THE COMPARATIVE ANALYSIS OF APPLYING DIFFERENT INDICATOR TYPES TO THE PERFORMANCE EVALUATION IN BOTH AIRLINES AND HIGHWAY BUS COMPANIES

Cheng-Min FENG
Professor
Institute of Traffic and Transportation
College of Management
National Chiao Tung University
4F, No.114, Sec.1, Chung Hsiao W. Rd.,
Taipei, Taiwan, Republic of China
Fax: 886-2-23822278 or 23120082
E-mail: cmfeng@cc.nctu.edu.tw

Rong-Tsu WANG
Assistant Professor
Department of International Trade
Van Nung Institute of Technology
6F, No. 8, Lane 202, Chung-Hsing Street,
Chung-Ho 235, Taiwan, Republic of China
Fax: 886-2-22464289
E-mail: caroljoe@mail.sysnet.net.tw

Abstract: Performance evaluation indicators can be divided into three types, according to their data models: transportation indicators, financial ratios, and mixed indicators. This paper tried to build the framework of evaluation indicators which could be used to the performance evaluation in transport industries, based on the results set forth by Feng and Wang on the performance evaluation of Taiwan's domestic airline industry and the highway bus industry operating within Taipei County, respectively. First, we introduce the performance evaluation framework of transportation industry proposed by Feng and Wang. Second, we explored the influences of different indicator types on the performance evaluation of the transportation industry from two distinct aspects, namely: the number and distribution of and the implication of representative indicators. The results showed that the transportation indicators and financial ratios were better suited for evaluating production and execution efficiency, respectively, whereas the mixed indicators are better suited for assisting the evaluation of each of the components. Otherwise, this paper provided the framework included by 9 evaluation indicator classifications. It is useful to the performance evaluation on the other transport industries under the market and cost structure conditions similar to Taiwan's domestic airline industry and the highway bus industry operating within Taipei County.

Key Words: Transportation indicator, Financial ratio, Mixed indicator

1. INTRODUCTION

There are many indicators for evaluating the performance of the transportation industry. They can be divided into three types according to their data models. The first type is the transportation indicator, which consists of transportation input (i.e. labor, fleet, vehicle, etc.) and transportation output (i.e. vehicle kilometer, frequencies, flights, etc.). This kind of indicator is formed from two items of transportation data divided by each other. The second

type is the financial ratio, which consists of one item divided by another in the financial statement. The third type is the mixed indicator, which consists of one item of transportation data and another in a financial statement divided by each other.

Most previous studies concerning the performance evaluation of transportation industry focus merely on one type of indicator and neglected the others. Those who have used transportation indicators as the main indicator for evaluation include Allen and Dicease (1976), Alter (1976), Dajani and Gilbert (1978), Talley and Anderson (1981), Zerrllo et al. (1981), Fielding et al. (1985). Research that has focused on financial ratios includes Doganis (1992), and Ashford and Moore (1992). The results of evaluations that stress a certain type of indicator only represent a certain portion of the overall performance, and are incapable of revealing performance as a whole.

Consequently, most papers dealing with performance evaluations limit themselves for instance to financial performance, level of service, etc, and are unable to measure the total operation performance of the transportation industry completely. Those papers that do contain overall performance evaluation restrict themselves to a specific industry (i.e. highway bus, bus, airlines, marine, etc.). They rarely explore the possibility of their evaluation models being applied to other transportation industries or to propose a collective set of evaluation indicators. Therefore, Feng and Wang (2000, 2001) in their studies of Taiwan's domestic airline industry and the highway bus industry operating within Taipei county incorporated financial ratios into their performance evaluation framework, and investigated different indicator types suitable for performance evaluation. Their research shows that using three indicator types to conduct performance evaluation so the transportation industry are more comprehensive than those using only one. The performance evaluation model they proposed could be used on individual cases or could be extended for application to other industries as well depend on whether the results of the two papers are similar.

This paper tries to provide a performance evaluation framework suitable for the transportation industry by comparing the similarities and contrasts between the results found by Feng and Wang (2000, 2001). A common framework is helpful reference to select representative indicators for evaluating the performance of transportation industry. First, we introduce the performance evaluation conceptual framework of transportation industry proposed by Feng and Wang (2000,2001). Second, with the two independent research as bases, it investigates the influences of three indicator types (transportation indicator, financial ratio, and mixed indicator) on performance evaluation of the transportation industry from the viewpoints of the number and distribution of representative indicators and the implication of representative indicators, and then arrives at a set of performance evaluation indicators for the transportation industry.

