

A STUDY ON THE FREIGHT OPERATING STRATEGY OF TAIWAN RAILWAY ADMINISTRATION

Chen-Yuan CHANG

Doctorial student

Institute of Traffic & Transportation

National Chiao Tung University

4F, 114, Section I, Chung Hsiao W. Rd., Taipei, Taiwan, R.O.C.

Fax:886-2-3120082

Tel:886-2-3315953

Wu-Cheng CHEN

Professor

Institute of Traffic & Transportation

National Chiao Tung University

4F, 114, Section I, Chung Hsiao W. Rd., Taipei, Taiwan, R.O.C.

Fax:886-2-3120082

E-mail: wilson@sunwk1.tpe.nctu.edu.tw

abstract : This study has initially conducted an in-depth analysis pertaining to the current situation and hub of problems of the freight service of Taiwan Railway Administration(TRA), then the TOWS matrix analysis method is employed to develop the management improvement strategies for future freight traffic service of TRA. The Fuzzy Multiple Criteria Decision Making Method (FMCDMM) is utilized to perform the evaluation and ranking for each of the strategy alternatives so as to determine their priority ranking, the result can be offered to the decision making authorities for reference when each of the improvement strategy alternatives is to be implemented.

1.INTRODUCTION

In recent years, the freight traffic service of TRA has gradually lost its importance in terms of the inland freight market as being impacted by each of the subjective and objective elements from the surroundings. Nevertheless, as viewed from the perspectives of transportation balance, decrement of land utilization and the need for defense, there remains the necessity that the freight traffic service of TRA should continue to function. Therefore, how to overcome the unfavorable operating environment and review the freight operating strategies so as to upgrade both the management efficiency and service quality have become the most important management issues for TRA at present.

Most of all, due to the influences of electrification project on the west trunk line since 1974 in Taiwan, both the transportation capacity of freight operation and service quality of TRA have been severely been constrained, as a result, its developments are unable to cope with the demand of fast economic growth, and it has also led to massive outflow of freight transportation to that of highway. Consequently, the market share of inland transportation controlled by TRA freight decreases tremendously.

Of the those several subjective and objective factors leading to the gradual downfall of freight business of TRA, the external factors would be of the fixed-price policy by government, multiple ports policy, and the impact of fast developments from highway transportation, while the internal factors would be of insufficient investment on freight equipment, transportation capability under demand, over-emphasis on customer transportation and negligence on freight transportation, unreasonable structure of transportation levy, and disregard for marketing, which, as a whole, has led to the gradual

deterioration of the freight operation and its feeble competitiveness. Thus, freight operation has been seriously affected, furthermore, with the implementation of Labor Standard Law by the government in 1988, it has even more worsened the financial conditions of TRA.

As stated in "Six-Year National Construction Project", "regarding the development of future railway transportation in Taiwan area, of the foremost, a high-quality service and island-wide railway network should be built up to be come the mainstream of inter-city transportation, so that the over-growth on private vehicle as transportation means can be alleviated. As for the conventional railway on the west trunk line, it would have to cope with the development of high-speed railway, therefore, its transportation functions would be transformed mainly to offer freight operation and service for commuters so as display the transportation capacity of the system to its utmost." Based on such transportation policy, the objectives of development for future transportation are primarily to offer transportation of goods and commuting service to passengers in metropolitan areas; should high-speed railway be built, the function of freight transportation of TRA would, a step more, be enhanced, and current policy "emphasis on passenger transportation and negligence on freight operation" would be completely changed. In view of the fact, it is critical that TRA would have to deal its freighting operation with each of the fluctuating factors from the environment, to review its development policy of freight so as to manifest its transportation function to its most, to help reduce the financial burden on the government, and to achieve the objective as to upgrade the freighting service quality by efficiently utilizing the entire transportation resources.

2. ANALYSIS OF CURRENT TRA FREIGHT SITUATION

2.1 Characteristic analysis of TRA freight

Asides from being enshrined with the features of general public transportation, such as extended demand, public service, restricted operation, peak- and slack-hour, capital intensive, depreciating cost, and assets that cannot be stored, TRA is also equipped with features of medium- and long-distance transportation, massive capacity of transportation, energy conservation, high safety, and few restraints by the climate.

