

해외출장복명서

기 간: 2016. 2. 13 ~ 2016. 2. 21

출장지: 바르셀로나, 스페인

출장자: 오성호 연구위원

I. 출장개요

1. 출 장 지 : 스페인 바르셀로나
2. 출장기간 : 2016. 2. 13 ~ 2. 21 (7박 9일_기내 1박)
3. 출 장 자 : 총 1명

소속	직급	성명
국토인프라연구본부	연구위원	오성호

4. 출장 목적

- 18th International Conference on Civil, Environmental and Structural Engineering 발표 및 주요 세션 참석
- 스페인의 선진 도시교통체계 견학 및 시사점 도출을 통한 적용방안 모색

5. 주요 수행 내용

- Conference 주제 발표
- Conference 주요 세션 참석
- 스페인 도시교통체계 파악

II. 출장일정

날짜	출발지	도착지	방문기관/ 장소	주요 수행업무	관계자
2.13 (토)	인천	마드리드		출발/도착	
2.14 (일)	마드리드	바르셀로나		출발/도착	
2.15 (월)	바르셀로나		Hotel Frontair Congress Barcelona	발표 : Effectiveness of ATMS(Advanced Transport Management Systems) in Asuncion	-Sura Al-Khafaji, Chair -Cinzia Federico, Chair
2.16 (화)	바르셀로나		Hotel Frontair Congress Barcelona	세션참석 : -Foundation of the Information Model for Connected-Cars -Impact of the Non-Energy Sectors Diversification on the Energy Dependency Mitigation: Visualization by the "IntelSymb" Software Application	- R a g h u n a n d a n a Kurkal, Chair -Ilaha Rzayeve, Emin ALasgarov, Orkhan Karim-Zada
2.17 (수)	바르셀로나			바르셀로나 도시교통체계 견학	
2.18 (목)	바르셀로나	마드리드		출발/도착	
2.19 (금)	마드리드			마드리드 도시교통체계 견학	
2.20 (토)	마드리드			출발	
2.21 (일)		인천		도착	

III. 수행사항

1. 컨퍼런스 주제발표

□ 일시 및 장소: 2016. 2. 15(월) 08:00~

□ 주요사항

○ (발표제목) Effectiveness of ATMS(Advanced Transport Management Systems) in Asuncion

○ (내용요약) 효과분석 대상 사업 소개

- 구축사업기간 : 2013.07~2015.12
- 규모 : PMC 72만 달러, 시공사 432만 달러
- 대상지 : 파라과이 아순시온市 8개 주요 도로
- 주요 시설물
 - 신호등(78기), CCTV(5기), VMS(6기), VDS(24기) 설치
 - TSM 및 교통정보센터 구축(s/w 한정)

○ 고려된 효과척도

효과척도	비교
접근로별 교통량	정량평가
교차로 지체도	설문평가
링크별 통행시간	정량평가
링크별 통행속도	정량평가
대기길이	설문평가
제공정보의 정확도/만족도	설문평가

※ 정성적 효과척도(5가지) : 통행속도개선, 신호등 시인성, 보행안전성, 도시미관 향상성, 실시간 정보활용도

○ 교통량 조사결과 : 첨두시 2.6%, 비첨두시 2.1% 증가

구 분	사전조사		사후조사		증감	
	첨두(오전)	비첨두	첨두(오전)	비첨두	첨두(오전)	비첨두
M.Cal Lopez y San Martin	6,472	5,388	6,652	5,511	180 (2.7%)	123 (2.2%)
Eusebio Ayala y De Gaulle	4,640	3,316	4,775	3,395	135 (2.8%)	79 (2.3%)
Fdo De La Mora y Bartolome	3,168	2,936	3,228	2,984	60 (1.9%)	48 (1.6%)
합계	14,280	11,640	14,655	11,890	375 (2.6%)	250 (2.1%)

○ 통행시간 및 통행속도 : 오전 첨두시간에 양방향 통행시간은 29분에서 20분으로 단축, 통행속도는 16.0km/h에서 22.5km/h로 증가됨

구 분 (오전 첨두)		통행시간 (분:초)		통행속도 (km/h)		증감
		사전	사후	사전	사후	%
Espana	in	19:49	16:37	23.9	28.5	19.3
	out	37:00	32:25	12.8	14.6	14.1
Mcal Lopez	in	30:20	18:06	17.4	29.2	67.6
	out	43:26	22:20	12.2	23.6	94.5
Eusebio Ayala	in	23:15	18:37	18.3	22.9	24.9
	out	26:06	19:20	16.3	22.0	35.0
Fernando de la Mora	in	24:46	18:37	15.0	20.0	33.0
	out	31:53	19:38	11.7	18.9	62.4
합계		29:05	20:07	16.0	22.5	40.9

○ 편익 산정 방법론

$$(\text{통행시간 절감편익}) \text{VOCS} = \text{VOC}_{\text{beforeproject}} - \text{VOC}_{\text{afterproject}}$$

$$\text{Where, } \text{VOT} = \sum_l \sum_{k=1}^4 (T_{kl} \times P_k \times Q_{kl} \times 365)$$

T_{kl} : Traffic time per vehicle and person in road 1

P_k : Time value per vehicle and person

Q_{kl} : Traffic volume per vehicle and person in road 1

k : Vehicle (1: car, 2: bus, 3: truck)

