for the

new dataset. It shows that the suspicious words do not appear anymore, and that this list can now be used to provide interesting insights for the rest of the study.

The ultimate goal of transportation is sustainable development [26]. The concept of sustainable transport was first proposed in 1996 by the World Bank and refers to accomplishing economic and financial sustainability, environmental and ecological sustainability, and social sustainability [27]. Regarding the most frequent words shown in Table 5, though the data were collected from the perspective of passengers' preference for high-speed railways and high-speed trains, they indicate that some words (in bold) of some topics are related to the concept of HSRs as a sustainable transport mode. "Fuzzy" has been put in bold because the use of fuzzy models to evaluate sustainability is becoming very popular [26]. For example, "environment", "carbon", and "emissions" appear in the second and fifth topics.

Table 5. The 20 topics (with 10 words each) of the 65 documents related to high-speed railways.

Topic	Keywords
1	hsr; transportation; transport; tourism; business; service; futuroscope; speed; safety; leisure
2	train; hsr; passengers; air; transport; speed; infrastructure; services; **environment**; accessibility
3	hsr; trips; rail; services; travel; trip; business; distance; air; income
4	hsr; train; transfer; station; distance; railway; waiting; speed; travel; destination
5	hsr; speed; transportation; tourism; intercity; **carbon**; **emissions**; economic; capacity; security
6	revenue; hsr; train; railway; classes; fare; time; seats; transportation; speed
7	hsr; transport; economic; exclusion; rail; travellers; services; car; accessibility; speed
8	speed; trains; travel; railway; machine; software; class; seats; income; harmony
9	rail; passengers; integration; speed; air; economic; **energy**; **sustainable**; schedule
10	hsr; travel; speed; intercity; business; rail; future; security; tourism; economic
11	hsr; services; travel; tourist; trip; tourism; access; **emissions**; **dioxide**; **carbon**
12	corridor; competition; hsr; speed; welfare; cost; technology; business; bus; fare
13	hsr; speed; travel; intercity; service; **fuzzy**; economic; capacity; tourism; security
14	train; frequency; accessibility; cities; techniques; distribution; connectivity; speed; transportation; vehicles
15	exclusion; hsr; time; transport; speed; economic; rail; mobility; stations; passengers
16	high; travel; speed; trains; railway; software; machine; income; transportation; age
17	hsr; fare; speed; high; train; pricing; ticket; capacity; aircraft; seat
18	speed; hst; hsr; train; workers; **fuzzy**; **energy**; commuting; reliability; comfort
19	hsr; spatial; speed; rail; transport; equity; accessibility; economic; sp; rp
20	speed; intercity; travel; train; railway; trips; car; **fuzzy**; machine; software

The number of documents published annually for the new dataset was analyzed and is presented in Figure 6. The first paper about passengers' preference for HSRs or HSTs was published in 2002. In comparison with Figure 1, Figure 6 demonstrates that the contents of documents published from 1966 to 2001 are not related to high-speed railways. In other words, the article published in 1966 was not about the Japanese Shinkansen. Furthermore, the number of articles dealing with passengers' preference for HSRs published in 2016 and 2017 started to increase significantly compared with previous years. In addition, 2019 was the most productive year with 12 documents.

The SP method is a survey method that measures individuals' preferences and demand for non-market alternatives based on hypothetical choice situations [28]. In other words, this approach is particularly suitable for estimating demand when one of the considered alternatives does not exist [29]. Thus, experimental designs could include more information in the choice tasks. Each interviewer is asked for their choice when they are faced with different situations [30]. It might be a reasonable way to analyze what alternatives and attributes the previous authors who applied the SP method had adopted to measure passengers' preferences for HSRs or HSTs.

The selection of the 24 documents written in English that use the SP method to analyze passengers' preferences for HSR services provides very interesting information regarding the authors of the articles, the alternatives used in the choice sets, the attributes used to

characterize the alternatives, the locations in which the authors conducted the surveys, and the main results.