At the meantime, the operation of TRA is mainly to offer passenger transportation, while freight transportation is conducted only in the break between the intervals of passenger transportation or in the nighttime when there is less passenger transportation. In addition to the working with policy of military transportation, it has exposed TRA to several of the following problems of freighting operation:

- (1) Since freight is conducted only in the break between the intervals of passengers transportation or in nighttime, transportation capacity has become quite limited and it is quite difficult for the maneuver of trains.
- (2) The goods being freighted is mainly of low-priced bulk goods, and the demand for the service is limited as of fixed freight, making it uneasy to attract new customers.
- (3) Because of seasonal and one-way traffic of goods, the issue of empty-compartment returning to home base has rendered problems both in train maneuver and freighting home-bound goods.
- (4) The working with national defense and military drill has caused TRA ever more burdened in its maneuver.

- (5) Loading and unloading of goods are mainly performed by laborer, and the problems because of staff maneuver and management have occurred as of different organization levels.
- (6) Loading and unloading is slow because of the delayed employment of mechanical equipment and facilities.
- (7) Since the hinterland of Taiwan is both narrow and small the distance of goods to be freighted is usually not very far, making the loading and unloading fees of goods responsible for the most part of the transportation expenses, the advantage of long distance transportation of railway is, therefore, unable to surpass that of highway.
- (8) The procedures of freight are rather bothersome.

2.2 Analysis of the actual performance of TRA freight

The aggregate of tonnage goods freighted by TRA in 1952 totals 8,231 thousand tons, which amounts to 41% of the inland transportation market, while it is only 20% for highway transportation. Until the year 1964, the tonnage goods freighted by TRA is, for the first time, lower than that of highway transportation; though there has been mild increment of freighting operation by TRA later on, the increase of goods freighted by highway transportation is so astonishing and the market share of TRA diminishes year after year. In the year of 1994, the annual aggregate of freight by TRA reaches 19,605 thousand tons, which amounts only to 6% of the total inland transportation market while that of highway transportation reaches 91%.

The ton-kilometer of TRA freight reached 1,158,549 thousand ton kilometers in 1954 as a whole, at which equivalent to 7.32% of the market share, before it was 63,682 thousand ton kilometers which amounted to 4.83% of the market share only. Then the railway freight market share kept on decreasing and finally lower than the highway transportation fee since 1974 for the first time. The total ton-kilometer reaches 1,947,146 thousand ton kilometers in 1994, but its market share had lowered down around 13% at this stage.

The average transportation distance of every ton of good by TRA is 140.8 kilometers in 1952, and 168.8 kilometers in 1968 is of the highest, then it gradually comes down yearly until 99.3 kilometers in 1994. As a whole, the average transportation distance of goods freighted by TRA diminishes increasingly, however, the average transportation distance by railway remains longer than that of highway, showing there still exists the niche of potential advantage of long-distance freight by TRA.

The revenue of TRA is only 113 million dollars in 1952, and it later increases to 2,252 million dollars at the end of 1994 progressively, with sign of growth every year.

3. STRATEGY PROGRAMMING FOR TRA FREIGHT DEVELOPMENT AND ANALYSIS OF THE EVALUATION METHODS

3.1 Strategy programming of TRA freight operation

This study has employed TOWS matrix (TOWS matrix) analytic method to formulate the development strategy for the freighting operation of TRA. Strategy programming itself is made up of very complex procedures, and it has to analyze current situations and predict

future possibilities so as to determine the development trend of the enterprise and bring forth alternative strategy in order to achieve the objective. During the processes bringing forth the strategy, it is critical to locate the strength and weakness within the domestic management from the internal environment of the enterprise as well as to find out the opportunity and threat the enterprise is exposed to so as to contrive suitable strategies to respond.

Hsu *et al* (1994) in "Privatization strategy programming study on the Forest Railway of Mt. Ali" investigated, with the instrument of the competition strategy (TOWS) suggested by Wehrich, the threats (T) to the external environment of the forest railway operation, its opportunity (O), weakness (W) as well as its strength (S) occurred from the internal environment, and he has formulated eight sets of privatization strategy alternatives for the forest railway of Mt. Ali. In regard to the five evaluation criteria as "entire turnover performance", "timeliness of privatization," "effect to maintain continuous railway operation," "government re-investment on railway construction and traveling facility cost," and "acceptability of private sector to the programmed alternatives", the optimal privatization alternative will then be selected from the quantification and qualification results using multiple criteria decision making (MCDM).