(유류비용 절감 편익) $VOC_{CS} = VOC_{beforeproject} - VOC_{afterproject}$

Where, $VOC = \sum_l \sum_{k=0}^N (D_{lk} \times VT_k \times 365)$

D_{lk} : Link(l), car type(k) car - km

VT_k : Operating cost per km of relevant link speed by car type(k)

k : Type (car)

(환경비용 절감 편익) $VOPCS = VOPC_{beforeproject} - VOPC_{afterproject}$

Where, $VOC = \sum_l \sum_{k=0}^N (D_{lk} \times VT_k \times 365)$

D_{lk} : Link(l), car type(k) car-km

VT_k : Air pollution cost per km of relevant link speed of car type(k)

k : Type (car)

○ 편익 산정 결과 : 총편익 471억원/년

- 1) 통행시간 절감 편익 : 309억원/년
- 2) 유류비용 절감 편익 : 152억원/년
- 3) 환경비용 절감 편익 : 10억원/년

○ 설문조사 및 분석결과 제시(부록참고)



2. 컨퍼런스 주제 참관

□ 일시 및 장소: 2016. 2. 16(화) 08:00~

□ 참관발표 주제 1 : Impact of the Non-Energy Sectors Diversification on the Energy Dependency Mitigation: Visualization by the “ IntelSymb” Software Application

○ 저자 : Ilaha Rzayeva, Emin Alasgarov, Orkhan Karim-Zada

○ 요약

This study attempts to consider the linkage between management and computer sciences in order to develop the software named “IntelSymb” as a demo application to prove data analysis of non-energy fields’ diversification, which will positively influence on energy dependency mitigation of countries. Afterward, we analyzed 18 years of economic fields of development (5 sectors) of 13 countries by identifying which patterns mostly prevailed and which can be dominant in the near future. To make our analysis solid and plausible, as a future work, we suggest developing a gateway or interface, which will be connected to all available on-line data bases(WB, UN, OECD, U.S.EIA) for countries’ analysis by fields. Sample data consists of energy (TPES and energy import indicators) and non-energy industries’ (Main Science and Technology Indicator, Internet user index, and Sales and Production indicators) statistics from 13 OECD countries over 18 years (1995–2012). Our results show that the diversification of non-energy industries can have a positive effect on energy sector dependency (energy consumption and import dependence on crude oil) deceleration. These results can provide empirical and practical support for energy and non-energy industries diversification’ policies, such as the promoting of Information and Communication Technologies (ICTs), services and innovative technologies efficiency and management, in other OECD and non-OECD member states with similar energy utilization patterns and policies. Industries, including the ICT sector, generate around 4 percent of total GHG, but this is much higher – around 14 percent – if indirect energy use is included. The ICT sector itself (excluding the broadcasting sector) contributes approximately 2 percent of global GHG emissions, at just under 1 gigatonne of carbon dioxide equivalent (GtCO₂eq). Ergo, this can be a good example and lesson for countries which are dependent and independent on energy, and mainly emerging oil-based economies, as well as to motivate non-energy industries diversification in order to be ready to energy crisis and to be able to face any economic crisis as well.

○ 키워드 : Energy policy, energy diversification, “IntelSymb” software, renewable energy.

