A Multi-criteria Framework for Evaluating Passenger Satisfaction in Greek Railways

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Keywords Service quality · Passenger satisfaction · Railway · Multi-criteria analysis · MUSA methodology

Introduction

The principle of measurement constitutes an essential function of management science in that it lays the ground for understanding, analysis and improvement. Most companies and organizations have recognized the importance of measuring customer satisfaction as a reliable feedback system, since it provides customer feedback in a meaningful and direct way. In the transport sector in particular, the ultimate goal of operators is to ensure high quality of transport services as a prime determinant of passengers' choices. Passengers having a satisfactory travel experience are more likely to use the transport service again, while simultaneously attracting a new customer base. For this reason, during the last decade, an increasing interest in measuring passenger satisfaction levels has been noticed, as proven by the growing number of studies conducted on public transportation systems mainly in Europe and Asia (Geetika & Shefali, 2010; Fu et al., 2017; Bhavani & Sakthipriya, 2021).

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Literature Review

The literature review has been conducted through the Systematic Literature Review (SLR) methodology to ensure the representativeness, reliability and relevance of reviewed research articles (Jesson et al., 2011). The process is initiated with the scoping of our research that lies on the intersection of three dimensions, namely service quality, transport and multi-criteria analysis. In particular, we aim to identify relevant research pertaining to the application of multi-criteria analysis methods for assessing service quality in the transport context. Scopus, ScienceDirect, Business Source Complete (EBSCO) and Google Scholar are selected as the primary data sources for literature search. Keywords used for search purposes split into three strings containing the main themes of our research scope: (i) String 1 related to "customer satisfaction" keywords, (ii) String 2 pertaining to "railway/transport" and (iii) String 3 related to "multi-criteria analysis". Common Boolean operators were used to help construct a composite search. Based on our search strategy, a total of 16,294 articles were initially found and then subsequently filtered and scaled down according to inclusion/exclusion criteria to 1636 articles retained. In order for a paper to be included it would be in English/Greek and published during the period from 2000 to 2019. Also, the papers retained were only scientific journal articles with full-text availability and their focus was on measuring passenger satisfaction. In the following step, the articles were assessed, first by screening titles and abstracts and then by full text, based on their relevance to the aim of the research. Finally, 36 articles were selected as the core literature list to be reviewed and further analyzed.

Evaluating service quality and efficiency in rail passenger transport has been the subject of research by many researchers worldwide. Many researchers have applied existing methodologies to measure passenger satisfaction, while others have developed new or adapted existing methodologies for this specific purpose. Nathanail (2007) developed a multi-criteria evaluation framework to help rail operators monitor and control the quality of services provided to their passengers. This framework was based on the evaluation of 22 indicators, grouped under six criteria (i.e., itinerary accuracy, system safety, cleanness, passenger comfort, servicing and passenger information). Geetika and Shefali (2010) proposed a model to measure passenger satisfaction on railway platforms through factor analysis. They implemented their model on a survey in Indian platforms by using 16 variables, grouped into five categories: refreshments, information system, safety and security, behavioral aspects, and basic facilities. De Oña et al. (2013) used the Classification and Regression Tree Approach (CART) methodology to analyze the quality of rail passenger services in Milan, based on quality characteristics such as courtesy and competence on board and in stations, information at stations, punctuality of runs, regularity of runs, windows and doors working etc.

Other researchers incorporated broader perspectives of passenger satisfaction and service quality and adopted both quantitative and qualitative methods in the context of rail transport services. Nedeliaková et al. (2014) proposed new methodics of

identification of the level of service quality on rail transport. The first part of the methodics is characterised by calculating the complex indicator of quality for the corresponding process of the provision of service (i.e., accessibility, costumer care, time and information), while the second part focuses on three approaches: customer, employee and supplier-oriented approach. Fu et al. (2017) proposed a multi-level extensible assessment model based on the matter element theory and the extension theory in order to evaluate rail transport quality. They used 7 primary assessment indices (i.e., safety, cleanliness, comfort, service reliability and availability, information, personnel, other) and 26 senior assessment indices, while they further applied their model to certain railway lines in Southern Italy. Isikli et al. (2017) conducted an analysis of service quality for passengers in Istanbul's railways using traditional voting procedures and three recently-proposed voting procedures (Schulze, Tideman, and Fallback Voting) to determine the highly-prioritized criteria among waiting time, crowding in vehicles, fare, cleanliness, information systems at stations, attitude of security personnel, access to stations etc.