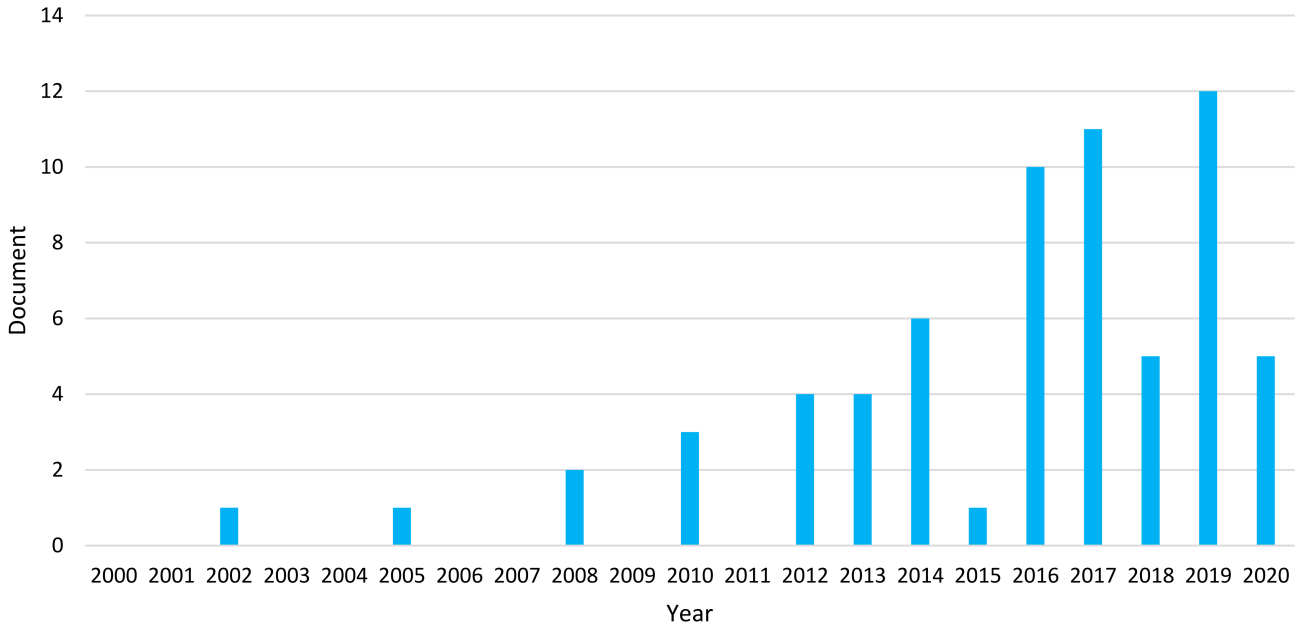

Figure 6. The number of documents published annually.

Table 6 lists the authors of each article and assigns a number to each document that will be used as a label to create other tables more efficiently. It shows that four authors, Pagliara F., Román C., Martín J.C., and Biggiero L., also appear in Figure 5 as the most prolific authors in the field. In addition, the first paper was published in 2002 and this information coincides with Figure 6.

Table 6. Authors of the 24 papers.

No.	Authors (Year)
(1)	Bergantino A. S. and Madio L. (2020) [29]
(2)	Cheng Q., Deng W., and Hu Q. Z. (2019) [31]
(3)	Putri A. L. and Widyastuti H. (2019) [30]
(4)	Raturi V. and Verma A. (2019) [32]
(5)	Zuo Z. and Pan X. F. (2019) [33]
(6)	Nurhidayat A. Y., Widyastuti H., and Utomo D. P. (2018) [34]
(7)	Biggiero L., Pagliara F., Patrone A., and Peruggini F. (2017) [35]
(8)	Brida J. G., Martín J. C., Román C., and Scuderi R. (2017) [36]
(9)	Cartenì A., Pariota L., and Henke I. (2017) [37]
(10)	Kusuma A., Tinumbia N., and Bakdirespati P. L. (2017) [38]
(11)	Muro-Rodríguez A. I., Perez-Jiménez I. R., and Gutiérrez-Broncano S. (2017) [39]
(12)	Raturi V. and Verma A. (2017) [40]
(13)	Sperry B. R., Burris M., and Woosnam K. M. (2017) [41]
(14)	Cascetta E. and Coppola P. (2016) [42]
(15)	Lee J. K., Yoo K. E., and Song K. H. (2016) [43]
(16)	Li Z. C. and Sheng D. (2016) [44]
(17)	Zhao W. Y., Zhu H. G., and Hu D. W. (2016) [45]
(18)	Barreira Á., Reis V., and Macário R. (2013) [46]
(19)	Kuo Y. W., Hsieh C. H., Feng C. M., and Yeh W. Y. (2013) [47]
(20)	Yao E. J., Yang Q. R., Zhang Y. S., and Dai H. N. (2013) [48]
(21)	Yao E. J., Yang Q. R., Zhang Y. S., and Sun X. (2013) [49]
(22)	Pagliara F., Vassallo J. M., and Román C. (2012) [50]
(23)	Yang C. W. and Sung Y. C. (2010) [51]
(24)	Yao E. J., Morikawa T., Kurauchi S., and Tokida T. (2002) [52]

