AN OPTIONAL OPERATION ORGANIZATION OF CHIANG KAI-SHEK INTERNATIONAL AIRPORT RAIL LINK PROJECT IN TAIWAN

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Abstract: With CKS International Airport remains one the important gateways to Taiwan, the CKS International Airport rail link system would serve as a most crucial mass transportation tool that would poise to excel the competitiveness of the international airport and its adjacent metropolises. In light of which, how best to locate an optimal operating organization that offers a sustainable management would emerge as a pressing concern. Taking into account urban transit and airport rail link service, the study, upon analyzing using the FAHP and TOPSIS methods, has chosen the Taipei Mass Rapid Transit Corporate alternative as the optimized alternative, together with the alternative of setting up a new private-run company as the second best alternative. As derived from analyses conducting on various decision-making groups, an operator with actual transportation operations would emerge as a crucial determining factor to become the future airport rail link operator. The study findings are not only intended as references to government departments but also to recommend the government to expeditiously finalize the operator as an urgent mission to facilitate subsequent implementation in light of the complexity in the rail system's interfacing logistical implementation.

Key Words: CKS airport rail link, Operation Organization, FAHP, TOPSIS, TRTC

1. INTRODUCTION

Studies by Ashford (1997), Blond (1998) pointed out that a rail link system remains a key element in curtailing international airport capacity growth and affecting an airport's overall service quality. Meredith (1994) also reiterated that when looking to excel an airport's service quality, how best to develop an airport's rail link system and enhancing its capacity and service level would emerge as one of the critical issues that needed to be taken into account when building a new airport or expanding the existing facilities. Of IARO data sorted showed that since Belgium Brussels Airport inaugurated its rail link system since 1955, a total of 146 airport rail links were operated by 97 airports in 26 countries, among them more than 80% were predominantly concentrated in Europe and the United States (with 88

in Europe and 35 in Americas). Deriving from the previous experience of European international airports, all signs show that the adaptation of a rail link system would lend itself as a viable solution to resolving airport rail link problem. And comparisons with a few airports in Asia revealed that Japan, emerging Shanghai, and the four Asian Dragons, except Taiwan have all had rapid, convenient and comfortable airport rail link services that have been installed to excel the competitiveness of the airport and its adjacent metropolises in respective locales.

On the contrary to gauge Taiwan's most crucial gateway – CKS International Airport since its initial inauguration of Terminal One in 1979, while the airport has seen phase two terminal buildings joining the operation in 2000, where landing and departure flights have surged from the initial 30,000 takeoffs and landings to now reaching 110,000 landings and takeoffs, with a passenger volume surging from 3 million passenger trips to now 19.2 million passenger trips in 2002. Yet in its development of airport rail link when compared with major airports worldwide that are serviced by precision rail link systems, Taiwan remains reliant on transits via highway transportation.

A transport service system that links CKS International Airport to the greater Taipei metropolitan area and the greater Taoyuan metropolitan area also commands an equal importance when it comes to developing the northern region. With that, the Executive Yuan has enlisted both the government-led Taoyuan MRT blue line and private-developed "Incentive private participation of the CKS Airport-Taipei Rail Link Development Project into the Challenge 2008 – National Infrastructure Focus Development Plan for prioritized implementation. Yet upon weighing the investment bottleneck and hindrances that mar the feasibility of the project implementation of the Challenge 2008 – National Infrastructure Focus Development Plan, the government has since revamped the project to a government-funded development mode, and has finalize that the Taoyaun MRT blue line be integrated to the CKS International Airport Rail Link Design Plan (short for CKS International Airport Rail Link hereon) in a joint promotion, taken into account the geographic characteristics and service by the Taiwan High Speed Rail System. Yet how is CKS International Airport rail link intended to be public and enterprising, which on the one hand is subject to the government's administrative supervision in providing public services much like most government agencies, yet it also required operating independence, on the other hand, in order to run the system independently, notwithstanding that the government could only push for the project to be implemented as early as possible, but without final decision on a particular operating mode of the system operator? In light of which, to support the route's operating objectives once the CKS International Airport rail link system has been completed that would duly address commuter and airport linkage service and attain a sustainable management goal would render the legitimacy for the study to delve into locating a feasible and enforceable optimal operator.

As the choice of operator often needs to take into account a host of ramifications related to the operator, user, monitor and so forth that falls under a multi decision issue, the Multiple Criteria Decision Making (MCDM) is of a widely adopted application for resolving such type of issues (Hwang, C.L. and Yoon, K., 1981). In which, the comprehensiveness that the criteria are being assessed, the objectivity in weighing distribution, and solution for performance value that cannot be quantifiable measured could all come to hinder the assessment results. In general multiple criteria decision making methods adopted for determining the sequence of the importance of selected alternatives often include three types, namely the AHP, Multiattribute Utility Theory (MAUT), and Out Ranking (ELECTRE) (Vargas, L.G., 1994), among them the AHP has been chosen by the study as a man method for instilling an evaluation criteria framework and for deriving various weighed value for how it is easier to apply in deriving the weighed value among the hierarchical tiers and for resolving various weighed value. Yet taken into account that AHP's Pairwise Comparison Matrix frequently comes with characteristic fuzzy

problem, the study has introduced the triangular fuzzy number into the process, intended to resolve fuzzy problems tat occur in criteria measurement and rendering process (Laarhoven and Pedrycz, 1983; Buckley, 1985). What followed was the TOPSIS method used to derive alternative performance value value as the basis in ranking the importance of the alternatives selected. And since there have been many factual applications since the AHP was first proposed by Saaty in 1971 (Saaty, 1980: Saaty, 1990: Vargas, L.G., 1994), and the TOPSIS was first presented by Hwang and Yoon (Hwang and Yoon, 1981; Chen, C.T. 2000), the study will no longer go into detail with theoretic premises of both.

2. CKS INTERNATIONAL AIRPORT RAIL LINK PROJECT

The route starts from CKS International Airport to Johnli City of Taoyuan County southward, and connects to the Taipei Station eastward along the Taiwan Railway. The total length is approximately 51.5km (see Figure 1.). The total project funding is estimated at approximately $93.6 billion. The section between CKS International Airport (P1) and the junction of Jongfong Road and Huanbei Road (B8) in Jongli is approximately 15.8km. The section between CKS International Airport (P1) and Taiwan Railway's Taipei Station (P11) runs approximately 35.7km.