Another major stream of research has focused on the evaluation of quality of rail transport services through the use of the SERVQUAL method (Parasuraman et al., 1988). SERVQUAL is a multi-dimensional research instrument designed to measure service quality by capturing respondents' expectations and perceptions along the five dimensions of service quality, namely reliability, assurance, tangibles, empathy and responsiveness. Existing relevant research has revealed that this methodology or its variations thereof tend to constitute the dominant measurement mechanism of service quality in Indian railways (Hundal & Kumar, 2015; Priyadharshini & Selladurai, 2016; Bhavani & Sakthipriya, 2021). Maruvada and Bellamkonda (2010) developed a comprehensive instrument called "RAILQUAL" by integrating SERVQUAL with Fuzzy Set theory in order to evaluate the service quality of the Indian railways. Moreover, Prasad and Shekhar (2010) evaluated rail passenger service quality of Indian railways by developing a Service Quality Management (SQM) model on the basis of SERVQUAL with the addition of three new dimensions (i.e., service product, social responsibility and service delivery).

Multi-criteria Analysis

MUSA Methodology

The MUSA methodology is a multi-criteria preference disaggregation approach following the principles of ordinal regression analysis under constraints using linear programming techniques. Its basic property is that it provides quantitative measures of customer satisfaction based on qualitative input in the form of customers' judgments or preferences. MUSA aggregates individual judgments into a collective value function, assuming that the client's global satisfaction depends on a set of criteria or variables representing service characteristic dimensions (Grigoroudis & Siskos, 2000).

In our research, the data was analyzed using MUSA methodology in order to address the given assessment problem with view to multiple criteria of passenger satisfaction, since it fully respects the qualitative form of customers' judgments and preferences, as they are expressed in a customer satisfaction survey (Grigoroudis & Siskos, 2002). Furthermore, the obtained results provide opportunities for an in-depth analysis of global customer satisfaction and its constituent elements (i.e., global and partial satisfaction indices), including an analysis of the demanding level of customers (i.e., demanding indices). It can also guide future improvement plans by identifying strong and weak points of a service process and deriving the respective action/improvement diagrams.

Survey Design and Implementation

Based on an extensive study of the existing literature on the service quality assessment of transport services, a total of eight (8) satisfaction dimensions were defined as the primary, first-level criteria (namely Safety, Cleanliness, Comfort, Ticket purchase, Information, Reliability and Flexibility, Personnel and Accessibility) and 32 second-level sub-criteria/indicators. Figure 1 provides, in detail, a schematic illustration of the hierarchical structure of railway passenger satisfaction evaluation problem.

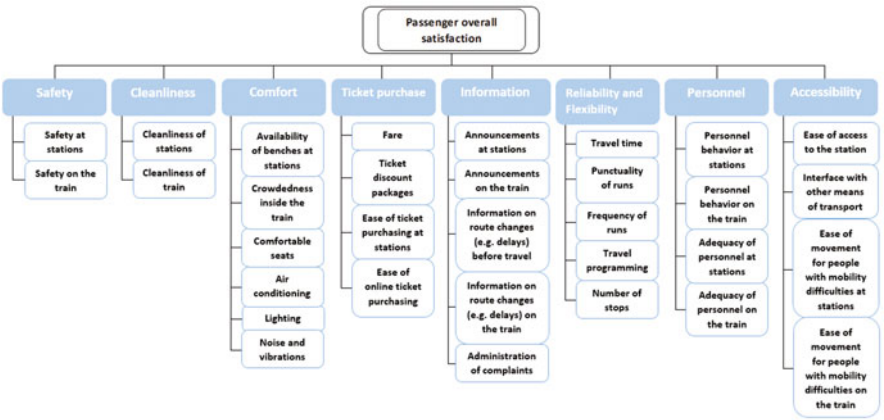

Fig. 1 Hierarchical structure of criteria

Results

The survey was operationalized by means of a structured survey instrument (i.e., questionnaire), developed in line with the methodological properties of MUSA methodology, in order to measure the railway passenger services in Greece. The survey instrument contained 4 discrete sections: (i) description of the research aims and general information about the satisfaction survey, (ii) demographic information about the respondent/passenger, (iii) travel profile of the respondent/passenger and (iv) passenger evaluations/perceptions (i.e., satisfaction ratings per sub-criterion/criterion/overall) of railway services in Greece. A total of 312 completed and analyzable questionnaires were collected through simple random sampling between May and June 2019 based on physical presence at Thessaloniki rail station (i.e., face-to-face interviews) and online form (150 and 162 questionnaires, respectively).

According to the results the sample of respondents was almost equally split by gender and almost half of the respondents were in the age group of 18-30 years old. In addition, the majority of the people who participated in this survey were well educated employees and as far as the monthly income level is concerned, 47% reported a monthly income of less than 500€. The main reason for travelling by train was tourism/pleasure and most of the respondents (41%) were found to commute by train less than once every six months, while a small percentage (12%) travels by rail at least once a week.