Chen *et al* (1995) besides from employing MCDM to evaluate alternatives of high-speed railway route, have further integrated fuzzy theory, and utilized fuzzy multiattribute evaluation to obtain more objective evaluation. As a result, the priority ranking for each alternative obtained can be cited as more objective reference for the decision makers.

Analytic hierarchy process (AHP) is a set of decision making methods developed by Saaty (1971), and it has mainly been applied on uncertain situations as well as on the decision making problems with multiple evaluation criteria. For decision makers, hierarchical structure is helpful to obtain understanding of events, however, it is necessary that some criteria have to be based on so as to conduct the evaluation of each alternative when the issue "selecting the optimal alternative" is open, as these criteria help determine the priority ranking for each alternative and locate the desirable alternative.

The fuzzy multiattribute evaluation method developed by Hwang (1989) includes two parts: first, the linguistic information will be transformed into fuzzy set, while the fuzzy set, in the second part, will be located of its actual evaluation value with the notion of max-min set, then the decision makers can utilize general multiattribute decision making to conduct the evaluation of alternative ranking.

Of the method that transforms the linguistic information into fuzzy set, Hwang (1981) put forward eight categories of linguistic comparison scales. What has to be noticed is that even if the terms of comparison are same but in different scales, the linguistic information changed into fuzzy set will not necessarily appear with same function form. Take the term "high" for instance, each fuzzy function is different after the transformation. This study has employed seven categories of scales with nine level of comparison terms, and each term of comparison will produce diverse function after being transformed into fuzzy set.

Hwang (1979) utilized TOPSIS which is based on the selection criterion that is nearest to the ideal solution and the farthest from the negative ideal solution. The method assumes that every criterion enjoys the effect of monotonic increase or monotonic decrease, in other

words, should the criterion be taken as its benefit criterion and if its performance value is greater its preference value will also be greater; should the criterion be taken as its cost criterion and if its performance value is greater its preference value will be smaller. Thus, the ideal solution A will be combined of the optimal values of all criteria, while the negative ideal solution will be made up of the most inferior solutions of all criteria.

3.2 Opportunity and threat analysis from the external environment of TRA freighting operation

(1) Opportunity analysis

From the viewpoint of policy analysis, it has been clearly stated in the report "Long-term Development Programming of the Integral Transportation System in Taiwan area, ROC" published by the transportation institute of the Communications Ministry in October, 1990 that TRA will mainly play the role of freight transportation and short-distance passenger commuting in the transportation corridor of Taiwan area. TRA, as viewed from the perspective of policy evaluation, will be changed of its current policy of "emphasis on passenger transportation and negligence of freight transportation", it is, therefore, to be expected that freighting transportation will once again become the main stream of TRA business.

From the viewpoint of environment analysis, since the west trunk line of TRA has been electrified completely, part of the electrification work on the east trunk line is largely under work, and the completion of electrification on southbound trunk is to be expected, transportation of goods by train can notably reduce the amount of air pollution. Thus to view from the perspective of long-term environmental quality, freighting operation of TRA is, undoubtedly, making tremendous contribution.

From the viewpoint of operation, besides enjoying the advantages of medium- and long-distance transportation, tremendous capacity of transportation, energy conservation, highly safe, and fewer constraints from the climate, TRA sees the deteriorating service quality of highway transportation as its second chance. Currently, the service quality of Chung-shan highway has come down to level "F" as an average, and should there be serial holidays the highway would even become a colossal "park", showing how crammed it is. On the other hand, since railway has its specialist tracks, it enjoys such advantage to compete with highway as it can be free from being jammed. Furthermore, should the freight of goods be conducted to be transported by train as viewed from the integral efficiency of transportation so as to reduce the frequency and number of trucks using highway, the condition of crammed highway might somehow be alleviated. As for east trunk line, the undulating Su-hwa highway is unfavorable to the maneuver of trucks, thus freight of goods by train is potentially advantageous.

According to the industrial bureau and the planning of Taiwan Cement Association, Hoping cement specialist zone is due to be completed of its construction by 1997. With the construction of such cement specialist zone, the industrial zone originally planned to build its specialist pier and its stocks will be transported by sea. However, it is understood that the construction expenditure of the pier will have to be shared by each company, but most are unwilling to bear up their share as indicated by each of the companies, thus they are to continue their production in the existing cement plants (most of them on the western side of Taiwan). Also, most of the mining rights of the cement companies on the west side of the island will run to its end by 1997 and they could not

continue to quarry after then, as a result, the lime needed for the production of cement will have to be transported to parts of the island on the west-side by TRA, and that would benefit the development of the freighting operation of TRA.