□ 참관 발표주제 2 :Foundation of the Information Model for Connected-Cars

○ 저자 :Hae-Won Seo, Yong-Gu Lee


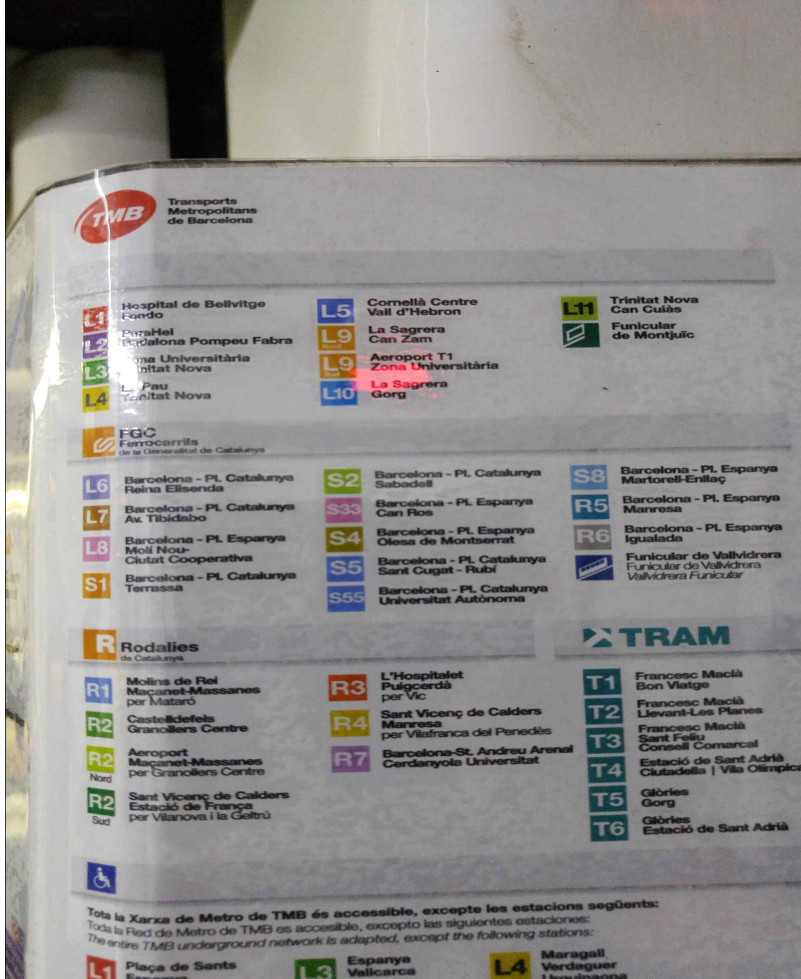
○ 요약

Recent progress in the next generation of automobile technology is geared towards incorporating information technology into cars. Collectively called smart cars are bringing intelligence to cars that provides comfort, convenience and safety. A branch of smart cars is connected-car system. The key concept in connected-cars is the sharing of driving information among cars through decentralized manner enabling collective intelligence. This paper proposes a foundation of the information model that is necessary to define the driving information for smart-cars. Road conditions are modeled through a unique data structure that unambiguously represent the time variant traffics in the streets. Additionally, the modeled data structure is exemplified in a navigational scenario and usage using UML. Optimal driving route searching is also discussed using the proposed data structure in a dynamically changing road conditions.

○ 키워드 : Connected-car, data modeling, route planning, navigation system.

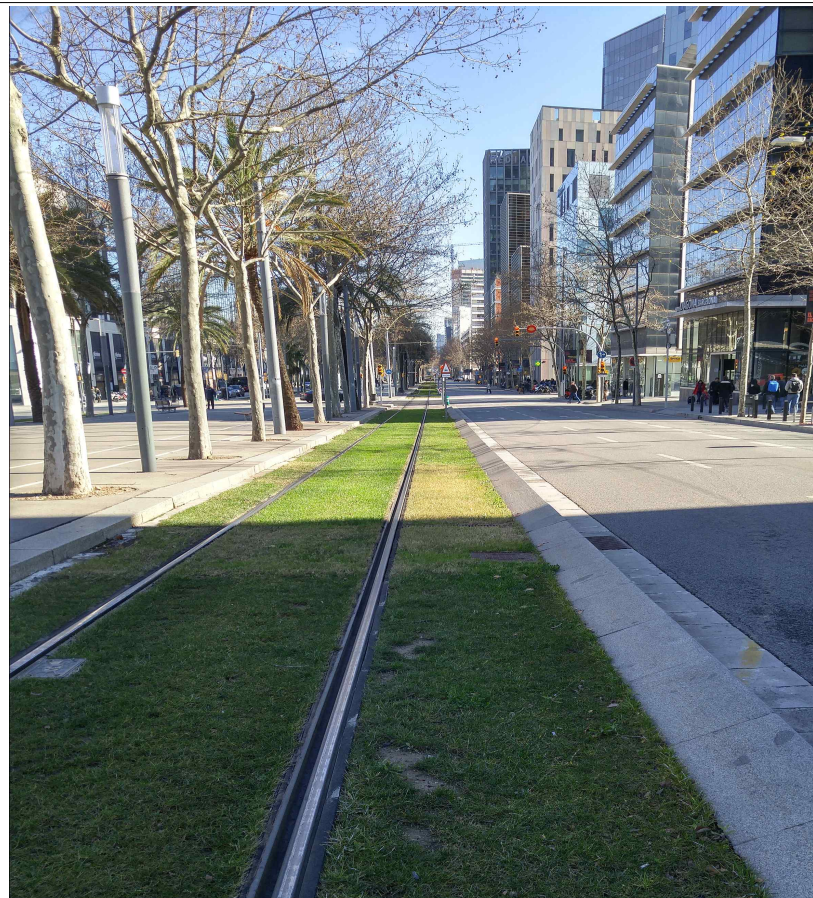


3. 바르셀로나 및 마드리드 도시교통체계 견학 및 시사점

사 진	내 용
	<ul style="list-style-type: none"> -스페인의 대표도시인 바르셀로나와 마드리드는 지하철 시스템이 도시전체에 대해 서비스를 제공하는 완성된 형태로 이루어짐 -고속철과 일반철의 연계를 중심으로 지하철과 도로위에서 운영되는 트램이 조화를 이루어 서비스를 제공하고 있음
	<ul style="list-style-type: none"> - 지하철은 총 9개의 라인으로 구성되었으며 건설순서에 따라 L1부터 L11으로 구성됨(L6~L8은 일반철도 분류) - S와 R로 구분되는 일반철은 주변의 주요위성도시를 연결시켜 출퇴근용을 사용되고 있음 - 트램의 경우 총 6개의 라인을 보유하고 있었으며 이들은 지하철시스템이 들어가기 어려운 지역을 대상으로 건설됨 - T1~3 라인은 서북부의 신도심내를 연계하는 역할과 T4~6라인은 구도심과 지중해를 연계하는 기능으로 건설 - 우리나라의 경우도 활발한 트램도입이 논의되고 있으나 현재 도로교통법의 한계로 도입이 어려운 실정으므로 도로법에 대한 개정이 필요



