Proceedings of the Eastern Asia Society for Transportation Studies, Vol. 5, pp. 175 - 189, 2005

EFFECTS OF KOREAN TRAIN EXPRESS (KTX) OPERATION ON THE NATIONAL TRANSPORT SYSTEM

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Abstract: Korean Train Express (KTX) started its high speed rail commercial service on April 1, 2004. It is the first stage opening of the scheduled two-stage commissioning scheme to be completed in 2010. It has two lines on the physical link of 661.1 kilometers with commercial speed of 300 kilometer per hour. This paper documents operators' service changes and customer's reaction to the introduction of KTX during the first year. KTX reduced rail travel time between major cities reduced almost by half with 128 daily services. . It achieved one million and 10 million passengers by the 14 and 142 days of operation, respectively. Rail demand for Seoul-Busan corridor increased 30% and 10% for Seoul-Mokpo corridor compared to the same period 2003 with KTX service. Long-distance travel customers, especially from air travel and existing rail passengers from Saemaeul service are major sources of KTX demand. Passengers' expected service level and initial marketing strategies are found very important with KTX introduction. KTX strengthened the viability of rail travel as a whole and is expected to contribute to building more balanced national transportation system.

Key Words: National Transportation System, Effect of Rail Operation, High Speed Rail, Korea Train eXpress (KTX), Policy Goals.

1. INTRODUCTION

The 410 kilometer-long corridor between Seoul and Busan is the backbone of Korean economy. The corridor was suffering from congestion caused by lack of transport capacity. Korean government choose high speed rail over conventional rail as a measure to provide capacity and decided to build a high speed rail in May 1989. Ground breaking ceremony in the test section was done is June, 1992, and system supplier for the Core System of rolling stock, catenary and signaling was chosen in 1994. Financial constraint forced the government to adapt staged commissioning scheme in 1997. The first scheme, which started on April 1, involves electrified existing rail line in addition to newly constructed links. The second stage will be completed by 2010 with all the line with newly constructed links. In addition, the plan to electrify existing line between 252 kilometers of Daejeon and Mokpo and run high speed train on it was conceived in 1999. KTX runs on both lines. Figure 1 shows distance and configuration of the segments for both Seoul-Busan and Seoul-Mokpo lines.