(2) Threat analysis

Due to the government effort on highway construction, Taiwan area has already formed a rather intensive highway network with the completion of Chung-shan high in 1978, and with "door-to-door" service the features of far-reaching ability and flexibility of highway transportation have exerted tremendous pressure on the freighting operation of TRA. Presently, the third highway, in regard to the construction plan of the government, has already been designed in the six-year national construction project, while there are also twelve east-west high-speed circuits and west corridor high-speed circuit. Once these circuits are completed, the highway network of the transportation corridor on the west will be even more convenient and intensive, which will form even greater threat to TRA.

Since TRA routes cross over each and every town and village and its railway terminal is usually located at the business center, railway tracks on the ground, in contrast to the with of urban developments, have become such impediment to the development of each city, rendering uneven developments on the two flanks of the track. Thus, each of the metropolitan areas is asking to make its track underground. Currently, the urban railway track of Taipei City has already been made underground, whereas the railway tracks of Taichung and Kaohsiung will also be made underground in steps. Railway freight is the one that is most severely affected by railway track made underground, as many of the urban freight terminals were built in city center and their warehouses would have to be moved, and Hwa-shan terminal of TRA is one of the most prominent example. Besides, trains of TRA running in the tunnels would be greatly restrained after the track is turned underground, for instance the hauling tonnage would be reduced, and large, bulk, and dangerous items cannot be transported, which would largely hinder the development of freighting operation of TRA.

Due to the fact that our industries are upgraded, most of the industrial products are delicate and expensive, transportation by trucks reduce the times to load and unload and also lower the percentage of damage, which is rather unfavorable to railway transportation. In addition, international container transportation has already become trendy throughout the world, yet most of the container piers in each of the ports in Taiwan area are not yet installed with railway track and the design of container field also has not taken railway transportation into consideration, which is very adverse to TRA to develop its container delivery business.

The transportation fees of TRA are significantly constrained by the governing authorities of communication, as TRA is, in no way, to reflect, its cost and could not, as well, solicit more goods for transportation with more flexible prices. On the other hand, operators of highway transportation are conducting cut-throat competition, and they even employ overloading to increase their transportation capacity in every delivery, which has rendered unfair competition between railway and highway transportation. Such unjust competition is, as well, one of the major factors that affect freight development of TRA.

3.3 Strength and weakness analysis from the internal environment of TRA freight

(1) Strength analysis

Asides from the features of medium- and long-distance transportation, colossal capacity of transportation, energy conservation, highly safe, and fewer constraints from the climate, railway freight also has the following advantages, which are then elaborated. In order to make up for the handicap as railway transportation cannot conduct "door-to-door" deliver service, TRA has actively encouraged establishments to install specialist side-track which being financed by the establishments themselves will run from terminals to the factories or warehouse. With the employment of side-track for transportation, it reduces the number of loading, unload and transportation, lessen damage of goods, lower cost down, and facilitate the arrival of goods on time. Currently, TRA owns 228 specialist side-tracks as long as 157.2 kilometer, and the percentage of starting transportation quantity amounts to 2% of the total transportation amount, while the arrival quantity reaches as high as 68%. The importance of the specialist side-tracks can, therefore, be manifested.

Though TRA freights various items of goods, 80% of its stocks are mainly of cement, lime rock, cereals, charcoal, and container five major bulk goods. Due to the fact that bulk goods are in massive amount, of lower level, and with cheaper transportation fee, most manufacturers would set up their factories along the railway tracks in order to save cost, and they have either installed their specialist track or had trucks for the transportation. Thus, the transportation of such bulk goods will become the main sources for TRA freight in the future.

(2) Weakness analysis

Currently, passenger transportation of TRA is the main source of its business while freight operation is only of auxiliary, thus each kind of transportation resources such as route and engines is shared between passenger and freight transportation. Though freight transportation has higher demands on high speed, punctuality, and convenience, freighter trains always have to wait to avoid passenger trains and can, therefore, run in the nighttime or during the breaks of passenger trains. Should there be holidays or new year time, delay of delivery becomes quite often. As a result, ill effects as lowered alternate turnover rate of trains and uncertain date of delivery are normal, and such operation idea as "emphasis on passenger transportation and negligence of freight transportation" has become the greatest impediment to the development of freighting operation of TRA.