The project is recommended for standard gauge rail or rubber-wheel system. The rolling stocks will consist of four cars, with carrying 522 passengers. Two types of services are on offer, which are "One-stop transit service" and "All-stop transit service". The "One-stop transit service" operating speed will take 55km per hour(running time 35 minutes, peak hour headway 5 minutes, off-peak hour headway 15 minutes). The "All-stop transit service" operating speed will take 45km per hour(running time 48 minutes, peak hour headway 7.5 minutes, off-peak hour headway 10 minutes). The service will be from 6:00 to 24:00, totaling 18 hours per day. So the developed forecast year cycle has 2009 set as the initial operating year, 2029 being the intermediary year, and 2038 being the projected target year. By the projected target year of 2038, the airport rail link passengers volume is expected to hit 244,106 people per day, among them those pass through CKS International Airport are estimated at 32,199 people per day, or approximately 13.2% against all passenger volume, with Trip O-D ratio between "Taipei - CKS International Airport" and "CKS International Airport – Jhongli" capped at approximately 85.2%, indicating that a majority of the travel modes had been based on CKS International Airport as the cutoff point.
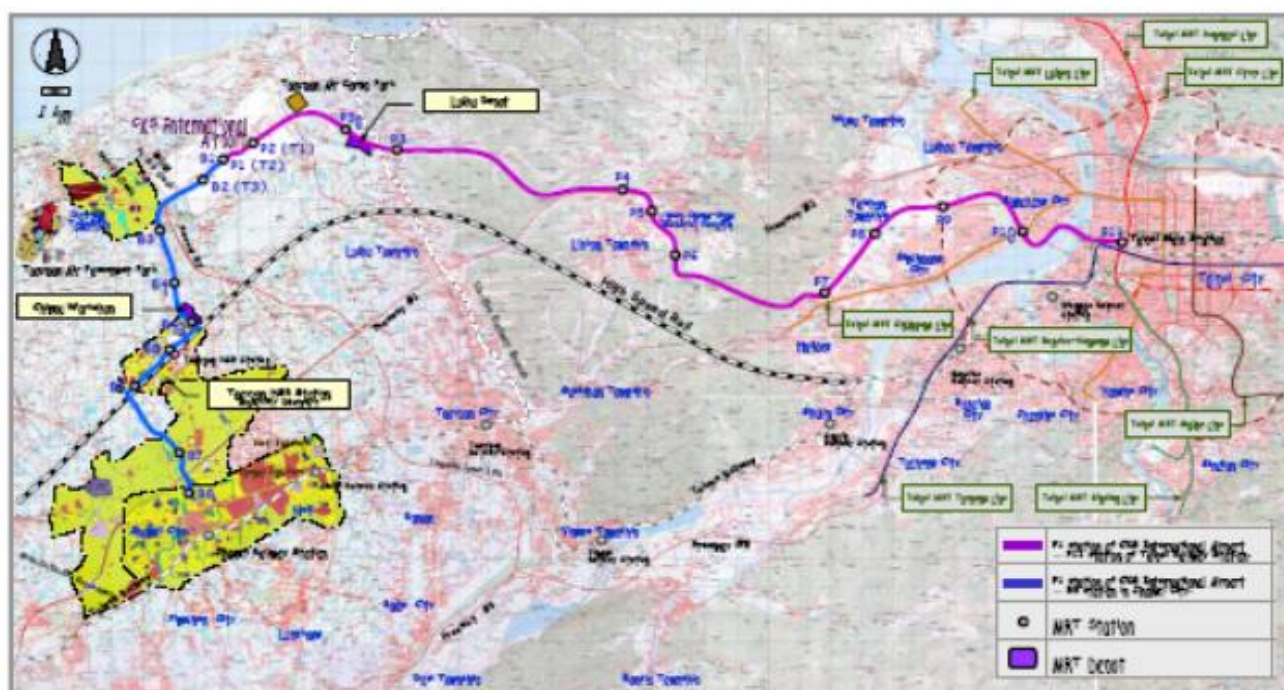
Figure 1. CKS International Airport Rail Link

Table 1. CKS International Airport Rail Link Ridership Forecasting

Item		2009		2029		2038	
Airport passengers volume(people per day)	Originating and destined trips	75,048		141,638		186,686	
	Workers trips	49,012		92,500		121,920	
	Visitors trips	37,524		70,818		93,342	
	Total	161,584		304,958		401,948	
Airport rail link passengers volume (people per day)		One-Stop 17,455	112,815	One-Stop 39,667	202,583	One-Stop 54,524	244,106
		All- Stop 95,360		All- Stop 162,916		All- Stop 189,582	
Peak hour volume in station(people per hour)		3,969		6,719		7,994	
Max. peak hour volume between station and station(people per hour)		One-Stop 1,000		One-Stop 2,322		One-Stop 3,256	
		All- Stop 1,890		All- Stop 3,124		All- Stop 3,832	
Passengers amount in P1, P2, and B2 (people per day)		14,628		74,806		104,665	

Resource: Bureau of Taiwan High Speed Rail, MOTC (2003), Author arranged

3. USER CHARACTERISTICS IN AIRPORT AND OPERATION EXPERIENCES OF RAIL
3.1 User Characteristics In Airport

Airport passengers often, but not always, constitute the majority of persons entering or leaving the airport. The airport population can be divided into three categories: (1) Passengers: including originating, destined, transit and transfer. (2) Employees: airline, airport, government, and such. (3) Visitors: greeters, senders, sightseers, and such.

As revealed by Askford (1997) in whose publication, "Airport Operations", of the makeup of average passengers account for 42%, greeters 35% and employees 18%. The greeters is found lowest in Europe, which not only emerges as an ethnic difference but rather that air travel has become a common form of transportation; the makeup and proportion of airport users are recapped in Table 2.