2. A CONCEPTUAL FRAMEWORK

Feng and Wang (2000, 2001), in the performance evaluation framework of transportation industry they proposed, divided total performance into three efficiency categories- production, marketing, and execution according to the cycle of operation activities. The production efficiency of factor input and service output measures the resources expended to produce output (i.e. labor productivity, short-term liquidation, and long-term solvency). It can be represented as the efficiency of production-related departments, such as manufacturing department. The marketing efficiency of service output and service consumption measures the extent to which output is used (i.e. flights marketing capability, seat marketing capability, and debts turnover). It can be represented as the efficiency of departments related to sale activities, such as the departments of sales and marketing. The execution efficiency of service consumption and factor input measures the output used against the resources expended (i.e. fleet execution capability, return of investment, and assets and stockholder's turnover). It can represent the efficiency of management-related departments, such as finance and management. The concept is illustrated in Figure 1.

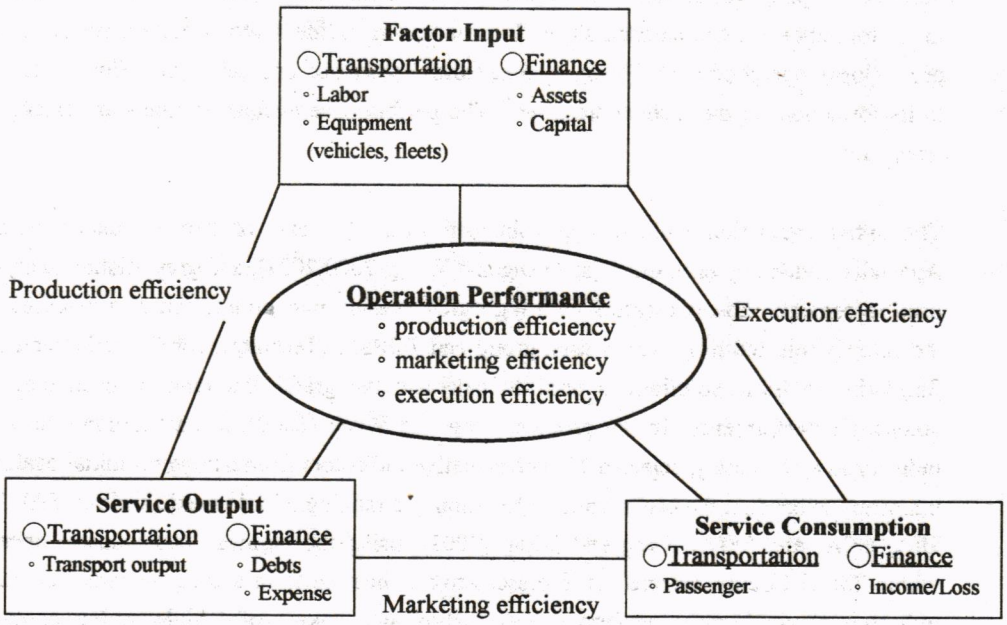

Figure 1. A Conceptual Framework of the Performance Evaluation of the Transportation Industry

In a competitive market situation, the activities of an enterprise can be viewed as a consecutive and cyclic process that consists of three parts—factor input, service output, and service consumption. In contrast to previous papers, which only considered transport or finance factors,

each part was evaluated according to both factors. Under the ambit of transport, according to the input—output—consumption concept, factor input is composed of labor and equipment; service output is composed of transport output; and service consumption is composed of passenger. Under the ambit of finance, according to the five accounting factors (assets, debts, stockholder's equity, income, and expense) assets and capital are categorized as financial input; debts and expense are categorized as financial output; and income/loss, belongs to financial consumption.

The above 9 major evaluation categories can be further divided into more detailed evaluation items of each category. The names and stresses of transport evaluation items are not entirely consistent because of the nature of individual industry and equipment. As shown in Appendix, in the highway bus industry, it is called vehicles, whereas in the airline industry, it is referred to as fleet. The transport outputs more heavily emphasized by the highway bus industry are frequencies and vehicle-km, whereas in the airline industry, they are flights, operation-km, number of salable seats, and seat-km. The division of financial evaluation items is assisted by three characteristics of the transportation industry. Aside from assets, debts, and expense as described in part two, capital is divided into stock capital and stockholder's equity, according to its formation on the balance sheet. Income/loss is divided into operation revenue, gross profit (loss), operation profit (loss), income (loss) before tax, and net income (loss), according to its formation on the income statement. The performance evaluation items are arranged in Appendix.