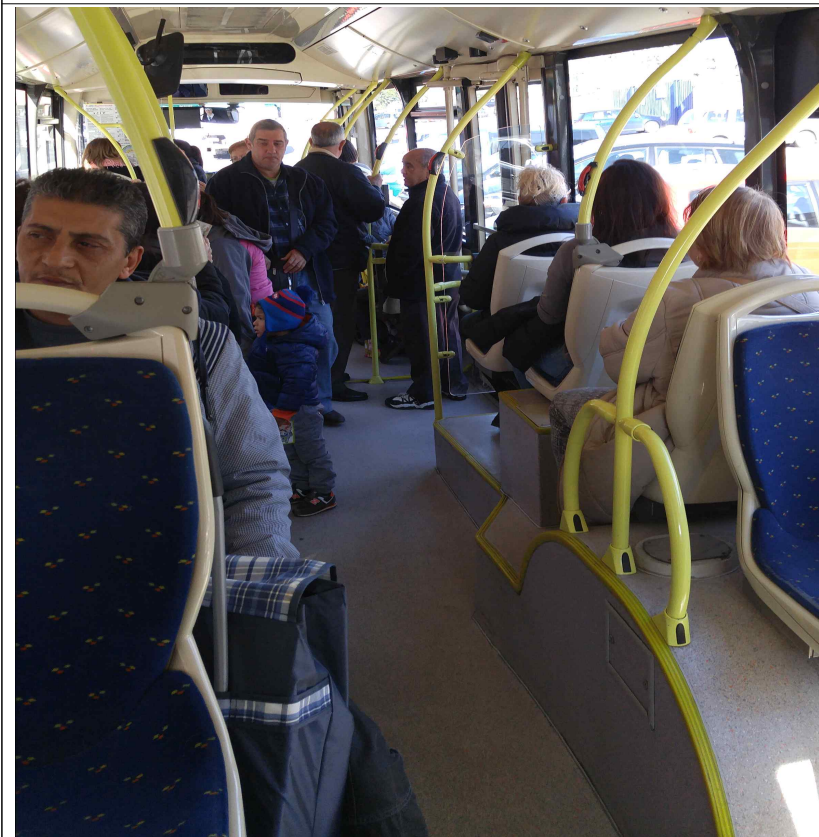
- 주변지역을 연계하는 일반 철의 경우 지하철과 유사한 형태(3개의 출입문)이나 장거리 통행자를 위한 많은 좌석을 배치하였으며 건설이 오래전에 이뤄져서 열차가 비교적 낮은 상태로 운영되고 있었음
- 열차, 버스, 트램을 모두 이용 가능한 티켓을 발행하여 여행자뿐만 아니라 일반이용자들의 이용효율을 높이고 있었으나, 현재까지 우리나라의 신용카드를 이용한 요금지불은 이뤄져 있지 않았음



- 도로위에서 운영되는 트램의 장점은 버스와 환승이 쉽고 여행자들에게 도시의 모양을 그대로 보여줄 수 있다는 것이어서 많이 도입되었으나 단점으로는 트램에 전기공급을 위한 구조물과 상부의 전선이 도시의 미관을 매우 해치는 것인데, 스페인의 경우 뾰뾰한 가로수를 조성하여 전기공급 구조물과 전선을 시야에서 사라지게 하는 효과 유도
- 일본, 유럽의 일부국가에서 트램의 전선문제로 도시미관문제가 대두되고 있는 점을 고려할 때 우리나라의 트램 건설시 해당 내용을 꼭 고려해야 할 좋은 시사점을 제공



- 트램 내부는 매우 쾌적한 편이었으며, 장애인, 자전거 이용자들에 대한 편의 시설이 잘 갖추어진 차량이 운영 중에 있었음



- 버스의 경우 완전한 저상차량으로 좌석이 저상공간으로부터 분리되어 한계층 혹은 두계층 위에 존재하고 있으며, 이는 장애인과 입석공간을 확보하기 위한 수단이라 판단됨

- 좌석자의 안전한 이동을 위해 별도의 손잡이 공간을 좌석별로 설치하여 안전성 향상을 꾀하였음

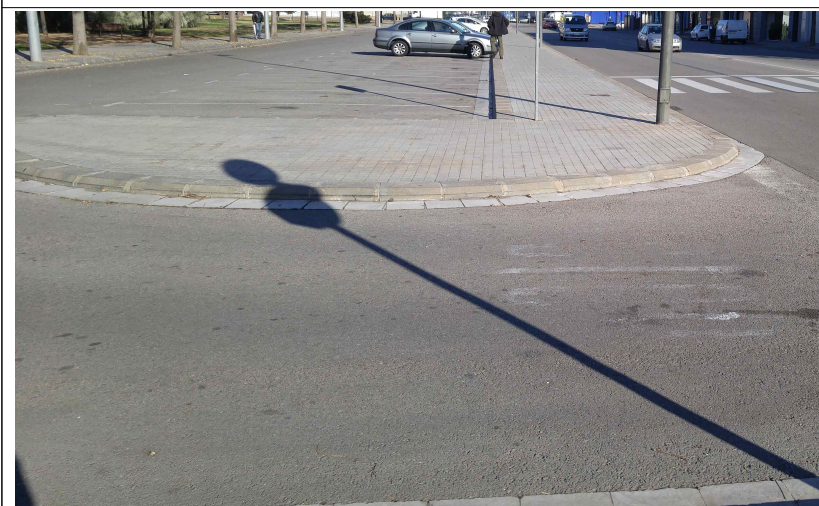
- 개별 좌석공간이 비교적 넓게 형성되어 버스이용자들의 불편을 최소화한 한점은 우리나라의 일반버스에서 도입을 고려해야 할 필요성 있으며 승객의 안전을 위해 많은 구조물 역시 중요한 시사점임



