"Public transportation and service quality management during the COVID-19 outbreak: A case study of Tunisia"

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NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
37	1	7

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PUBLIC TRANSPORTATION AND SERVICE QUALITY MANAGEMENT DURING THE COVID-19 OUTBREAK: A CASE STUDY OF TUNISIA

Abstract

This study aims to investigate the quality management of public transportation services in the Tunisian context during the COVID-19 outbreak. The empirical study was based on the conjoint analysis approach. The sample collected is composed of 250 individuals who often use the train as a means of transport and the pairwise comparison method is adopted for conjoint analysis.

This study assesses quality management of customer service and takes into account four aspects of service quality such as comfort, way of reservation (possibility of online booking), speed, and safety. The findings revealed that the optimal combination of service offered by the Tunisian national railway company is characterized by the terms "first class", "online booking", "express", and "safety". It is favored by Tunisian customers during the COVID-19 outbreak.

Additionally, the results show that the maximum utility corresponds to the "safety train" modality followed by "second class", "online booking", and finally "stopover". Moreover, the use of new information and communication technologies (NICT) has importance for train users during the COVID-19 outbreak. Indeed, Tunisians are looking for safety and measures to reduce crowding in a train, to minimize the risk of contagion of COVID-19 outbreak.

Keywords	COVID-19 outbreak, quality of service, transportation, conjoint analysis, pairwise comparison method
JEL Classification	L91, L97, R40, M20

INTRODUCTION

All over the world people are suffering from COVID-19. The World Health Organization declared the outbreak of COVID-19 as a global pandemic on March 11, 2020. This pandemic has shaken the global markets. Following this pandemic, the literature on the effects of COVID-19 on the quality of public transportation service has immediately started and has been increasingly developed ever since. For instance, Tirachini and Cats (2020) seek measures to reduce crowding on public transport. Liu et al. (2020) show that the COVID-19 pandemic has caused a significant drop in transit demand for many transit systems in the United States. In the same vein, Gkiotsalitis and Cats (2021) introduced a mixed quadratic programming model for the redesign of public transport services. Operating costs, passengers, and lost revenue are taken into account when assessing the effects of different social distancing policies. The model is applied to the Washington DC metro network.

By studying the public transport sector, companies and managers research the expectations of non-customers and seek to understand

their local community better. They focus investment on the development of the dimensions of quality to increase the ability to attract new customers.

The choice of the transport mode is often influenced by the offered quality of service. As a result, public transportation gives great importance to the services offered to travelers and examines their expectations. To engage and retain their existing customers and attract new ones, the carriers are asked to improve the quality of their services, especially in times of crisis. They follow the changing needs of their customers: safety needs, comfort needs, needs for TIC use, needs for continuity with other services offered in the city, etc. (Parasuraman et al., 1988; Azman & Yusrizal, 2016). Indeed, several studies confirm the existence of a close link between the quality of service improvement and the increase in the number of customers. Zongjiang (2012) points out that the number of public transportation users has increased because of network restructuring in terms of time.

Managers in public transport service organizations often experience different difficulties in trying to exceed customer expectations. The use of the train as a means of public transport requires the definition of certain criteria to satisfy users and to attract non-users especially in periods of risk. Train users make the reservation for their trips either by direct contact before the trip or by an online reservation. Other quality dimensions, such as reliability, responsiveness, assurance, empathy, tangibles, and punctuality, are more commonly used.

Numerous methods have been adopted to explain the preference of customers for one of the services offered by urban transport over others. There is not yet a consensus on the determinants of the quality of transport service preferred by the customer nor on the methods used to explain them during the COVID-19 outbreak.

1. LITERATURE REVIEW

1.1. Service quality

Service quality has been widely discussed since the 20th century. It helps today's organizations differentiate themselves and gain a competitive advantage in the era of the borderless world and globalization (Karatepe & Avci, 2017). Numerous studies have been conducted on service quality (Brady & Cronin, 2001; Ismail & Yunan, 2016; Parasuraman et al., 1994). A variety of definitions were proposed to service quality by marketing researchers. The French Standardization Association (AFNOR) defines the quality of service as "the capacity of a service to respond by its characteristics to the different needs of its users or consumers".

The quality of service is considered as the ability of the service to satisfy the needs of users. It is associated with the physical elements of the service and with the results of the transaction between the customer and the staff.