Table 7 indicates the publication year of the 24 studies. It can be seen that 2017 is the most prolific year, followed by 2013, 2016, and 2019. It is also worth noting that two gap periods exist: one between 2002 and 2010 and the other between 2013 and 2016.

Table 7. Analysis of the publications by year.

Year	Counts	Papers
2020	1	(1)
2019	4	(2–5)
2018	1	(6)
2017	7	(7–13)
2016	4	(14–17)
2013	4	(18–21)
2012	1	(22)
2010	1	(23)
2002	1	(24)

Table 8 shows the counts of published papers according to the countries that were analyzed. China is the most prolific country (16 publications), followed by Italy (4 publications) and Spain and Indonesia (3 publications each). The remaining countries are India, Japan, South Korea, and the United States. It is interesting to note that there was only one research paper (No. 18) that studied passengers' preference for HSRs in two countries (Spain and Portugal).

Table 8. Analysis of the publications by country.

Country	Counts	Papers
China	8	(2,5,16,17,19,20,21,23)
Italy	4	(1,7,9,14)
Spain	3	(8,11,22)
Indonesia	3	(3,6,10)
India	2	(4,12)
Japan	1	(24)
South Korea	1	(15)
United States	1	(13)
Spain and Portugal	1	(18)

Table 9 summarizes the alternatives used in the 24 publications. According to the data in Table 9, 23 studies are based on modal competition between HSRs and other existing transport modes, such as road transport (bus and private car) (15 publications), air transport (13 papers), and conventional rail (11 studies). Interestingly, there is only one paper (No. 8) that does not use HSRs as an alternative because the authors included the multimodal Air–HSR and Air–Air alternatives to analyze the competitiveness of the modal integration of HSR and air transport that is now being developed in some of the most important airports in the world.

Table 9. Analysis of the publications by alternatives.

Alternative	Counts	Papers
HSRs	23	(1–7,9–24)
Road Transport	15	(1,4,7,10,11,12,14,17–24)
Air transport	13	(1,4,6,7,14,15,16,18,20–24)
Conventional rail	11	(1,4,5,7,9,10,17,20,21,23,24)
Multimodal Air–HSR	2	(8,16)
Air–Air	1	(8)

Table 10 shows the attributes included in the 24 papers by different transport modes: (a) HSR; (b) Bus; (c) Air Transport; (d) Conventional rail; and (e) Private Car. For the Time and Cost (Price) attributes, sub-categories were established according to the specific perspectives that authors took for their research purposes.

Regarding Table 10a (HSR), all 24 papers considered Time and Cost to be essential attributes. This is not a surprise in studies on transport economics, as these are the two main components in the definition of generalized price. In the Time group, the top three attributes were Travel time (16 articles), Access/egress time (5 papers), and In-vehicle time (4 papers). In the Cost group, 16 studies adopted Travel cost as an attribute. Furthermore, the Price of tickets can also be considered a cost, but as the original nomenclature was used in the table, this attribute ranks in third place (it was adopted in 10 papers). Herein, the Fare integration attribute in Paper 8 is a remarkable one, as is the Baggage integration attribute, since Paper 8 estimates the multimodal Air–HSR and Air–Air alternatives as mentioned above. In addition, the Frequency attribute appeared in the attribute lists of nine papers.

According to Table 10b (Bus), Time is a vital attribute and was included in 11 papers. Among those, eight articles analyzed the Travel time attribute, and two examined the In-vehicle time attribute. The Cost category ranks in second place with 10 studies, nine of which analyzed the Travel cost attribute. Moreover, Frequency and Price are crucial attributes and were included in four and three papers, respectively.