- 버스승강장과 동일레벨로 버스의 출입문이 열리면 평면공간이 확보되어 장애인휠체어나 자전거 등이 보관될 수 있도록 구성되어 있으며, 한계층의 좌석(그림의 오른쪽 윗부분)과 두계층의 좌석(그림의 왼쪽 아랫부분)으로 구성된 모습을 보여주고 있음
- 두계층의 좌석은 버스의 바퀴부분에 해당되는 자리로 승차가 불편하지 않았음
- 우리나라의 경우에는 시내 버스 바퀴부분에 한계층의 좌석이 있어 앉기까지가 다소 불편하므로 위의 두계층좌석도입 검토 필요



- 컨퍼런스 발표장소는 도심에 다소 떨어진 한적한 부도심지역으로 해당지역에는 많은 Round-about체계가 도입되어 운영중임
- 우리나라도 현재 해당체계를 도입하여 운영중이나 도심보다는 외곽지역에서 효과가 더 크음을 인지할 필요성 있음



- 도로건설시 일부공간에 대한 도로변 확보를 통해 인근지역을 방문하고자 하는 차량의 주차공간을 제공하였고 도로에서 바로 접근가능
- 우리의 경우 노변주차장이 위의 기능을 하고 있으나 통행차량에 영향을 줄 수 있어 신도시 건설시 해당시스템의 적극적 도입을 고려하여 보다 더 체계화 필요



- 관광도시에 맞게 도로중앙을 보행자에게 제공하고 보행로 좌우측변으로 일차로 해당되는 도로를 차량이 사용할 수 있도록 운영중
- 우리나라에서는 오직보행자만을 위한 보행전용도로의 계획수립이 이뤄지고 있으나 스페인의 사례처럼 대부분의 도로를 보행자에 주된 차량의 흐름도 함께 처리될 수 있도록 하여 상생하는 시스템의 검토 필요



- 일반적으로 사지교차로에서 동일방향에 대해 2개의 횡단보도가 필요하지만 중앙 보행전용도로에서는 중앙에 1개의 횡단보도만이 필요하게 되어 교차로 운영에 매우 큰 장점이 존재
- 보행공간과 횡단로 사이에 단차가 전혀 없는 상태 구성되어 캐리어를 갖춘 사람과 자전거의 이동을 편리하게 유도



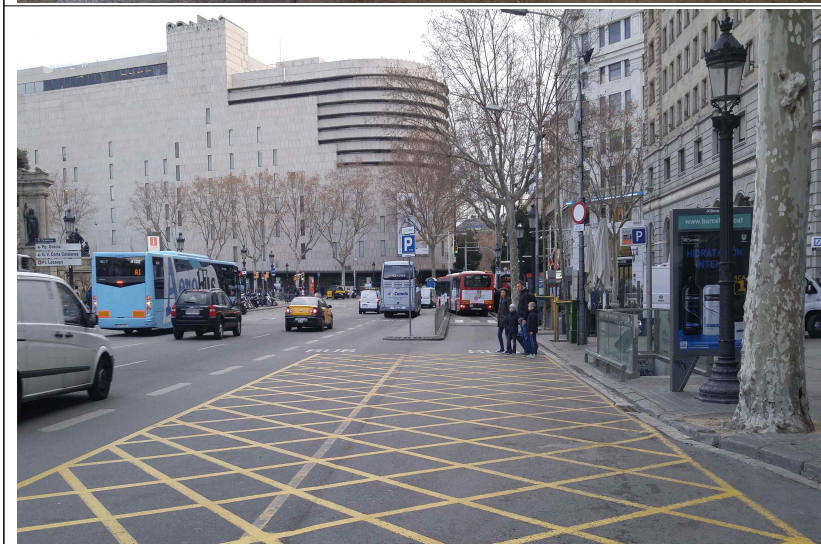
- 좌우측에 보행공간이 형성된 일반적으로 도로에서 보도내에 차량이 접근할 수 있는 별도의 공간을 제공하여 조업주차나 택시의 승하차가 이뤄지도록 처리하여 메인차량의 흐름을 방해하지 않고 또한 보행자가 큰 불편을 받지 않도록 구성함
- 현재 우리나라에는 조업주차만을 허용하나 택시의 이용도 검토해 볼만 함



- 스페인의 대표적인 관광도시인 바르셀로나에서는 친환경교통수단이용을 장려하기 위해 공공자전거를 도입하여 운영 중이나 관광객이나 시민들로부터 많은 호응을 얻고 있지 않았음
- 우리나라 역시 공공자전거 이용률이 매우 저조한 편임



- 마드리드에서는 야간에 자전거 이동의 안전성을 확보하기 위해 공공자전거에 안전 불빛을 확보하고, 또한 거치대의 보호와 이용 여부를 알려주기 위해 야간에 적색과 녹색의 조명으로 구분하여 제공



- 관광버스를 이용객을 위해 도심 광장에 별도의 안전지대와 승강대를 만들어서 이용장려와 안전향상 도모
- 서울의 경우 많은 관광버스가 매일 방문하고 있으나 이들을 위한 별도의 지정공간이 부족하거나 없어서 안전성이 떨어진다는 점을 고려할 때 주요 광장에 관광버스 정류장을 검토할 필요있음

Effectiveness of ATMS (Advanced Transport Management Systems) in Asuncion, Paraguay

Sung Ho Oh

Abstract—The advanced traffic lights, the system of traffic information collection and provision, the CCTVs for traffic control, and the traffic information center were installed in Asuncion, capital of Paraguay. After pre-post comparison of the installation, significant changes were found. Even though the traffic volumes were increased, travel speed was higher, so that travel time from origin to destination was decreased. The saving values for travel time, gas cost, and environmental cost are about 47 million US dollars per year. Satisfaction survey results for the installation were presented with statistical significance analysis.

