



A modified VIKOR multiple-criteria decision method for improving domestic airlines service quality

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A B S T R A C T

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This study applies a modified VIKOR method to improve service quality among domestic airlines in Taiwan. Our model allows decision-makers to understand the gaps between alternatives and aspired-levels in practice. A large sample is used to establish a complete service quality evaluation framework for reducing the gaps to achieve the aspired-level. We then applied the modified VIKOR method to establish the gaps in priorities between alternatives and aspired-levels. Finally, based on these gaps in priorities, we provide managerial implications to improve different carriers for satisfying the customers' needs to achieve the aspired-level.

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1. Introduction

In a competitive environment, delivering high-quality service is important but from 2008 the global economic downturn saw airlines are struggling just to survive. This paper evaluates the service level of Taiwan's domestic airlines and to identify gaps between what airlines provide and what customers' seek.

Traditional statistical testing and multiple-criteria decision-making (MCDM) methods have been used to establish service quality criteria, with most of the latter comparing all alternatives based on synthesized rankings. In practice, however, decision-makers often simultaneously evaluate their progress in attaining one or a limited number alternatives and thus need to know where gaps in alternatives exist to minimize them. Traditional methods are unsuitable for ranking these gaps because each alternative has its own criteria. This study uses a modified VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje in Serbian, meaning multicriteria optimization and compromise solution) method for tackling this problem (Opricovic and Tzeng, 2004).

2. Service quality in the airline industry

There is no universally accepted definition of air service quality. In general, air service quality can be defined as a consumer's overall

impression of the relative efficiency of a supplier's organization and services (Park et al., 2004) and involves various interactions between a passenger and airline employees, as well as anything that is likely to influence passengers' perceptions, of a carrier's image (Gursoy et al., 2005).

Understanding exactly what customers expect is a crucial step in delivering high-quality service, but only customers, however, can truly define service quality. Parasuraman et al. (1985), however, have developed a framework that defines service quality as the degree and direction of discrepancy between customers' expectations and perceptions. Their model, further developed, has become known as SERVQUAL, and contains five dimensions with 22 attributes of quality (Parasuraman et al., 1988). It has become the most widely used model of customer-perceived service quality.

Most previous MCDM models focus on ranking and selecting from a set of alternatives based on the synthesized scorings for each alternative with the same criteria. Our modified VIKOR method built on SERVQUAL allows solving MCDM problems with conflicting and non-commensurable criteria and provides a solution that is the closest to the optimum.

3. The modified VIKOR method

The main difference between our modified VIKOR and the original VIKOR (Opricovic and Tzeng, 2002) is the replacement of a fixed common number of criteria for all alternatives with a set of criteria for each alternative, and providing a method for ranking the

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Table 1
The normalized weight-rating table for modified VIKOR.

Alternative	Criteria					Alternative	Criteria				
	c_1	...	c_j	...	c_n		c_1	...	c_j	...	c_{n_i}
A_1	f_{11}	...	f_{1j}	...	f_{1n}	A_1	$w_1^1 r_{11}$	...	$w_j^1 r_{1j}$	...	$w_{n_1}^1 r_{1n_1}$
\vdots	\vdots		\vdots		\vdots	\vdots	\vdots		\vdots		\vdots
A_i	f_{i1}	...	f_{ij}	...	f_{in}	A_i	$w_1^i r_{i1}$	...	$w_j^i r_{ij}$	...	$w_{n_i}^i r_{in_i}$
\vdots	\vdots		\vdots		\vdots	\vdots	\vdots		\vdots		\vdots
A_m	f_{m1}	...	f_{mj}	...	f_{mn}	A_m	$w_1^m r_{m1}$	...	$w_j^m r_{mj}$	...	$w_{n_m}^m r_{mn_m}$

Normalized $\Rightarrow \times w_j^i$

unimproved gaps of alternatives. The alternatives are denoted as $A_1, A_2, \dots, A_i, \dots, A_m$ and are assessed by $n_1, n_2, \dots, n_i, \dots, n_m$ criteria. w_j^i is the weight attached to criterion j of alternative A_i and f_{ij} is the rating of criterion j of alternative A_i . The modified VIKOR involves:

Step 1. Determine the best f_j^* and the worst f_j^- values. Because each alternative is evaluated, not compared according to its own-criteria, an ideal and negative ideal point, as in the VIKOR method ($f_j^* = \max f_{ij}$ and $f_j^- = \min f_{ij}$), cannot be set. Therefore, the benefit or cost must be reset according to the expectation of the decision-maker for each criterion of the alternatives; the best f_{ij}^* is the aspired level and the worst f_{ij}^- the tolerable level; these functions are expressed as;

$$f_{ij}^* = \text{aspired_}f_{ij} \text{ (or } f_{ij}^* = \text{aspired_level}),$$

$$f_{ij}^- = \text{tolerable_}f_{ij}, \text{ (or } f_{ij}^- = \text{tolerable_level}).$$

In addition, we rewrite the normalized weight-rating table for the new method in real world as Table 1: where n_i is the number of criteria in each alternative A_i because each alternative has its own assessing criteria. The weights w_j^i must be normalized under the same alternative (where $j = 1, \dots, n_i$), i.e., $\sum_{j=1}^{n_i} w_j^i = 1$. In addition, the best f_{ij}^* is the desired level, and the worst f_{ij}^- is the tolerable level for each criterion of each alternative. The normalized ratings r_{ij} are

$$r_{ij} = \frac{(|f_{ij}^* - f_{ij}|)}{(|f_{ij}^* - f_{ij}^-|)}. \tag{1}$$

Step 2. Compute S_i and $Q_i, i = 1, 2, \dots, m$. The functions are

$$S_i = \sum_{j=1}^{n_i} w_j^i r_{ij}, \quad i = 1, 2, \dots, m \text{ and } \sum_{j=1}^{n_i} w_j^i = 1 \tag{2}$$

$$Q_i = \max_j \{r_{ij} | j = 1, 2, \dots, n_i\}, \quad i = 1, 2, \dots, m \tag{3}$$

In the traditional VIKOR method, Q_i is represented as $\max_j \{w_j r_{ij} | j = 1, 2, \dots, n_i\}$, implying that group utility is more important than maximum regret. Because Q_i is only a part of S_i, S_i must exceed $Q_i \cdot S_i$ is emphasized more than Q_i in the traditional VIKOR method. However, the maximum regret is often important in practice and is usually taken into account. To balance S_i and $Q_i, Eq. (3)$ is used instead of the traditional Q_i in VIKOR. We use $Eq. (3) \max_j \{r_{ij} | j = 1, 2, \dots, n_i\}$ in $i = 1, 2, \dots, m$ as showing the maximum gap to be improved.

Step 3. Compute the index values $R_i, i = 1, 2, \dots, m$.

$$R_i = v(S_i - S^*) / (S^- - S^*) + (1 - v)(Q_i - Q^*) / (Q^- - Q^*), \tag{4}$$

where $0 \leq v \leq 1$; when $v > 0.5$, this indicates that S is emphasized more than Q in Eq. (4), whereas when $v < 0.5, Q$ is emphasized. More specifically, when v equals unity, it represents a decision-making process that could use the strategy of maximizing group utility, whereas when v is zero, it represents a process that could use a minimum individual regret strategy that is found among maximum individual regrets/gaps of lower-level criteria of each alternative. The weight v would affect the ranking of the alternatives and is usually determined externally by the experts. Moreover, S^*, S^-, Q^* and Q^- are rewritten and listed as

$$S^* = \min_i S_i, \quad S^- = \max_i S_i \quad \text{or} \quad S^* = \text{best_}S, \quad S^- = \text{worst_}S,$$

$$Q^* = \min_i Q_i, \quad Q^- = \max_i Q_i \quad \text{or} \quad Q^* = \text{best_}Q,$$

$$Q^- = \text{worst_}Q$$

In the VIKOR method, we set S^*, S^-, Q^* and Q^- by $S^* = \min S_i, S^- = \max S_i, Q^* = \min Q_i$ and $Q^- = \max Q_i$. However, in the modified VIKOR method, we append an aspired level and a tolerable level for S and Q of the compared alternatives respectively to obtain absolute relations for the index values R_i . Here we can decide the best $S^* = 0$ and $Q^* = 0$, the worst $S^- = 1$ and $Q^- = 1$ to get absolute relations for the index values R_i , we can re-writing Eq. (4) as $R_i = vS_i + (1 - v)Q_i$. Specifically, if we use $\min S_i$ as S^* and $\min Q_i$ as Q^* , it implies a relative relation for the index relations R_i of these alternatives, whereas if we use a zero gap as the best level and unity as the worst, it implies an absolute relation for the index relations R_i of these alternatives.