According to Brady and Cronin (2001), service quality is considered a multi-dimensional con-struct. It was found that the Nordic School of thought implies that efficient service quality should have two important dimensions: technical quality and functional quality.

Karatepe and Avci (2017) showed that service quality is still relevant to help today's organizations in creating differentiation and gaining competitive advantage in an era of a borderless world and globalization. In the same vein, Kotler and Dubois (1997) defined quality of service as the gap between the customer expectations of the service and the perception of quality after using the service. Service is good if it meets the expectations of the customer or exceeds them. It is, therefore, necessary to identify customer expectations for quality services. Several factors influence these expectations such as word-of-mouth marketing, personal needs, experience, and external communication (advertising, vendor promises, etc.).

1.2. Determinants of service quality

To evaluate service quality, Murray and Howat (2002) used a very large number of attributes. In fact, 166 attributes were considered; they are

grouped into a smaller number of dimensions. While there is no agreement on the nature of the service quality, there is a general recognition that it is a multidimensional and multilevel or hierarchical construct.

Along the same line, Parasuraman et al. (1988) defend the existence of a generic list of attributes and dimensions to analyze the quality of any service. Ten non-isolated determinants of service quality that are not of equal importance to customers were developed, namely: tangibility, reliability, speed, competence, courtesy, credibility, safety, accessibility, communication, and finally knowledge and understanding of the customer. However, many authors criticize this generic list. Fonseca et al. (2010) investigated customer satisfaction through transport services. It was found that security, comfort, reliability, speed, and punctuality are quality dimensions of greater importance for public transport services. Most authors agree that the attributes included in a survey must be selected for each specific case. In fact, Carrillat et al. (2007) show that the predictive value of the Parasuraman model increases when the model items are adapted to the study context. However, many items are repeated regardless of the type and context of the considered service due to their general importance.

For example, for transit services, the items to take into account are frequency of the service, punctuality, comfort and cleanliness, safety, availability of information, personnel courtesy, and others.

A review of the recent literature on the quality of the workplace that was published in the 21st century emphasizes that tangible elements, reliability, responsiveness, insurance, and empathy are generic components of service quality. These factors are retained by researchers and practitioners to evaluate the effectiveness of service quality in various types of service sectors: for instance, in banks (Kranias & Bourlessa, 2013), and telecommunications (Segoro, 2013).

The quality of service is studied in various countries, including the United States (Kilbourne et al., 2004), India (Randheer et al., 2011), China (Chang et al., 2010), Ghana (Aidoo et al., 2013), and South Africa (Mokonyama & Venter, 2018). It is also applied in various sectors such as airline, banking, and public transport.

1.3. Quality of the transport sector

The context of the study is the quality of service offered by public transport (the train). To evaluate the service aspects in the transport sector and specifically the bus, Stradling et al. (2007) used a 68-item measurement scale. It was found that six dimensions of quality are prominent: service delivery, covering security, unwanted arousal cost, access difficulties due to disabilities, and self-image considerations.

On the other hand, Lai and Chen (2011) deploy an original measurement scale for the perceived quality of service that identifies two dimensions associated with basic transit services (frequency, service coverage, and information) and physical environment (stability, cleanliness, and security). These dimensions affect the perceived satisfaction. Carreira et al. (2014) estimate the quality of service in public bus transportation. To do so, a scale of measurement was developed based on an assessment of customer opinion. Staff skills, vehicle maintenance, individual space, off-board facilities, ticketing services, and social environment were studied. Yaya et al. (2015) identify several dimensions of service quality. It was found that users of public transport consider that service quality covers functional issues of service provision (e.g., employee interaction and information) as well as aspects of the physical environment (e.g., temperature, legroom, and crowding).

1.4. Measuring customer preference

Numerous methods have been adopted to explain customer preference for one service over others, taking into consideration different quality dimensions. Mushi (2013) uses regression analysis to test whether customer satisfaction is explained by five service quality dimensions (reliability, empathy responsiveness, assurance, and tangibles). Ojo et al. (2014) investigate customer satisfaction using SERVQUAL model concerning public transportation (bus) in Ghana. Five dimensions were used: tangibility, reliability, assurance, empathy, and responsiveness. These dimensions comprise 26 attributes. This model has been applied in various countries, including China (Chang et al., 2010) and Ghana (Aidoo et al., 2013).