Keywords—Advanced transport management systems, effectiveness, Paraguay, traffic lights

I. INTRODUCTION

THE city of Asuncion in Paraguay has continuously serious traffic congestion because of massive population and geographical problems by urban location. Asuncion's population is approximately 0.54million as of 2012, which means it has a low residential population, but economically active population from rural area is over 1.5million. Geographically, Asuncion city has been built as a cone shaped by performing central area thus vehicle traffic converged on central city in peak time and it leads to serious traffic congestion. For resolving severe traffic congestion causing environmental pollution, traffic accident and the others, city government of Asuncion decided to introduce Korean Advanced Traffic Management System(ATMS) into Asuncion. And the project was finished at April, 2015. This ATMS includes 78 advanced traffic signals, 24 video detectors for real time traffic information, 5 CCTV for traffic control and 6 variable message in 6 main roads of Asuncion including a few road of CBD. In addition, traffic control center was built during the project period.

The core of the project was the new green time depending on the real-time traffic volumes. Also, the traffic signal progression, which make automobile pass the signal intersections without stops, was the other core of the project. The systems for traffic information and control supported that the new traffic signal systems work very well. This paper shows qualitative and quantitative effect of the project in Asuncion, Paraguay. [2], [5]

II. SURVEY

The quantitative effect of the project is counted based on

difference of traffic volumes and speeds with and without ATMS. This difference would be transferred into travel time, gas and carbon saving. The qualitative effect of the project is showed on the 92 people surveys including 6 detailed questions. Surveys for quantitative effect are following. [1], [5]

- **Before survey:** Feb. 28 ~ Mar. 17, 2014
- **After survey:** Jun. 11 ~ Jun. 20, 2015
- **Survey times:** AM peak (6 o'clock~8 o'clock), non-peak (11 o'clock~13 o'clock), PM peak (17 o'clock~19 o'clock)

Average Speed Method used for travel speeds

Output of surveys tells us that the average travel speed gets higher to 22.5 km/h from 16.0 km/h, even though the traffic volumes are minutely increased. Output of survey is following.

A. Quantitative Analysis [1], [3], [5]

1. Benefit of Traffic Time Reduction

Traffic time reduction benefit is conversion of traffic time reduction to monetary value after the project. If traffic speed increases by the project, it has traffic time reduction effect of all users who use vehicles. Traffic time cost is calculated by multiplying traffic volume, traffic time and traffic time value.

$$VOC_{CS} = VOC_{beforeproject} - VOC_{afterproject}$$

$$VOT = \sum_{l=1}^4 \sum_{k=1}^4 (T_{kl} \times P_k \times Q_{kl} \times 365)$$

where T_{kl} is Traffic time per vehicle and person in road 1, P_k is Time value per vehicle and person, Q_{kl} is Traffic volume per vehicle and person in road 1 and k Vehicle (1: car, 2: bus, 3: truck).

When traffic volume, traffic time and time value were applied, daily average time reduction benefit of 3 axes is \$ 46,200/day and annual average benefit is \$16.9 mil/year.

TABLE I
TRAFFIC VOLUMES AND DIFFERENCE

Road	Before		After		Difference(veh./hr)	
	Survey(veh./hr.)		Survey(veh./hr.)			
	AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak
M. Cal Lopez y San Martin	6,472	5,388	6,652	5,511	180	123
Eusebio Ayala y De Gaulle	4,640	3,316	4,775	3,395	135	79
Fdo De La	3,168	2,936	3,228	2,984	60	48
					(2.7%)	(2.2%)
					(2.8%)	(2.3%)

Sung Ho Oh is Ph. D, Research Fellow in Korea Research Institute for Human Settlements, Korea (phone: +82-31-380-0343, e-mail:

shoh@krihs.re.kr).

Mora y				(1.9%)	(1.6%)
Bartolome					
total	14,280	11,640	14,655	375	250
				(2.6%)	(2.1%)

Axis no. 4	74,188	54,890	19,298	7,043,833
Axis no. 5	28,909	21,659	7,250	2,646,305
Total	160,337	114,073	46,263	16,886,239

TABLE II
AVERAGE TRAVEL TIME

AM Peak		travel time(min sec)		travel speed(km/h)		difference %
		before	after	before	after	
España	in	19.49	16.37	23.9	28.5	19.3
	out	37.00	32.25	12.8	14.6	14.1
Mcal Lopez	in	30.20	18.06	17.4	29.2	67.6
	out	43.26	22.20	12.2	23.6	94.5
Eusebio Ayala	in	23.15	18.37	18.3	22.9	24.9
	out	26.06	19.20	16.3	22.0	35.0
Fernando de la Mora	in	24.46	18.37	15.0	20.0	33.0
	out	31.53	19.38	11.7	18.9	62.4
total		29.05	20.07	16.0	22.5	40.9

