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Intelligent Bus Operation Service Quality Evaluation System Construction

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Abstract: Taking the quality of intelligent bus operation service as the research object, the evaluation index system of intelligent bus operation service quality is established with the dimensions of safety, comfort, convenience, timeliness, wisdom and economy. Using the fuzzy evaluation method, combined with AHP hierarchical analysis and expert method, we evaluated the smart public transportation in Tangshan and Anshan cities. Release online passenger satisfaction survey questionnaires in Tangshan and Anshan cities, in conjunction with fuzzy evaluation. Combined with the analysis of comparative passenger satisfaction survey data, the evaluation results are valid. Based on the results of the survey, reference opinions on the shortcomings of smart public transportation in Tangshan City and Anshan City are provided.

Keywords: Intelligent public transportation, evaluation index, fuzzy comprehensive evaluation, satisfaction survey.

1. Status of Research

1.1 Research purpose and significance

Since the State Council issued the "Guidance on the Priority Development of Public Transportation in Cities", China's urban bus industry has actively responded to the call for priority public transportation development, improved priority public transportation policies, increased funding, and promoted and applied new energy buses. According to the characteristics of the region, to create a bus system adapted to the characteristics of the city; improve the quality of bus services, expand the impact of bus services; extensive publicity of bus travel, to improve the attractiveness of bus travel.

Smart bus combines smart phones, buses and mobile Internet to extend bus services to users' cell phones. Based on traditional public transportation, combining intelligent technology of information and bus operation services, managers can monitor the location of buses and vehicle operation status and scientifically dispatch the number; allocate, increase or reasonably reduce the number of stations set; and provide passengers with time-sensitive information through intelligent information technology. The establishment of bus route operation display system, multimedia integrated query system, passenger service information system. Make full use of information technology to build an intelligent terminal information network connecting the computer operation management system and the parking lot to strengthen the command and control of operating vehicles and improve operational efficiency.

The framework of the existing intelligent public transport service quality evaluation system is mainly constructed from the following aspects: accessibility, service time, punctuality, fares and payment methods, transfer convenience, comfort, safety, information services, and travel environment. The above index systems do not address the psychological situation of public transport participants; lack of consideration for the physiological situation of public transport participants; lack of a service system based on traveler characteristics; lack of an effective governmental regulatory mechanism and comprehensive evaluation indexes under both subjective and objective levels[1]; and immaturity of the evaluation system for smart public transport systems.

Based on the development of technology and the actual situation, the indexes are added and subtracted, the evaluation system is established and optimized, and a survey on public transportation passenger satisfaction is conducted in Tangshan City, Hebei Province, for example, through an online survey questionnaire. The online survey data were collected and analyzed to draw conclusions and propose optimization plans or improvements to the bus operation in Tangshan City. In order to reduce the individual variability of the survey results and make the evaluation indexes more universally applicable, a similar online passenger satisfaction survey was made on the bus service quality in Anshan City by comparing the bus experience in Anshan City, and the final collected data was processed and compared with the data in Tangshan City.

1.2 Brief description of Smart Bus

Smart transportation is a new concept in the process of building smart cities, and a macro construction concept and comprehensive transportation development goal in urban rail transportation in the process of urbanization development. This technical system is guided by human wisdom and experience, based on signal and information digital processing technology, intelligent information collection as the core, and the full networking of people, machines, and things as the information resource sharing and exchange platform, so as to gradually realize the wisdom of urban transportation management[2]. Smart bus uses positioning technology, communication technology, geographic information system technology, information technology data collection technology, etc., combined with the operating characteristics of bus vehicles, the construction of intelligent bus scheduling system, reasonable planning and arrangement of routes and vehicles, intelligent scheduling, improve the utilization rate of bus vehicles, through the construction of a complete video monitoring system to achieve the monitoring

and management of the bus, stations and stations[3].

Smart bus should contain four dimensions: operation and scheduling, travel service, big data analysis, and safety assurance. Its system architecture is divided into data collection layer, storage layer, application layer, and mining layer.

