

DOI 10.17816/transsyst201843s1115-123

© M. Hekler¹, J. Klühspies²

¹ Institute CERM

(Center for Education & Research on Mobility)

² The International Maglev Board

(Deggendorf, Germany)

DISRUPTIVE TECHNOLOGIES TRANSFORMING URBAN MOBILITY? THE ROLE OF THE ECOBEE URBAN MAGLEV SYSTEM IN THE SEOUL TRAFFIC VISION 2030, SOUTH KOREA

The dynamics and extent of disruptive technologies have been very well developed in Asian cities by the beginning of the 21st century, and are becoming particularly future-oriented. It also appears that urban mobility strategies in Asia are hardly slowed by resistance such as seen in the European context, where holding on to existing systems is the norm. The effects of accelerated mobility strategies in Asia are already apparent compared to what may be expected in Europe. So one could ask, which innovation processes will allow mobility to further develop? How will urban transport systems likely change in the future to minimize adverse impacts of current forms of mobility? In looking forward, any implementation of innovative mobility strategies heavily depends on spatial structures, transport networks and technologies as well as a political planning and decision-making. In Asia, concepts of transport and innovative transportation concepts (such as Rotem's Ecobee Urban Maglev) are developing with considerable promise, which, if successful, can turn into trendsetters with considerable future relevance on a global scale.

Aim: The aim is to identify relevant effects of new mobility strategies on cities and to analyze to what extent so called disruptive transport technologies are considered. The city of Seoul with its transport strategy 2030 and the disruptive maglev system Ecobee serves as an example.

Methods: Analysis of official documents of city and transport planning departments of Seoul city. Evaluation of interviews with Maglev experts.

Results: Seoul's transport strategy may seem ambitious. However, it does not take into account the Ecobee Maglev technology in the official plans – even though it is a South Korean proprietary development that is considered to be particularly environmentally friendly. Instead, planning for Seoul's future has so far taken place solely on the basis of established transport systems, which become more efficient through better IT-based management. Disruptive technologies, such as the Ecobee Urban Maglev, do not play any relevant role in the strategy.

Conclusion: It might be advantageous to discuss a leapfrog approach like the Ecobee Urban Maglev on a rational basis rather than ignoring it.

Keywords: mobility strategy, urban transport, maglev, Ecobee, Asia, Seoul, Incheon.

INTRODUCTION

Asian cities pursue ambitious, sometimes contradictory, urban mobility strategies. Even disruptive technologies – also fundamental technologically new developments – can be part of efforts to provide future-oriented answers to the various challenges of designing urban and regional mobility. On the one hand, highly technology-based transport management approaches are used. However also, procedures are being tested with a view to a fundamental reduction of selected modes of transport.

While Asian cities, for example, cannot usefully decouple from globalized trends in airport developments, there are at least concrete opportunities for their own development in a regional context, such as public transport, slow transport (pedestrians, bicyclists) or the management of the car transport. In addition, some scientists are also proposing new – and potentially disruptive – linear motor-based rail systems such as maglevs or urban cableways for public transport in Asian cities.

For a possible objective analysis and evaluation of possible trends, the foresight method seems to be a meaningful (scientific) approach for strategic transport infrastructure planning. The approach, for example, asks several questions of urban developers: How will urban transport systems likely change in the future in order to minimize adverse impacts of current forms of mobility? How can the efficiency of transport infrastructure be increased? Overall, how is the future of mobility and transport meaningful to create and which trends should be trendsetting? The extent to which such strategic transport infrastructure planning can actually have future-oriented solutions (and where there may also be limitations and *blind spots*) can be demonstrated by using the strategic plan *Seoul Traffic Vision 2030* as an example.

SEOUL TRAFFIC VISION 2030: BUILDING AN ECO-FRIENDLY TRANSPORTATION SYSTEM

Beyond Seoul: The South Korean capital, Seoul, has about 10.3 million inhabitants and a relatively high density (compared to Europe) with 17,018 inhabitants per square kilometer. The city occupies a land area of 605 square kilometers. Fourteen percent of this area will be used for roads and transport infrastructure. Seoul has invested heavily in its transport infrastructure and is using vehicle infrastructure in the form of city motorway – Information and Communication Technologies (ICT) for managing transport volumes. The urban modal share of public transport is about 66 percent. The public transport network consists of nine subway lines and over 350 inner-city bus lines [1] (pp. 95–96), [10].