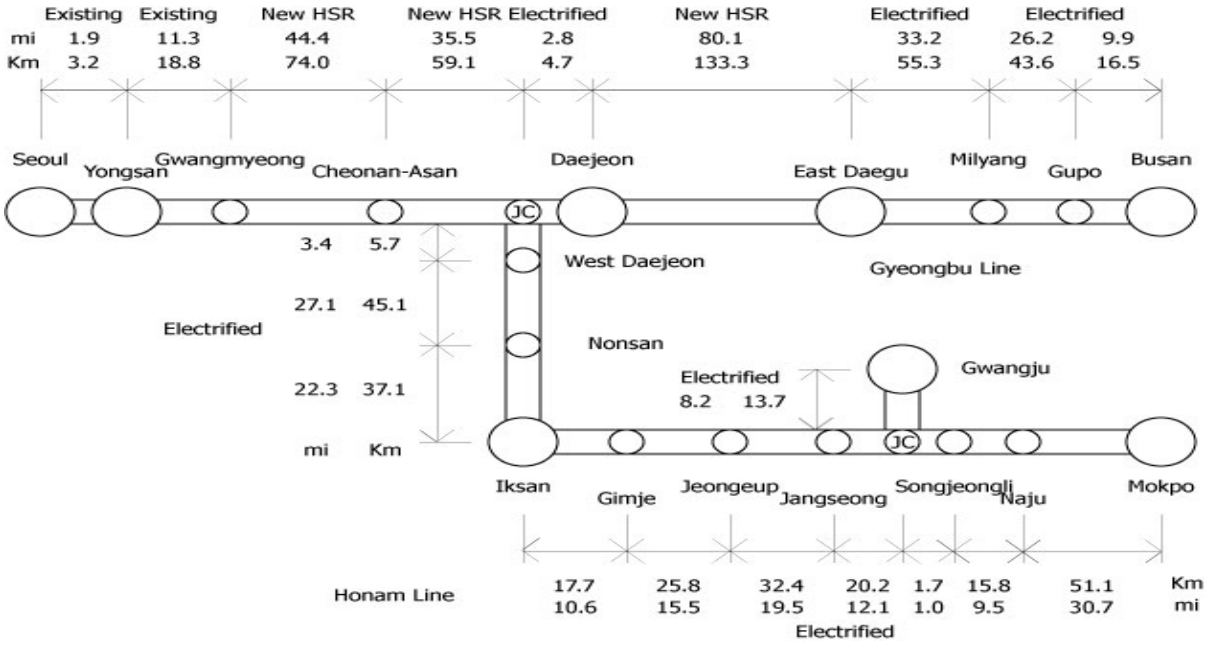

Figure 1. Distance between Stations and Configuration of Lines

Korean Train Express (KTX), a Korean high speed rail system, started its commercial service on April 1, 2004 with 300 kilometers per hour speed. It has been twelve years from the ground breaking in 1992. The two mains goal of the project was to provide additional rail capacity in Seoul and Busan corridor, and acquire technology for high speed rail system. With the commission of the KTX, both project goals were satisfied. Even in the first stage opening which heavily utilizes joint use of electrified existing links, KTX manages to provide additional rail capacity. And utilizing transferred technology, Korea successfully developed its own high speed system which is capable of running 350 kilometers per hour. The prototype is currently under test runs. Some ordeals and lessons learned during those periods are documented in Suh (2001), and Kang and Suh (2003) documents the case of Precast Span Method (PSM) utilized in the construction phase. Figure 2 shows picture of KTX in operation.

Figure 2. KTX in Operation

Table 1 compares design variables of electrified existing line and newly constructed link in two lines. For KTX operation, two new stations were build, 2 stations were renovated to function as retail and cultural center in the cities. Other stations were also expanded to accommodate KTX operation. Mixed use decision added complexities to the project. Train control system became complex. Speed and control systems are different as show in the Table 2. Construction of KTX while existing line is in operation added more complexity to the project. Also mobilizing manpower for commissioning with existing service in on-going is another factor which made the whole process more complex. For more detailed information on KTX, see for example, Kang and Suh (2003) and Suh (2000).

Table 1. Comparison of Design Variables

	Curvature	Grade	Rail	Turnout	Ballast	Tie
High Speed	+7,000m	25.0‰	UIC 60kg/m	Nose Movable	35cm	Concrete(2.6m)
Existing	+600m	12.5‰	KS 60kg/m	Fixed Crossing	30cm	Concrete(2.4m)

Source: Kim (2004)

Table 2. Differences in Speed and Signaling System

	Max Speed	Signaling	Operating Classes
KTX	300Km/h	ATC (On-board)	KTX
Conventional Line	140Km/h	ATS (Ground Based)	KTX/Saemaeul/Mugung/Freight

Source: Kim(2004)

Each train-set has two locomotives and two powered coaches and 16 coaches, thus making 20 cars train-sets. Currently KTX has 46 train-sets. Table 3 shows information of train-sets. The total cost for the first stage was 10.58 Billion US$ with 1200 Won: 1$ exchange rate and for the 2nd stage is forecasted to be 15.3 Billion US$.

Table 3. Train-Set Characteristics

Length/Weight	388m / 771.2ton with Passengers
Seat Arrangement	1st Class: 127Seats (1+2) 2nd Class: 808 Seats(2+2) Total Seats: 935 Seats (Folding Chair: 30 Seats)
Max. Op. Speed	300km/h (188mph)
Traction Power	13,560KW(18,200 HP)
Acceleration	6 Min. 5 Sec. to 300km/h (188mph)
Braking Distance	6,400m from 300km/h (2min 32sec)
Amenities	Video/Audio, Intercom, Passenger Information System, Vending Machines (10 Can, 3 Snack)
Handicapped	2 Seats, 1 WC, 1 Place for Wheelchair

Source: Kim (2004)

2. PREPARATION FOR KTX COMMISSIONING AND SERVICE CHANGES

For KTX commissioning, operation strategies and organizational structure should be ready in addition to the system. To check the system readiness, test runs and inspections were carried out. Table 4 documents these efforts.