Table 2. Proportion of passengers, employees and visitors at selected airports (%)

Airport	Passengers	Employees	Visitors		Airport Rail Link	
			Senders/Greeters	Others	Yes	No
Europe						
Amsterdam (AMS)	41	28	23	8	O	
Frankfurt (FRA)	60	29	6	5	O	
Paris Orly (ORY)	62	23	7	8	O	
Vienna (WIE)	51	19	22	8	O	
North America						
Atlanta (ATL)	39	9	26	26	O	
Los Angeles (LAX)	42	12	46	-	O	
New York (JFK)	37	15	48	-	O	
Toronto (YYZ)	38	8	54	-		O
Center America						
Bogota (BOG)	21	36	42	1		O
Curacao (CUR)	25	8	64	3		O
Mexico City (MEX)	35	13	52	0	O	
Asia/Austrlia						
Melbourne (MEB)	46	14	32	8	O	
Singapore (SIN)	23	16	61	0	O	
Tokyo (HND)	66	17	11	6	O	
Average	42	18	35	-		

Source: Ashford (1997), sorted by the authors

From 1991 to 1997, originating and destined trips distributions do not show significant dissimilarity for CKS International Airport(see Table 3.). The trips generation are primarily concentrated on areas north of Taoyuan, which account for approximately 69.3% ~ 68.5%, followed by areas south of Taoyaun and other areas that account for 25.3% ~ 26.4%, and trailed by trips generation within the Taoyuan area that account for 5.4% ~ 5.1%.

Table 3. Proportion of originating/destined trips generated in CKS airport (%)

Region	1992			1997		
	Taiwan	Foreign	Total	Taiwan	Foreign	Total
Keeling	0.8	1.5	1.0	1.0	1.3	1.1
Taipei	63.9	83.9	68.3	60.6	80.8	67.4
Taoyuan	6.7	0.9	5.4	6.6	2.0	5.1
Hsinchu	3.7	2.4	3.4	3.3	1.0	2.6
Others	24.9	11.3	21.9	28.5	14.9	23.8
Total	100	100	100	100	100	1200

Source: Institute of Transportation, MOTC (1991, 1997), sorted by the authors

IARO(March, 2003)distinguishes airport rail link systems into six types, namely High Speed Dedicated, High Speed Network, LRT, Metro, Regional and Suburban. There are 146 airport rail link routes that are currently in operation, a majority of which are concentrated in Europe (60.3%), followed by Americas (24%). Suppose to take into account both the suburban rails and regional rails, which account for 64.4% against all systems in service, the statistics still reflect that a majority of them entailed

having an extension built from conventional rails. Of those that fell under High Speed Dedicated, there were those built specification to support the development of a new airport, such as Hong Kong International Airport's Airport Express Line; and there were those built to improve an airport rail link following the development of an airport, such as United Kingdom London Heathrow Airport's Heathrow Express. Upon recapping by the characteristic of route length, the study found that the route length of international rail link systems primarily fell between the length of 20km, followed by that between 20 and 40km.

While a recap of the development process at the international airport rail link systems finds that it comes in two forms – one that is built alongside the development of a new airport, such as Hong Kong's Airport Express Line, Japan Tokyo's JR Narita Kukou Line and Sky-liner Line, Japan Osaka's JR Kansai Kukou Line and Nankai extend line, Germany Frankfurt's B-Bahn and so forth; and the other being an improvement rail link developed following the completion of an airport, such as United Kingdom London's Heathrow Express, France Paris's RER B Line and TGV and so forth. By operator role, international rail link system operators can be divided into the following four categories:

(1) I: operator being the airport operator: of those that the airport rail links are run by the airport operator, such as United Kingdom BAA run and managed Heathrow Express, Gatwick Express and Stansted Express at London's Heathrow Airport, Gatwick Airport, Stanstead Airport.

(2) II: of those of an extension or newly built route by a rail operator – meaning a rail operator extends from whose existing service network to form an airport rail link through extension or a newly built route, such as Hong Kong Airport Express Line, Japan Osaka Kansai Airport's Nankai extend line, JR Kansai Kuko Line.

(3) III: those run by independent operators – where the airport rail link is operated by a rail operator, while the rail operating right is limited to that route only without any other route operating rights, such as Japan Tokyo Monorail.

(4) IV: A combination of the operating modes (primarily of a mixture of Type II and Type III): An airport rail link is connected to the existing rail route network, except the airport rail link is jointly managed by the route operator and the rail operator that runs the connecting route network, such as Sydney Airport Link. The study has gathered some of the relevant illustrated cases of international airport rail link systems worldwide, with a recap as shown in Table 4.

Table 4. Types of airport rail link operators

Heading	Type	Operations	Case illustration (airport – operators)
Operator being the airport operator	I	Operated Airport and Airport Rail Link	UK London Heathrow airport, Gatwick airport, Stansted airport – BAA
Operator is Rail Operator	II	Airport rail link extended from a rail or new rail line to the airport	Japan Tokyo Haneda airport –Keihin Electric Express Railway Japan Tokyo Narita airport – Keisei Electric Railway, East JR Japan Osaka Kansai airport –Nankai Electric Railway, West JR Japan Fukuoka airport – Fukuoka Municipal Transportation Bureau Japan Miyazaki airport –Kyushu JR Hong Kong International Airport – HK MRT Singapore Changchi airport – MRTC Sweden Stockholm Arlanda airport – SJ The Netherlands Amsterdam airport – NS Belgium Brussels airport – SNCB England London Heathrow airport – LUL France Paris De Gault airport – SNCF, RATP & SNCF syndicated operations France Paris Orly airport – RATP France Leon Saint Exupery airport – SNCF Germany Frankfurt airport – DB AG US Chicago O'Hare airport – CTA, METRA
	III	Operator only	Japan Tokyo Narita airport – Tokyo Monorail Japan Osaka Isetan airport – Osaka High Speed Rail Corp. Sweden Stockholm Arlanda airport – A-Train Company Malaysia Serpang airport – KLITA
	IV	II and III combined	Australia Sydney airport (Type II) CityRail and (Type III) Airport Link Company in joint management, where the route is provided by CityRail Netowrk with junctions fun by CityRail

4. OPTIMAL OPERATION ORGANIZATION MODEL AND ALTERNATIVES ORDER
4.1 Building Model

The study adopts AHP to simply the issue and ascertain an elemental hierarchy system, together with introducing the fuzzy theory for fuzzy weighing of various criteria, and then utilizes the TOPSIS method to compute the performance attainment rating of all alternative alternatives in order to select an optimal alternative; the evaluation model is as shown in Figure 2.