Khurshid et al. (2012) conducted a survey on 120 individuals in Pakistan to examine how service quality influences customer satisfaction. Multiple regression models were used. It was revealed that there is a positive relationship between service quality and customer satisfaction in public transport services. Philip and Hazlett (1997) propose a model with a hierarchical structure, based on three types of attributes: pivotal, core, and peripheral attributes. This model is different for the rail transportation industry used by Tripp and Drea (2002). It was found that attributes (seat comfort, service announcements, restroom, and café car) have the greatest influence on the passengers' satisfaction levels. Aksoy et al. (2003) identify key service dimensions for predicting satisfaction in the airline sector using discriminant analysis. This method is similar to probit regression and logistic regression.

2. AIM AND HYPOTHESES DEVELOPMENT

This paper aims to explain customer preferences for one of the services offered by Tunisian urban transport over the others during the COVID-19 outbreak taking into consideration different quality of service aspects: comfort, safety, availability of new information and communication technologies i.e., possibility of online booking, and speed.

Throughout this study, two hypotheses are tested:

H0:   *Services offered by the national company of Tunisian railway have the same degree of importance for the Tunisian customer during the COVID-19 outbreak.*

H1:   *There is an optimal combination of services offered by the national company of Tunisian railway preferred by the Tunisian customer during the COVID-19 outbreak.*

3. METHODOLOGY

A survey is conducted using a questionnaire with both a verbal and pictorial description of the service to better explain the modalities[1] to the respondents. The sample is composed of 250 individuals who often use the train as a means of transport. The individual is faced with four possible alternatives: he can choose the first service, the second service, both services, or neither service.

This paper focuses particularly on the service quality of rail transport. Four dimensions are used to measure the quality of this service.

The first one is the comfort of use (Ismail & Yunan, 2016). The second dimension is the way of reservation. In this case, an individual can make his train reservation online (online booking) beforehand, or by direct contact on the day of his trip. Indeed, online train ticket reservation system is a web-based application that allows visitors to check train ticket availability, buy train tickets, and pay it online. According to Oloyede et al. (2014), online train reservation system provides a train transportation system, a facility to reserve seats, cancel seats, and different types of inquiries that need a quick and instant reservation. The third one is the speed. This dimension is important and deterministic depending upon the situation (Azman & Yusrizal, 2016). The last dimension is the safety; it has a very high impact on passenger satisfaction and passengers' perception of public transport quality especially during the COVID-19 outbreak (Tirachini & Cats, 2020).

The pairwise comparison method is used for conjoint analysis, following Benammou et al. (2003). It was introduced in marketing in the early 70s by Green and Rao (1971) to study and analyze the consumer choice for a certain product or service. This is a simple, structured, and particularly appropriate method when the number of scenarios[2] (products) is low.

First, it requires the use of experimental plans to determine the optimal number of products and pairs of products obtained after reduction. Second, the implementation of a questionnaire based essentially on reduced pair products is needed. Finally, the determination of the partial utilities of the attributes using an adapted estimation procedure is done.

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1   A modality is an attribute that can have a series of elements.
2   A scenario is the result of the combination of modalities of two or more factors. It is also called profile or object or stimuli. The term product has the same designation.
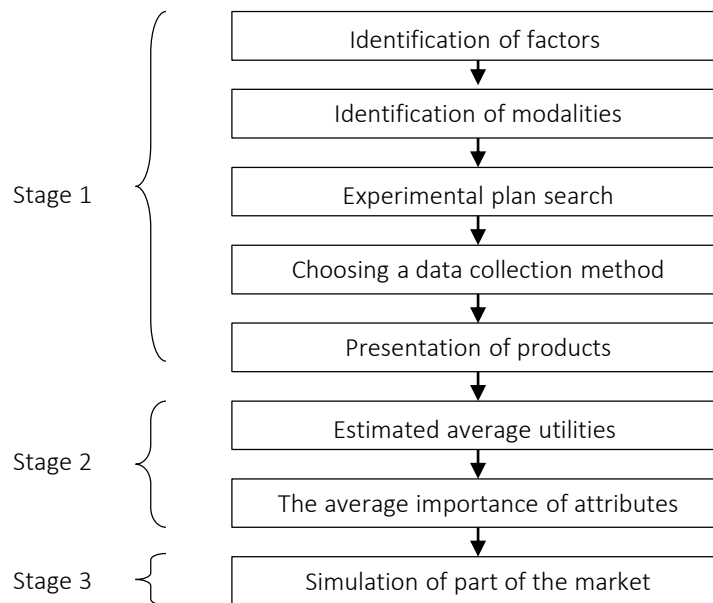
Figure 1. Conjoint analysis process

The analysis procedure can be summarized in 3 stages:

- The first stage: collecting data based essentially on the experimental plans.