Table 4. Summary of Test Runs

	Period	Major Activities
Design Approval	`99.12 ~ `04. 3	To Check Performance of R/S
Compatibility with Existing Line	`03. 5. ~03. 7	Technical Compatibility Test for KTX R/S and Existing Infra 65 test items(22runs, 90 trains]
Dynamic Comprehensive Test	`03. 7. ~03.12	System Interface between New Line and Existing System 61 test items[23runs, 132trains]
		Train Control System/Comprehensive System Integration Test (CSIT), Test Under Emergencies 50test items, Daily 5-10 runs between Seoul-Busan, Mokpo
Revenue Test Runs	`04. 1. ~04. 3	<1・2 Phase> 78 test runs, Acceptance Test 22 Passenger Evaluation Team((2004.2.3~3.10)
		<3Phase> Test Runs with Actual Dia 114 Runs of KTX without reducing Existing Service Final Test for Operation and Passenger Handling

Source: Kim(2004)

KNR also devised new fare structure which favors long distance travel with decreasing rate with increasing travel distance. Fare structure on the conventional passenger service is proportion to the distance traveled. New fare for the second class KTX is about 1.3 times of the fare of Saemaeul train service, which is the highest existing class. KTX fare roughly corresponds to the 62 percent of air fare.

With KTX introduction, existing four classes of rail passenger service on conventional rail are shuffled. Existing four classes are reduced to two. Operation patterns were also redefined to KTX, long distance, feeder rail, and commuter rail operation. To systematically search for 'optimal' operation pattern under different operation objectives, such as revenue maximization, travel time minimization, and profit maximization, mathematical optimization models based on non-linear integer programming model, were developed and solved. Kim and Suh (2003) reports details of the effort.

KTX's high speed of 300 kilometers per hour has been expected to cause drastic change in customer's perception on travel time. Therefore in anticipation of the KTX commissioning, service providers of transportation service were bracing for impact and preparing suitable counter measures. Express bus operators were afraid that big chunk of their demand base will divert to KTX, and sought changes in line configuration. The biggest system changes were happened in the air and passenger rail service area. For passenger rail service, many service revisions were anticipated. Because there are some segments of line which are shared by KTX service and existing rail service, thus KTX operation inevitably tied with operation of conventional passenger rail service. Expressway operator, the Korea Highway Corporation, which is semi-public, did not prepare noticeable measures in anticipating of KTX introduction.

There are two domestic air travel service providers, Korean Air and Asiana Airline. Itineraries which are directly affected by KTX are Seoul-Busan, Seoul-Daegu, Seoul-Mokpo, and Seoul-Gwangju. Anticipating heavy impact of KTX on air demand, they both reduced daily number of flight drastically for the above mentioned trips. Table 5 shows changes in the flight number on these airport pairs. Fare system was not modified. Seoul-Daegu market received most severe impact from KTX operation. Its distance is relatively short for air travel, and the biggest time reduction in rail travel was realized.

Table 5. Flight Number Changes on Selected Airport Pairs for 2004
(Unit: Monthly number)

		January	February	March	April	May	June
Seoul –Gwangju	AAR	469	411	377	294	301	298
	KAL	385	342	352	249	253	266
	Sub	854	753	729	543	554	564
Seoul – Mokpo	AAR	56	44	50	50	46	42
	KAL	0	0	0	0	0	0
	Sub	56	44	50	50	46	42
Seoul – Daegu	AAR	517	457	293	129	131	183
	KAL	583	513	540	151	188	180
	Sub	1,100	970	833	280	319	363
Seoul – Busan	AAR	966	877	870	659	657	750
	KAL	1,805	1,615	1,688	1,349	1,319	1,339
	Sub	2,771	2,492	2,558	2,008	1,976	2,089

Source: Korea Airport Authority, 2004
Note: AAR: Asiana Airline, KAL: Korean Air

3. IMPACTS ON NATIONAL TRANSPORTATION SYSTEM

Since the commissioning, there were some minor glitches at the early stage of the operation, but system soon stabilized as shown in Table 6.