2. Establish a Comprehensive Evaluation Index of the Quality of Intelligent Public Transport Operation Services

2.1. Basic Principles for Selecting Evaluation Indicators

Public transportation evaluation system indicators are selected mainly from the standard and empirical two parts. A wide variety of evaluation indicators of the level of service quality of public transport operations, but can not be fully applied to each city, should be combined with the development characteristics of urban public transport to select the appropriate indicators, the indicator system should be able to reflect the comprehensive and comprehensive level of service of urban public transport system, specifically following the principles of comprehensiveness, consistency and ease of operation.

2.2. Selection Criteria of Evaluation Indicators

The service evaluation index screening criteria of public transportation participants are divided into two aspects, namely, the government management and planning aspect and the main aspect of public transportation participants, with passenger experience as the main focus, and the respective criteria are established according to the characteristics of both aspects. In terms of government management as well as planning and operation, the policy of prioritizing the development of public transportation travel is introduced to provide passengers with a faster and more convenient way to travel by public transportation; a relational database is used to establish a link between the server and the client[4] to collect real-time and effective data on vehicles, passengers, and road conditions, monitor the operation of public transportation based on the data information, and appropriately increase or decrease the frequency of public transportation during peak or low hours to improve the The long-term monitoring data is used to analyze whether the number of vehicles and operating hours are reasonable and to improve the analysis results. On the user side, passengers can check the location, direction of travel, stopping points, departure time and frequency of bus vehicles in real time by viewing smartphone applications, in order to reduce delays and improve travel efficiency.

2.3. Establishment of Evaluation Indicators

Combined with the development dynamics of intelligent public transport, the actual development of intelligent public transport in the city to choose the appropriate evaluation indicators, safety, comfort, convenience, timeliness, intelligence, economic six dimensions as evaluation criteria, combined with the survey questionnaire passenger satisfaction with the quality of public transport operation services, each set of corresponding evaluation indicators under the guidelines, as shown in Table 1.

Table 1. Evaluation Indicators

Criterion system D_i（i=1~6)	Indicator system D_{ij}
Security D_1	Sanitation and disinfection environment in the bus D_{11}
	Safety of property in the bus D_{12}
	Driver's driving skills D_{13}
Comfort D_2	Public Transport On-board TV D_{21}
	Crowding in the bus D_{22}
	Seating comfort D_{23}
	Facilities D_{24}
Convenience D_3	Site Setup D_{31}
	Live Times D_{32}
	Number of vehicles on line D_{33}
	Route map displayed inside the bus D_{34}
	Average time spent on public transport trips D_{35}
	Convenience of interchange D_{36}
	Vehicle travel speed D_{37}
	First and last bus time D_{38}
Timeliness D_4	On-time arrival of vehicles D_{41}
	Departure interval D_{42}
Intelligence D_5	Access to ride information D_{51}
	WIFI coverage D_{52}
	Payment by code D_{53}
	Line Search D_{54}
	Vehicle arrival time D_{55}
	Number of people in the bus D_{56}
	Weather conditions D_{57}
	Temperature conditions inside the bus D_{58}
	Road congestion D_{59}
Economical D_6	Ticket Price D_{61}

3. Fuzzy Comprehensive Evaluation of Intelligent Bus Operation Service Quality

3.1. Fuzzy evaluation

Due to the complexity of the evaluation factors, the hierarchical nature of the evaluation object, the ambiguity and uncertainty of the evaluation criteria and influencing factors, and the difficulty of quantifying qualitative indicators, it is difficult for users to accurately describe the objective reality with an absolute "yes or no", and the description is mostly expressed in natural language. There are ambiguities and vagueness, and it is difficult to use classical mathematical models to measure this vagueness uniformly and accurately. Therefore, the fuzzy comprehensive evaluation method is used to comprehensively evaluate the affiliation degree of the evaluation object from multiple indicators, divide the change interval of the evaluation object, consider the hierarchy of the object, and make full use of expert experience to evaluate, so that the evaluation results are more objective and in line with reality. Fuzzy comprehensive evaluation can realize the combination of qualitative and quantitative factors, expand the amount of information, so that the evaluation number can be improved and the evaluation conclusion is credible.

Based on the basic concepts of fuzzy mathematics, the relevant terms in the fuzzy comprehensive evaluation method are defined as follows.

1. evaluation factor (D): refers to a series of relevant criteria and indicators set in order to evaluate the quality of public transport services.

2. Evaluation factor value (D_V): the technical value assigned to the corresponding evaluation factor by

establishing the evaluation function of the relevant index.