- The second stage: constructing the model and estimating the parameters.

- The last stage: simulation (Figure 1).

4. RESULTS AND DISCUSSION

4.1. Collecting data based on the experimental plans

The first step consists of identifying factors and their modalities. Four factors are represented by 4 qualitative variables having respectively 3, 2, 2, and 2 modalities. The first variable is the carriage class on the train that reflects the comfort of use. It has three modalities, which are comfort class, first class, and second class. The second variable is the way of reservation, it reflects the use of new information and communication technologies i.e., the possibility of reserving online. In this case, an individual can make his train reservation online (online booking) beforehand, or by direct

contact on the day of the trip. The third variable is the speed of the train. The modalities, in this case, are a stopover train and a non-stop train (express). The fourth and last variable is the safety, its modalities are safety train and non-safety train (measures to reduce crowding in a train).

Then the study looks for the corresponding experimental plan. According to Benammou et al. (2007), the information provided by a pair of products is represented by a set of differences between the attributes[3] forming the scenarios of the pair (products). A zero difference on one factor means that the two products have the same modality and a difference equal to 1 or (–1) means that the two products take different modalities on this attribute. In this step, it is important to determine what product pairs are used in the questionnaire.

To fix these pairs, experimental plans are used. The determination of the number of pairs to be studied requires several steps. First, the complete plan following a combination of the different levels of factors, then an optimal plan using the SAS software optex procedure is determined, all the possible pairs are built, and finally the reduced pairs are found by a reduction procedure. The number of possible combinations of all modalities is equal to $3 \cdot 2^3 = 24$ products (see Table 1).

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3   An attribute is a factor composed of a series of elements. It is also called a variable.

An individual will have to compare the products two by two. However, considering 24 scenarios (products), there are 276 pairs, which is obviously not practical.

Table 1. Complete plan

Obs	Comfort of use	Reservation	Speed	Safety
1	comfort class	online booking	with stop-over	yes
2	comfort class	online booking	with stop-over	no
3	comfort class	online booking	express	yes
4	comfort class	online booking	express	no
5	comfort class	direct contact	with stop-over	yes
6	comfort class	direct contact	with stop-over	no
7	comfort class	direct contact	express	yes
8	comfort class	direct contact	express	no
9	first class	online booking	with stop-over	yes
10	first class	online booking	with stop-over	no
11	first class	online booking	express	yes
12	first class	online booking	express	no
13	first class	direct contact	with stop-over	yes
14	first class	direct contact	with stop-over	no
15	first class	direct contact	express	yes
16	first class	direct contact	express	no
17	second class	online booking	with stop-over	yes
18	second class	online booking	with stop-over	no
19	second class	online booking	express	yes
20	second class	online booking	express	no
21	second class	direct contact	with stop-over	yes
22	second class	direct contact	with stop-over	no
23	second class	direct contact	express	yes
24	second class	direct contact	express	no

The next step consists of applying the SAS-QC op-tex procedure to reduce the number of products. The optimal plan obtained using this procedure is reported in Table 2.

Table 2. Optimal plan

Obs	Comfort of use	Reservation	Speed	Safety
1	comfort class	online booking	with stop-over	yes
2	comfort class	direct contact	express	no
3	first class	direct contact	with stop-over	no
4	first class	online booking	express	yes
5	first class	direct contact	with stop-over	no
6	first class	online booking	express	yes
7	second class	online booking	express	no
8	second class	direct contact	with stop-over	yes

The following step is to code these products in a disjunctive form. This form presents all modalities in the form of 0 and 1 (modality 1 for example for a variable to 3 modalities will be noted 1 0 0). This representation allows determining the pairs that must be compared. (Benammou et al., 2007). Table 3 presents the coding of these products in a disjunctive form.

Table 3. Products coding

Obs	Comfort of use			Reservation		Speed		Safety	
1	1	0	0	1	0	1	0	1	0
2	1	0	0	0	1	0	1	0	1
3	0	1	0	1	0	1	0	0	1
4	0	1	0	1	0	0	1	1	0
5	0	1	0	0	1	1	0	0	1
6	0	1	0	0	1	0	1	1	0
7	0	0	1	1	0	0	1	0	1
8	0	0	1	0	1	1	0	1	0

From these coded products, all possible pairs can be constituted:

$$\frac{8 \times 7}{2} = 28 \text{ pairs.}$$

There are two cases in Table 3:

- Different pairs leading to identical table lines.