Table 6. Causes and Numbers of Operations Irregularities
(unit: Occurrence)

	Total	R/S	Signal	Power	Track
April	28	18	6	3	1
May	27	16	6	2	3
June	22	11	8	1	2
July	19	10	6	2	1
August	8	5	-	1	-

Source: Kim(2004)

First KTX from Seoul station starts on 5 am, and last one on 10:45 pm with 128 operations

per day. KTX operation is fairly spread out during the day. Four KTX trains per hour are available for the most of the day. Two trains are available in 5 am and 9 pm. Three trains in 1 pm, 6 pm, and 10 pm. Five trains are available in 7 am, while only one train departs from the Seoul station in 11 am. Table 6 shows travel time with KTX introduction. Table 7 shows the number of rail operation for Seoul-Busan and Seoul-Mokpo corridors before and after KTX. One can notice that with KTX introduction, number of conventional rail service has been reduced substantially, and also travel time has actually increased noticeably. This was caused by two factors. The first factor is the capacity limitation on the joint use segments. To accommodate addition of KTX operation, service frequency of conventional trains has to be reduced. The second factor is to compensate for longer headway, trains stop at more stations, and this inevitably increased travel time.

Table 6. Travel Time Comparison

(Unit: hour: minute)

Segment	Competing Modes			KTX
	Saemaeul	Express Bus	Air	
Seoul-Cheonan	0:57 (1:04)	1:30	-	0:34
Seoul-Daejeon	1:39 (1:51)	1:50	-	0:51
Seoul-Daegu	3:15 (3:40)	3:50	0:55	1:39
Seoul-Busan	4:27 (5:02)	5:20	1:00	2:40

Note: Saemaeul travel time in parentheses shows increased travel time with KTX operation

Table 7. Rail Service Changes with KTX Introduction

	Conventional Rail in 2003	With KTX introduction			Increase Rate
		Sum	KTX	Conventional Rail	
Seoul-Busan	167	188	96	92	13 %
Seoul-Mokpo	62	70	34	36	13 %
Total	229	258	130	128	13 %

Rail demand increases on Seoul-Busan corridor and on Seoul-Mokpo corridor were 39% and 12 % respectively as shown in Table 8 since the commissioning of KTX in 2004. Revenue increased substantially. For Seoul-Busan corridor, it shows increase of 101%, and 56% for Seoul-Mokpo corridor as shown in Table 9. Total seat supply increased about 33 % compared to the same period of last year.

Table 8. Increases in Rail Demand

(Unit: Thousand Passengers)

Line		2003.04 ~ 2004.03(A)			2004.04 ~ 2004.05(B)			B/A
		Yearly	Daily	Rate	Yearly	Daily	Rate	
Seoul-Busan	Mugung	29,712	81	0.74	25,015	69	0.45	0.84
	Saemaeul	10,227	28	0.26	7,891	22	0.14	0.77
	KTX	-	-	-	22,743	62	0.41	-
	Total	39,939	109	1.00	55,649	153	1.00	1.39
Seoul-Mokpo	Mugung	9,931	27	0.87	7,324	20	0.57	0.74
	Saemaeul	1,531	4	0.13	1,178	3	0.09	0.77
	KTX	-	-	-	4,375	12	0.34	-
	Total	11,462	31	1.00	12,877	35	1.00	1.12

Source: Korea Rail, 2005

Table 9. Revenue Increases

(Unit: in Million Won)

O/D		2003.04 ~ 2004.03(A)			2004.04 ~ 2004.05(B)			B/A
		Yearly	Daily	Rate	Yearly	Daily	Rate	
Seoul-Busan	Mugung	247,159	677	0.52	144,614	386	0.15	0.59
	Saemaeul	225,067	616	0.48	135,335	341	0.14	0.60
	KTX	-	-	-	671,284	1,830	0.71	-
	Total	472,226	1,293	1.00	951,233	2,557	1.00	2.01
Seoul-Mokpo	Mugung	87,664	240	0.75	50,762	137	0.28	0.58
	Saemaeul	28,850	79	0.25	18,825	52	0.10	0.65
	KTX	-	-	-	112,157	306	0.62	-
	Total	116,514	319	1.00	181,744	495	1.00	1.56