TABLE III
TIME REDUCTION BENEFIT CALCULATION RESULT

Category	Before project(s)	After project(s)	Benefit(s)	Annual benefit(s)
Axis no. 3	57,240	37,524	19,715	7,196,101

2. Benefit of Vehicle Operating Cost Reduction

Vehicle operating cost reduction benefit is divided into fuel cost, engine oil cost, tire abrasion cost, maintenance cost and depreciation cost

$$VOCS = VOC_{beforeproject} - VOC_{afterproject}$$

$$VOC = \sum_l \sum_{k=0}^N (D_k \times VT_k \times 365)$$

where D_k is Link(l), car type(k) car - km, VT_k is Operating cost per km of relevant link speed by car type(k) and k Type (car)

Using vehicle operating cost per speed, the vehicle operating cost reduction benefit was estimated. As a result, daily average vehicle operating cost reduction benefit of 3 axes is \$22,700/day. Annual average reduction is \$8.3 mil/year.

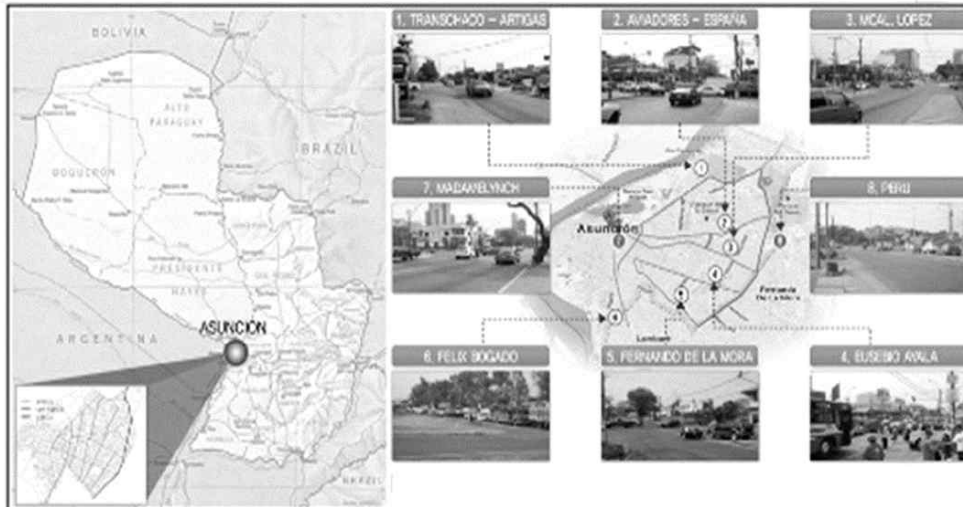


Fig. 1 Spatial boundary

TABLE IV
VEHICLE OPERATING COST REDUCTION BENEFIT CALCULATION RESULT

Category	Before project(s)	After project(s)	Benefit(s)	Annual benefit(s)
Axis no. 3	59,922	51,067	8,855	3,232,300
Axis no. 4	87,632	78,117	9,514	3,472,733
Axis no. 5	47,654	43,366	4,288	1,565,237
Total	195,208	172,550	22,657	8,270,270

3. Benefit of Environmental cost reduction

Environmental cost reduction benefit is calculated using air pollution cost and air pollution cost per car type and speed

$$VOPCS = VOPC_{beforeproject} - VOPC_{afterproject}$$

$$VOC = \sum_l \sum_{k=0}^N (D_k \times VT_k \times 365)$$

where D_k is Link(l), car type(k) car-km, VT_k is Air pollution cost per km of relevant link speed of car type(k) k is Type (car)

Using air pollution cost per speed, the air pollution cost reduction benefit was estimated. As a result, the daily average air pollution cost reduction benefit of 3 axes is \$1,500/day. Annual average reduction is \$0.55 mil/year.

TABLE V
AIR POLLUTION COST REDUCTION BENEFIT CALCULATION RESULT

Category	Before project(s)	After project(s)	Benefit(s)	Annual benefit(s)
Axis no. 3	1,376	785	591	215,880
Axis no. 4	1,918	1,260	658	240,281
Axis no. 5	997	737	260	95,211
Total	4,291	2,782	1,509	551,372

4. Total benefits

Traffic time reduction benefit, vehicle operating cost reduction benefit and air pollution reduction cost of 3 axes is annually average \$25.7 mil/year

TABLE VI
3-AXES BENEFIT CALCULATION RESULT

Category	Traffic time reduction benefit	Vehicle operating cost reduction benefit	Environmental cost reduction benefit	Total benefit
Axis no. 3	7,196,101	3,232,300	215,880	10,644,281
Axis no. 4	7,043,833	3,472,733	240,281	10,756,847
Axis no. 5	2,646,305	1,565,237	95,211	4,306,753
Total	16,886,239	8,270,270	551,372	25,707,881

To calculate the other 3 axes where no benefit was calculated (axe no. 1, 2 and 6), the benefit per km on axes no. 3 4 and 5 was calculated, which was multiplied to the extension of 3 axes. total extension of axe no. 3, 4 and 5 was 22.1 km. Benefit per km is about \$1.2 mil/year. Total extension of axe no. 1, 2 and 6 was total 18.4 km with 4.9km, 9.0km and 4.5km respectively. Total benefit of remaining 3 axes is \$21.4 mil/year. Accordingly, annual economic benefit of Asuncion City ATMS project is about \$ 47.1 mil/year

TABLE VII
BENEFIT CALCULATION RESULT

Benefit of axe 3, 4, 5 (A)	Extension of axes 3, 4, 5 22.1km	Benefit / km \$ 1,163,25	Extension of axes 1, 2, 6 18.4km	Benefit of axes 1, 2, 6 (B) \$ 21,403,84	Total benefit (A+B) \$ 47,111,73
3		2	8	8	2

In benefit item, traffic time reduction benefit was 65.7%, vehicle operating cost reduction benefit was 32.2% and

environmental cost reduction benefit was 2.1%.