Based on the overall analysis results, a very low global satisfaction level is demonstrated for the passengers, with the global satisfaction index reaching only 33.01% (Fig. 2—side part), indicating that the passengers are quite dissatisfied with the currently provided services in Greek railways. The satisfaction function is convex (Fig. 2—upper part), meaning that customers (i.e., passengers) are demanding, since they are only satisfied if they are offered the optimum level of service. The same conclusion is also reached by observing that the global demanding index has a positive value (36.63%) (Fig. 2—lower part).

Regarding each service quality criterion separately, as it can be seen in Table 1 below, it is obvious that the Greek railway passengers found almost all of the criteria not satisfactory enough, since the criteria satisfaction indices are rated to medium or poor levels. According to the findings, the main element causing dissatisfaction is "cleanliness", since the surveyed passengers assigned it with the lowest satisfaction rate (11.94%). Besides, its demanding index is the highest (71.58%) as it is shown in Table 1, implying that passengers expect much better service performance with respect to this particular satisfaction dimension. On the other hand, the element scoring higher appears to be the "ticket purchase" with the rate of 51.19%. The importance weights assigned by respondents to the first-level satisfaction criteria are also presented in Table 1. The criterion of "cleanliness" appears to be by far the most important criterion for responding passengers at a rate of 28.15%. With rates ranging at about 12%, significantly lower than the criterion of "cleanliness", "comfort" and "safety" were assigned with importance weights of 12.5% and 11.78%, respectively.

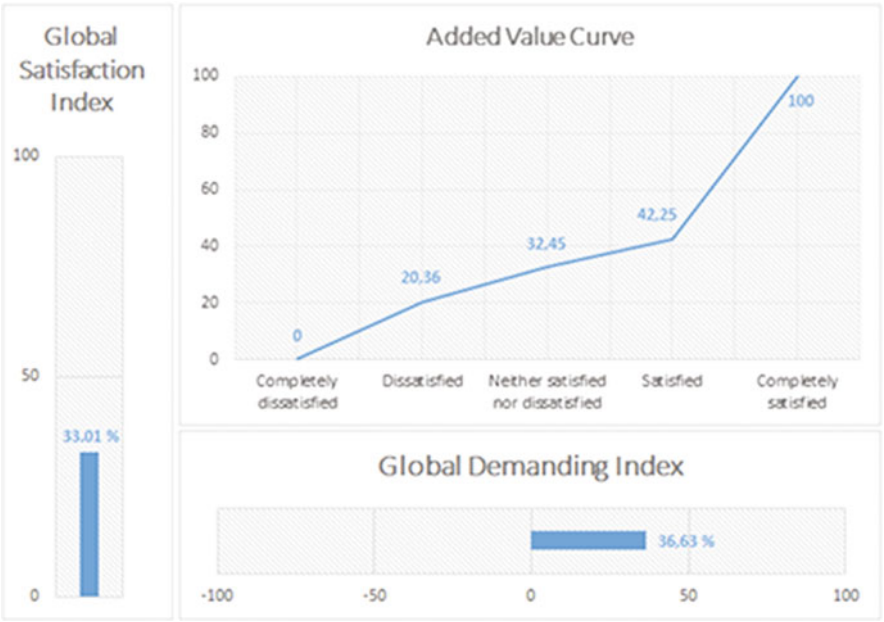

Fig. 2 Added value curve, global satisfaction and demanding index

Table 1 Criteria weights, satisfaction and demanding indices

Criteria	Weights [%]	Satisfaction Indices [%]	Demanding Indices [%]
Safety	11.78	30.40	32.10
Cleanliness	28.15	11.94	71.58
Comfort	12.50	31.31	36.00
Ticket purchase	8.91	51.19	10.18
Information	10.40	33.49	23.09
Reliability & Flexibility	9.54	44.27	16.12
Personnel	9.03	46.96	11.40
Accessibility	9.69	39.70	17.45
Global		33.01	36.63

As demonstrated in the action diagram below (Fig. 3), there is no criterion rated as both of high efficiency and high importance. This further implies that none criterion belongs to the leverage opportunity area, so as to serve as a source of advantage against competition. The only criterion that belongs to the action area of the map, having a low performance index, but scoring high in importance is "cleanliness", and this is where all improvement efforts should be concentrated in order for the level of passengers' satisfaction in Greek railways to be increased. "Safety" and "information" belong to the status quo, that is, the area of low performance and low importance and usually no further action is required. "Comfort" is located between the status quo and the action opportunity area. This implies that this feature may be