Source: Korea Rail, 2005

The fast KTX trains and reduced number of trains for conventional passenger trains induced passenger diversion from conventional rail to KTX. Table 10 shows rail passengers. Currently KTX shows about 74,000 passengers (62,000 on Seoul-Busan and 12,000 on Seoul-Mokpo line) on both lines daily, which is about half of the demand forecasted. Original demand forecast was done assuming KTX runs on a completely separate line without any mixed operation issues. Current low economic activities in Korea are also attributed to low demand. Passengers' expected level of service for KTX was much higher than actually provided. Seat pitch, comfort, fixed seat arrangement, comfort inside of tunnels, and travel speed were worse than expected. In a sense, this results from wrong market strategies of KNR providing general public too bright pictures of KTX before commissioning. There were severe negative exposures in news media during the initial opening stages. Therefore it is not wise directly compare these two numbers at this time. Table 11 compares actual realized demand with forecasted demands.

Table 10. Rail Demand between Major Cities

(Unit: Passenger/Day)

	2003.04. ~ 2004.03				2004.04 ~ 2005.03			
O/D	Saemaeul	Mugung	KTX	Total	Saemaeul	Mugung	KTX	Total
Seoul-Cheonan	540	9,274	0	9,814	1,329	7,690	2,357	11,376
Seoul-Daejeon	3,585	8,636	0	12,221	1,713	4,568	8,940	15,221
Seoul-Daegu	5,089	5,476	0	10,565	1,342	1,970	15,171	18,483
Seoul-Busan	7,392	5,347	0	12,739	1,820	1,931	18,103	21,854
Seoul-Iksan	465	2,157	0	2,622	248	1,057	1,604	2,909
Seoul-Jeongeup	219	887	0	1,106	142	477	412	1,031
Seoul-Kwangju	1,007	2,340	0	3,347	340	808	3,265	4,413
Seoul-Mokpo	314	1,138	0	1,452	118	467	1,378	1,963

Table 11. Comparison of Realized and Forecasted KTX Demand

(unit: average passenger per day)

	Forecasted				Realized (April, 2004)
	December, 1998	November, 1999	January, 2003	August, 2003	
Seoul-Busan	141,497	-	145,623	115,828	62,000
Seoul-Mokpo	-	22,818	28,011	36,085	12,000

Note: Date in the Table represents date the demand forecasts were published. Project names are not listed here.

Realized load factor on Seoul-Busan is about 73 percent on the average. During weekend of Saturday and Sunday and peak hours of day, it is above 85%. Therefore, there is high possibility that demand will increase with increased frequency. Peak hour demand calls for more KTX service, but currently rolling stock reserve ratio and capacity limitation on joint use segments prevent additional operation of KTX. Realized demand should not be considered to be the full potential of KTX demand. Table 12 shows load factor on the service lines

Table 12. KTX Load Factors of Average Day

	Daily Operation	Daily Demand	Load Factor (%)
Total	128 trains	74,000	63.9 (average)
Seoul-Busan	94	62,000	72.7
Seoul-Mokpo	34	12,000	39.7

Note: Demand Density of Seoul-Mokpo Line does not warrant 20-car KTX configuration. Short train-set is recommended for Seoul-Mokpo Line

Air travel also showed big change in demand volume. Table 13 shows demand change of air travel before and after KTX introduction. Not only the distance but also other transport factors, such as proximity of airport to the downtown and travel time reduction by KTX, etc., are in working here. Daegu showed higher reduction compared to longer distance Busan. But for Gwangju and Mokpo, the trend is reverse. Mokpo is far from Seoul than Gwangju.

Table 13. Air Demand with KTX Introduction

- (Unit: Average Daily Passenger)

O/D	2003.04 ~ 2004.03	2004.04 ~ 2005.03	Change(%)
Seoul-Daegu	3,829	816	-78.7%
Seoul-Busan	14,415	8,973	-36.6%
Seoul-Kwangju	3,216	2,322	-27.8%
Seoul-Mokpo	190	74	-61.1%

Source: Korea Airport Corporation, 2005

Automobiles and express bus running on expressway also were affected. Table 14 and 15 show demand pattern of automobile and express bus for major O/D pairs. Automobile demand is based on the toll-gate to toll-gate traffic volume on the expressway and does not include trip on the national roads.