4.2 Alternatives

The drafting of the alternative alternatives is divided into two stages. Stage one being to generate alternative alternatives, and stage two being to screen for the legitimacy of all alternatives presented, which largely derive form relevant archival publications on rail operating organizational modes, field implementations by foreign international airport rail link operators, the CKS International Airport rank link development plan, and the state of local rail system operators in anticipation of sorting out four crucial elements for the alternatives: (1). The operation organization being monolithic; (2). The rail operation organization will be chosen from four rudimentary forms of a government agency, public organization corporation, private corporation and nonprofit incorporated entity; (3) The three elements of resources, process and core value, as cited by Clayton and Overdrof (2000), that poise to affect the organization mode; (4) The main business entity of the operator. A total of six feasible alternatives have been drafted as shown in Table 5.
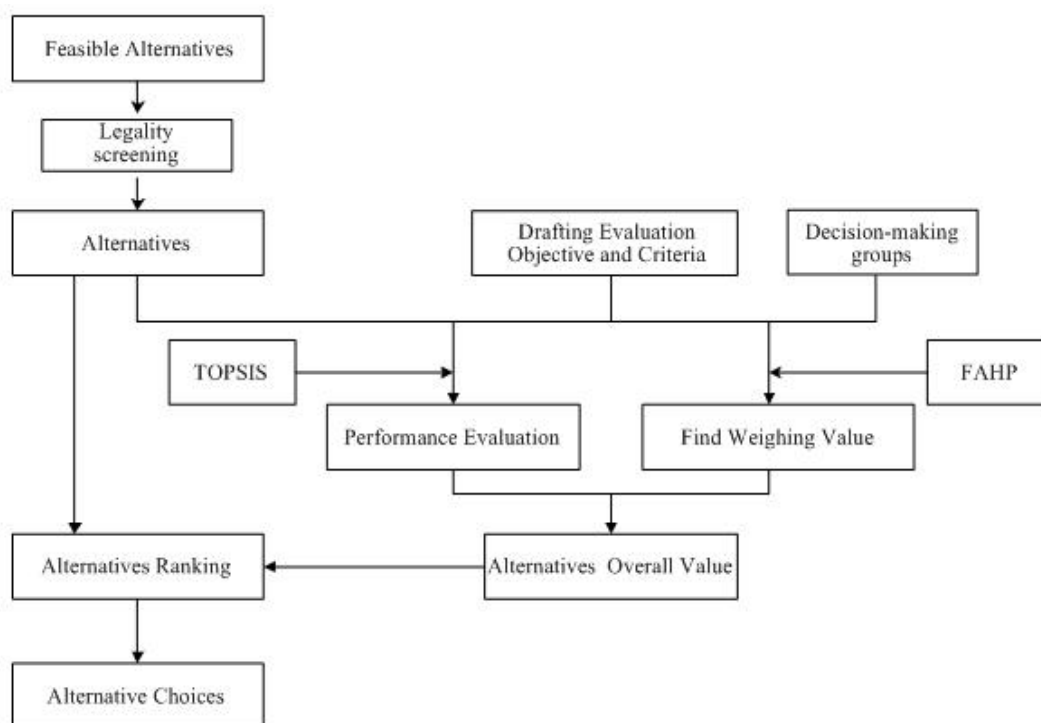
Figure 2. Optimal operation organization evaluation model

Table 5. CKS airport rail link operator alternative selection alternative

Heading	Type	Type description	Alternative
Operator being the airport operator	I	Operated Airport and Airport Rail Link	Civil Aeronautics Administration(CAB), MOTC
Operator is Rail Operator	II	Airport rail link extended from a rail or new rail line to the airport	Taipei Rapid Transit Corporation (TRTC)
			Taiwan Railway Administration(TRA)
			Taiwan High Speed Rail Corporation (THSR)
	III	Operator only	A new public organization
			A new independent private corporation

A total of four feasible alternatives has been narrowed down in phase two as per the Mass Rapid Transit Act, which are (1) Alternative 1. Taipei Rapid Transit Corporation (TRTC); (2) Alternative 2. Taiwan High Speed Rail Corporation(THSR); (3)Alternative 3. a new public organization; (4) Alternative 4. a new independent private corporation.

4.3 The Characteristics of Alternatives

(1) Alternative 1. Taipei Rapid Transit Corporation (TRTC):
Founded on July 29, 1994, Taipei Mass Transit Corporation is of the only incorporated entity that has had experience running an urban mass rapid transport system, and of a state-run enterprise, with its major shareholders being the Taipei City Government, with shareholdings exceeding 70%. The Taipei MRT system is comprised of rubber-tired and heavy rail systems, which runs seven lines covering 66km in train service; the alternative's advantages include:

Advantages:
a. Having had experience: The company boasts a good operating value, with 2000 after-tax net profit reporting at $370 million, with a high level of employee aptitude, and of younger average

age, with employee productivity rising over the years.
b. Lower cost infusion: As the company possesses the experience and capability of operating steel rail and rubber rail MRT systems, the addition of the airport rail link would cost the company lesser cost infusion than the other companies.
c. Advantage in geographical accessibility: The distribution of inbound and outbound passenger flow passing through CKS International Airport that has 68% coming or heading for areas north of Taoyuan, 25% for areas south of Taoyaun, and 5% within Taoyuan would put the company to command a geographical advantage.
d. Operating scale expansion: When granted with the airport rail link operating rights, the company's operating network will surge instantly from the exiting 66km to 117.5km to instantly prop up its market share, and future train purchases will enjoy a reduced purchasing cost with increased train number.
e. The advantage of train operations integration: When given to run the airport rail link, an integration to the company's Taipei MRT network would be easier and cost efficient than being run by two separate companies.

Disadvantages:
a. Lesser independence in operating strategy: As a unit that falls under the Taipei City Government, the company is subject to supervision of the City Council and administrative agencies and may command less independence in decision making.
b. Becoming a monopolistic market: If given the airport rail link operating rights, the company would monopolize Taiwan's northern regional MRT system and led to a stagnant improvement to its service quality without outside competitors.
c. Ignoring servicing central and southern passengers: if given the airport rail link operating rights, the company may focus on servicing passengers in the northern region for its geographical location to ignore servicing passengers from the central and southern regions.