The initial evaluation indicators set obtained from the ratio of two evaluation items in Appendix divided by each other (see Feng and Wang, 2000,2001), and grey relation analysis is used to separate those indicators with high grey relation into groups. Then, a representative indicator is selected from within each group and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is used to calculate the grade and rank of each individual company's performance. In the process, Feng and Wang (2000), using the domestic airline industry as a case study, selected 15 representative indicators from among 63 initial evaluation indicators to conduct the performance evaluation and ranking of 5 domestic airlines (FAT, TNA, UIA, GCA, and FMA). Feng and Wang (2001), using the highway bus industry operating within Taipei County, selected 16 representative indicators from among 56 initial evaluation indicators to conduct the performance evaluation and ranking of 4 highway bus companies (San-Chung, Capital, Tam-Sui, and Chih-Nan). The division of initial indicators and the selection of representative indicators are shown in Table 1.

Table 1. Classification of Indicator Groups of Production, Marketing, and Execution

Taiwan's domestic airlines industry				Taipei County highway bus industry		
Groups		Representative indicator of each group	Evaluation Formula	Groups	Representative indicator of each group	Evaluation Formula
P[1]	AF-I	AF_2* (ratio of operation-km to number of employees)	Operation kilometers/ number of employees	BF-I	BF_1* (ratio of frequencies to number of employees)	Frequencies/ number of employees
	AF-II	AF_4* (ratio of seat-km to number of employees)	Seat kilometers/ number of employees	BF-II	BF_3* (ratio of frequencies to number of maintenance employees)	Frequencies/ number of maintenance employees
	AF-III	AF_5* (ratio of number of flights to number of fleets)	Number of flights/ number of fleets	BF-III	BF_8* (ratio of vehicle-km to number of vehicle)	Vehicle-kilometers/ number of vehicle
	AF-IV	AF_7* (ratio of number of seats to number of fleets)	Number of seats/ number of fleets	BF-IV	BF_9* (ratio of vehicle-km to fuel)	Vehicle-kilometers/ fuel
				BF-V	BF_{10}*** (ratio of frequencies to total assets)	Frequencies/ total assets
	AF-V	AF_{19}** (equity ratio)	Stockholder's equity/ total assets	BF-VI	BF_{14}** (equity ratio)	Stockholder's equity/ total assets
M[2]	AM-I	AM_3*** (ratio of operation income/loss to number of flights)	Operation income (loss)/ number of flights	BM-I	BM_3*** (ratio of operation revenue to frequencies)	Operation revenue/ frequencies
	AM-II	AM_6* (passenger ratio)	Number of passengers/ number of seats	BM-II	BM_5* (ratio of passengers to vehicle-km)	Number of passengers/ vehicle-kilometers
	AM-III	AM_9*** (ratio of operation income/loss to number of seats)	Operation income (loss)/ number of seats	BM-III	BM_{11}** (operation profit ratio)	Operation income (loss)/ operation revenue
	AM-IV	AM_{17}** (net income ratio)	Net income (loss)/ operation revenue			
	AM-V	AM_{21}** (interest expense ratio)	Operation revenue/ interest expense	BM-IV	BM_{15}** (total debts turnover)	Operation revenue/ total debts
E[3]	AC-I	AC_3*** (ratio of operation revenue to number of employees)	Operation revenue/ number of employees	BC-I	BC_2* (ratio of passenger-km to number of employees)	Passenger-kilometers/ number of employees
				BC-II	BC_4*** (ratio of income/loss before tax to number of employees)	Income (loss) before tax/ number of employees
	AC-II	AC_5* (ratio of number of passengers to number of fleets)	Number of passengers/ number of fleets	BC-III	BC_6*** (ratio of operation revenue to number of drivers)	Operation revenue/ number of drivers
	AC-III	AC_{11}** (return on fixed assets)	Net income (loss)/ fixed assets	BC-IV	BC_{16}** (return on fixed assets)	Income (loss) before tax/ fixed assets
	AC-IV	AC_{14}** (return on operation profit to capital)	Operation income (loss)/ average capital	BC-V	BC_{19}** (return on operation profit to capital)	Operation income (loss)/ average capital
	AC-V	AC_{15}** (return on income before tax to capital)	Income (loss) before tax/ average capital	BC-VI	BC_{22}** (total assets turnover)	Operation revenue/ stockholder's equity