3. Evaluation value (E): the value given to the evaluation factor after determining the service level through the evaluation factor value, expert score, customer questionnaire, etc.

4. Average evaluation value (E_P): The ratio of the sum of the evaluation value of the participants to the number of participants.

5. Weight (W): refers to the proportion of evaluation factors in the evaluation system, reflecting their relative importance.

6. Weighted average evaluation value (E_{PW}): E_{PW} = average evaluation value (E_P) × weight (W).

7. Comprehensive evaluation value (E_Z): the sum of evaluation values after comprehensive weighting.

Establishing the set of factors for fuzzy judging $D=\{D_1, D_2, D_3, D_4, D_5, D_6\}$,i represents the i-th criterion in the criterion system. Establish the corresponding set of indicators under each criterion family $D_1=\{D_{11}, D_{12}, \cdots, D_{1n}\}$, n represents the nth evaluation indicator in the standard system. The fuzzy evaluation set V={very satisfied A, satisfied B, average C, less satisfied D, very dissatisfied E} was established and assigned the corresponding scores of superiority and inferiority, i.e. V={0.9,0.7,0.5,0.3,0.1}. Let the set of weights of the criterion system be $W = \{W_1, W_2, W_3, W_4, W_5, W_6\}$, and W_i represents the weight occupied by the i-th element in the criterion layer, and:

$$W_i \geq 0,\ \sum_{i=1}^{6} W_i = 1;\ W_{ij} \geq 0,\ \sum_{j=1}^{n} W_{ij} = 1 \qquad (1)$$

The judgment matrix created is specified as follows:

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \cdots & \cdots & \cdots \\ a_{n1} & \cdots & a_{nn} \end{bmatrix} \qquad (2)$$

aij denotes the importance of i relative to j when judging the jth element on the ith series.The value of aij uses a scale of 1 to 9. The conclusion values derived from the judgment matrix are the weights of each level.Establish the fuzzy relationship affiliation matrix R. After constructing the set of evaluation factors, the fuzzy relationship matrix is obtained from the affiliation of a single factor compared with other evaluation factors of the same family[5].

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1n} \\ \cdots & \cdots & \cdots \\ r_{n1} & \cdots & r_{nn} \end{bmatrix} \qquad (3)$$

The fuzzy evaluation matrix is weighted to produce a fuzzy comprehensive evaluation result.

$$B = W \times R \qquad (4)$$

The evaluation results will be finally rated according to the score corresponding to the level.

$$K = B \times V^T \qquad (5)$$

3.2. Example Analysis

3.2.1. Evaluation of Quality of Service of Intelligent Bus Operation in Tangshan City

1.Establishing weight distribution

AHP hierarchical analysis was used to determine the weight assignment of each indicator. The weights were derived using the expert method. Based on the AHP hierarchical analysis, the weight matrix of the criterion system and the indicator system was synthesized using the expert method of group decision making, as shown in Table 2.

Table 2. Weighting table of the indicator system

Indicator family weighting table (bottom element)	*Weight*
Sanitation and disinfection environment	0.0749
Safety of property in the bus	0.0682
Driver's driving skills	0.0739
Public Transport On-board TV	0.0194
Crowding in the bus	0.0470
Seating comfort	0.0420
Facilities	0.0286
Site Setup	0.0282
Live Times	0.0232
Number of vehicles on line	0.0233
Route map displayed inside the bus	0.0250
Average time spent on public transport trips	0.0264
Convenience of interchange	0.0300
Vehicle travel speed	0.0175
First and last bus time	0.0201
On-time arrival of vehicles	0.0923
Departure interval	0.0850
Access to ride information	0.0190
WIFI coverage	0.0149
Payment by code	0.0172
Line Search	0.0210
Vehicle arrival time	0.0216
Number of people in the bus	0.0108
Weather conditions	0.0056
Temperature conditions inside the bus	0.0091
Road congestion	0.0154
Ticket Price	0.1405

2. Establish the evaluation matrix

Establish an affiliation matrix R to determine the degree of affiliation of each evaluation object to the evaluation set. Considering that people of different age groups have different needs for bus service quality, psychological and physiological factors lead to a certain gap in the perception of each age group for bus service experience, therefore, the relative importance of the index system is decided by dividing the age interval into three parts, i.e., 18 and below to 25 years old, 26 to 59 years old, and 60 and above.