(2) Alternative 2. Taiwan High Speed Rail Corporation(THSR):
The Taiwan High Speed Rail boasts as the premiere BOT transportation project in Taiwan. The Ministry of Transportation and Communications has entered a "Taiwan south-north high speed rail BOT contract with Taiwan High Speed Rail Consortium on July 23, 1998, and the project has been kicked of as of March 26, 1999 and scheduled to complete by October 2005, with a BOT operating concession set for 35 years. The project's advantages include,

Advantages:
a. Flexible in ticketing rates: If given the airport rail link operating rights, there would be no problem in ticket authentication with the high speed rail system to provide a more flexible ticketing strategy.
b. Advantage in train operations integration: If given the airport rail link operating rights, the integration with the high speed rail train would be easier and more cost efficient than when run by two separate companies.
c. Reducing the competition between high speed rail and airport rail link: If given the airport rail link operating rights, it would also resolve competition problem between the high speed rail system and the airport rail link servicing between the airport and Taipei.
d. Lower information integrating costs: If given the airport rail link operating rights, the integration of passenger information service with the high speed rail system would be easier and cost efficient than when run by two different companies.

Disadvantages:

a. High-speed rail stops being far away: Except the Taipei Station, the rest of the High Speed rail system's stations are far away from downtowns.

b. Lack experience: the consortium does not posses prior experience in running urban rail systems.

c. Operating value remained unknown: as the system is currently under construction even though with a dynamic grasp of its development schedule (where the project progress has been complying or partially exceeding the anticipated schedule), its future operating capability remains to be seen.

(3) Alternative 3. a new public organization:

Advantages:
a. More prone to supporting government policy: A newly launched state-run company could decide to support the policy in absorbing some of the personnel following the completion of the development.

b. Focusing on competitiveness enhancement: For having a market competitive role with TMTC, THSRC and Taiwan Rail, the newly launched state-run enterprise would tend to focus on its competitiveness by enhancing its service quality.

c. Prone to the promotion of urban rapid transit systems: Irrespective whether it falls under the jurisdiction of Taipei County Government or Taoyaun County Government, there is a higher tendency that the firm will be conducive in helping to extend the regional transport network.

d. Varied operating role: Its operating characteristics would differ from that of the Taipei MRT Corporation.

Disadvantages:
a. Inability to lower infusion costs: It lacks actual operating experience and capability, which may curtail reducing the government's reinvestment cost.

b. Underrated entity shareholdings: The local government in charge of running the system may not have sufficient fiscal funding to invest in the company's shareholdings.

c. High cost in transit/transfer interface: Besides coordinated with airport operating logistics, it also needs to coordinate transfer and transmit logistics with Taipei MRT, the high speed rail consortium and the Taiwan Rail Administration to lead to increase in time and costs.

(4) Alternative 4. a new independent private corporation:

Advantages:
a. Clearly defined responsibilities and entitlements: The government collects the operating concession royalties, and the private-run company is responsible for its earnings or deficit. It helps to free the government from assuming a refereeing role, but only to carry out its supervision, development, administration and audit functions.

b. Relatively lower investment risks: Not having to assume assets, a private-run enterprise is regarded as having a relatively lower investment risk and a higher willingness to invest.

c. New management mode: It helps to bring in new technology and management mode.

d. Contractual supervision: Through contractual arrangements, the government could set to maintain a certain security requirements and equipment maintenance for the airport, and to promote its transportation and environmental conservation policy.

Disadvantages:
a. Lesser prone to supporting government policy: A private run enterprise could choose freely whether to absorb some of the personnel after the project has been completed, and the

government would have no say in it.
   b. Contractual disputes: The contract could be disrupted, resulting in extra costs and service disruption.
   c. Higher cost in transit/transfer interface: Besides support the airport's operating procedures, it also requires to interface with Taipei MRT, Taiwan High Speed Rail and Taiwan Rail pertaining to transfer, transit and ticket authentication, to lead to increase in time and costs.

4.4 Building An Evaluation Hierarchical Structure

Upholding the generalgoal of an optimal operation organization of CKS International Airport rail link, the study has presented five objectives that would poise to satisfy the two subgoals of Optimal value in airport rail link operating service value and Optimal value in system integration and pertinent technical support, which are Upgrading operations efficiency, Enhancing finance management, Completing airport feeder system, Integrating relative technology support structure, and Meeting government's policy, intended to conduct comprehensive assessment. In the next tier of objectives, a total of 16 evaluation criteria have been defined before an optimal selection hierarchy structure for selecting an operator is constructed, where there were a total of five major objectives and sixteen selection criteria; a hierarchy framework correlation is as shown in Table 6., and further described as follows:

Table 6. Evaluation Hierarchical Structure for CKS International Airport Rail Link

Goal	Objective	Criteria
1.Optimal value in airport rail link operating service value 2.Optimal value in system integration and pertinent technical support	Upgrading operations efficiency	Staffing efficiency
		Contribution toward core transportation business
		Ability to form cross-industry strategic pact
		Able to instill a fine company reputation
	Enhancing finance management	Ability to manage peripheral enterprises
		Risk management capabilities
		Flexibility in company financial management
	Completing airport feeder system	Ability to offer flexibility ticketing policy
		Ability to offer flight schedule requirements
		The level of support in rail system transit/transfer service and ticket authentication
		The capability in providing vital points with transit service
	Integrating relative technology structure	The ability to enforce a service and maintenance system
		Industry relevancy
		The ability to provide travel information
	Meeting government's policy	Sum of government reinvestment in project implementation, or sum of operating concession rights
		Level of support by government policy

(1) The objective of "Upgrading operations efficiency":
   a. Staffing efficiency: unit employee productivity value (operational revenue/number of employees); unit employee passenger served (passenger volume/number of employees); number of employees allocated per kilometer (number of employees/route kilometer count).
   b. Contribution toward core transportation business: Where the company in various alternatives that is given the operating rights to run the route would poise to expand its operating scale or business territories, hence the higher the operator's contribution towards its core transport business, the

higher the value of the alternative would become.

   c. Ability to form strategic cross-industry alliance: As the route's importance source of riders being from airline passengers that are related to travel agencies, airliners and the tourism industry, the higher the operator's ability to strike strategic appliance, the higher its operating value will be increased and the higher its alternative value would become.

   d. Instilling a fine company reputation: As CKS International Airport remains an important gateway to Taiwan, enhancing the user's confidence towards the rail service quality would poise to draw foreign passengers to utilize the system, and in turn promote Taiwan's cosmopolitan image, hence the higher the company image, the higher the value of the alternative would become.