- Different pairs leading to equal lines in absolute value.

The number of pairs is still too high and the questionnaire will be long and boring for the respondents. To obtain a reduced number of pairs, equal pairs are removed in absolute value and the pairs which evaluate a single attribute (Benammou et al., 2007).

The first step begins by grouping equal pairs in absolute value. Indeed, when two rows of Table 3 are equal in absolute value, it is because they represent the same pair. Thirteen equivalence classes are formed. Then keeping one pair from each group (the first for example), which results in 13 pairs.

The second step is to eliminate the pairs that evaluate a single attribute. Considering for example the pair of products "First class, online reservation, with a stopover, no safety" and "First class, direct contact, with a stopover, no safety". Making a choice, in this case, amounts to express a preference based on only one characteristic (i.e., the way of reservation) since all the other characteristics are identical in both products. Hence, the evaluation of this pair will not give a relation between attributes, but between two levels of the same attribute. The information sought, however, is a relation between different attributes, which explains the removing of the pairs that only differ on a single attribute. In this case, there is one pair that evaluates a single attribute (which is pair p35). After eliminating this pair, a final matrix of 12 pairs is obtained in Table 4. This matrix presents the reduced pairs.

The following step consists in choosing a method for data collection and product presentation. The statistical processing is carried out on the data collected through questionnaires that targeted 250 Tunisians who use the train as a means of transport. The questionnaires came with both a verbal and pictorial description of the service to explain the modalities to the respondents better. The method adopted is the pairwise comparison for conjoint analysis. Each respondent individual

has 4 possible alternatives: he could choose the first product, the second product, neither product, or both products simultaneously.

4.2. Constructing the model and estimating the parameters

The conjoint analysis by choice uses the multinomial Logit model for the estimation of partial utilities. The estimation of the parameters of individual specification is with the maximum likelihood method.

Each questioned individual has his own utility. These utilities are standardized so that the sum of the utilities of the same attribute will be zero. It reflects a hierarchy of these modalities according to individual preferences. Indeed, the higher the utility is, the more the corresponding modalities are preferred.

Table 5 shows the results of the estimated average utility of the modalities. It was found that the maximum utility corresponds to the "safety train" modality with an average of 17.491, followed by "second class", "online booking" and finally "stopover".

The importance of an attribute i is defined as follows:

$$The\ importance\ of\ an\ attribute\ \mathrm{i} =$$
$$= \frac{\max utility(i) - \min utility(i)}{\sum_{i=1}^{n}\left[\max utility(i) - \min utility(i)\right]}. \quad (1)$$

Table 6 shows the averaged importance of attributes, under the assumption of homogeneity.

Table 4. Reduced pairs

Obs	Pairs	Comfort of use			Reservation		Speed		Safety	
1	p78	0	0	0	1	−1	−1	1	−1	1
2	p67	0	1	−1	−1	1	0	0	1	−1
3	p68	0	1	−1	0	0	−1	1	0	0
4	p34	0	0	0	0	0	1	−1	−1	1
5	p57	0	1	−1	−1	1	1	−1	0	0
6	p58	0	1	−1	0	0	0	0	−1	1
7	p23	1	−1	0	−1	1	−1	1	0	0
8	p24	1	−1	0	−1	1	0	0	−1	1
9	p25	1	−1	0	0	0	−1	1	0	0
10	p26	1	−1	0	0	0	0	0	−1	1
11	p27	1	0	−1	−1	1	0	0	0	0
12	p28	1	0	−1	0	0	−1	1	−1	1

Table 5. The estimated average utilities of different modalities

Variables	Number	Mean	Std Error	Minimum	Maximum
Comfort class	250	−9.748	1.538	−31.853	37.345
First class	250	−4.705	0.558	−11.864	18.350
Second class	250	14.453	1.788	−39.412	41.392
With stop-over	250	−3.971	1.217	−29.820	41.336
Express	250	3.971	1.217	−41.336	29.820
Online booking	250	13.713	1.054	−14.715	41.955
Direct contact	250	−13.713	1.054	−41.955	14.715
Safety	250	17.491	1.479	−29.508	40.432
No safety	250	−17.491	1.479	−40.432	29.508

Table 6. Average importance of attributes

Variables	Number	Mean	Std Error	Minimum	Maximum
Comfort of use	250	36.260	1.855	0.861	64.163
Practicality and the speed	250	17.196	1.826	0.047	63.523
Way of reservation	250	21.203	1.203	0.115	48.589
Safety	250	25.341	1.173	1.998	49.340

Results show that the attribute "Comfort of use" is the most important factor in consumer preferences (with an average of 36.260%), followed respectively by "safety" (25.341%), "reservation" (21.203%), and "speed" (17.196%).