Seoul has attempted to shift urban transport planning priorities from vehicle-based prioritization to more people-centered mobility based on public transport and slow transport through planning and decision-making processes, although the focus continues to be on the requirements of motor vehicle transport. However, another factor relates to significant strengthening of public transport. The problems of air pollution, traffic jams and land usage (parking lots), which are usually the consequences of a car-centered urban development, seem too massive.

The bus reform in 2004 was already a first step towards a strategic reorientation of public transport policy. Since then, a semi-public bus operating system has been introduced, allowing the city government to intervene to control the design and operation of the bus networks. A Bus Information System (BIS) was also implemented, which determines real-time information (such as arrival times, current location of the buses) and informs the customer [1].

Since 2004, Information Technology (IT)-based transport control systems have been in everyday use in Seoul as well. Electronic ticket systems, road sensors and cameras monitor, among other things, using GPS (Global Positioning System) transport flows in the city. The real-time data flows into a central system for updating and evaluating digital street posters and transport reporting systems. The transport- and information service (Transport Operation and Service Information Service, TOPIS) of the city government controls transport flows through a control center [1]. Urban maglev systems are not currently included in urban areas. Instead, they will be realized in metropolitan peripheral locations in the surroundings of the Incheon International Airport and tested for suitability.

Seoul is pursuing a relatively broad-based strategy to shape its urban transport infrastructure with the strategic plan *Seoul Traffic Vision 2030*, which was presented by the city government in 2013. The strategic plan includes all relevant forms of urban mobility: public transport, motor vehicle transport, slow transport (pedestrians, bicyclists). One focus of the *Seoul Traffic Vision 2030* is the networking of technologies, infrastructures, mobility services and mobility to offer an optimal as possible transport efficiency. In addition to ICT-based transport management, so-called *green* mobility solutions are to be expanded. For example, over the next 20 years (from 2013), there will be reach a 30 % reduction of car traffic volume, a 30 % reduction of commuting time by public transport and a 30 % increase in the use of environmentally-friendly modes of transport (walking, cycling, public transport). These concepts and goals require a structural reduction of motor vehicle transport. At the same time, they are also related with massive investment in better-networked public transport. “By 2030, the city of Seoul will have evolved into a city with a highly convenient transport system, where people will not need to rely on their cars” [2]. The strategic plan *Seoul Traffic Vision*

2030 requires a paradigm shift that calls for a rethinking of different actors – e.g., politics, society, economy and planning.

Relevant aspects of the paradigm shift for Seoul include:

- prioritizing transport by considering pedestrians instead of cars;
- taking a bottom-up approach for decision-making processes instead of top-down approach;
- integration transport solutions instead of divided modalities.

The strategic plan *Seoul Traffic Vision 2030* identifies a variety of long-term goals and visions for transport design. The strategic plan is intended to demonstrate a basic orientation of transport policy in Seoul. Also, specific concepts are discussed. A key issue here is so-called eco-friendly, efficient mobility solutions. It is noticeable, however, that disruptive new technologies are not mentioned in the concepts and strategies. Disruptive transport technologies, such as the Ecobee Urban Maglev (an urban transport maglev train), which is considered to be low in emissions and resource-efficient, have no discernible value in the concepts. Is a new urban mobility-system like the Korean Ecobee Maglev therefore not desirable? If so, will this technology not be needed in cities of the future?

ASPECTS OF REASONS AND OBJECTIVES OF THE URBAN MAGLEV PROJECT: ECOBEE MAGLEV

The South Korean Ecobee (Fig. 1), South Korea's domestically developed urban maglev system, has in commercial operation since 2016 at Incheon International Airport. The pilot project is the result of a collaboration between the Korea Institute of Machinery and Materials (KIMM), a government-funded research institute, and the rail vehicle manufacturer Hyundai Rotem.

The system is based on traditional magnetic-levitation technologies, in which the vehicles levitate over a track, or guideway, without touching it. This allows a large reduction in friction and wear during operation of the system, which can reduce operating costs [3].