(2) The objective of "Enhancing finance management":

   a. Ability to operate peripheral enterprises: As this concerns the net valuation of shareholder's investment, internal rate of return on shareholder's investment, and proportion of amortized debt repayment, the higher the company is able to operate in peripheral enterprises, the higher the value of the alternative would become.

   b. Risk management capabilities: As this is tied to risk management checklist, risk preventive measures and risk response or easing strategy, the higher the firm's risk management capability, the higher the value of the alternative would become.

   c. Flexibility in company financial management: As this is correlated to the operator's source of capitalization, and source and capability of financing, the more venues the company possesses, the higher the value of the alternative would become.

(3) The objective of "Completing airport feeder system":

   a. Ability to offer flexibility ticketing policy: The more likely the operator is able to offer a flexible ticketing policy by operating hours and riders by offering as many choices to the passenger, the higher the value of the alternative would become.

   b. Ability to offer flight schedule requirements: Train dispatch accuracy, comfort of passenger's train space (square meter/passengers); frequency of train dispatch during peak hours; accuracy of interactive information prompted.

   c. The level of support in rail system transit/transfer service and ticket authentication: As an operator is expected to cooperate fully with varied rail systems, including the Taiwan MRT, the Taiwan High Speed Rail, and Taiwan Rail, to expand the scope of services through routing, dispatch and ticket authentication to convenient the passengers, the higher the level of support the operator is able to offer in rail system transit/transfer service and ticket authentication, the higher the rail transport utilization would be, hence the higher the value of the alternative would become.

   d. The capability in providing vital points with transit service: As the collaboration with private transport means or public transport offered throughout CKS International Airport terminals coordinated to airport operating procedures, and at nearby strategic points, such as hotels, crossroads, tourism attractions and between stations with incentive or complimentary transit service would poise to expand the scope of services and convenient the tourists, the more incentive or free service that the operator is able to offer, the higher the value of the alternative would become.

(4) The objective of "Integrating relevant technical support structure":

   a. The ability to enforce a service and maintenance system: To maintain the transport system in normal operation, ensure travel safety within the limited resources of the operator, the higher the operator's capability to enforce a repair and maintenance system, the higher the value of the alternative would become.

   b. Industry relevancy: As an operator would be more prone to support the rail transport technology

and be able to respond to the transport system's emergency responses when it is closely related to the rail transport industry, the higher the industry relevancy, the higher the value of the alternative would become.

c. The ability to provide travel information: As air travel often requires accurate travel information as the passengers are often traveling by different transportation means, the higher the ability to offer travel information, the higher the value of the alternative would become.

(5) The objective of "Meeting government's policy":

a. Sum of government reinvestment in project implementation, or sum of operating concession rights: As the government is likely to reinvest capital during the implementation process under various alternatives, the higher the capital invested the higher the Alternative 1.mplementation cost would become; hence, the study has intended to derive the Alternative 1.mplementation cost based on the sum of government reinvestment versus the sum of the concession operating rights granted, in which the higher the amount of reinvestment, the lower the value of the alternative would become.

b. Level of support by government policy: As airport rail link falls under a ring of the mass transportation service, it lends the legitimacy as part of the public infrastructure rather than sole for profit making, yet at times require the enforcement of public equity and private consensus, hence the higher the lever of government policy and private consensus the higher the value of the project would become.

5. EVALUATION AND ANALYSIS FOR ALTERNATIVES

In expert questionnaire design and surveying, the questionnaire design and expert entries are used to conduct a paired criteria weighing comparison, made under the criterion of pairing an element of a level to a given element of its higher tier. During the questionnaire survey, the significance and content of all evaluation criteria and alternative alternatives are explained fully to the respondents to reiterate the disparity among their importance. The study's surveying subjects include three major decision-making groups, which are government agency representatives, academic representatives, and operator representatives, in which government agency representatives pertain to officials of agencies that are related to the study, academic representatives pertain to those trained and experienced in rail transport operating management, and management representatives pertain to company executives (such as those on a manager level or higher) that hold the right to decision making. The current survey has the questionnaire poll conducted with 25 respondent polls, and valueed a total of 22 valid questionnaires.

5.1 Calculation and Analysis on Objectives and Criteria Weighed Value

Upon putting the various decision-making groups' evaluation objectives and criteria weighed value through fuzzification, normalization and defuzzification computation processes, the best non-fuzzy performance values (BNP) are derived; the results as sorted as shown in Table 7. , which depicts the evaluation objectives and criteria weighed values by various decision-making groups and by the overall decision makers.

Table 7. Table of weighed value by various decision-making groups

Objective	Decision-making groups				Evaluation criteria	Decision-making groups			
	Government agency representative	Scholar representatives	Management representative	Overall decision maker		Government agency representative	Scholar representatives	Management representative	Overall decision maker
Excelling operating performance	0.3305	0.3131	0.3247	0.3234	Staffing efficiency	0.4224	0.3202	0.2049	0.3103
					Contribution toward core transport business	0.3463	0.4718	0.3764	0.4126
					Ability to form cross-industry alliance pact	0.2095	0.2109	0.3718	0.2665
					Able to instill a good company reputation	0.1364	0.1760	0.2785	0.1979
Enhancing financial management	0.2580	0.2003	0.2465	0.2362	Ability to operate peripheral enterprises	0.3775	0.1760	0.2785	0.1979
					Risk management capability	0.4012	0.5257	0.4567	0.4750
					Flexibility in company financial maneuverability	0.4493	0.3465	0.3668	0.3931
Completing airport feeder system	0.2913	0.3739	0.3209	0.3318	Ability to offer flexible ticketing policy	0.3324	0.1649	0.1976	0.2225
					Ability to support flight schedule requirements	0.3565	0.3967	0.3044	0.3547
					Level of support for rail system transit/ transfer service and ticket authentication	0.4634	0.2967	0.3440	0.3671
					Ability to offer strategic point transit service	0.2108	0.2910	0.3481	0.2818
Supporting relevant technical backup system	0.1362	0.1950	0.3222	0.2059	Ability to enforce a repair and maintenance system	0.4650	0.5302	0.5965	0.5365
					Industry relevancy	0.2277	0.2268	0.2029	0.2239
					Ability to provide travel information	0.5092	0.3831	0.2618	0.3825
Meeting government's policy	0.1603	0.0916	0.1667	0.1360	Government's reinvestment in project implementation, or sum of concession operating rights	0.7394	0.6877	0.3459	0.5725
					Level of support by government policy	0.6018	0.5901	0.6863	0.6156

Of the state of weighed differentials as shown in Table 7. as concluded by the varied decision-making groups and evaluation criteria, the level of preference by various decision-making groups toward varied objectives and evaluation criteria can be discerned. The term level of preference refers to the higher the weighed value the more partial that the respondent has towards a particular objective. For instance, in objective rating, as far as the overall decision makers are concerned, it carried a weighed value of 0.3318 towards Completing airport feeder system, which exceeded that for Meeting government's policy rated at 0.1360, a sign indicating that the importance of Completing airport feeder system to be higher than Meeting government's policy.