Table 2
Passenger profiles.

Attributes/distribution	Sample number	Frequency (%)
Gender		
Male	3426	61.7
Female	2127	38.3
Age		
20 or younger	291	5.2
21–30	1322	24.0
31–40	1356	24.4
41–50	1293	23.3
51–60	967	17.4
61 or older	322	5.7
Occupation		
Government employee	1386	24.0
Private-sector employee	1170	21.1
Student	384	6.9
Private business	555	10.0
Management	547	9.8
Others	1511	28.2
Education		
Junior high or below	519	9.3
Senior high	1447	26.1
College	2851	51.3
Graduate school	736	13.7

Table 3
Passenger flight information.

Attributes/distribution	Sample number	Frequency (%)
<i>Number of flights per month</i>		
1 or less	3761	67.7
2–4	1469	26.5
5–7	215	3.9
8 or more	108	1.9
<i>Booking channel</i>		
Telephone	293	5.3
Internet	1326	23.9
Travel agency	1357	24.4
Airline counter	1295	23.3
Others	1282	23.1
<i>Seat class</i>		
Business	5418	97.6
Economy	135	2.4
<i>Purpose of travel</i>		
Business	2078	37.4
Visiting friends/relatives	1552	27.9
Tourism	1701	30.6
Other	222	4.1

4. Data

Since the high-speed railroad has completed, the domestic airline marketing of Taiwan has faced a stronger challenger. At first, airlines tried to reduce price to attract more customers, but they soon realized that was a no-win situation. The service quality is the

fundamental element needed to survive in this highly competitive domestic market. Supported by the Civil Aviation Administration of Taiwan (CAAT) and four major domestic airlines, we surveyed passengers directly to obtain their perceptions on airline services.

Although SERVQUAL has been widely used to measure service quality across industries, no two providers of service are exactly alike (Gilbert and Wong, 2003). We thus conclude that the adaptation of SERVQUAL is needed and should serve only as a framework for this study. We designed a questionnaire in several steps in light of the previous literature. First, SERVQUAL and a Gallup survey delegated by the CAAT in 2000 were taken into consideration. Even though SERVQUAL presents general quality attributes for service industries, it does not include specific attributes to reflect the specific operation environment that is being investigated. Therefore, we proposed a 32-item questionnaire that included airline service quality dimensions consistent with the SERVQUAL model and with the Gallup survey. With the help of four customer-service managers of domestic airlines and officers of CAAT who had experience in the Gallup survey of 2000, we called a meeting to refine the questions. Through a four-hour brainstorming session, experts deleted and added questions from the original 32 items, ending up with 30 service attributes. The refined questionnaires were pre-tested by 45 passengers. According to the results of the pre-test, another meeting was called and the experts revised the questionnaire to eight dimensions with 28 service attributes. Therefore, the content validity of the questionnaire was deemed adequate. The questions were adapted to reflect the industry

Table 4
Passengers' importance and perception for service criteria.

