Rubric 4. TRANSPORT ECONOMICS

DOI 10.17816/transsyst20206331-42

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A MAGLEV, A TUNNEL, A RIVER. ON THE DELAYS IN THE REALIZATION OF THE TOKYO-NAGOYA MAGLEV LINE

Abstract: The Chuo Shinkansen is a Japanese maglev line under construction between Tokyo and Osaka. On a central section of the line, construction has come to a standstill in 2020 for reasons of regional policy. This threatens the completion of the entire line. The article describes some of the interests triggering the underlying conflict. Some of the key points contained in the Japanese solution proposals are summarized. Overall, the opening of the high-speed maglev system is likely to be postponed by several years.

Key words: Maglev, participation, water balance, tunnel construction, transport economics, communication, transport geography

STATE OF TECHNOLOGICAL DEVELOPMENT (2020)

The Chuo Shinkansen is a Japanese maglev line under construction between Tokyo and Osaka. Its initial section is between Shinagawa Station in Tokyo and Nagoya, with stations in Sagamihara, Kōfu, Iida, and Nakatsugawa. The line is expected to connect Tokyo and Nagoya in 40 minutes, running at a maximum speed of 505 km/h (314 mph) [1]. About 90 % of the 286 km (178 mile) line to Nagoya will be tunnels, with a minimum curve radius of 8,000 m (26,000 ft) and a maximum grade of 4 %. The project leader and future operator is the Central Japan Railway Company (in short: JR Central) [2].

Coils on the track and superconducting magnets on the vehicles generate the force that is needed for levitation. Reaching speeds of about 120 km/h, the vehicle rolls on wheels, generating particulate matter [3]. The wheels are then retracted, much like in the case of an airplane, when the vehicle reaches levitation. The absence of wheel friction at higher speeds allows normal operation at over 500 km/h, and higher acceleration and deceleration performance compared to conventional high-speed rail. Magnetic coils are used both for propulsion and levitation [4].

Received: 17.09.2020 **Revised: 23.09.2020** **Accepted: 30.09.2020**
Поступила: 17.09.2020 **Одобрена: 23.09.2020** **Принята: 30.09.2020**

JR Central began operating new L0 series maglev vehicles at the Yamanashi test track on August 17, 2020. According to JR Central, the new version of the superconducting L0 Series high-speed maglev system vehicles features improved aerodynamics, which should enable a 13 % reduction in drag as well as reduced noise emissions and power consumption compared to the previous design [5]. No information has been provided as to whether the new vehicles have now been successful in better shielding the passenger cabins against electromagnetic fields during operation [6].

IRRITATIONS WITH THE SELECTION OF THE MAGLEV ROUTE

The discussion about the exact route that the high-speed maglev system should take between Tokyo and Osaka, one that was restricted to expert circles and political circles, dates back to the end of the 20th century. In 2011, a decision was finally reached and one of the three variants (A, B, C variant) chosen. JR Central, as the project leader, is said to have exclusively endorsed the C variant from the beginning, which today forms the basis for the realization (Fig. 1). Japanese project participants critically note that environmental aspects played only a minor role in the decision, partly because of a considerable lack of information, which made it difficult to compare the variants. In some cases, only variant C was considered. F. Nakamura [7], who was involved in the evaluations as environmental verifier, summed up in 2020: "The consultations were in line with JR's intentions" (in the original: 審議はＪＲの思惑通りに進んだ). From F. Nakamura's point of view, variant C might still have been modified or a different variant might have been chosen if researchers with knowledge of the regional conditions had been involved in the consultations [7].