Similarly to Table 10a (HSR), Table 10c (Air Transport) shows that the top four most important attributes are Time (13 papers), Cost (10 papers), and Price and Frequency (both with 6 studies). In the sub-categories of the Time group, Travel time (seven studies), Access/egress time (five studies), and In-vehicle time (three studies) were again important attributes. Nine papers included Travel cost as an attribute. As mentioned in Table 10a (HSR), Fare integration and Baggage integration were only included in Paper 8. Additionally, Duty-free shopping availability is a novel attribute that was analyzed in Paper 15.

Table 10d (Conventional rail) shows that: (i) 11 papers included the Time attribute, 6 and 2 of which included Travel time and In-vehicle time, respectively; (ii) eight papers considered the Cost attribute, especially Travel cost; (iii) four papers involved the Price attribute; and (iv) the Frequency attribute appeared in four papers.

Table 10e (Private Car) presents the following top three vital attributes: Time (nine papers); Cost (seven papers); and Price (three papers). Similarly to other transport modes, Travel time and Travel cost were the most considered attributes (five studies each). Differently from the above-mentioned modes, Frequency is not an attribute that could characterize this transport mode.

Table 10. Analysis of the publications by attributes included by mode.

(a) HSR		
Attributes	**Counts**	**Papers**
Time	24	(1–24)
Travel time	16	(2,5,6,9–15,19–24)
Access/egress time	5	(7,8,14,16,23)
In-vehicle time	4	(1,4,8,16)
Total travel time	3	(3,11,18)
Departure time	2	(2,23)
Connecting time	2	(8,16)
Waiting time	2	(17,23)
Out-vehicle travel time	1	(4)
Ticket sold-out time	1	(5)
After-train time	1	(5)
Arrival time	1	(5)
Prob. of 2 h delay	1	(5)
Average headway	1	(14)

Table 10. *Cont.*

(a) HSR		
Attributes	**Counts**	**Papers**
Cost	24	(1–24)
Travel cost	16	(3,4,7,8,10,11,13,15,16,17,19,20,21,22,23,24)
Access/egress cost	1	(7)
Operating cost	1	(12)
Cost reimbursed/not reimbursed	1	(14)
Early/late schedule penalty	1	(14)
Price (Cost)	10	(1,2,4,5,6,7,8,9,15,18)
Fare integration	1	(8)
Frequency	9	(1,3,4,9,15,18,22,23,24)
Service	4	(9,13,14,17)
Reliability	3	(1,19,22)
Comfort	3	(17,19,22)
Accessibility	2	(3,19)
Ticket type	2	(5,23)
Safety	2	(15,17)
Companion	1	(5)
Baggage integration	1	(8)
Distance	1	(9)
Capacity	1	(12)
High professional condition	1	(14)
Rapidness	1	(17)
Convenience	1	(17)
Seat pitch	1	(18)
Hand luggage space	1	(18)
Noise level	1	(18)
Efficiency	1	(19)
(b) Bus		
Attributes	**Counts**	**Papers**
Time	11	(1,4,7,10,11,12,18,20,21,22,23)
Travel time	8	(10,11,12,18,20,21,22,23)
In-vehicle time	2	(1,4)
Out-vehicle travel time	1	(4)
Access/egress time	1	(7)
Total travel time	1	(18)
Cost	10	(4,7,10,11,12,20,21,22,23,24)
Travel cost	9	(4,7,10,11,20,21,22,23,24)
Access/egress cost	1	(7)
Operating cost	1	(12)
Frequency	4	(1,18,23,24)
Price (Cost)	3	(1,7,18)
Reliability	1	(1)
Capacity	1	(12)
Seat pitch	1	(18)
Hand luggage space	1	(18)