In recent years, TRA has been tied up in the financial difficulty and is unable to purchase any more freight trains and put more investment on freight facilities, thus its freight trains are greatly insufficient to meet demands, resulting in deficient transportation capacity. Since TRA is unable to satisfy demand, and could not explore wider sources of financial turnover so as to purchase more freighter trains, or encourage plants owners to have to have their trucks, it will severely affect the development of railway transportation. Though TRA has as many as 113 stations, 96% of the turnover from the freight business is concentrated to 60 of the stations, the income from the rest 53 stations only amount to 4% of the turnover. Therefore, the insignificant business of those small stations will not substantially affect to completely turn over, so is that so the cost could be reduced or the performances and market competitive powers of freighting operation could be enhanced in case those station be eliminated or integrated.

As stipulated in the regulations of TRA, goods should be loaded and unloaded within the terminal unless these goods are on delivered to the specialist side-track, and the work of loading and unloading has to be conducted by the designated object -- the transportation company, and the expenses of loading and unloading would largely affect the development of freighting operation. The percentage of loading and unloading expenses in railway transportation cost increases year after year, and there is even sign that expenses of loading and unloading surmounts that of the transportation costs, resulting outflow of transportation business.

As viewed from the analysis of price structure, the goods of TRA are currently found in two price levels. According to the information, the basic price rate of each level is lower than its cost, while its average cost is even more lower, and more than 90% of the goods are found to be in level 2, indicating how unreasonable the price structure is. Thus, how price rates can be suitably adjusted and levels simplified is one of the most important issues to be worked out in the future. Besides, the calculation of TRA cost remains to be considered as it operates both passenger and freight transportation and most of its investment, equipment, and personnel are shared between the two. Therefore, it would be very difficult to mark most of the operation costs as "passenger transportation" or "freight transportation" because the costs are united. And the unfair distribution of united costs has resulted in higher cost regarding freighting operation on the balance sheet, which reduces its competitiveness.

Since container transportation will become the main stream of freight in the future TRA has also listed container transportation as one of its major areas of business development, however, TRA is now confronted with several of the following impediments as it is to develop container transportation. One is that TRA has no their own container terminals, secondly is the inland transit fees charge by TRA for containers are obviously too high to compete with other transportation media. As a result, if TRA intends to develop its container transporting business, it must first find out the suitable terminals then lower the expenses of collected from the container goods owner.

The development of TRA is, as well, exposed to the influences of constraints from the capacity of their routes; for west trunk line, the links of routes in the metropolitan north are such utilized that they have already been employed over 100% of their capacity. Especially of the link of route between Taipei -- Hwashan, its employment even exceeds 112% of its capacity, indicating the fact that route capacity on the west trunk lines is exceedingly insufficient.

As for east trunk line, though the rate of employment in most of the links of routes stands averagely below 75%, the rate of employment reaches as high as 145% at the bottleneck between Hoping--Suao. For sure the problem of insufficient routes strangles freight development, and the conventional management policy of TRA "emphasis on passenger transportation and negligence of freight transportation" has even worsened it current situation and constricted the survival of TRA freight operation.

3.4 The formulation of freighting operation strategies by TRA

In view of the preceding opportunity and threat analysis from the external environment of TRA as well as the strength and weakness analysis from the internal environment, this

study has formulated following several strategies for development, which are elaborated as follows:

Strategy 1: compete for the transportation for bulk goods and abandon L.C.L. goods.

Strategy 2: dispose of those small and economically undeserving stations in large scale so as to lower cost and raise the efficiency of operation.

Strategy 3: actively promote the business of specialist side-track.

Strategy 4: efficiently encourage manufacturers to have their own trucks.

Strategy 5: employ flexible price rates so as to solicit wider sources of goods for transportation.

Strategy 6: adjust reasonable price rate so as to come to one-price rate.

Strategy 7: change the mode of transportation and dispatch mainly with single-item train.

Strategy 8: study for the development of double decker so as to increase the capacity of container transportation.

Strategy 9: seek for the opportunity to work with container field so as to develop container transportation.

Strategy 10: to work with all effort the establishment of Ho-ping cement specialist zone and plan for the installation of large-scale container field and specialist side-track.

Strategy 11: simplify the procedures of consignment.

Strategy 12: review the manner of cost distribution regarding joint cost so as to lower transportation expenses and bring up its competitiveness.

Strategy 13: break down monopoly of transportation companies working to load and unload in TRA terminals so as to lower the expenses of consignors.