Table 14. Automobile Demand Changes

(Unit: vehicle/day)

O/D	2003.04 ~ 2004.03	2004.04 ~ 2005.03	Change(%)
Seoul-Cheonan	14,874	14,483	-2.6%
Seoul-Daejeon	10,013	9,187	-8.2%
Seoul-Daegu	3,583	3,256	-9.1%
Seoul-Busan	1,846	1,526	-17.3%
Seoul-Iksan	1,227	1,187	-3.3%
Seoul-Jeongeup	495	483	-2.4%
Seoul-Kwangju	3,101	3,031	-2.3%
Seoul-Mokpo	1,662	1,595	-1.4%

Source: Korea Highway Corporation, 2005

Table 15. Express Bus Demand Changes

(Unit: Passenger/Day)

O/D	2003.04 ~ 2004.03	2004.04 ~ 2005.03	Change(%)
Seoul-Cheonan	4,014	3,848	-4.1%
Seoul-Daejeon	6,942	6,374	-8.2%
Seoul-Daegu	3,830	2,604	-32.0%
Seoul-Busan	2,605	1,680	-35.5%
Seoul-Iksan	1,286	1,277	-0.7%
Seoul-Jeongeup	962	876	-8.9%
Seoul-Kwangju	8,615	8,611	-0.0%
Seoul-Mokpo	884	972	10.0%

Source: Express bus Association, 2005

Modal share shown in the Table 16 is based on the trip interchange for Cheonan, Daejeon, Daegu, Busan, Gwangju, Mokpo and Seoul. One can see that share of express bus and automobile is decreasing since the KTX introduction, but transfer rate from these modes is not significant. Large share of KTX trip came from Saemaeul and air. This fact was also proved with the survey result. A KTX passenger interview was done in April, 2004. The survey asked what was previous transport modes. Figure 3 summarizes composition of diverted passengers to KTX. One can see that diversion from existing rail service highest with 56%, followed by 17 % from air, 15% express bus, and 12 % automobile. Passengers on the existing rail were in a certain sense forced to divert to KTX because of new operation scheme which drastically reduced operation of conventional rail service. With the second stage opening, average speed of KTX is expected to increase thus make itself more attractive to automobile travelers.

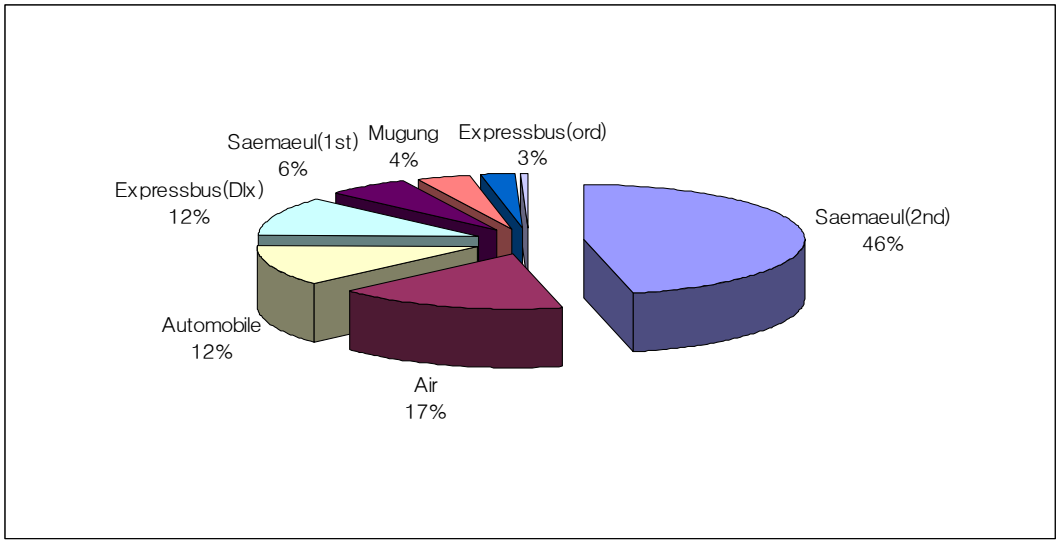

Figure 3. Percent of Diverted Trips Originating Modes

Table 16. Modal Share Change with KTX Introduction (2004)