Table 10. *Cont.*

(a) HSR		
Attributes	**Counts**	**Papers**
Noise level	1	(18)
(c) Air Transport		
Attributes	**Counts**	**Papers**
Time	13	(1,6,7,8,14,15,16,18,20–24)
Travel time	7	(6,14,15,20–23)
Access/egress time	5	(1,7,8,14,16)
In-vehicle time	3	(1,8,16)
Connecting time	2	(8,16)
Average headway	1	(14)
Total traveling time	1	(18)
Line-haul time	1	(24)
Terminal time	1	(24)
Cost	10	(7,8,14,15,16,20–24)
Travel cost	9	(7,8,15,16,20–24)
Access/egress cost	1	(7)
Cost reimbursed/not reimbursed	1	(14)
Early/late schedule penalty	1	(14)
Price (Cost)	6	(1,6,7,8,15,18)
Fare integration	1	(8)
Frequency	6	(1,15,18,22,23,24)
Reliability	2	(1,22)
Baggage integration	1	(8)
High professional condition	1	(14)
Safety	1	(15)
Duty-free shopping availability	1	(15)
Seat pitch	1	(18)
Hand luggage space	1	(18)
Noise level	1	(18)
Comfort	1	(22)
(d) Conventional Rail		
Attributes	**Counts**	**Papers**
Time	11	(1,4,5,7,9,10,17,20,21,23,24)
Travel time	6	(5,9,10,20,21,23)
In-vehicle Time	2	(1,4)
Out-vehicle travel time	1	(4)
Ticket sold-out time	1	(5)
After-train time	1	(5)
Arrival time	1	(5)
Prob. of 2 h Delay	1	(5)
Access/egress time	1	(7)
Waiting time	1	(17)
Line-haul time	1	(24)
Terminal time	1	(24)
Cost	8	(4,7,10,17,20,21,23,24)
Travel cost	8	(4,7,10,17,20,21,23,24)
Access/egress cost	1	(7)
Price (Cost)	4	(1,5,7,9)
Frequency	4	(1,9,23,24)

Table 10. *Cont.*

(a) HSR		
Attributes	**Counts**	**Papers**
Reliability	1	(1)
Ticket type	1	(5)
Companion	1	(5)
Distance	1	(9)
Comfort	1	(17)
Safety	1	(17)
Service	1	(17)
Rapidness	1	(17)
Convenience	1	(17)
(e) Private Car		
Attributes	**Counts**	**Papers**
Time	9	(1,4,7,10,11,14,18,20,21)
Travel time	5	(10,11,14,20,21)
In-vehicle time	2	(1,4)
Access/egress time	2	(7,14)
Out-vehicle travel time	1	(4)
Average headway	1	(14)
Total travel time	1	(18)
Cost	7	(4,7,10,11,14,20,21)
Travel cost	5	(4,7,10,11,20,21)
Access/egress cost	1	(7)
Cost traveling alone/with party	1	(14)
Early/late schedule penalty	1	(14)
Price (Cost)	3	(1,7,18)
Reliability	1	(1)
High professional condition	1	(14)
Service	1	(14)
Frequency	1	(18)
Seat pitch	1	(18)
Hand luggage space	1	(18)
Noise level	1	(18)

The five sub-tables of Table 10 indicate that Travel time, Travel cost, and Price are the most important attributes of different passengers' transport modes that have been used by researchers when they analyzed the modal competition between HSRs and other transport modes. Other important attributes are Frequency, In-vehicle time, and Access/egress time. Finally, certain attributes, such as Departure time, Waiting time, Access/egress cost, Operating Cost, Reliability, Comfort, Ticket type, Capacity, Rapidness, Seat Pitch, Hand Luggage Space, and Noise Level, are attributes that have been less used in the literature. It seems obvious that passengers can make some tradeoffs with the secondary attributes as long as the travel time, travel cost, and ticket price, which determine the generalized cost, are within an acceptable range. It is interesting to note that researchers have not included any attributes related to sustainable transport, such as emissions, energy use, fuel consumption, and pollutants.

Table 11 summarizes the socio-demographic variables used to analyze heterogeneity in passengers' preferences. The top three variables are Age, Income, and Trip purpose, which

are included in 12 papers, respectively. Career and Gender are two important variables, each of which is involved in eight papers. Education (five papers) and Trip frequency (four papers) are not considered to be as important as the previously mentioned variables. Number of Household vehicles, Number of children in the household, Pieces of checked bags, and Driving experience do not play an essential role in the studies. As stated above, it is remarkable that researchers have not used any type of variable that would act as a proxy for passengers' attitude towards climate change. For example, there are interesting social movements, such as 'Fridays for future' or 'flight shame' led by the young Swedish activist Greta Thunberg, that put emphasis on passengers' responsibility for reducing our personal footprint on the planet. It is time to make the necessary changes to minimize energy-intensive and environmentally problematic trips.