1: Production; 2: Marketing; 3:Execution
*:transportation indicators; **:financial ratios; ***:mixed indicators
Source: Feng and Wang(2000,2001)

3. THE COMPARISON OF EVALUATION RESULT

This paper proceed from the two angles of the number and distribution of representative indicators and the implication of representative indicators to examine the influence of three indicator types on the performance evaluation of the transportation industry, and then propose a framework of indicators suited for use in the performance evaluation of the transportation

industry.

3.1. The Number and Distribution of Representative Indicators

Investigating the number and distribution of representative indicators can help determine whether the roles played by the different indicator types in the performance evaluation framework of the airline industry and highway bus industry are similar. This is performed separately from three distinct angles—total operation efficiency, efficiency categories, and the distribution of indicators.

3.1.1. Total operation efficiency

An excess of indicators in the evaluation process slows and complicates the process, and can produce biased results due to ambiguous relationships between indicators. As shown in Table 1, in the airline industry, an initial set of 63 indicators has been reduced to 15 representative indicators, a reduction of 76.2%. In the highway bus industry, 16 representative indicators were selected from among 56 initial indicators, a reduction of 71.4%. This level of reduction in the number of indicators can save labor, expenses, and time in the evaluation process.

Furthermore, as shown in Table 2, among the 15 representative indicators of the airline industry, 6 are transport indicators and 6 are financial ratios, each occupying 40% of the total number of indicators. There are 3 mixed indicators, occupying 20% of the total number. Among the 16 representative indicators of the highway bus industry, there are six of each transport indicators and financial ratios, each occupying 37.5% of the total number, and there are 4 mixed indicators, which occupy 25% of the total number. Given the number and distribution of transport indicators and financial ratios among representative indicators and the percentages of the total number of representative indicators these two indicator types occupy, using only one type of indicator to conduct performance evaluation would be insufficient to represent total performance efficiency.

Table 2. The Distribution of Indicator Types by Industry

Industry	Transportation indicator		Financial ratio		Mixed indicator	
	Number	percentage	number	percentage	number	percentage
Airline	6	40.0	6	40.0	3	20.0
Highway bus	6	37.5	6	37.5	4	30

3.1.2. Efficiency categories

Further dissection of the distribution of each indicator type according to three efficiency categories (production, marketing, and execution) of total operation performance can help us to understand indicator types in the evaluation of different efficiency categories. As shown in Table 3, out of the 5 representative indicators for evaluating production efficiency of the airline

industry, 4 of them are transport indicators, occupying 80% of the total. Out of the 5 representative indicators for evaluating execution efficiency, 3 of them are financial ratios, occupying 60% of the total. A similar situation occurs in the highway bus industry. There are 6 representative indicators each in the production and execution efficiency categories. Among the former, 4 are transport indicators, and in the latter, 3 are financial ratios. They occupy 67.7% and 50% of the total respectively. The representative indicators of marketing efficiency are distributed more dispersedly.

Table 3. The Distribution of Indicator Types by Efficiency Category

Category	Industry	Transportation indicator		Financial ratio		Mixed indicator	
		number	percentage	number	percentage	number	percentage
Production efficiency	Airline	4	80.0	1	20.0	0	0.0
	Highway bus	4	66.7	1	16.7	1	16.7
	Total	8	72.7	2	18.2	1	9.1
Marketing efficiency	Airline	1	20.0	2	40.0	2	40.0
	Highway bus	1	25.0	2	50.0	1	25.0
	Total	2	22.2	4	44 4	3	33.3
Execution efficiency	Airline	1	20.0	3	60.0	1	20.0
	Highway bus	1	16.7	3	50.0	2	33.3
	Total	2	18.2	6	54.5	3	27.3

If we add up the totals each indicator type among the airline industry and highway bus industry, it can be seen in Table 3 that 8 of the 11 representative indicators that measure production efficiency are transport indicators, occupying 72.7% of the total. Out of the 11 representative indicators that measure execution efficiency, 6 are financial ratios, occupying 54.5% of the total. As for the 9 representative indicators that measure marketing efficiency, each indicator type occupies a more average ratio. The above analysis reveals that production efficiency and execution efficiency are simpler. Transport indicators dominate the former and financial ratios the latter. Marketing efficiency must be collectively measured by each of the three indicator types.