(1) For ages 18 and below to 25, see (1) For ages 18 and below to 25, see Table 3, to obtain R_1

Calculation of affiliation (retain four decimal places), such as r1i: r11=52/327=0.1590, r12=121/327=0.3700, r13=80/327=0.2446,r14=39/327=0.1193,r15=35/327=0.1070, and so on.

(2) For ages 26 to 59, see Table 4, to obtain R_2

(3) 60 years and above, see Table 5, to obtain R_3

Table 3. Passenger Satisfaction Survey Form(proportion)

Satisfaction level of various services of Tangshan public transport	*A*	*B*	*C*	*D*	*E*
Rationalization of bus stop settings	52	121	80	39	35
On-time bus arrival	72	96	100	28	31
Bus departure interval	52	97	94	30	54
Access to bus ride information	61	109	77	45	35
Bus WiFi coverage	51	62	90	65	59
Actual bus stop reporting	63	110	85	36	33
Number of vehicles on line	30	129	71	40	57
Bus interior display route map	64	113	77	33	40
Public Transport On-board TV	45	102	81	38	61
Crowded conditions in the bus	69	97	79	46	36
Sanitation and disinfection environment in the bus	74	93	93	42	25
Safety of property in the bus	55	115	92	34	34
Average travel time by public transport	54	118	94	35	26
Reasonableness of fares	70	119	79	17	42
Seating comfort	67	100	95	43	22
Convenience of interchange	54	114	74	39	46
Driver's driving skills and service attitude	62	117	62	51	35
Facilities	65	121	74	33	34
Bus travel speed	55	130	70	34	38
First and last bus time	59	98	82	46	42
Payment by code	69	98	89	35	36
Line Search	66	100	96	40	25
Vehicle arrival time	50	101	79	51	46
Number of people in the bus	41	96	99	40	51
Weather conditions	78	109	69	36	35
Temperature conditions inside the bus	88	103	56	36	44
Road congestion	57	111	83	29	47

Table 4. Passenger Satisfaction Survey Form(proportion)

Satisfaction level of various services of Tangshan public transport	*A*	*B*	*C*	*D*	*E*
Rationalization of bus stop settings	26	55	66	29	28
On-time bus arrival	30	59	65	25	25
Bus departure interval	37	45	57	24	41
Access to bus ride information	34	64	72	21	13
Bus WiFi coverage	27	34	54	53	36
Actual bus stop reporting	46	56	50	26	26
Number of vehicles on line	20	61	53	31	39
Bus interior display route map	45	53	56	33	17
Public Transport On-board TV	32	50	54	36	32
Crowded conditions in the bus	49	39	57	36	23
Sanitation and disinfection environment in the bus	38	60	57	28	21
Safety of property in the bus	27	55	59	36	27
Average travel time by public transport	34	56	63	29	22
Reasonableness of fares	35	64	46	24	35
Seating comfort	28	58	64	36	18
Convenience of interchange	36	52	53	36	27
Driver's driving skills and service attitude	40	67	40	35	22
Facilities	43	63	47	16	35
Bus travel speed	31	67	57	27	22
First and last bus time	19	50	52	51	32
Payment by code	39	50	42	41	32
Line Search	40	61	39	40	24
Vehicle arrival time	33	56	47	39	29
Number of people in the bus	42	63	55	20	24
Weather conditions	39	51	57	23	34
Temperature conditions inside the bus	44	46	50	31	33
Road congestion	39	41	55	36	33

Table 5. Passenger Satisfaction Survey Form(proportion)