The study has discovered that how the fairly consistent weighed values on the evaluation objective of completing airport feeder system as rated among the various decision-making groups would lend it as an indispensable crucial consideration factor in assessing the management of a mass transport system that would satisfy the rudimentary requirements of the transportation market. As to the evaluation objective of meeting government's policy, the consensus among the various decision-making groups has consistently fallen lower than the four other evaluation objectives would imply it be of a secondary consideration factor, and suggest that a management organization that adheres to the market mechanism remains a requisition criterion to ensure a sustainable management of the rail operator.

Under the objective of excelling operating performance and among the sixteen evaluation criteria comprising of staffing efficiency and so forth, the evaluation criterion of the contribution toward core transport management is equally preferred by the academic representatives and operator representatives, whose importance has been rated higher than all other evaluation criteria under this heading. Under the objective of enhancing financial management, the evaluation criterion of risk management capability are equally preferred by the academic representatives and operator representatives, whose importance has been rated higher than all other evaluation criteria under this heading. Under the objective of completion airport feeder system, the evaluation criterion of providing vital strategic point with transit service has had its preference responses from the government agency representatives and the operator

representatives differed in a contrasting manner. Under the objective of integrating relevant technology support structure, the evaluation criterion of the ability to enforce a service and maintenance system has the weighed value given by the operator representatives to be far higher than that for the rest of the evaluation criteria under the same group. In terms of the evaluation criterion of industry relevancy, all division-making group voiced identical preference, yet whose importance is, however, rated lower than the other evaluation criteria under the same heading.

5.2 Alternative Choices

Upon putting the various alternatives through the TOPSIS method, the anticipated performance attainment ratio and a sequence of priority among the chosen alternatives can be extrapolated, with results as recapped in Table 8., where it also indicates the decision making results that the various decision making groups and the overall decision maker have toward the alternatives .

Table 8. Table for sequence of priority on various selection alternatives by decision-making groups

Alternative	Government agency representatives		Academic representatives		Operator representatives		Overall decision maker representatives	
	Performance attainment ratio	Ranking	Performance attainment ratio	Ranking	Performance attainment ratio	Ranking	Performance attainment ratio	Ranking
Alternative 1. TRTC	0.5681	1	0.5057	3	0.5105	2	0.5472	1
Alternative 2. THSRC	0.5549	2	0.5852	1	0.3807	4	0.5395	3
Alternative 3. a new public organization	0.4829	4	0.4432	4	0.5227	1	0.4822	4
Alternative 4. a new independent private corporation	0.4990	3	0.5642	2	0.4874	3	0.5424	2

As shown in Table 8., from the government agency's perspective, an operator comes with prior operating experience (which coincides with a majority of international cases) is found superior than one that does not have any prior operating experience, and that an operator with similar service mode would also take priority. As a result, Alternative 1.TRTC that falls under an urban transport mode is considered slightly superior than Alternative 2. THSR that falls under an intercity transport mode. Thus treating the rail link as part of the Taipei MRT system and have the system run by TRTC would become an optimal alternative. Suppose due to government policy that a new enterprise is to be launched, then Alternative 4. a new independent private corporation would be regarded as superior than Alternative 3.a new public organization, for how it better supports the government's policy of promoting private participation in public infrastructure development.

Gauging from the academic's perspective, the management of an eligible private enterprise would support the theoretic argument of a higher level of business orientation and efficiency than a state-run enterprise, and that an operator with prior operating experience would be given priority than one without. Hence CKS International Airport rail link ought to take to a private-run operator management mode that comes with a higher level of business sophistication and efficiency (meaning superior than public organization). Thus, THSR of Alternative 2. that would soon inaugurate the high speed system in October 2005 would emerge to be most favorable; while TRTC of Alternative 1., though comes with abundant urban rail transportation system management know-how, still trials behind Alternative 4.of a new independent private corporation operating mode for how it remains a new public organization.

Gauging from the operator's perspective, as mass transport enterprises are a tough business that often relies on government support, a new public organization would have a greater chance of enduring it than a new independent private corporation, and that a new public organization should take precedence than an existing one for how it does no have to shoulder burdens. Hence Alternative 3. a new public organization found slightly superior than Alternative 1.TRTC; Alternative 4. a new independent private corporation slightly superior than Alternative 2. THSR. The foregoing described also shows how the academic's perspective has drastically differed from the operator's perspective.

As a recap concluding opinions from various decision-making groups indicates that the selection of an optimal CKS International Airport operator is best avoid setting up a new company as a prioritized consideration, this would leave Taipei Rapid Transportation Corporation with actual operating experience as a priority, whereas when considering setting up a new company, a private-run enterprise would be a prioritized choice. However, the disparity between the two alternatives has been rather insignificant. Hence the ranking in sequential order for choosing an optimal operator for running CKS International rail link would be Alternative 1. TRTC , then Alternative 4. a new independent private corporation, then Alternative 2.THSR, and trailed by Alternative 3. a new public organization.

6. CONCLUSIONS AND RECOMMENDATIONS
6.1 Conclusions

(1)Given that the transportation service of airport rail link systems are increasingly emphasized by world countries, and gauging by statistics on the current state of airport rail link systems in service worldwide, the number of airport rail link systems in European countries dominates worldwide at 60.3%. Meanwhile, study reviews conclude that the route length among international airport rail link systems is predominantly within 20km, followed by the travel distance of between 20 and 40km, which would help to establish an operating scale trend for the operator. With that, upon recapping the route length and its characteristics, the study has identified that the issue of choosing system technical service would be something that the operator or operator companies need to ponder carefully.