Strategy 14: develop diversified styles of freighting operation.

4. ESTABLISHMENT AND EVALUATION REGARDING THE FREIGHTING DEVELOPMENT STRATEGY EVALUATION SYSTEM OF TRA

Strategy evaluation is of the final phase in the entire strategy programming processes, and a lot of evaluation methods can be found for the process. In recent years, the development of system method has been widely applied on social and behavioral sciences in order to streamline complicated problems. This study will, at first, employ interview of experts to integrate opinions of all aspects so as to obtain the objective hierarchical structure for freighting development strategy of TRA. After which, AHP method is utilized to find out the preference of the evaluation criteria, and the weights for each of the criterion is derived from the calculation. At the end, maxi-mini set of fuzzy ranking and TOPSIS of the multicriteria decision making are employed to determine the priority ranking for each of the development strategies.

4.1 Establishment of the evaluation system

The evaluation work of strategies must, at first, establish its objectives and criteria as basis for the evaluation of alternatives. This study has construed its objective and criterion two hierarchical structures according to hierarchical analysis. With basis on the study of

literatures and expert interview, two objectives as "service quality enhancement" and "decrement of financial burden" have been suggested, and six evaluation criteria as elaborated in figure 1 have also been put forward under these objectives, which are briefed as follows:

(1) Enhancement of service quality

Being a public utility, TRA must focus on the service quality so as meet public demand and satisfy requests from the consignor. Thus, two evaluation criteria as "agreement from the integral transportation performance" and "enhancement of transportation service quality" have been construed under the objective "enhancement of service quality."

a Agreement from the integral transportation performance

The development of the freighting operation must not only meet the growth of the enterprise but also cope with the development of the integral transportation environment.

b. Enhancement of freight service quality

Since the current service standard of TRA is affected by many factors it is, therefore, not being given with high regard, as a matter of course, alternatives of each strategy must also be beneficial to the enhancement of service standard of freighting operation.

(2) Decrement of financial burden

The already long-term financial loss of TRA has been a great burden to the government, thus, how such financial burden can be reduced has become one very important objective, and four criteria have been construed as "increment of turnover from freighting operation," "decrement of transportation cost", "enhancement of competitiveness", and "competition for wider sources of transportation efficiently" under such objective.

a. Increment of turnover from freight operation

Under the situation of long-term financial loss, it is desperate for TRA to find out ways to increase its turnover, while the development strategy of TRA freighting operation can effectively satisfy such demand.

b. Decrement of transportation cost

The reduction of transportation cost for TRA freight is one of the crucial key to the future development strategy of TRA, thus this study has enlisted this item as one of its important evaluation criteria.

c. Enhancement of competitiveness

At the meantime, TRA freight is extremely weak in terms of its inland transportation market and it can enjoy rather minor market share; in view of the fact, TRA would have to reinforce its competitive niche on the market.

d. Competition for wider source of transportation efficiently

Presently, the primary sources of transportation of TRA freight are concentrated to a few large items of bulk goods, and its future development strategies would have to be able to meet and consolidate current sources of consignment and open up fresh targets of merchandises efficiently.