Satisfaction level of various services of Tangshan public transport	*A*	*B*	*C*	*D*	*E*
Rationalization of bus stop settings	9	5	8	8	7
On-time bus arrival	6	8	9	8	6
Bus departure interval	7	9	10	4	7
Access to bus ride information	3	13	8	6	7
Bus WiFi coverage	6	6	12	6	7
Actual bus stop reporting	7	15	2	4	9
Number of vehicles on line	4	16	4	6	7
Bus interior display route map	9	10	7	1	10
Public Transport On-board TV	5	9	5	10	8
Crowded conditions in the bus	5	10	13	5	4
Sanitation and disinfection environment in the bus	4	12	5	8	8
Safety of property in the bus	4	13	9	4	7
Average travel time by public transport	5	9	3	9	11
Reasonableness of fares	11	9	6	4	7
Seating comfort	8	9	9	8	3
Convenience of interchange	8	11	8	7	3
Driver's driving skills and service attitude	8	11	6	5	7
Facilities	9	9	10	4	5
Bus travel speed	5	10	9	4	9
First and last bus time	7	10	4	9	7
Payment by code	4	8	10	10	5
Line Search	5	7	6	9	10
Vehicle arrival time	8	9	11	6	3
Number of people in the bus	6	7	10	8	6
Weather conditions	9	8	10	5	5
Temperature conditions inside the bus	8	10	9	4	6
Road congestion	7	7	9	8	6

$$R1=\begin{bmatrix}
0.1590 & 0.3700 & 0.2447 & 0.1193 & 0.1070\\
0.2202 & 0.2936 & 0.3058 & 0.0856 & 0.0948\\
0.1590 & 0.2966 & 0.2875 & 0.0917 & 0.1651\\
0.1865 & 0.3333 & 0.2355 & 0.1376 & 0.1070\\
0.1560 & 0.1896 & 0.2752 & 0.1988 & 0.1804\\
0.1927 & 0.3364 & 0.2599 & 0.1101 & 0.1009\\
0.0917 & 0.3945 & 0.2171 & 0.1223 & 0.1743\\
0.1957 & 0.3456 & 0.2355 & 0.1009 & 0.1223\\
0.1376 & 0.3119 & 0.2477 & 0.1162 & 0.1865\\
0.2110 & 0.2966 & 0.2416 & 0.1407 & 0.1101\\
0.2263 & 0.2844 & 0.2844 & 0.1284 & 0.0765\\
0.1682 & 0.3517 & 0.2813 & 0.1040 & 0.1040\\
0.1651 & 0.3609 & 0.2875 & 0.1070 & 0.0795\\
0.2141 & 0.3639 & 0.2416 & 0.0520 & 0.1284\\
0.2049 & 0.3058 & 0.2905 & 0.1315 & 0.0673\\
0.1651 & 0.3486 & 0.2263 & 0.1193 & 0.1407\\
0.1896 & 0.3578 & 0.1896 & 0.1560 & 0.1070\\
0.1988 & 0.3700 & 0.2263 & 0.1009 & 0.1040\\
0.1682 & 0.3976 & 0.2141 & 0.1040 & 0.1162\\
0.1804 & 0.2997 & 0.2508 & 0.1407 & 0.1284\\
0.2110 & 0.2997 & 0.2722 & 0.1070 & 0.1101\\
0.2018 & 0.3059 & 0.2936 & 0.1223 & 0.0765\\
0.4950 & 0.3089 & 0.2416 & 0.1560 & 0.1407\\
0.1254 & 0.2936 & 0.3028 & 0.1223 & 0.1560\\
0.2385 & 0.3333 & 0.2110 & 0.1101 & 0.1070\\
0.2691 & 0.3150 & 0.1713 & 0.1101 & 0.1346\\
0.1743 & 0.3394 & 0.2538 & 0.0887 & 0.1437
\end{bmatrix}$$