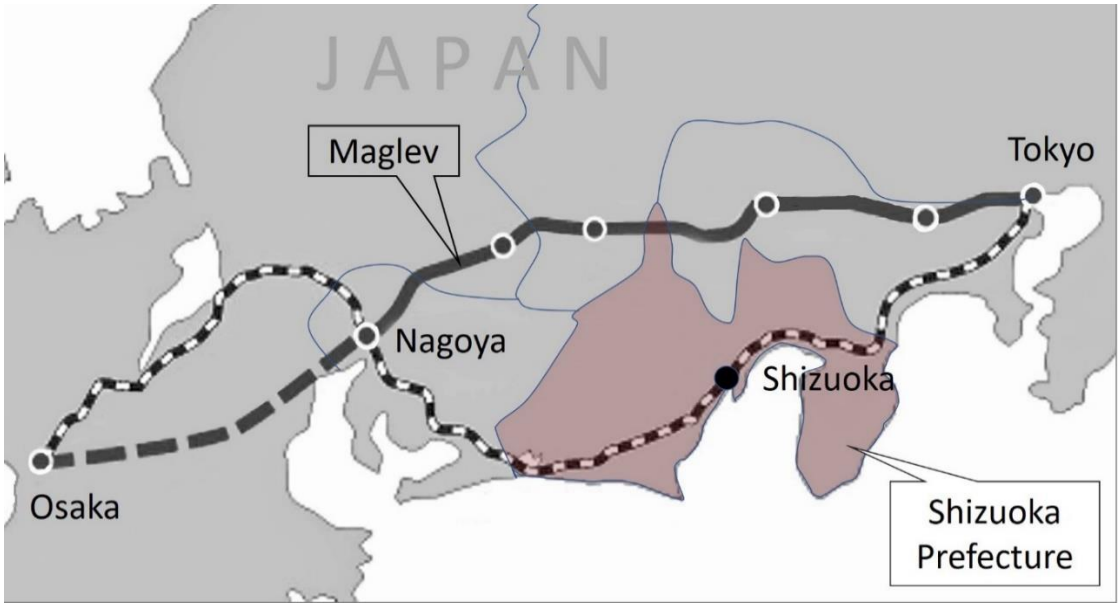

Fig. 1. Route of the Shinkansen and maglev lines

Received: 17.09.2020
Поступила: 17.09.2020
Revised: 23.09.2020
Одобрена: 23.09.2020
Accepted: 30.09.2020
Принята: 30.09.2020

The version chosen, the C variant supported by JR Central, involves bypassing the Fuji Volcano to the north and briefly crossing Shizuoka Prefecture without stopping. The plans (status 2020) thus do not include a railroad station in Shizuoka Prefecture. Therefore, the prefecture is mainly burdened by the construction of the line, but has no discernible advantages from any realization of the maglev project. JR Central's plans originally foresaw a lower number of stations than at present (2020). However, all the regions along the route opposed these initial plans and demanded at least one high-speed maglev system stop per prefecture. The plans were then adjusted in order to obtain prefectural approval for construction to commence. However, Shizuoka Prefecture remained the only prefecture along the maglev line where no station was envisaged.

Although Shizuoka Prefecture Governor Heita Kawakatsu is, in principle, considered a proponent of maglev technology [8], in the course of the discussion, the reservations against a route without a station in the prefecture have grown more pronounced. With regional elections scheduled for 2021 and the issue playing a relevant role in the election campaign, the situation appears additionally complex.

ON THE VIEWPOINT OF SHIZUOKA PREFECTURE

For decades, Shizuoka Prefecture has endeavored to strengthen its tourism in order to take greater advantage of its favorable location near the Fuji Volcano Nature Reserve. To this end, Shizuoka Prefecture is demanding that the fast Nozomi Shinkansen trains from JR Central also stop in the prefecture. JR Central has not yet agreed to this. They are also calling for the prefecture's regional airport, Fuji Shizuoka, to receive a Shinkansen station in order to promote regional development. The railroad company JR Central has also rejected this demand, despite the airport being located directly on the conventional Shinkansen railroad line. This rejection serves to reinforce the impression in the prefecture that JR Central is not much concerned about the regional interests of the prefecture. As a result, JR Central is now regarded in the prefecture as a company that is primarily focused on its own economic interests and has little interest in cooperating with the regional government. This attitude has clearly resulted in disappointment and annoyance in the prefecture.

Thus, from the perspective of Shizuoka Prefecture, there are primarily three reasons for opposing the maglev project in the region: first, JR Central's rejection of a maglev station in the prefecture; second, poor integration into the conventional Shinkansen network (by JR Central); third, JR Central's rejection of a Shinkansen station at the prefectural airport.