The objective of the Korean project developers is to set new standards for urban transportation concepts worldwide with this disruptive technology. However, can the Ecobee system credibly fulfill the claim to be a trendsetter for city and transport infrastructure projects if it is not considered in its own country (South Korea) in the strategic plans that are typically considered forward-looking efforts?

Selected for the maglev project was the far from city center location of Incheon International Airport and its surroundings [6]. Incheon International



Fig. 1. Ecobee Urban Maglev on its guideway at Incheon Airport [4].

So far, this innovative transport system, which is considered to be very environmentally friendly, plays no role in the strategic plan 2030 of the city of Seoul

Airport, launched in 2001, was built on a new ground-polder area in the sea and is a major hub of air transport in East Asia. Around 58 million passengers use the airport every year (as of 2016) [5]. This high number of passengers – and thus potential users of the Ecobee system – is cited as a major reason for choosing the Incheon location, which succeeded in a competition against the cities of Daegu, Daejeon and Gwangju [6]. In the master plan of the new ground area, the center of Incheon International Airport can be found as well as the International Business Center, theme parks, shopping centers, hotels, residential areas and other facilities. These projects should ensure adequate passenger numbers in the future.

A complete structural implementation of the Incheon master plan was not attained for various reasons, which is why the passenger numbers of the system probably do not have the desired values. In contrast, the international airport will be expanded, with another passenger terminal being opened in 2018. Whether this contributes to an increase in use of Ecobee, however, remains to be seen. A senior official on the project team expresses his critical view of Ecobee maglev's location choice: "If the line had been built in Daejeon, Gwangju, or Daegu – which competes with Incheon for the bid – the technology would probably become commercially viable and successful more quickly. It's a bit unfortunate" [6].

Since the maglev project is located in a new ground area in the sea, the Ecobee Maglev is exposed to crosswinds, which are rather unlikely in urban transport. Crosswinds can have a high impact on lateral displacements of the electromagnetic guidance systems on the vehicles. An adaptation of vehicles and guideways to withstand these crosswind effects was therefore inevitable before commercial use. Also, the inspection intervals should be adapted to the salty winds [3].

Why a maglev project in Incheon? The Incheon International Airport connects the South Korean capital of Seoul, which is about 60 kilometers southwest, and relevant parts of the country, among others, with rail infrastructures in place since 2007. These include the Airport Railroad Express (AREX) train with express (non-stop) and commuter (all-stop) options for connecting to the city center of Seoul. The conventional high-speed train Korea Train Express (KTX) has been in operation since 2014 and links Incheon with Seoul, Daegu, Busan and other Korean cities. The Ecobee Maglev, as an additional system, seems primarily intended for use by people living and working around Incheon Airport.

Three phases are planned to be realized for the Ecobee Maglev over a distance of about 57 kilometers along the coastline of Yeongjongdo Island, on which, among others, is the Incheon International Airport. The pilot line (Fig. 2) – the first implementation stage – with a length of about 6 kilometers has been completed and connects the airport and Yongyu with each other.