$$R2=\begin{bmatrix}
0.1275 & 0.2696 & 0.3235 & 0.1422 & 0.1373\\
0.1471 & 0.2892 & 0.3186 & 0.1225 & 0.1225\\
0.1814 & 0.2206 & 0.2794 & 0.1176 & 0.2010\\
0.1667 & 0.3137 & 0.3529 & 0.1029 & 0.0637\\
0.1324 & 0.1667 & 0.2647 & 0.2598 & 0.1765\\
0.2255 & 0.2745 & 0.2451 & 0.1275 & 0.1275\\
0.0980 & 0.2990 & 0.2598 & 0.1520 & 0.1912\\
0.2206 & 0.2598 & 0.2745 & 0.1618 & 0.0833\\
0.1569 & 0.2451 & 0.2647 & 0.1765 & 0.1569\\
0.2402 & 0.1912 & 0.2794 & 0.1765 & 0.1127\\
0.1863 & 0.2941 & 0.2794 & 0.1373 & 0.1029\\
0.1324 & 0.2696 & 0.2892 & 0.1765 & 0.1324\\
0.1667 & 0.2745 & 0.3088 & 0.1422 & 0.1078\\
0.1716 & 0.3137 & 0.2255 & 0.1176 & 0.1716\\
0.1373 & 0.2843 & 0.3137 & 0.1765 & 0.0882\\
0.1765 & 0.2549 & 0.2598 & 0.1765 & 0.1324\\
0.1961 & 0.3284 & 0.1961 & 0.1716 & 0.1078\\
0.2108 & 0.3088 & 0.2304 & 0.0784 & 0.1716\\
0.1520 & 0.3284 & 0.2794 & 0.1324 & 0.1078\\
0.0931 & 0.2451 & 0.2549 & 0.2500 & 0.1596\\
0.1912 & 0.2451 & 0.2059 & 0.2010 & 0.1569\\
0.1961 & 0.2990 & 0.1912 & 0.1961 & 0.1176\\
0.1618 & 0.2745 & 0.2304 & 0.1912 & 0.1423\\
0.2059 & 0.3088 & 0.2696 & 0.0980 & 0.1176\\
0.1912 & 0.2500 & 0.2794 & 0.1127 & 0.1667\\
0.2157 & 0.2255 & 0.2451 & 0.1520 & 0.1618\\
0.1912 & 0.2157 & 0.2696 & 0.1765 & 0.1618
\end{bmatrix}$$

$$R3=\begin{bmatrix}0.2432 & 0.1351 & 0.2162 & 0.2162 & 0.1892\\ 0.1622 & 0.2162 & 0.2432 & 0.2162 & 0.1622\\ 0.1892 & 0.2432 & 0.2703 & 0.1081 & 0.1892\\ 0.0811 & 0.3514 & 0.2162 & 0.1622 & 0.1892\\ 0.1622 & 0.1622 & 0.3243 & 0.1622 & 0.1892\\ 0.1892 & 0.4054 & 0.0541 & 0.1081 & 0.2432\\ 0.1081 & 0.4324 & 0.1081 & 0.1622 & 0.1892\\ 0.2432 & 0.2703 & 0.1892 & 0.0270 & 0.2703\\ 0.1351 & 0.2432 & 0.1351 & 0.2703 & 0.2162\\ 0.1351 & 0.2703 & 0.3514 & 0.1351 & 0.1081\\ 0.1081 & 0.3243 & 0.1351 & 0.2162 & 0.2162\\ 0.1081 & 0.3514 & 0.2432 & 0.1081 & 0.1892\\ 0.1351 & 0.2432 & 0.0811 & 0.2432 & 0.2973\\ 0.2973 & 0.2432 & 0.1622 & 0.1081 & 0.1892\\ 0.2162 & 0.2432 & 0.2432 & 0.2162 & 0.0811\\ 0.2162 & 0.2973 & 0.2162 & 0.1892 & 0.0811\\ 0.2162 & 0.2973 & 0.1622 & 0.1351 & 0.1892\\ 0.2432 & 0.2432 & 0.2703 & 0.1081 & 0.1351\\ 0.1351 & 0.2703 & 0.2432 & 0.1081 & 0.2432\\ 0.1892 & 0.2703 & 0.1081 & 0.2432 & 0.1892\\ 0.1081 & 0.2162 & 0.2703 & 0.2703 & 0.1351\\ 0.1351 & 0.1892 & 0.1622 & 0.2432 & 0.2703\\ 0.2162 & 0.2432 & 0.2973 & 0.1623 & 0.0811\\ 0.1623 & 0.1892 & 02703 & 0.2162 & 0.1623\\ 0.2432 & 0.2162 & 0.2703 & 0.1351 & 0.1351\\ 0.2162 & 0.2703 & 0.2432 & 0.1081 & 0.1632\\ 0.1892 & 0.1892 & 0.2432 & 0.2162 & 0.1632\end{bmatrix}$$

3. Weighting the fuzzy evaluation matrix to derive fuzzy comprehensive evaluation results.

1) 18 years and younger to 25 years

B_1 = [0.1973, 0.3282, 0.2575, 0.1085, 0.1166]

2) 26 and up to 59 years old

B_2 = [0.1718, 0.2767, 0.2657, 0.1485, 0.1376]

3) Age 60 and above

B_3 = [0.1867, 0.2658, 0.2074, 0.1598, 0.1804]