In addition, as E. Volkova points out (2020), skepticism concerning high-speed transport projects seems to be growing in general: their feasibility and economic efficiency are being questioned due to the considerable capital

Received: 17.09.2020 Revised: 23.09.2020 Accepted: 30.09.2020
Поступила: 17.09.2020 Одобрена: 23.09.2020 Принята: 30.09.2020

expenditure required for construction and the lengthy payback period. Whether this criticism is justified or not: doubts about the feasibility of developing high-speed transport especially intensify during global economic crises [9]. The debate surrounding which transportation projects are suitable for the future has long been a matter of concern for Japanese scientists as well.

ON THE VIEWPOINT OF JR CENTRAL

Due to JR Central's many years of pursuing a restrictive information policy, only general, i.e. sparse statements have been made public that could provide more precise answers to the arguments put forward by the prefecture. It is therefore necessary to understand, at least from the point of view of an ideal-typical railroad company, which interests could be of particular relevance to JR Central in the present situation.

The construction of a new high-speed maglev station in Shizuoka Prefecture would be very costly for JR Central. Not only the station, but also the surrounding infrastructure would have to be newly built and financed. The station would be a time-consuming, new planning process, which would threaten to further delay the project as a whole. Given the peripheral location in the prefecture, the users of the station are, in the main, likely to be tourists and the annual average passenger volume is likely to be rather low. It seems doubtful that such a station would be able to cover its operating costs from revenue generated through tourist traffic. From an operational point of view, an additional station would lead to a drop in performance on the entire maglev line. The more stations there are to be served, the more the average speed and train sequence will decrease. Even if the stations are served alternately, a single additional station can have a significant impact on the efficiency of the entire line. For economic reasons, JR Central will therefore probably try to prevent another station from being built.

Incorporating the city of Shizuoka into the Nozomi Shinkansen network and constructing a new Shinkansen station under Shizuoka Airport would probably have similar economic effects, albeit with a weaker impact on the economy. The more frequent stops at the newly-added stations would significantly extend travel times for all Nozomi Shinkansen, making their use less attractive overall. This is likely to affect customers' willingness to pay and thus impact JR Central’s balance sheet, which the company would certainly wish to avoid.

JR Central's interest is likely to provide the fastest possible, unhindered transportation between the cities of Tokyo, Nagoya and Osaka, avoiding any intermediate stops. The target group at which the high-speed maglev system is aimed primarily involves time-sensitive business travelers and day commuters, but not time-tolerant, price-sensitive tourists. From JR Central's point of view,

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Поступила: 17.09.2020 Одобрена: 23.09.2020 Принята: 30.09.2020

tourism-oriented stations are likely to be disruptive factors that should be avoided from a business perspective.

JR Central modernized its communication platform in 2020 and is seeking to strengthen its standing in the discussion by providing better information marketing. The website (Japanese version) has been updated and reinforced with animations. Statements and presentations on ecology and the environment (through JR Central's looking glass) have been added and made available as downloads [2]. This can be interpreted as a turnaround in the company's communication strategy.

A RIVER AS A TRIGGER FOR AN OPEN CONFLICT

The river Oi has its source in the Southern Alps ("Minami"), an area recognized by UNESCO as a geopark. The Oi carries large amounts of water and flows through the central and western part of Shizuoka Prefecture (Fig. 2). The water is used intensively for power generation, agriculture and industry. The river Oi became the center of attention when reports became public about possible changes in the region's water balance occurring due to the construction of the tunnel for the high-speed maglev system. In 2001, JR Central announced the results of a water balance analysis in which potential changes in groundwater and surface water were scientifically simulated [10]. The values quoted showed that the inflow of water into the river Oi could decrease by up to two tons of water per second. JR Central proposed a number of protective measures: using pumping stations, by laying watertight foils, and by injecting chemicals into the rock bed, the plan envisaged a return of the spring and groundwater displaced due to the construction work to the Oi River so that the volume of water there would not decrease [10]. However, the prefectural government questioned the results of the water balance analysis and described the measures taken by JR Central as insufficient.