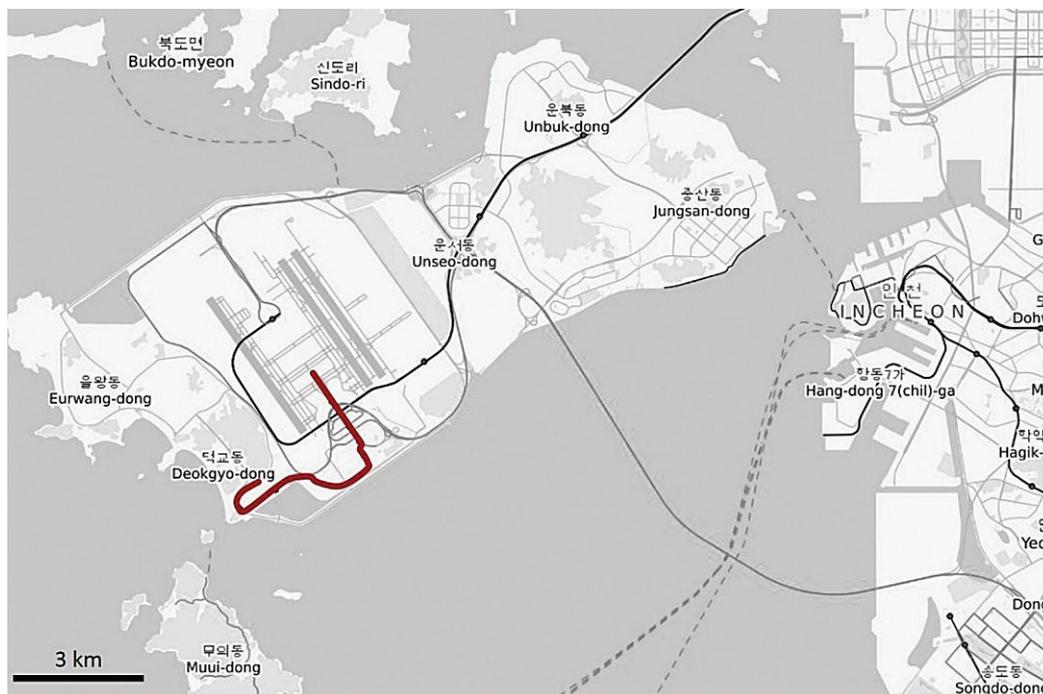


Fig. 2. The Incheon International Airport with the current Ecobee pilot line
[Visualization based on OpenStreetMap, Aug 2018]

For this line, the Ecobee takes about 15 minutes driving time, stopping at five stations [3]. The track is elevated. The Ecobee Maglev is a fully automated, driverless system based on the electromagnetic suspension (EMS) system. Propulsion and braking take place via a linear induction motor (LIM) [3].

Hyung-Suk Han, a scientist from the Korea Institute of Machinery and Materials (KIMM), characterizes Ecobee Maglev as a «very environmentally friendly train. It produces less than 65 A-weighted decibels (dBA) noise, which practically means that we don't have to build noise walls. Also, vibrations are very limited. That is crucial in an urban environment, because it means that the impact on buildings is low» [7]. The Ecobee, as a low-speed maglev train, reaches a maximum speed of 110 km/h and a maximum operating speed of 80 km/h. Johannes Klühspies also states: «At speeds under 200 km/h (125 mph), maglev systems can hardly be heard, especially in an urban environment – an important advantage for populated areas» [8]. The Japanese Linimo in Nagoya, which has been in commercial use since 2005, as well as the Chinese Changsha (commercial operation since 2016) prove this impressively.

In maglev technology, there is usually no wear from rolling friction – in contrast to conventional wheel-rail systems. The wheel-less levitation minimizes, among others, rolling noise and vibrations. Maintenance is considered simple and relatively inexpensive. These features appear to make maglev trains such as the Ecobee Maglev fundamentally interesting for operation in urban transport.

South Korea claims to take the maglev project into a new era of urban transport and now also sees its maglev system as ready for mass transportation. The development should not only serve the state-owned infrastructure, but also lay the foundations for exporting the South Korean maglev technologies to other countries, such as China, Malaysia, Russia and the USA over time.

Scientific publications have been discussing this disruptive, new urban transport system, Ecobee Maglev, since the Ecobee came into operation relatively extensively. An application as a metro line in the South Korean city of Daejeon has also been discussed, but the urban maglev project was not realized. Only Hyung-Suk Han and Dong-Sung Kim state that in 2014, the transport infrastructure plans seemingly changed to avoid implementing the maglev project in Daejeon [3]. Reasons are not named. Concrete information on the reasons for these changes to the plan cannot be found, either in academic or in grey literature.

CONCLUSION: NEW WAYS OF TRANSPORTATION

Asian cities are characterized by their openness to technology. Asian cities combine a high degree of flexibility in their mobility design with highly adaptable

and highly efficient strategies. Nevertheless, it is undisputed that disruptive technologies, such as the urban maglev system, could have a high relevance for future transport infrastructure development. “Maglev is a competitor to automobiles, trains and airplanes, as well as buses and metro-systems,” [9] emphasizes Laurence Blow, an American consultant in the transportation. Cities need more efficient transport infrastructure systems for which meaningful ways of implementation should be found.