4. Scoring of the obtained results.

1)18 years old and below to 25 years old

$$K_1 = (0.1973, 0.3282, 0.2575, 0.1085, 0.1166) \times (0.9, 0.7, 0.5, 0.3, 0.1)^T = 0.5803$$

2)26 years old to 59 years old

$$K_2 = (0.1718, 0.2767, 0.2657, 0.1485, 0.1376) \times (0.9, 0.7, 0.5, 0.3, 0.1)^T = 0.5395$$

3)60 years old and above

$$K_3 = (0.1867, 0.2658, 0.2074, 0.1598, 0.1804) \times (0.9, 0.7, 0.5, 0.3, 0.1)^T = 0.5238$$

5. Inspection

The data from the questionnaire on public transport satisfaction in Tangshan City are summarized in **Table 6**.

Table 6. Satisfaction survey questionnaire data statistics table

Age Segment	A	B	C	D	E
18 years old and below to 25 years old	17.56%	33.18%	25.32%	11.88%	12.05%
26 years old to 59 years old	16.59%	27.16%	27.50%	15.49%	13.26%
60 years old and above	17.57%	27.57%	19.86%	16.22%	18.78%

B1*=[0.1756, 0.3318, 0.2532, 0.1188, 0.1205]

B2*=[0.1659, 0.2716, 0.2750, 0.1549, 0.1326]

B3*=[0.1757, 0.2757, 0.1986, 0.1622, 0.1878]

With B_1, B_2, B_3 evaluation results are basically the same, this evaluation is valid.

6. Analysis and evaluation

Based on the evaluation results, combined with the evaluation set, it is concluded that.

1) the age group 18 and younger to 25 years old, with an evaluation score of 0.5803, which tends to be between satisfactory and average.

2) 26-59 years old age group, with an evaluation score of 0.5395, between satisfactory and average, tending to be average.

3) Age group 60 and above, evaluation score 0.5238, between satisfactory and average, tending to be average.

Overall evaluation of the level of service of intelligent bus operation in Tangshan City between satisfactory and average, tends to be average, according to the results of the survey, a brief description of the survey items with large data fluctuations or relatively obvious contrast, and correspondingly put forward reference for improvement.

(a) the average time spent on public transport, this in the age group of 60 years and above showed a high level of dissatisfaction, accounting for about 55%. According to the analysis of the characteristics of the age group, 60 years old and above due to older, physical conditions do not allow long-term travel, the performance of unsatisfactory situation during the bus ride.

(b) the first and last bus time, 18 years old and below to 25 years old accounted for a relatively high degree of satisfaction with this, 26-59 years old, 60 years old and above age group showed greater dissatisfaction. As most of the 26-59 age group are commuters and most of the 60 and above age group are retired or in a jobless state, they have relatively higher requirements for the first and last bus times in the morning and evening.

3.2.2. Evaluation of Quality of Service of Intelligent Bus Operation in Anshan City

In order to make the selection, establishment, evaluation and application of the comprehensive evaluation index of intelligent bus operation service quality less individual variability and more convincing, this paper adds a comparison city based on the example application of Tangshan City, and selects Anshan City, Liaoning Province as a comparison city to further test the applicability of the evaluation index. Anshan city transit satisfaction questionnaire data for statistics, as shown in Table 7.

Table 7. Satisfaction survey questionnaire data statistics table

Age Segment	A	B	C	D	E
18 years old and below to 25 years old	38.11%	27.26%	27.12%	4.25%	3.25%
26 years old to 59 years old	21.55%	39.37%	30.78%	4.86%	3.44%
60 years old and above	28.13%	35.66%	25.97%	6.92%	3.32%

B1*=[0.3811, 0.2726, 0.2712, 0.0425, 0.0325]

B2*=[0.2155, 0.3937, 0.3078, 0.0486, 0.0344]

B3*=[0.2813, 0.3566, 0.2597, 0.0692, 0.0332]

The evaluation results are basically consistent with B1, B2 and B3, so the evaluation is valid. Based on the evaluation results, combined with the evaluation set, it is concluded that.

1) For the age group of 18 and below to 25 years old, the evaluation score is 0.6766, which tends to be satisfactory between satisfactory and average.