Table 11. Analysis of the publications by segmentation variables.

Variables	Counts	Papers
Age	12	(1,2,3,8,13,16,17,19–23)
Income	12	(1,2,3,6,8,13,16,17,20–23)
Trip purpose	12	(1,3,6,8,15–18,20,21,22,24)
Career	8	(1,2,3,6,17,20,21,23)
Gender	8	(1,2,3,6,8,13,17,23)
Education	5	(2,6,8,13,19)
Trip frequency	4	(1,3,8,17)
Household vehicles	2	(13,19)
Number of children in household	2	(13,19)
Financial source	1	(2)
Consideration of ease of mode and mobility	1	(3)
Consideration of time and speed	1	(3)
Pieces of checked bags	1	(8)
Image package viewed	1	(13)
Number of adults in household	1	(13)
Driving experience	1	(19)

4. Existing Gaps

This paper aims to analyze the passengers' preference for HSRs and HSTs through a systematic literature review. In this section, several existing gaps are identified based on the obtained results.

4.1. Speed of HSRs

It is known that there is no uniform definition for the term "high-speed railways" across the world. For example, the Japanese government issued the "National Shinkansen Railway Development Act No. 71" in 1970. The definition of "Shinkansen railway" in this Act means that an artery railway is capable of operating at a maximum speed of more than 200 km/h in the predominant part of the railway [53]. In mainland China, according to Article 107 of the Regulations on Railway Safety Management, the term "high-speed railway" refers to a passenger-train-dedicated railway that is designed to operate at a speed of more than 250 km/h and has an initial operation speed of no less than 200 km/h.

Comparing only the different definitions of HSRs in these two countries, HSRs in China are apparently faster than those in Japan. Therefore, as there are different speed standards for HSRs in each country, it is highly recommended that experts, scholars, and researchers clarify the speed of HSRs when studying HSR-related topics. Otherwise, readers from different countries may misunderstand the results as the speed of HSRs affects the transport mode's competitiveness. In particular, none of the 24 articles clearly stated this important issue.

4.2. Competing Alternatives and Access to Terminals

Table 9 presents the commonly used transport alternatives. It can be seen that road transport (buses and private cars), air transport, and conventional rail have been, so far, the most used alternatives. However, in the future, there will be more competitive transportation modes, such as maglev, autonomous vehicles, and even ships or ferries; for example, China's first cross-sea high-speed railway with a speed of 350 km/h will begin operation in 2022.

Another interesting area in which further research is required is associated with the access and egress transport modes to terminals. In this sense, currently, subways are booming in developing countries [54]. For instance, traffic congestion and emissions have increased because of the rapidly growing motorization, which has encouraged many Chinese metropolitan areas to invest in subway developments [55]. After the 2008 Olympic Games in China, many cities began developing and improving urban rail transit systems, including tram, light rail, metro, and monorail systems. At present, 31 cities in China have subways, with a total of 133 lines [56]. In addition to avoiding serious traffic jams on the road, subways are more convenient, faster, cheaper, and, to a certain extent, the optimal option for the low-income and middle-income classes. However, this issue has been neglected in the current literature.

4.3. Attributes for the Development of HSRs in Logistics

HSRs do not only play an essential role in serving passengers among other transport modes, but also bring about a novel option for freight transport. HSRs are adjusting to the requirements of the rapid growth of the modern logistics industry. As shown in Table 10a (HSR), Travel time, Travel cost, Ticket price, Frequency, and Access/egress time are the most-used attributes. Indeed, people prefer to use time rationally and efficiently, but this issue has not been deeply studied in logistics, and it may be relevant, especially in an era when more sustainable transport modes are a necessity to mitigate negative externalities.

High-speed freight trains have been launched in many countries, such as Germany, France, Denmark [57], and China. Since 2014, China Railway Corporation has launched the high-speed railway express delivery (HSReD) system, cooperated with express transport companies and e-commerce platforms, initially focusing on time-sensitive and valuable items, and launched services such as "Same-Day Delivery" and "Next-Day Delivery". According to the Statistical Office of the People's Republic of China (2017), in 2016, the volume of express delivery parcels reached 31.35 billion pieces, increasing by 51.67% over 2015. China's example indicates that the HSReD system is feasible and has been operating for several years. Thus, questions need to be considered, for instance: What is the impact of HSReD on passengers' demand and preferences? Will some attributes (e.g., number of carriages carrying parcels, delivery time, and delivery frequency) of HSReD affect passengers' choices? In addition, Bi et al. [57] claim that the HSReD parcel volume on China's HSR network will reach the transportation capacity limit in 2021. Will this prediction be true? Will this affect the travel demand of passengers and the sustainable development of HSRs? These are worthy lines of future research.