3.1.3. The distribution of indicators

In order to further illustrate the influence of each indicator type on the performance evaluation of transportation industries, the distribution of each indicator type is shown in Table 4. In both the airline industry and highway bus industry, the 6 transport indicators are distributed among the production, execution, and marketing categories as 4,1,1; and 6 financial ratios are distributed among the three categories as 1,2,3. This shows that when using transport indicators or financial ratios to conduct performance evaluation, no inconsistencies will arise between the two different industries.

Table 4. The Distribution of Indicator Types

Indictor type	Industry	Production efficiency		Marketing efficiency		Execution efficiency	
		Number	percentage	number	Percentage	number	percentage
Transportation indicator	Airline	4	66.7	1	16.7	1	16.7
	Highway bus						
Financial ratio	Airline	1	16.7	2	33.3	3	50.0
	Highway bus						
Mixed indicator	Airline	1	25.0	1	25.0	2	50.0
	Highway bus	0	0	2	66.7	1	33.3

Moreover, the distribution of each indicator type reveals that in the airline industry, 4 out of the 6 transport indicators belong to production, and 3 out of the 6 financial ratios belong to execution. Their ratios to total numbers are 66.7% and 50% respectively. The mixed indicators are distributed more dispersedly. A similar situation exists in the highway bus industry. The result shows that transport indicators are more suited for evaluating production efficiency, financial ratios are more suited for evaluating execution efficiency, and mixed indicators are best used to supplement the evaluation of each category.

3.2 The Implication of Representative Indicators

The above analysis illustrates the distribution and characteristics of different indicator types through the numbers of the representative indicators of each indicator type and the ratios they occupy in each efficiency category. Whether the contents of the 15 representative indicators of the airline industry and the 16 representative indicators of the highway bus industry are similar is of crucial importance to establish a framework for performance evaluation. The higher the degree of similarity between the representative indicators of each industry, the more reliable this framework will be for evaluation of other industries. However, as stated in part 2, due to differences in characteristics and the terms of equipment between the two industries, there are differences in their evaluation items. Therefore, these kinds of factors must be eliminated before a comparison can be conducted. As shown in Appendix, in the asset category, the component of flight equipment has been added to fixed assets for the airline industry because the cost of fleet purchase far exceeds that of the highway bus industry. In the transport output category, highway bus industry frequencies correlates to airline industry flights and operation-km, and vehicles-km correlates to number of salable seats and seat-km. In addition, because insufficient data is available on number of maintenance employees and number of drivers, only number of employees has been included in the labor evaluation category for the airline industry. This paper takes the above situations into consideration in its comparison of representative indicators, so as to facilitate comparison of representative indicators for other industries.

3.2.1. The comparison of representative transport indicators

The comparison of representative transportation indicators is illustrated in Table 5. In the production category, both industries emphasize the ratio of transport output to number of employees (AF_2,AF_4,BF_1,BF_3), and emphasize the ratio of transport output to number of equipment units (AF_5,AF_7,BF_8). In the marketing category, both emphasize the size of passenger ratio (AM_6, BM_5). The differences are that the ratio of transport output to fuel (BF_9) is added as a representative indicator to the production category of the highway bus industry. Also, in the execution category, the airline industry emphasizes the ratio of number of passengers to number of fleets (AC_5), while the highway bus industry emphasizes the ratio of passenger-km to number of employees (BC_2).

Table 5. The Comparison of Representative Transportation Indicators

Category	Airline industry		Highway bus industry	
	Code	Evaluation formula	Code	Evaluation formula
Production efficiency	AF_2	Operation-km/number of employees	BF_1	Frequencies/number of employees
	AF_4	Seat-km/number of employees	BF_3	Frequencies/number of maintenance employees
	AF_5	Number of flights/number of fleets	BF_8	Vehicle-km/number of vehicle
	AF_7	Number of salable seats/number of fleets	BF_9	Vehicle-km/fuel
Marketing efficiency	AM_6	Number of passengers/number of salable seats	BM_5	Number of passengers/vehicle-km
Execution efficiency	AC_5	Number of passengers/number of fleets	BC_2	Passenger-km/number of employees

3.2.2 The comparison of representative financial ratios

The comparison of representative financial ratios is illustrated in Table 6. In the production category, both industries emphasize the equity ratio (AF_{19}, BF_{14}). In the marketing category, they both emphasize the ratio of income to operation revenue (AM_{17}, BM_{11}), and return on fixed assets (AC_{11}, BC_{16}) and return on operation profit to capital (AC_{14}, BC_{19}) both appear in the execution category of each industry. The differences are that in the marketing category, interest expense (AM_{21}) and total debts turnover (BM_{15}) are respectively added to the two industries as representative indicators. In the execution category, return on income before tax to capital (AC_{15}) is added to the airline industry and total assets turnover (BC_{22}) is added to the highway bus industry.