2) The age group 26-59 years old, with an evaluation score of 0.6317, between satisfactory and fair, tending to be satisfactory.

3) Age group 60 and above, evaluation score 0.6612, between satisfactory and average, tending to be satisfactory.

Analysis shows that the overall evaluation of the level of service of intelligent bus operation in Anshan City is not a big gap, between satisfaction and general, tends to be satisfied, according to the results of the survey, briefly describe the data fluctuation or contrast relatively obvious survey items, and accordingly put forward improvement reference.

(a) From the overall view of the data collected from the questionnaire, the bus WiFi coverage, on-board TV, bus crowding situation and fare reasonableness account for a high percentage of dissatisfaction. WiFi coverage of Anshan city bus is low, most of the line buses have not yet installed WiFi facilities; car TV not only helps passengers to spend time when riding the bus, enhance the bus ride experience, but also can be used as a medium to spread public welfare, business, policy and other social information, but some of the buses in Anshan city on the car TV is damaged, closed to stop using or not installed, should be as soon as possible Installation or repair of car TVs; certain lines of buses are crowded with large numbers of people, and the crowding level in the bus is high, and the riding experience is poor, such as the 9 road, the line from the city center to the suburbs of the town, through the school, farmers market, used car market, airport, etc., the site around the construction of a variety of people flow. Should be appropriate to increase the number of cars on the line, shorten the interval time between departures, in the morning and evening peak and holidays and other special times in a timely manner to adjust the number of vehicles on the line; Anshan bus fares in May 2018 rose to 2 yuan, more than 20 kilometers to 3 yuan, passengers expressed dissatisfaction in terms of fare increases.

(b) A large proportion of passengers access to bus line information is through the bus stop, and in asking passengers hope that the Anshan Intelligent Bus again to provide which services, the installation of electronic stop signs higher voice. At present, some of the stations in Anshan to install electronic signs, the relevant departments can consider planning for the installation of a comprehensive electronic station in Anshan bus stations, the installation of electronic signs can greatly facilitate passengers to obtain information on the bus, according to the information provided by the electronic station to reasonably arrange travel plans.

(c) Some of the bus driver's attitude is not friendly, or extreme passenger attitude, occasionally clashes with passengers, in this regard, the bus company should strengthen the requirements of the driver during the work on duty etiquette, passengers should also understand to comply with the fixed rules and regulations of the bus vehicle.

4. Summary

With the evaluation index of wisdom bus operation service quality as the research object, the evaluation index system of wisdom bus operation service quality was established by using fuzzy comprehensive evaluation method, combined with expert method, and the evaluation of wisdom bus in Tangshan City and Anshan City was conducted. The evaluation results are that the quality of smart bus operation service in Tangshan City is between satisfactory and average, and tends to be average; the quality of smart bus operation service in Anshan City is between satisfactory and average, and tends to be satisfactory. According to the statistical analysis of passenger satisfaction questionnaire data, the evaluation results are basically the same, and the evaluation is valid.

The following references to intelligent public transport in Tangshan City and Anshan City are proposed.

1. Bus companies should establish excellent management mechanisms, real-time monitoring, train the business skills of drivers and passengers, set up regular assessment and promotion to improve the competitiveness of drivers and passengers, improve the professional ethics of staff, and provide high-quality services to passengers with a civilized and friendly attitude.

2. Improve station facilities and the waiting environment, update bus facilities in a timely manner, set up new technological means such as electronic station signs, code payment, and bus cell phone software, optimize and simplify the operating system, and provide accurate information to passengers.

3. Through research, set up customized buses in densely populated neighborhoods with similar destinations to save resources and improve the convenience of passengers from departure to destination.

4. Bus companies should put passengers first, improve the quality of bus services, and develop with services, build a scientific and reasonable bus service system, continuously improve service quality, actively cater to passenger needs, and do their best to solve travel problems for passengers.

In particular, most public transportation was completely shut down due to the outbreak of novel coronavirus pneumonia in late 2019. When an infectious disease outbreak occurs, the inherent characteristics of public transportation make the bus a dangerous high-incidence infectious area, and it is difficult to do real-time disinfection during the operation of public transportation vehicles, so perhaps in the future, a lot of human and material resources can be invested in building products that can do real-time disinfection in the car. In a way, the new crown epidemic also promotes the development of public transportation to new areas.

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