(Unit: percent)

- Seoul-Busan KTX

O/D		Express way	Express Bus	Air	KTX	Conv. Rail
Seoul-Cheonan	2003.4 ~ 2004.3	70.3	8.6	0.0	0.0	21.1
	2004.4 ~ 2005.3	67.7	8.2	0.0	5.0	19.1
Seoul-Daejeon	2003.4 ~ 2004.3	49.6	22.9	0.0	0.0	27.5
	2004.4 ~ 2005.3	45.1	21.0	0.0	19.9	14.0

Seoul-Daegu	2003.4 ~ 2004.3	30.2	14.7	14.7	0.0	40.5
	2004.4 ~ 2005.3	24.6	9.0	2.8	52.2	11.4
Seoul-Busan	2003.4 ~ 2004.3	12.1	7.8	42.2	0.0	37.9
	2004.4 ~ 2005.3	9.4	4.7	25.0	50.5	10.5

Note: Load Factor of Auto on Expressway is 2.2

- Seoul-Mokpo KTX

O/D		Express way	Express Bus	Air	KTX	Conv. Rail
Seoul-Iksan	2003.4 ~ 2004.3	40.9	19.5	0.0	0.0	39.6
	2004.4 ~ 2005.3	38.4	18.8	0.0	23.6	19.2
Seoul-Jeongeup	2003.4 ~ 2004.3	34.5	30.5	0.0	0.0	35.0
	2004.4 ~ 2005.3	35.8	29.5	0.0	13.9	20.9
Seoul-Kwangju	2003.4 ~ 2004.3	31.0	39.2	14.6	0.0	15.2
	2004.4 ~ 2005.3	30.3	39.1	10.5	14.8	5.2
Seoul-Mokpo	2003.4 ~ 2004.3	59.1	14.3	3.1	0.0	23.5
	2004.4 ~ 2005.3	53.8	14.9	1.1	21.1	9.0

Note: Load Factor of Auto on Expressway is 2.2

4. ISSUES AND FUTURE DIRECTION

Five months are not long enough for a new introduced transportation service to realize true potential. Therefore, all the facts in this paper based on the five months operation results should be further monitored for possible modification. Also additional detailed ex-post analysis is desirable to isolate true impact of KTX or high speed on national transportation system. Observed demand pattern changes are compound impact of systems changes of modes including especially air and conventional rail. Transport system providers are closely observing demand diversion trends. System providers will adapt themselves, in time, to the changed environment.

Several issues were raised after the initial operation of KTX. Accessibility issues attracted high attention. Stations without subway access especially attracted criticism for poor accessibility. For example, Gwangmyung and Cheonan-Asan stations lack proper rail access mode, thus become examples of poor accessibility. According to a survey for access mode to

the existing railway stations, about 54 % are using subway to access rail stations. Next widely used modes were taxi (24%), bus (19%), and auto (12%).

Some areas experienced rail service deterioration with KTX introduction. Those areas are where direct access to KTX service is not available and service frequency and travel time of the conventional rail deteriorated. Modified KNR operation plan recovers most of delayed travel time of conventional rail service to the level of before KTX situation. This means that there are somewhat strong resistances to system service change. Also there is demand for wider coverage of KTX service. This calls for construction of additional intermediate stations. Government already promised to add three more intermediate stations in Seoul-Busan. This will, however, eventually increase travel time on KTX and will lower overall service level. Also additional existing lines will be electrified for direct connection to the KTX operation.

Current train configuration has 20 fixed cars with 935 seats. This configuration does not pose much problem for Seoul-Busan corridor where demand density is fairly high. But for Seoul-Mokpo corridor smaller train sets will be more desirable. Twenty car train sets were prepared for the Seoul-Busan corridor without considering service on Seoul-Mokpo corridor. Decision to electrify Seoul-Mokpo corridor and run high speed trains came later. For more efficient utilization of resource, flexibility of train configuration is a must. There is talk about the possibility of utilizing Korean developed trains on the corridor. The train, which is capable of running in 350 kilometers per hour, is in test phase now.