- - Traffic time reduction benefit : \$ 31 mil/year
- - Vehicle operating cost reduction benefit : \$ 15 mil/year
- - Environmental cost reduction benefit: \$1 mil/year

B. Qualitative Analysis [5]

Questionnaire survey had been done for qualitative analysis. Total 92 people answered to questionnaire. Among them, male was 47% and female was 53%. As for age, 20s were the most with 31% followed by 30s with 29%, 40s with 17% and over 50s with 12%

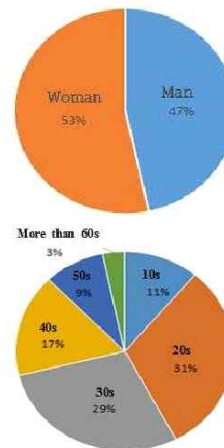


Fig. 2 Gender and age of respondents

As for the reduction of stop at new signaled intersection, 23% of respondents answered "Very positive" followed by "Slightly positive" with 49%, "Same as before" with 13%, "Slightly negative" with 14%, and "Very negative" with 1%. As for the reduction of wait-time at new signaled intersection, 53% of respondents answered "Slightly positive" followed by "Very positive" with 20%, "Same as before" with 12%, "Slightly negative" with 13% and "Very negative" with 2%.



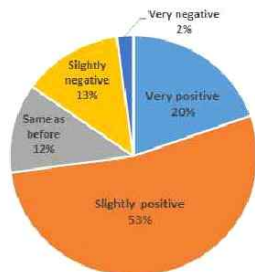


Fig. 3 Reduction of stop and wait-time at new signaled intersection

As for visibility of new traffic signal light, "Very positive" was 75% of the respondents followed by "Slightly positive" with 19%, "Same as before" with 3% and "Slightly negative" with 3%. As for safety improvement at walking, "Very positive" was the most with 39%, followed by "Slightly positive" with 30%, "Same as before" with 21%, "Slightly negative" with 9% and "Very negative" with 1%

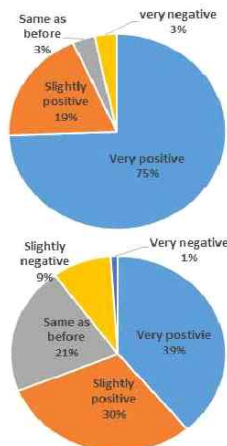


Fig. 4 Visibility and Safety improvement at walking

As for the positive impact on city view, "Very positive" was the most with 52% followed by "Slightly positive" with 31%, "Same as before" with 10% and "Slightly negative" with 7%. As for the check of real-time traffic information on road, 55% answered Yes and 45% answered No.

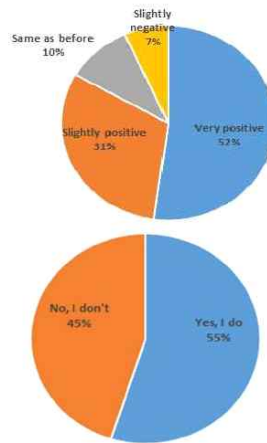


Fig. 5 City view improvement and Real time traffic information check

As for usefulness of real time traffic information, "Very positive" was 54% followed by Slightly positive with 34%. Thus, positive answers account for 88%. As for accuracy of real time traffic information, "Very positive" was 21% and "Slightly positive" was 61%. "Do not know" was 10%, "Slightly negative" was 6% and "Very negative" was 2%.

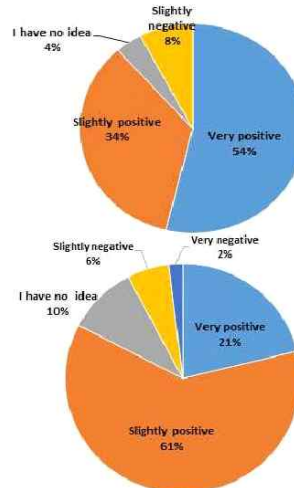


Fig. 6 Usefulness and Accuracy of real time traffic information

III. CONCLUSION

The paper shows that the effect of ATMS in Asuncion, Paraguay, is very prominent as annual economic benefit of Asuncion City ATMS project is about \$ 47.1 mil/year. Also in

the questionnaire survey citizens in Asuncion response very positive for each question. But there are many limitations for output of this paper. While economic benefits were calculated based on standard method, it was an estimated value by applying various assumptions due to lack of data. As a result of calculation of benefit in 6 axes in east-west, no negative (-) benefit of south-north due to signal interlock with east-west direction was not reflected. In addition, 92 questionnaire surveys couldn't give us statistic confidence.

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