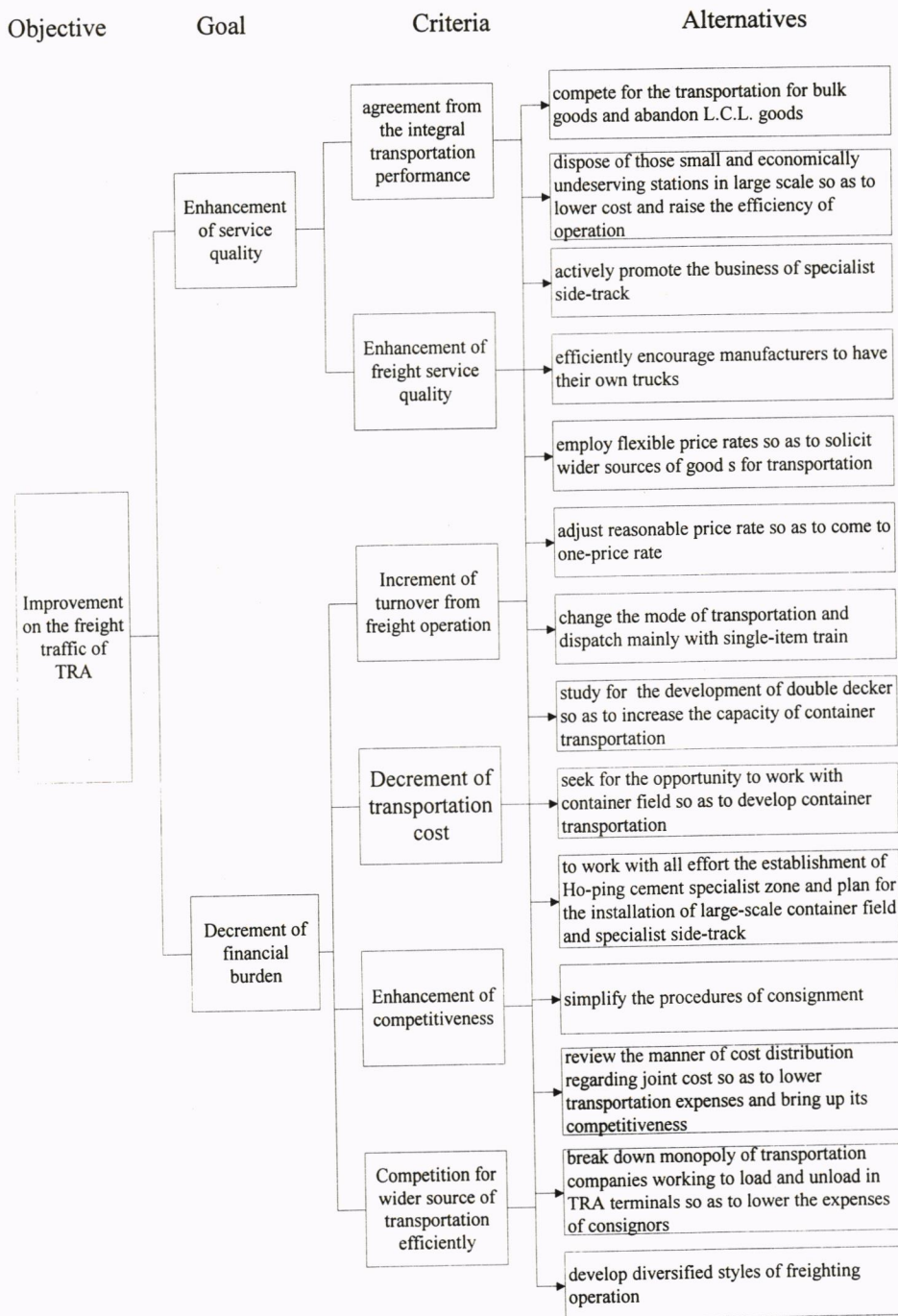


Figure 1 The Development Strategy Evaluation Framework of the Freight Operation of TRA

4.2 Analysis of the evaluation results

(1) Analysis of the preference structure

In regard to the samples of investigation, this section has conducted preference analysis for each of the criterion. As a whole, this study has given out forty copies of questionnaires, and has retrieved twenty-five valid copies after consistency verification, while the comparative importance for each of the criteria is found out using AHP method. The weight values given to the six evaluation criteria by the interviewees in the questionnaires are as shown in table 1, which shows the preference, demonstrated in arithmetic mean and geometric mean, as given by the interviewees for the criteria.

Table 1 Preference Structure of the Evaluation Criteria

Criteria	Mathematical Average	Geometrical average	Standard Deviation	Variance
Agreement from the integral transportation performance	0.0840	0.0901	0.0796	0.9119
Enhancement of freight service quality	0.1021	0.1104	0.0822	0.7221
Increment of turnover from freight operation	0.1455	0.1531	0.0924	0.7118
Decrement of transportation cost	0.0985	0.0962	0.0779	1.2209
Enhancement of competitiveness	0.1140	0.1435	0.0807	1.0398
Competition for wider source of transportation efficiently	0.1221	0.1245	0.0969	0.8744

In terms of arithmetic mean, the weight value of "increment of turnover from freight operation" stands the highest, while that of "agreement from the integral transportation performance" the lowest, and there is similar result found in geometric mean. As can be learned from the interview, it is generally acknowledged that the increment of turnover for TRA freight is critical in this time. Though there is great disparity in opinions among the interviewees, coefficient of variation (CV) can be employed as the basis for judgment; among them, greatest variation can be found in "decrement of transportation cost," seconded by "enhancement of competitiveness", and trailed by "increment of turnover from freighting operation."