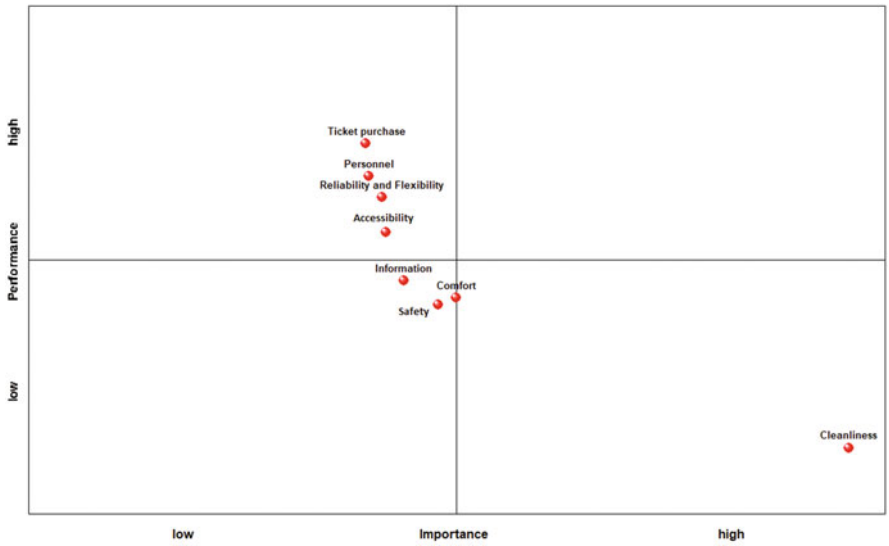

Fig. 3 Action diagram for Greek railways

shifted in the future to the action opportunity area and it can be critical for improving the overall passenger satisfaction. Finally, the satisfaction dimensions of "ticket purchase", "reliability and flexibility", "personnel", and "accessibility" correspond to the transfer resources area, where the firm would better transfer the resources and efforts using for them into others considered more important by the customers.

The MUSA method also produces the improvement diagrams that help identify satisfaction dimensions that need to be enhanced. According to the improvement diagram below (Fig. 4), it is further confirmed that the railway operators should primarily focus on the dimension of "cleanliness", since it is the only criterion that requires large effort but has a large effectiveness as well. In other words, the passengers are quite demanding and with important improvement actions for this quality dimension the overall satisfaction will be increased. Finally, all the remaining criteria belong to the third priority area of the map, meaning that they are low efficiency and high demanding features and they represent the final areas for improvements.

Conclusions

In the present paper, we developed a multi-criteria evaluation framework, aiming to measure passenger satisfaction in Greek railway services. This was accomplished by conducting extensive literature search guided by a Systematic Literature Review (SLR) process, following the determination of the 8 first-level criteria and 32 second-level satisfaction sub-criteria/dimensions that would be included in our

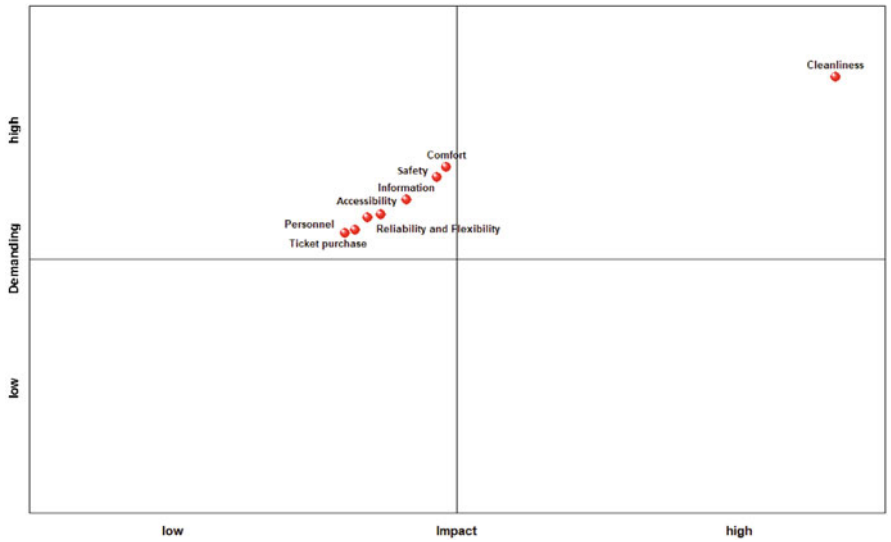

Fig. 4 Improvement diagram for Greek railways

proposed multi-criteria framework. The evaluation process was based on the Multi-criteria Satisfaction Analysis (MUSA) method that has been extensively used in existing research for customer satisfaction analysis purposes. We then applied the proposed model in the case of rail passenger services in Thessaloniki, Greece.

The findings of this paper may be helpful for practitioners who can include important quality attributes to satisfaction measures on the basis of passengers' perceptions, as well as design and implement strategies or programs towards improving passenger satisfaction and perceived level of service. Finally, the proposed multi-criteria evaluation framework can be easily generalized and applied in similar satisfaction analysis problems in rail or other transport modes in that they largely share similar quality attributes and satisfaction dimensions.

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