In the case of Seoul, the development of public transport systems shows a relatively long planning horizon in international comparisons, technology-oriented strategies and a consistent focus on transport services for a growing urban area. As early as 1971, when Seoul began planning the first subway line, its integration into the regional rail network was an important criterion.

Future-oriented mobility strategies are also characterized by their positive connections to existing transport infrastructure systems. This seems to have been achieved with the Ecobee Maglev at Incheon International Airport, even though it is only a pilot route so far. If the Ecobee Maglev is meaningful and attractive in the long term; if it can become a trendsetter on a global scale, all this also seems to be dependent on the vision and the technology openness of the relevant actors from politics, society, economy, media. The rather limited marketing as well as the lack of consideration in urban strategic plans currently seem to be of little advantage for the future prospects of the South Korean system. It seems necessary to overcome this structural disadvantage of a disruptive but interesting technology and to discuss it on a rational basis as another innovation.

References

1. OECD. Urban Transport Governance and Inclusive Development in Korea. 2017 Mar 28. Paris: OECD Publishing. [cited 2017 Jul 29] Available at: <http://dx.doi.org/10.1787/9789264272637-en>
2. Seoul Metropolitan Government. Seoul Traffic Vision 2030. 2013. [cited 2018 Jul 29] Available at: <http://english.seoul.go.kr/policy-information/traffic/seoul-traffic-vision-2030/>
3. Han HS, Kim DS. *Magnetic levitation: maglev technology and applications*. Vol. 13. Dordrecht: Springer; 2016. doi: 10.1007/978-94-017-7524-3
4. The International Maglev Board. Ecobee Urban Maglev. 2016. [cited 2018 Aug 01] Available at: <https://www.maglevboard.net/en/pics/rotem-urban-maglev>
5. Feldhoff T. Flughäfen in Ost- und Südostasien – Infrastrukturpolitische Strategien und Perspektiven Japans im transnationalen Standortwettbewerb (Airports in East and Southeast Asia: Japan’s infrastructural strategies facing competition) *Zeitschrift für Wirtschaftsgeographie*. 2002;46(1):146–162. doi: 10.1515/zfw.2002.0011.

6. The Hankyoreh. South Korea's first domestically-developed maglev train opens. *The Hankyoreh*. 2016 Feb 3. [cited 2018 Jul 23] Available at: http://english.hani.co.kr/arti/english_edition/e_national/729163.html
7. Siemens. Case Study. Research institute uses Simcenter solutions to cut development time of magnetic levitation train by 50 percent. [cited 2018 Aug 08] Available at: https://www.plm.automation.siemens.com/en/about_us/success/case_study.cfm?Component=240634&ComponentTemplate=1481
8. Kluehspies J. Maglev trends in public transport: The perspectives of Maglev transportation systems. Proceedings of the 11th International Symposium, *Linear Drives for Industry Applications (LDIA)*, 2017 Sep 6–8; Osaka, Japan. *IEEE*. p. 1–4. doi: 10.23919/LDIA.2017.8097240
9. Kingsland P. Will Maglev ever become mainstream? *Railway Technology*. 2018 Jan 17. [cited 2018 Jul 30] Available at: <https://www.railway-technology.com/features/will-maglev-ever-become-mainstream/>
10. These figures refer to statistics from the Seoul Metropolitan Government (SMG) of 2016.

Information about the authors:

Hekler Martina, M.A. Geography (Univ.), Research Associate, Doctoral Candidate;
ORCID: 0000-0002-7120-0988;
E-mail: martina.hekler@th-deg.de

Klühspies Johannes, Prof. Dr. habil. Dr. h.c., full Professor;
ORCID: 0000-0001-6089-9853;
E-mail: jok@maglevboard.net

To cite this article:

Hekler M, Kluehspies J. Disruptive Technologies Transforming Urban Mobility? The Role of the Ecobee Urban Maglev System in the Seoul Traffic Vision 2030, South Korea. *Transportation Systems and Technology*. 2018;4(3 suppl. 1):115-123. doi: 10.17816/transsyst201843s1115-123