Dimensions/criteria	UNI Air (n = 2917)		Transasia (n = 1302)		Mandarin (n = 1102)		Daily Air (n = 277)	
	Imp.	Per.	Imp.	Per.	Imp.	Per.	Imp.	Per.
<i>Booking service</i>								
Convenience of booking (1)	3.73	3.83	3.87	3.87	3.93	3.90	3.77	3.76
Promptness of booking (2)	3.62	3.83	3.82	3.89	3.93	3.89	3.77	3.73
Courtesy of booking employee (3)	3.90	3.86	4.00	3.92	4.01	3.91	3.87	3.77
<i>Ticketing service</i>								
Convenience of buying ticket (4)	3.91	3.85	3.96	3.89	3.99	3.91	3.88	3.73
Promptness of buying ticket (5)	3.89	3.85	3.94	3.92	4.00	3.92	3.88	3.72
Courtesy of selling employee (6)	3.94	3.87	3.98	3.92	4.02	3.92	3.97	3.80
<i>Check-in</i>								
Convenient check-in (7)	3.97	3.88	3.99	3.92	4.05	3.95	3.94	3.75
Efficient check-in (8)	3.95	3.88	3.95	3.93	4.03	3.92	3.92	3.74
Courtesy of check-in employee (9)	3.95	3.88	4.00	3.94	4.00	3.95	3.94	3.76
Check-in information (10)	3.94	3.87	3.97	3.90	3.94	3.89	3.90	3.75
<i>Baggage handling</i>								
Convenience of baggage handling (11)	4.00	3.74	4.01	3.75	3.94	3.78	3.96	3.68
Courtesy of baggage handling employee (12)	3.90	3.72	3.95	3.75	3.81	3.75	3.89	3.68
<i>Boarding process</i>								
Clarity of announcement (13)	3.91	3.85	3.92	3.88	3.93	3.88	3.95	3.73
Promptness of ID check (14)	3.98	3.84	4.01	3.86	4.00	3.85	4.00	3.72
Courtesy of boarding employee (15)	3.97	3.85	4.01	3.90	4.02	3.87	3.97	3.72
<i>Cabin service</i>								
Cabin safety demonstration (16)	4.01	3.85	4.02	3.90	4.05	3.86	3.89	3.69
Variety of newspapers and magazines (17)	3.76	3.75	3.76	3.77	3.81	3.75	#	#
Courtesy of flight attendants (18)	4.04	3.87	4.07	3.93	4.07	3.90	#	#
Flight attendant willing to help (19)	4.02	3.87	4.00	3.88	4.03	3.89	#	#
Clean and comfortable interior (20)	3.99	3.88	4.03	3.92	4.13	3.92	3.75	3.68
In-flight facilities (21)	3.98	3.84	3.98	3.87	4.05	3.87	3.78	3.65
Captain's announcement (22)	3.95	3.83	3.96	3.87	4.02	3.86	3.69	3.66
<i>Baggage claim</i>								
Convenient baggage claim (23)	3.66	3.65	3.65	3.70	3.70	3.66	3.76	3.61
Courtesy of baggage claim employee (24)	3.65	3.63	3.68	3.66	3.68	3.62	3.71	3.57
<i>Responsiveness</i>								
Fair waiting-list call (25)	3.56	3.47	3.53	3.41	3.80	3.77	3.72	3.68
Handling of delayed flight (26)	3.53	3.47	3.52	3.40	3.69	3.65	3.63	3.48
Complaint handling (27)	3.78	3.76	3.70	3.64	3.95	3.93	3.77	3.45
Missing baggage handling (28)	3.76	3.75	3.69	3.57	3.89	3.87	3.68	3.65

Note: # Not applicable; Imp. = importance; Per. = perception.

Table 5
The modified VIKOR weight gap analysis of four airlines.