(2)Statistics compiled by the study polling the routes of 146 airport rail link systems currently in service, the choice of rail technology can roughly be divided into six types, among them suburban rails account for the most of 51 in total, or at 34.9%; followed by regional rails, which totaled to 43, or 29.4%; and trailed by high speed dedicated, which totaled to 8, or 5.6%. Suppose to take into account both the suburban rails and regional rails, which account for 64.4% against all systems in service, the statistics still reflect that a majority of them entailed having an extension built from conventional rails.

(3)From 1991 to 1997, originating and destined trips distributions do not show significant dissimilarity for CKS International Airport. The trips generation are primarily concentrated on areas north of Taoyuan, which account for approximately 69.3% ~ 68.5%, followed by areas south of Taoyaun and other areas that account for 25.3% ~ 26.4%, and trailed by trips generation within the Taoyuan area that account for 5.4% ~ 5.1%. Based on the figures, it is evident that developing an airport rail link servicing CKS International Airport and Taipei has emerged as an important project in support of Taiwan's future tourism development demand. While a recap of the development process at the international airport rail link systems finds that it comes in two forms – one that is built alongside the development of a new airport, such as Hong Kong's Airport Express Line, Japan Tokyo's JR Narita Kukou Line, Japan Osaka's JR Kansai Kukou Line; and the other being an improvement rail link developed following the completion of an airport, such as United Kingdom London's Heathrow

Express and the like. Taiwan's development would fall under the latter development mode.

(4) In terms of the operating mode in international airport rail link systems, the existing international airport rail link systems can be divided, by the role of the operator, into four types: I. operated airport and airport rail link, II. airport rail link extended from a rail or new rail line to the airport, III. Operator only, IV. II and III combined. Based on the consideration of organization pattern and rail operation requirement, four alternatives including alternative 1. Taipei Rapid Corporation (TRTC), alternative 2. Taiwan High Speed Rail Corporation (THSRC), alternative 3. a new public organization, and alternative 4. a new independent private corporation are revealed for further analysis.

(5) Considering of the service requirement of both commuters and airport passengers, this study chooses the Fuzzy Analytic Hierarchy Process (FAHP) as the major alternatives evaluation methodology. Five objectives are brought into the hierarchy evaluation system including upgrading operation efficiency, enhancing finance management, completing airport feeder system, integrating relative technology support structure and meeting government's policy. Next, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is adopted to evaluate the operator's priority. The evaluation criteria drafted and finalized are described as follows,
  a. Four criteria are adopted to evaluate the objective of "Upgrading operation efficiency": staffing efficiency, contribution toward core transportation business, ability to form cross-industry alliance, and instilling fine company reputation.
  b. Three criteria are adopted to evaluate the objective of "Enhancing finance management": ability to run peripheral enterprises, risk management capabilities, and flexibility in company financial maneuver.
  c. Four criteria are adopted to evaluate the objective of "Completing airport feeder system": ability to offer flexible ticketing policy, ability to support airline flight schedule, level of support to rail system transit/transfer service and ticket authentication, and ability to provide strategic point transit service.
  d. Three criteria are adopted to evaluate the objective of "Integrating relative technology support structure": ability to enforce a maintenance and upkeep system, industry relevancy, and ability to offer travel information.
  e. Two criteria are adopted to evaluate the objective of "Meeting government's policy": the sum of government reinvestment for project implementation or the sum of concession operating rights, and the level of support by government policy.

(6) The study has discovered that how the fairly consistent weighed values on the evaluation objective of completing airport feeder system as rated among the various decision-making groups would lend it as an indispensable crucial consideration factor in assessing the management of a mass transport system that would satisfy the rudimentary requirements of the transportation market. As to the evaluation objective of meeting the government's policy, the consensus among the various decision-making groups has consistently fallen lower than the four other evaluation objectives would imply it to be of a secondary consideration factor, and suggest that a management organization that adheres to the market mechanism remains a requisition criterion to ensure a sustainable management of the rail operator.

(7) The study has concluded a total of 22 valid questionnaires, which upon being assessed are then sorted and analyzed to derive at the perspectives that the varied decision-making groups have toward the selection of various alternatives. To government agency representatives, they reckon that an operator with operation experience is to be chosen as the optimal alternative but do not rule out

the alternative of launching a new independent private corporation. To academic representatives, they reckon that a independent private corporation is preferable than a public organization, and one that has operation experience is more preferable than one that does not. To operator representatives, they reckon that a public organization is preferable than a independent private corporation, and it needs to be a newly formed organization. Recapping the above, with an operator that possesses operation experience being a consensus among the various decision-making groups, yet taking into account the characteristics in mass transport system management, the respondents of the operator representatives reckoned that a government-backed transport operator being an optimal alternative, which drastically differs from how the respondents of the academic representatives who recommended that it be implemented by revamping the business management to a private corporation.

(8) Upon recapping the assessment by various decision-making groups for selecting an optimal operator alternative for the CKS International Airport rail link system, Alternative 1. TRTC emerges as the optimal alternative, with an anticipated performance value at 0.5472; followed by Alternative 4. a new independent private corporation as the next best alternative, with an performance value at 0.5424. Although these two alternatives do not show significant dissimilarity, the operation experience is the key factor to decision-making group while assessing the operation organization.

6.2 Recommendations

(1) Characterized by having to shoulder the responsibility of providing public transportation service, the management of a mass transport system does vary form other business modes, and as concluded by the study that the viewpoints held by management representatives interviewed versus that of academic representatives surveyed have varied with a rather significant disparity. Hence, attempting to determine whether a private corporation mode or a public organization mode would be superior lends itself as a crucial topic to be scrutinized in subsequent studies.

(2) In light that the development mode for Taiwan's CKS International rail link system requires to close to a decade from BOT to government-sponsored development, it is best that the future operator management mode be finalized as early as possible in anticipation of providing the local denizens with a convenient airport rail link travel service. Suppose the study's Alternative 1. TRTC, the subsequent studies would include train operations planning, manpower resources utilization (including technical repair and service), company organization and financial analysis.

(3) Base on promoting private participation in public construction of Taiwan. Suppose the study's Alternative 4. a new independent private corporation, relevant development governing Operate-Transfer (OT) would need to be drafted in accordance with the "The Statute for Promoting Private Participation in Public Construction" in order to select an optimal concession firm, all of which require further evaluation and analysis.

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