3.2.3 The comparison of representative mixed indicators

The comparison of representative mixed indicators is illustrated in Table 7. In the marketing category, both industries emphasize the ratio of profit to transport output (AM_3, BM_3). In the execution category, they both emphasize the ratio of profit to number of employees

(AC_3,BC_4,BC_6). The differences are that ratio of profit to number of employees (BF_{10}) is added as a representative indicator to the production efficiency category of the highway bus company, and the production efficiency category of the airline industry contains no mixed indicators. In the marketing category, ratio of income (loss) to number of salable seats (AM_9) is added as a representative indicator in the airline industry.

Table 6. The Comparison of Representative Financial Ratios

Category	Airline industry		Highway bus industry	
	Code	Evaluation formula	Code	Evaluation formula
Production efficiency	AF_{19}	Equity ratio	BF_{14}	Equity ratio
Marketing efficiency	AM_{17}	Net income ratio	BM_{11}	Operation profit ratio
	AM_{21}	Interest expense ratio	BM_{15}	Total debts turnover
Execution efficiency	AC_{11}	Return on fixed assets	BC_{16}	Return on fixed assets
	AC_{14}	Return on operation profit to capital	BC_{19}	Return on operation profit to capital
	AC_{15}	Return on income before tax to capital	BC_{22}	Total assets turnover

Table 7. The Comparison of Representative Mixed Indicators

Category	Airline industry		Highway bus industry	
	Code	Evaluation formula	Code	Evaluation formula
Production efficiency	—	—	BF_{10}	Frequencies/total assets
Marketing efficiency	AM_3	Operation income(loss)/number of flights	BM_3	Operation revenue/frequencies
	AM_9	Operation income(loss)/number of seats		
Execution efficiency	AC_3	Operation revenue/ number of employees	BC_4	Income(loss) before tax/number of employees
			BC_6	Operation revenue/number of drivers

3.3 The Evaluation Indicators Framework of Operation Performance

According to the results of the above analysis, this paper categorizes the performance indicators for the airline industry and highway bus industry into 9 major indicator classifications. These are used separately in the evaluation of production efficiency, marketing efficiency, and execution efficiency. When the conditions of the transport industries are similar, these can serve as reference for the performance evaluation of other industries. They are illustrated in Table 8. Moreover, the result shows that inconsistencies still exist among certain representative indicators in the airline industry and highway bus industry. Specifically are the interest expense burden generated by the predilection of the airline industry for expensive flight equipment, the return on income before tax to capital and the ratio of number of passengers to number of fleets, and the ratio of operation income (loss) to number of salable

seats. In the highway bus industry, there are the total assets turnover, total debts turnover and the ratio of transport output to fuel, and the ratio of number of employees to passenger-km. The reasons for these inconsistencies can tentatively be attributed to the higher investment capital required of the airline industry, which causes it to tend toward evaluation indicators related to flight equipment and stocks. In contrast, due to differences in cost calculation units in the highway bus industry, it tends toward evaluation indicators related to fuel, service consumption, assets, and debts. Therefore, the "characteristic indicators" has been added to Table 8 to act as a base for evaluation indicators that arise out of the differences in industry characteristics between the two industries.

Table 8. The Framework for Transportation Industry Performance evaluation Indicators

Total operation performance	Major evaluation indicator type	Classification	Type
Production efficiency	Transportation indicator	Transport output per employee	Transportation
		Transport output per unit equipment	Transportation
		Equity ratio	Financial ratio
		Characteristic indicator	
Marketing efficiency	Three indicator types	Passenger ratio	Transportation
		Profit per unit operation revenue	Financial ratio
		Profit per flight (or frequency)	Mixed indicator
		Characteristic indicator	
Execution efficiency	Financial ratio	Return on fixed assets	Financial ratio
		Return on operation profit to capital	Financial ratio
		Profit per employee	Mixed indicator
		Characteristic indicator	