In 2017, Governor Heita Kawakatsu spoke out clearly and unequivocally against continuing the maglev project on the basis of the current plans and called for changes. In 2020, he blocked further preparations for the construction of the tunnel. This brought construction on this section of the line to a standstill. According to Japanese media reports, the reason for the halt in construction was the lack of information from JR Central concerning the consequences the project would have for the region's water balance. JR Central could not or did not want to promise to return all the groundwater and surface water displaced by the tunnel construction to the Oi River [10]. The communication strategies of Governor H. Kawakatsu and the citizens' initiatives in the prefecture therefore typically portray JR Central as a company that imposes the negative impact of a water issue on the local population without bringing any benefit to the region.

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The prefecture's right of appeal against the high-speed maglev system tunnel is basically derived from the fact that the route of the maglev system runs for a few kilometers across the prefecture's territory. The disputed section of the planned tunnel is only about 9 km long.

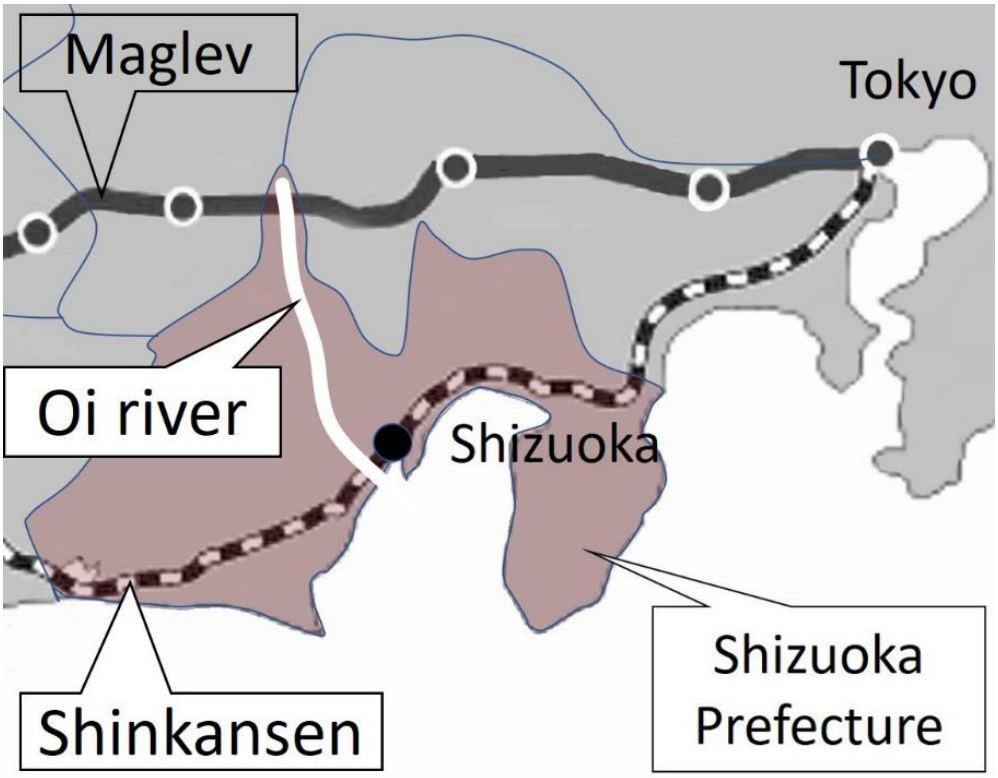

Fig. 2. Course of the Oi River in the Japanese Alps

The northern territory of the prefecture appears like a small wedge that has been pushed into the maglev line. In fact, however, the territory and the river have been overplanned by the Maglev Project

The speed-related large curve radii of the high-speed maglev system as well as the already largely completed tunnel sections in the vicinity considerably limit the flexibility of the planning and make such an alternative solution appear too expensive. It appears unlikely that the issue with the river Oi can be resolved through any realignment of the maglev line any more.