4.4. Attributes Related to Environmental Costs and Passengers' Attitudes towards Climate Change

This fourth gap probably represents the most promising line of future research. It was certainly a surprise to find that none of the 24 SP studies included any attributes related to environmental costs in order to characterize the transport modes. In this respect, the comparative advantages of HSRs over other transport modes could have not been properly analyzed in previous studies. Similarly, the more or less pro-environmentalist or green behavior associated with each passenger could also have an effect on mode choices, so it is highly possible that there is a latent heterogeneity in passengers' preferences that has not been analyzed. Air travel can be affected by the interference of 'flight shame' supporters who obtain the media's attention in order to change social norms, and, apparently, these changes have more or less been accepted by some nationalities. Gössling et al. [57] assessed

the effect of 'flight shame' on policy support for the decarbonization of the transport system for 16 different measures, and found that a majority of respondents considered the following three measures as the most effective: (1) an annual reduction in the aviation industry's total CO_2 emissions by 5%; (2) a reduction in specific emissions by 5% per year and a total of km flown; and (3) a decline in the cost of train travel to make this transport mode relatively more cost-competitive. Interestingly, the authors studied these issues from a conceptual point of view, and it is time to include these segmentation variables in the discrete choice approach.

5. Conclusions

This paper provided a critical overview of the evolution of passengers' preference for HSRs in the last 20 years. An initial database containing 143 related articles, obtained from Scopus by using the keywords TITLE-ABS-KEY (hst AND preferenc*) OR TITLE-ABS-KEY (hsr AND preferenc*), was filtered because it was found that the use of abbreviations was not appropriate for selecting a particular field of study. The bibliometric analysis with the refinements showed that the first paper about passengers' preference for HSRs was published in 2002.

The Latent Dirichlet Allocation (LDA) method was applied to elicit the topics of the 65 selected documents that deal with high-speed railways. The meanings of the abbreviations "HSR" and "HST" other than "high-speed railway" and "high-speed train", respectively, are shown in Table 4. The other three main categories are: (1) "HSR", which stands for "Health Star Rating"; (2) "HST", which means "Hubble Space Telescope"; and (3) "HSR", which means "High levels of Social Reinstatement behavior".

The 24 studies that conducted a SP experiment were selected to provide more insights into passengers' preferences for HSRs. The in-depth analysis of the selected papers demonstrates that: (1) the SP surveys were implemented for measuring the passengers' preference for HSRs in different countries: China, Italy, Spain, Indonesia, India, Japan, South Korea, the United States, and Portugal (Table 8); (2) the most frequently used transport alternatives are Road Transport, Air transport, and Conventional rail (Table 9); (3) the top five most used attributes are Travel time, Travel cost, Price, Frequency, and In-vehicle time (Table 10); and (4) the top five segmentation variables are Age, Income, Trip purpose, Career, and Gender (Table 11).

We found four important gaps that need to be addressed as future lines of research: (1) the definition of HSRs according to the speed needs to be mentioned; (2) more competing alternatives need to be included as well as other transport modes for accessing and egressing to/from terminals; (3) the role of HSRs as an alternative in logistics needs to be studied to analyze what effects HSRs could have on passengers' demand; and (4) environmental and sustainability issues need to be included in the choice experiment to determine whether HSRs could be more competitive, as well as other variables that could act as proxies for passengers' attitudes toward mitigating transport externalities.

This study is also subject to some shortcomings. First, the information was extracted from only a single platform (Scopus), and the results may be biased by this issue. Second, using the abbreviations HSR and HST as search keywords is inappropriate when researchers want to study a specific field. Third, only the SP method was considered when filtering out the 24 papers written in English in order to analyze the passengers' preferences. Other methods or topics need to be used in the future and, for that, the list of the topics presented in this study will be valuable.

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