	UNI Air		Transasia		Mandarin		Daily Air	
	Gap ($\times 10^{-2}$)	Rank	Gap ($\times 10^{-2}$)	Rank	Gap ($\times 10^{-2}$)	Rank	Gap ($\times 10^{-2}$)	Rank
<i>Booking service</i>								
Convenience of booking (1)	0.806	27	0.803	25	0.783	24	0.974	25
Promptness of booking (2)	0.782	28	0.778	22	0.790	20	0.998	22
Courtesy of booking employee (3)	0.821	24	0.793	24	0.791	19	0.992	24
<i>Ticketing service</i>								
Convenience of buying ticket (4)	0.831	17	0.807	17	0.787	22	1.027	17
Promptness of buying ticket (5)	0.827	19	0.781	13	0.782	25	1.035	13
Courtesy of selling employee (6)	0.823	21	0.789	23	0.786	23	0.993	23
<i>Check-in</i>								
Convenient check-in (7)	0.822	23	0.790	18	0.770	26	1.026	18
Efficient check-in (8)	0.817	25	0.776	16	0.788	21	1.029	16
Courtesy of check-in employee (9)	0.817	25	0.778	20	0.760	28	1.018	20
Check-in information (10)	0.823	21	0.802	21	0.799	18	1.016	21
<i>Baggage handling</i>								
Convenience of baggage handling (11)	0.931	3	0.920	4	0.870	4	1.089	4
Courtesy of baggage handling employee (12)	0.922	5	0.906	6	0.862	5	1.070	6
<i>Boarding process</i>								
Clarity of announcement (13)	0.831	17	0.806	11	0.797	16	1.045	11
Promptness of ID check (14)	0.853	11	0.839	7	0.833	9	1.067	7
Courtesy of boarding employee (15)	0.844	14	0.810	10	0.822	12	1.059	10
<i>Cabin service</i>								
Cabin safety demonstration (16)	0.852	13	0.812	9	0.836	8	1.062	9
Variety of newspapers and magazines (17)	0.868	7	0.849	26	0.862	5	#	#
Courtesy of flight attendants (18)	0.844	15	0.799	26	0.811	13	#	#
Flight attendant willing to help (19)	0.839	16	0.822	26	0.810	14	#	#
Clean and comfortable interior (20)	0.826	20	0.799	14	0.808	15	1.031	14
In-flight facilities (21)	0.853	11	0.825	8	0.829	11	1.063	8
Captain's announcement (22)	0.854	10	0.821	15	0.830	10	1.030	15
<i>Baggage claim</i>								
Convenient baggage claim (23)	0.913	6	0.871	5	0.898	3	1.089	5
Courtesy of baggage claim employee (24)	0.924	4	0.905	3	0.919	1	1.105	3
<i>Responsiveness</i>								
Fair waiting-list call (25)	1.001	1	1.030	19	0.846	7	1.023	19
Handling of delayed flight (26)	0.997	2	1.034	2	0.902	2	1.150	2
Complaint handling (27)	0.866	9	0.924	1	0.765	27	1.218	1
Missing baggage handling (28)	0.868	7	0.966	12	0.796	17	1.035	12

Note: # Not applicable.

circumstances of Taiwan and specific service contexts by perception.

For the primary survey, one weekday and one weekend were picked to target passengers of various backgrounds who used four domestic airlines, namely, UNI Air, Transasia, Mandarin, and Daily Air. We trained graduate students as coworkers, who were then sent to 16 domestic airports in Taiwan. Coworkers distributed the questionnaire and a pen to passengers at each boarding gate at the 16 airports, and others collected their answers at exit doors after the baggage claim. In the primary survey, we approached all passengers taking flights with the four airlines in question and asked them for three types of data: information on their flights, their expectation and satisfaction level regarding each service attribute, and their personal profiles. Part 1 of the passengers' questionnaire gathers flight information such as airline name, how many times the passenger flies with the airline per month, class of the seat, the purpose of the flight, and what booking and ticketing channels they used. Part 2 dealt with airline service attributes. Respondents were asked to indicate the perceived importance of each attribute using a 5-point Likert scale with anchors of "1 = least important" to "5 = most important." The performance for each attribute was rated from "1 = strongly dissatisfied" to "5 = strongly satisfied." The last part of the questionnaire collected demographic information such as sex, age, education, and occupation.

We distributed 25,334 questionnaires and received 5598, a return that after eliminating those that contained incomplete answers provide 5553 useful responses. The useful questionnaires completed were 2917 for UNI Air, 1303 for Transasia, 1056 for

Mandarin, and 277 for Daily Air. The distribution matches the domestic marketing share, as Daily Air has relatively small fleets and mainly operates between small islands. The passenger profiles and flight information are seen in Tables 2 and 3.¹

5. Results

According to the data collected as described above, we first discuss the importance and performance of each criterion. Then, based on the modified VIKOR method, we prioritize the gaps of four airlines for improvement. Finally, we analyze four airlines' overall performance from different aspects.