Without taking into account the rights of a further 400 companies in the Oi area, the known permissible water use is about 176 m^3/s (Table). In hydropower and agricultural uses, significant amounts of water may flow back into the river elsewhere and be available for use again. Against this quantitative background, the possible reduction of the inflow by 2 m^3/s through the tunnel can be considered relatively small.

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Table. Users and water use rights for the Oi River in Shizuoka Prefecture, 2020

User	**Purpose**	**Water rights for use, (max.) in m^3/s**
a) Four Oi-river irrigation areas	Agriculture	35.103 m^3/s
b) Tokushu Tokai Seishi (paper manufacturer)	Hydroelectric power	33.8 m^3/s
c) Shin Tokai Seishi (paper manufacturer)	Industrial use	2.0 m^3/s
d) Shi Mada Shi Waterworks	Drinking water	0.178 m^3/s
e) Oigawa Koiki Consortium	Commercial use	2.0 m^3/s
f) Makinohara Agricultural Improvement District	Agriculture	3.045 m^3/s
g) Touen Kougyou Suido Consortium	Industrial use	0.104 m^3/s
h) Chubu Denryoku Shizuoka Suryoku power generator; dam	Hydroelectric power	100 m^3/s
i) Another 400 private houses and companies in the catchment area with about 1000 wells	various	unknown
Calculated total, without i)		**ca. 176 m^3/s**
• Maglev Tunnel	Reduction of inflow	ca. 2.0 m^3/s

Table based on K. Hirota, T. Ohashi, 2020 [10]

However, the absolute value is likely to be decisive here: according to Oigawa Regional Waterworks Corporation, which is responsible for supplying water to the cities within the catchment area of the river Oi, 2 m^3/s correspond to the amount of water that has to be made available per second for about 600,000 people in the cities across the region [8]. These two tons of water per second could thus cover the water needs of 600,000 people.

The conflict between JR Central and the prefecture was further aggravated by the halt in construction in 2020. The Japanese Ministry of Land, Infrastructure, Transport and Tourism is now trying to act as a mediator, and expert meetings have been held to assess whether any lasting effects on the groundwater flow to the Oi River are to be anticipated. To date (Sept. 2020), however, it has not been possible to bridge the gap between the two parties and their respective positions even with the ministry's mediation efforts [7].

Without question, the issue of whether the volume of water in the catchment area of the Oi River, where more than 600,000 people live, can be maintained is of fundamental importance. For many people in the prefecture, however, the water issue was clearly also the tipping point that ultimately escalated the level of resentment that people across the region had held against JR Central for years.

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OPTIONS FOR CONFLICT RESOLUTION?

From a prefectural perspective, the situation is a rather *useful conflict*, which, if escalated in a targeted manner, could reap benefits for the region and some decision-makers. From a JR Central perspective, however, the situation is a *threatening conflict* that could lead to considerable concessions and financial burdens.

The governor's tough position on JR Central seems to be aimed at obtaining the greatest possible concession from JR Central for prefectural approval of the maglev tunnel construction. Whilst the importance of the existing Tokaido Shinkansen line will be significantly reduced with the opening of the new high-speed maglev system, it will still be very important for the prefecture, for reasons of regional development, to obtain superior Nozomi Shinkansen (wheel-rail) stations, which JR Central has so far refused to provide (2020). There is also a slight possibility of a new, dedicated station being implemented on the maglev line despite the considerable infrastructure development costs this would involve for all parties concerned. At a meeting on June 26, 2020, Governor H. Kawakatsu proposed to the president of JR Central the establishment of a tourist route in Shizuoka Prefecture along the Fuji volcano: tourists would arrive within 20 minutes by high-speed maglev from Tokyo and return some hours later from Shizuoka station by wheel-rail Nozomi Shinkansen [8].

On the whole, there is much to suggest that the political price for continuing the high-speed maglev project could promise massive transport infrastructure-related improvements for Shizuoka prefecture. A consensus on such a basis would serve the region’s economic and tourism interests in the prefecture, but, from a business perspective, it would appear to be highly disadvantageous for JR Central. New railroad station construction in particular could become a serious burden. In transportation science, the construction and operation of foreseeable uneconomic stations are referred to as *political stations*.