4.3. Simulation of the part of the market

The last stage consists of the simulation of market shares for the eight scenarios forming the optimal plan. The calculation of market shares is determined from the individual probabilities of choice, which is the probability that a scenario will be purchased by the customer.

$$Part\ of\ the\ market =$$
$$= \frac{\sum probability\ of\ choice}{number\ of\ individuals(250)}. \quad (2)$$

To do this, the model of maximum utility is used. Each respondent chooses the scenario that gives him more satisfaction. The next step is the calculation for each individual of the total utilities of the eight scenarios. Then, the comparison of the total utilities of each scenario with the maximum utility calculated for this individual:

- If the maximum utility is for a single scenario, the latter will have a probability of purchase

equal to 1 and the other scenarios will have zero probabilities.

- If the maximum utility is relative to k scenarios, then the probability of buying each of these scenarios will be 1/k, otherwise, it is zero. Finally, the last step is the calculation of the market shares of each scenario as shown in Table 7.

The results in Table 7 show that the optimal combination of service offered by the Tunisian national railway company is characterized by the terms: "first class", "online booking", "express", and "safety". It is favored by Tunisian customers with a market share of 32.377% during the COVID-19 outbreak.

The results are consistent with Oloyede et al. (2014), who found that online train reservation provides facility to reserve seats. Moreover, it is consistent with Azman and Yusrizal (2016), who found that practicality and speed are important and deterministic depending upon the situation.

The H1 is accepted in this study. Indeed, the results show that there is an optimal combination of services offered by the national company of Tunisian railway preferred by the Tunisian customer during the COVID-19 outbreak and is characterized by the terms: "first class", "online booking", "express", and "safety".

Table 7. Part of the market

Obs	Comfort of use	Reservation	Speed	Safety	Part
1	comfort class	online booking	with stop-over	yes	2.295
2	comfort class	direct contact	express	no	6.315
3	first class	direct contact	with stop-over	no	7.540
4	first class	online booking	express	yes	12.786
5	first class	direct contact	with stop-over	no	7.868
6	first class	online booking	express	yes	32.377
7	second class	online booking	express	no	8.934
8	second class	direct contact	with stop-over	yes	21.885

CONCLUSION

The purpose of this paper is to explain customer preference for one of the services offered by urban transport over the others, taking into consideration the different qualities of this service: comfort of use, way of reservation (possibility of online booking), speed, and safety.

The results using the pairwise comparison method allow concluding the importance of these modalities. The use of NICT has importance to Tunisian national railways company users during the COVID-19 outbreak. Moreover, Tunisians are looking for safety and measures to reduce crowding in a train, to minimize the risk of contagion of COVID-19. The finding revealed also that Tunisian travelers prefer speed (express) and enough comfort (first class).

Additionally, the results show that the maximum utility corresponds to the "safety train" modality followed by "second class", "online booking", and finally "stopover".

This result can be considered as a guideline in planning and operating the public transport sector. The implementation of a service quality approach for transport is very important, given its economic, strategic, and human issues implications. It is therefore interesting for managers to take care of the quality of service offered by public transport especially in the case of a crisis in order to be able to satisfy travelers, gain their trust, build loyalty, and engage them in a long-term relationship while improving the brand image and reinforcing its advantages over other means of transport.

Management should continuously control customer satisfaction and carry market surveys frequently. Managers should also determine customer requirements since their needs and wants keep on changing from time to time. These surveys should be as frequent as possible to provide the right service.

Study on the subject of public transportation and service quality management during COVID-19 is in its nascent stages. As avenues for future research, other dimensions of service quality are proposed, such as personnel courtesy, reliability, and insurance.

AUTHOR CONTRIBUTIONS

Conceptualization: Imen Zorgati, Hajer Zorgati, Elmoez Zaabi.
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Visualization: Hajer Zorgati.
Writing – original draft: Imen Zorgati.
Writing – review & editing: Imen Zorgati, Elmoez Zaabi.

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