5.1. The importance of each criterion

Table 4 indicates that cabin service criteria are considered the most important factor of service quality, with the exception of the "variety of newspapers and magazines". This is to be expected, because cabin service occupies more of a passenger's traveling time than other aspects of service. Conversely, respondents considered the experience of baggage claim as the least important attribute of service. It is reasonable to have such low expectations, as many passengers are on business trips and do not have large bags to claim. The results also imply that offering a wide selection of

¹ In terms of reliability, Cronbach's alphas were found to be 0.98 for expectation-related items and 0.99 for perception-related items.

Table 6
Results of modified VIKOR analysis.

	$S_i (v = 1)$	$Q_i (v = 0)$	$R_i (v = 0.5)$
UNI Air	0.241 (3)	0.306 (2)	0.273 (2)
Transasia	0.236 (2)	0.320 (4)	0.278 (3)
Mandarin	0.229 (1)	0.276 (1)	0.253 (1)
Daily Air	0.262 (4)	0.310 (3)	0.286 (4)

Ranking in parentheses.

newspapers and magazines is not essential to keep passengers content.

The levels of passenger satisfaction with service attributes range between 3.40 and 3.95. Generally, the reservation, ticketing, check-in, and boarding processes received the highest service satisfaction levels, with baggage claim, complaint mechanisms, and handling of delays showed lower satisfaction levels. This would seem to suggest passengers are more content highly computerized services than those, involving personal contact with staff, although, the courtesy shown by check-in employees did obtained the highest levels of service satisfaction level. This implies that passengers are generally happy with the frontline employees, but not other staff. There are also differences between the agency supply labor services, e.g., the average rating for baggage handling is greater than that for baggage claim. On domestic flights, baggage handling at check-in is usually done at the counter by airline employees, while the baggage claim is mainly managed by ground-handling companies.

5.2. The modified VIKOR weighed gap analysis

We combine the passengers' importance assessment (weighting) and perception (performance) to obtain the weighted gaps of airlines and rank them by carrier. For example, Table 5 shows that UNI airline has a significant gap between the desire situation and perception in its fair waiting-list call; the carrier has the largest market share for domestic flights, but passengers seem not to be satisfied with its system of wait-listing passengers. Its wait-list calling is completely dependent on check-in staff based on passengers' signatures. Hence travelers do not instantly know their updated status. Customers complain about Transasia and Daily Air's handling, and in particular in the indifferent handling of complaints by staff. In the case of Mandarin, its main problem is "courtesy of baggage claim employee." We also see from the table that the handling of delayed flights due to the changeable weather and air traffic control issues over Taiwan, also poses challenges to the airlines.

5.3. Overall service competition

To examine the airlines' relative competitive strengths on service criteria identified by customers, a modified VIKOR analysis can be carried out based on the weighted gap evaluation result in Table 5. Note that because the planes used by Daily Air are small

and flight time is short, some service attributes are not applicable. That is, its criteria are different from other airlines. Table 6 shows the results that are based on different gap analysis, namely, maximal group utility ($v = 1$), maximal regret ($v = 0$), and combined both ($v = 0.5$).

If we set $A > B$, (i.e., A outranks B) then the rank of service quality based on the R_i value for the airlines is: Mandarin $>$ UNI $>$ Transasia $>$ Daily. However, depending on our maximum group utility or regret, so rankings differ. It can be seen that Transasia is better than UNI if we highlight maximum group utility. On the other hand, UNI is second, Daily Air third, and Transasia last if the maximum level of regret is considered. Consequently, the decision-makers can select suitable weights (v) according to their priorities: if they are concerned about maximum group utility and individual regret, then $R (v = 0.5)$ would be used; if they are concerned about maximum group utility, then $S (v = 1)$ would be used; if they are concerned about individual regret it would be $Q (v = 0)$. In addition, the modified VIKOR method is able to derive and rank the unimproved gaps of the airlines, and the results can help related managers strengthen their weaknesses and prioritize the strategies for improvement.

6. Conclusion

The analysis provides airlines with summaries of their weaknesses and suggestions for improvement. We have isolated important items on which airlines may wish to focus and those in which airlines have already done well and can reduce their efforts without affecting the overall service level.

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