Lack of marketing effort was also criticized in many situations. Currently KNR is a government agency. From the January 1, 2005, it will become a semi-public corporation. The rail operation corporation is expected to be more active in marketing activities than a government agency. More flexible operation is expected too. High demand during peak hours calls for more KTX operation, but current operation scheme is not flexible enough to fully realize potential demand.

Removal of capacity limitation on joint use segments will give more flexibility in providing KTX service. After the second phase, most of joint use segments become independent. But small link leading to Seoul will remain for joint use. This bottleneck should have high priority for improvement.

For the second objective of rail technology advancement, Korean prototype of high speed rail train was developed by the Korea Railroad Research Institute. Figure 4 shows Korean high speed rail rolling stock. It is currently going under test runs, and broke its speed record of 352 kilometer in December 2004. It is expected that these trains will contribute to the flexibility of high speed rail operation when they are put into actual daily operation in various corridors.

Figure 4. Korean Model of High Speed Rail Train (HSR-350x)

5. CONCLUSION

Impacts on KTX operation on national transport systems was analyzed with observed demand data. Demand pattern after KTX introduction was analyzed based on the actual realized data gathered from the various modal operators for the initial three months covering April through August, 2004. Total number of rail demand in number of passengers between station pairs where KTX is serviced increased 85 % during the period of April through June. Revenue increased more than 91.4% compared to the same period of the last year. Total seat supply increased about 33 % compared to the same period of last year. KTX realized demand of one million in 14 days and 10 million in 142 days of operation. Currently KTX's demand is about half of the demand forecasted. Original demand forecast was done assuming KTX runs on a completely separate line without any mixed operation issues. Current low economic activities in Korea are also attributed to low demand. Passengers' expected level of service for KTX was much higher than actually provided.

Customer survey showed that diversion from existing rail service to KTX is highest with 56%, followed by 17 % from air, 15% express bus, and 12 % automobile. Low diversion rate from automobile should attract attention from the policy makers to fulfill KTX's objective. With the second stage opening, average speed of KTX is expected to increase thus make itself more attractive to automobile travelers. KTX strengthened the viability of rail travel as a whole and is expected to contribute to building more balanced national transportation system.

Five months are not long enough for a new introduced transportation service to realize true potential. Also additional detailed ex-post analysis is desirable to isolate true impact of KTX or high speed on consumer's choice behavior. Observed demand pattern changes are compound impact of systems changes of modes including especially air and conventional rail.

Accessibility issues attracted high attention. Stations without subway access especially attracted criticism for poor accessibility. Some areas experienced rail service deterioration with KTX introduction. Those areas are where direct access to KTX service is not available and service frequency and travel time of the conventional rail deteriorated. Current train configuration has 20 fixed cars with 935 seats. This configuration does not pose much problem for Seoul-Busan corridor where demand density is fairly high. But for Seoul-Mokpo corridor smaller train sets will be more desirable. Twenty car train sets were prepared for the Seoul-Busan corridor without considering service on Seoul-Mokpo corridor. Lack of marketing effort was also criticized in many situations. Currently KNR is a government agency. From the January 1, 2005, it will become a semi-public corporation. The rail operation corporation is expected to be more active in marketing activities than a government agency.

REFERENCES

a) Journal papers

S. Suh (2001). Lessons leaned after nine-years on the Seoul-Busan high-speed rail project in Korea**.** ***WCTR***, Seoul

S. Suh (2000) . Risk Management in a Large-Scale New Railway Transport System Project Evaluation of Korean High Speed Railway Experience. **IATSS Research**, Vol. 24, No.2, pp. 53-63

Kang K-D and S. Suh (2003), Experience with the Precast Span Method on the Korean High-Speed Rail Project, **Transportation Research Record 1825 Paper No. 03-3000** pp.15-21.

Kim K-H and S. Suh (2003), Allocation of Rail Line Capacity between KTX and Conventional Trains under Different Policy Goals with Mathematical Programming**, Journal of the Eastern Asia Society for Transportation Studies**, **Vol.5**, October, pp.236-251

b) Other documents

Kim C-H (2004), "**The status of KTX operation**, Paper presented at an international seminar held in September 17 by KNR in Daejeon. Korea.