4. CONCLUSIONS

This paper takes as its foundation the results found by Feng and Wang (2000, 2001) in their separate papers on the performance evaluation of Taiwan's domestic airline industry and the highway bus industry operating within Taipei County. First, we introduce the conceptual evaluation framework. Second, we analyze the influences of different indicator types on the performance evaluation of transportation industries, and then produce a suitable framework of indicators for the performance evaluation in the transportation industry. The results are as follows:

1. Because the results of the comparative analysis of the two cases are similar, it reveals that the conceptual framework could be applied to the performance evaluation of the other transportation industries under the similar market and cost structure conditions.
2. The distribution of indicator types shows that transportation indicators and financial ratios are equally important in the performance evaluation of the transportation industry, and

mixed indicators are helpful for augmenting evaluation results. Namely, transportation indicators are better suited for evaluating production efficiency; financial ratios are better suited for evaluating execution efficiency; and, mixed indicators are better suited for supplementing the other two indicator types in the evaluation of each efficiency category.

3. The results show that the performance evaluation indicators for the transportation industry could be divided into 9 major classifications. These 9 classification of indicators are helpful references to select evaluation indicators for measuring the performance of other industries under the market and cost structure conditions similar to Taiwan's domestic airline industry and highway bus industry operating within Taipei County.

REFERENCES

Allen, W. G. and Dicease, F. (1976) Transit service evaluation: preliminary identification of variables characterizing level of service, **Transportation Research Record 606,** 41-47.

Alter, C. H. (1976) Evaluation of public transit services: the level-of-service concept, **Transportation Research Record 606,** 37-40.

Ashford, N. J. and Moore, C. A. (1992) **Airport Finance**, Van Nostrand Reinhold, New York.

Dajani, J. S. and Gilbert, G. (1978) Measuring the performance of transit systems, **Transportation Planning and Technology, Vol.4,** 79-103.

Dognais, R. (1992) **The Airport Business**, Routledge, London.

Feng, C. M. and Wang, R.T. (2000) Performance evaluation for airlines including the consideration of financial ratios, **Journal of Air Transport Management, Vol. 6,** 133-142.

Feng, C. M. and Wang, R. T. (2001) Considering the financial ratios on the performance evaluation of highway bus industry, **Transport Reviews.** (Accepted)

Fielding, G. J., Babitsky, T. T., and Brenner, M. E. (1985) Performance evaluation for bus transit, **Transportation Research, Vol.19A, No.1,** 73-82.

Scherer, F. M. and Rose, D. (1990) **Industrial Market Structure and Economic Performance (3rd edition)**, Houghton Mifflin Company, New York.

Talley, W. K. and Anderson, P. P. (1981) Effectiveness and efficiency in transit performance: a theoretical perspective, **Transportation Research, Vol.15A, No.6,** 431-436.

Zerrllo, R. J., Keck, C. A., and Schneider, N. R. (1981) Analysis of transit performance measures used in New York State, **Transportation Research Record 797,** 52-58.

Appendix: Items for Performance Evaluation in Two Industries

Classifications	Evaluation category	Evaluation items for highway bus	Evaluation items for airline
Factor input	Labor	Number of employees	Number of employees
		Number of maintenance employees	
		Number of drivers	
	Vehicle	Number of vehicle	Number of fleets
		Fuel	Fuel
	Assets	Current assets*	Current assets*
		Fixed assets*	Flight equipment*
			Fixed assets*
		Total assets*	Total assets*
	Capital	Stock capital*	Stock capital*
		Stockholders' equity*	Stockholders' equity*
Product output	Transport output	Frequencies	Flights
			Operation kilometers
		Vehicle kilometers	Number of salable seats
			Seat kilometers
	Debts	Current liabilities*	Current liabilities*
		Long-term liabilities*	Long-term liabilities*
		Total liabilities*	Total liabilities*
	Expense	Operation cost*	Operation cost*
		Interest expense*	Interest expense*
Consumer consumption	Passengers	Number of passengers	Number of passengers
		Passenger kilometers	Passenger kilometers
	Income/Loss	Operation revenue*	Operation revenue*
		Gross profit(loss)*	Gross profit(loss)*
		Operation income(loss)*	Operation income(loss)*
		Income(loss) before tax*	Income(loss) before tax*
		Net income(loss)*	Net income(loss)*

* refers to the accounting items in financial statements