The pressure exerted by the Japanese central government on the prefecture is also likely to increase: the Japanese high-speed maglev system is also a high-tech industrial policy project that is primarily intended to promote exports. The first such export project is the maglev line between Baltimore and Washington in the United States, which is already in an advanced planning stage (2020). Significant delays or even the cancellation of the Japanese project would have a foreseeable negative impact on the realization of the US project as well.

Overall, it seems rather unlikely that the magnetic levitation train project will be permanently prevented by the prefecture's resistance. Although the halt in construction in 2020 directly affects only the small section in Shizuoka Prefecture and construction continues elsewhere on the line, it seems unavoidable that the start of operations of the Chuo Shinkansen Line will be put

Received: 17.09.2020 **Revised: 23.09.2020** **Accepted: 30.09.2020**
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back by several years. The restrictions and delays caused by the coronavirus pandemic are also contributing to further delays. An opening before 2030 is becoming increasingly unlikely.

OUTLOOK

In Asia, high-speed maglev systems are regarded as important future technologies for mobility in the 21st century. In the People's Republic of China and South Korea, maglev technologies are among the strategic innovations that receive state support in the form of considerable financial resources and research programs. N. Zhuravleva points out the potential relevance of maglev technologies in transportation: due to their speed, maglev systems initiate a fundamental change in the perception and evaluation of time and create a new quality of transport service, which the existing wheel-rail technologies for freight and passenger transport cannot provide [11]. J. Kluehspies also emphasizes this aspect [12].

The significant progress currently being made in the development of maglev technologies (2020) contrasts sharply in Japan with the restrictive information policy pursued by the technology protagonists at JR Central. For a long time, participation was not an issue in Japan, when the first application case (Tokyo – Nagoya) was developed. The fact that a harsh and bitter conflict has ensued in connection with the maglev line realization process is probably a result of the general lack of relevant participation opportunities for citizens and science in Japan.

A restrictive information policy can be used to keep potential (international) competitors in the dark about the status of Japanese developments and widen the country’s technological leadership edge over its European and Chinese competitors for. In the case of the Japanese high-speed maglev system, the communication strategy pursued by JR Central, as the project lead, was particularly limited and superficial. This led to a de facto information blockade on many important aspects of the entire construction project. For a long time, communication with affected parties took place only to a very limited extent.

In democracies, such top-down planning implementation rarely has a chance of gaining broader acceptance, especially when it so strongly impacts the living conditions of so many citizens of a country. It is therefore not surprising that both the prefectural government and citizens' initiatives have called for opposition to the maglev project – although even opponents often would, in principle, welcome a sensible use of the Japanese maglev technology. In Japan, the river Oi has become a symbol of societal unease over intransparent planning processes. The delays in the construction of the high-speed maglev system are thus not due to, but rather despite its high technological quality.

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From a prefectural perspective, the water issue surrounding the river Oi is a useful conflict that can be used to the benefit of the region. From the perspective of JR Central, however, the conflict threatens to lead to considerable financial burdens. JR Central now seems to have recognized that this is a realistic danger and therefore began, in 2020, to improve its communication strategy for the general public, [2], a move clearly intended to better deal with the accusations presented in the media.

The author(s) declare(s) that

1. They have no conflict of interest;
2. This article does not contain any research involving people as objects of research.

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Received: 17.09.2020 **Revised: 23.09.2020** **Accepted: 30.09.2020**
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Received: 17.09.2020 **Revised: 23.09.2020** **Accepted: 30.09.2020**
Поступила: 17.09.2020 **Одобрена: 23.09.2020** **Принята: 30.09.2020**

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To cite this article:
Klühspies J, Hekler M. A Maglev, a tunnel, a river: on the delays in the realization of the Tokyo-Nagoya Maglev Line. *Transportation Systems and Technology*. 2020;6(3):31-42. doi: 10.17816/transsyst20206331-42

Received: 17.09.2020 **Revised: 23.09.2020** **Accepted: 30.09.2020**
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