(2) Analysis of the ranking procedures

This section will elaborate on the performance values of each strategy alternative under different evaluation criteria, while fuzzy multicriteria decision making is being used to evaluate the ranking procedures. Based on preceding fourteen improvement strategies of freight development, the opinions of the interviewees are obtained of its evaluation performance values in linguistic terms and these linguistic performance is transformed into the fuzzy sets of nine evaluation scales through fuzzy multicriteria decision making. With the employment of maxi-mini set ranking from the fuzzy ranking method, the aggregate value for each of the fuzzy functions is obtained as basis to evaluate the order of ranking. At the end, TOPSIS is being utilized to acquire the

priority ranking for each of the alternatives evaluated, and the results are as shown in table 2.

Table 2 Results of Ranking for the Alternative Evaluation

Alternative	TOPSIS score	Ranking
employ flexible price rates so as to solicit wider sources of goods for transportation.	0.7933	1
review the manner of cost distribution regarding joint cost so as to lower transportation expenses and bring up its competitiveness.	0.6454	2
study for the development of double decker so as to increase the capacity of container transportation.	0.6099	3
seek for the opportunity to work with container field so as to develop container transportation.	0.5891	4
simplify the procedures of consignment.	0.5873	5
change the mode of transportation and dispatch mainly with single-item train.	0.5116	6
adjust reasonable price rate so as to come to one-price rate.	0.4330	7
dispose of those small and economically undeserving stations in large scale so as to lower cost and raise the efficiency of operation.	0.4328	8
to work with all effort the establishment of Ho-ping cement specialist zone and plan for the installation of large-scale container field and specialist side-track.	0.4182	9
compete for the transportation for bulk goods and abandon L.C.L. goods	0.3895	10
develop diversified styles of freighting operation.	0.3399	11
break down monopoly of transportation companies working to load and unload in TRA terminals so as to lower the expenses of consigners.	0.2874	12
efficiently encourage manufacturers to have their own trucks.	0.1137	13
actively promote the business of specialist side-track.	0.0764	14

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

(1) This study has utilized the method of analysis as TOWS in strategy programming to analyze the strength and weakness within the internal environment of freighting operation of TRA as well as its opportunity and threat exposed to on the external environment, and it has further formulated fourteen development strategies as it contests for the transportation of bulk goods and its pullout from delivering petty merchandises.

- (2) In order to evaluate each of the development strategies, this study has formulated two objectives as "enhancement of service quality", and "decrement of financial burden", and respectively construed six evaluation criteria under each of the criteria as "agreement from the integral transportation performance," "enhancement of transportation service quality," "increment of turnover from freighting operation," "decrement of transportation cost," "enhancement of competitiveness," and "competition for wider source of transportation efficiently."
- (3) This study employed AHP questionnaire to appreciate the preference of experts for each of the experts, and the results indicate that the weight value of "increment of turnover from freighting operation" stands the highest, seconded by "competition for wider source of transportation efficiently," "enhancement of competitiveness," "enhancement of transportation service quality," "decrement of transportation cost," and "agreement from the integral transportation performance." As can be viewed from the order, it is critical that TRA must seek for ways to increase its turnover for its development.
- (4) In order to obtain more objective and reasonable evaluation results, this study has employed fuzzy multicriteria decision making to evaluate each of the development strategies. Besides, the priority ranking of each of the alternatives is resolved by using fuzzy ranking method for the reference of the authorities concerned, and the results reveal that "maneuver of flexible price policy to efficiently compete for wider sources of consignment" scores 0.7933 in the first place of the ranking, seconded by "revision regarding the distribution of united cost to lower transportation cost and enhance competitiveness," and trailed by "actively promote the employment of specialist side-track."

5.2 Recommendations

- (1) Of the priority ranking derived from fuzzy multicriteria ranking method in this study, TRA can employ each of the strategies in phases according to its need in practice, and designate its steps of implementation regarding each of the strategy alternatives so as to help improve the freighting operation of TRA.
- (2) Application of multicriteria decision making on alternative evaluation has already been quite widespread, only it is necessary to appreciate the features of the problems before suitable method is selected. The purpose bringing fuzzy theory into the evaluation of performance value in this study is intended to render the results more objective and justifiable. It is further suggested that fuzzy AHP method can be exploited in the future to analyze the preference structure of each criterion in more profound sense, or select several evaluation methods to further correlate the evaluation results from each of the evaluation methods, and offer itself as basis for choosing the evaluation methods.

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