


Future Scenarios of High-Speed Rail Transport Technologies in Iran

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Abstract

Objective: Iran's presence in a geopolitical region and its proximity to some countries that do not have access to open waters and its location on the path of international corridors, the development of transportation, along with the presence of tourist, cultural and social attractions, are among the potentials that make the creation of high-speed rail transport technologies one of the primary necessities of sustainable development in the country. Based on global experience, the rail transport system has special advantages over other transport systems in terms of energy consumption, economy, environmental damage, passenger transport speed, transported cargo volume and safety. This research was conducted with the aim of developing future scenarios for high-speed rail transport in the country.

Method: In this study, using futures research methods, importance/uncertainty matrix, structural analysis, MICMAC cross-analysis, key factors affecting the future technologies of the high-speed rail transportation industry were identified, and then technological options were obtained through interviews and consensus of experts and the analyses carried out, and scenarios for the future of this industry were developed using the GBN method.

Findings: Seventeen effective factors were identified, and by analyzing the MICMAC software, two key factors were finally obtained: government support in providing budget and sanctions. Key factors and technological options were reviewed in the expert panel, and based on that, scenarios for the future of this industry were developed.

Conclusion: In this study, four scenarios were obtained, including: 1- Thoroughbred, 2- Unbridled, 3- Tamed, 4- Miniature Horse. Given these scenarios, if the system has a long-term supportive view of technology localization, even despite sanctions, the country can reach a position that is in the hands of a small number of countries, which will have financial benefits and national authority for the country.

Keywords: Technology policymaking, futures research, MICMAC software, high-speed rail transport system, train.

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Introduction

Rail transport is one of the clean and green forms of transport with the lowest level of pollution compared to other methods of freight and passenger transit. The high-speed transport system includes infrastructure and wagons. This infrastructure can be for newly built dedicated lines with trains that have speeds above 250 km/h or upgraded conventional lines with speeds of 200 or even 220 km/h (Inara Watson, 2021). This type of transport has many effects on the country's economic growth process due to its infrastructural role. Without a transportation network, facilities, ancillary equipment, and a desirable fleet, it seems impossible to imagine the general growth and development of the country (Fathi et al., 2018).

The quantitative and qualitative development of rail transport and high-speed trains using new technologies has been one of the most important future-oriented priorities of the government in recent years. The necessity of creating and expanding short, sustainable, and safe communication routes between different regions has led to the formation of emerging competitions in the form of corridor competition in the region in recent years. Obviously, the lack of necessary attention to the issue can face the country's national interests with numerous threats in the future (Zarei and Hossein Ghezel-Ayagh, 2022).

The purpose of this article is to explain the future scenarios of the country's high-speed rail transport sector, despite various uncertainties related to the transition from current rail transport systems to advanced and high-speed transport, and to develop the rail transport industry. Therefore, the issue of this research is the necessity of understanding the drawing of credible scenarios of the future space of high-speed rail transportation in the country, in such a way that a reassuring space can be provided for decision-making, policy-making, strategies and actions in this area.

Methodology

This research is classified as applied research in terms of classification and in which an attempt has been made to use the results obtained to resolve ambiguities and unknowns and to develop the practical

application of the research subject, using the cognitive context and existing information (Danaei Fard et al., 2017: 32). The research approach is qualitative. The methods selected in this study are a combination of existing methods. First, a literature review was conducted and theoretical concepts were discussed. Technological options were obtained through expert interviews and library studies. Then, using PESTEL environmental analysis to obtain influential drivers in the field of high-speed rail transportation, the importance/uncertainty matrix, structural analysis with a combination of expert panels, and the application of technological options to draw scenarios were put on the agenda. Confirmation and assessment of key uncertainties to enter the scenario stage were followed using the expert panel method. Table (1) shows the step-by-step framework of the research.

Table 1 step-by-step research framework

output	Data collection tool	method	steps	row
technologically options High speed rail transport	study --- A library --- interview --- experts	Content analysis	Knowledge of technological options	1
Primary uncertainty factors	teacher study --- interview --- experts	Pestel environmental analysis (PESTEL)	Primary engines	2
Final uncertainty factors	Questionnaire	Certainty importance matrix	Uncertainty	3
and drivers Key factors	from use Software Micmac	Mutual analysis	Statistics of key driving factors	4
Transport scenarios High speed rail	Based on factors Key and comments experts	GBN	Draw the scenario	Δ

Research findings

In this study, technological options were extracted based on library studies, interviews, and holding a panel with experts in the field of high-speed rail transportation in the country, including:

1- International lines. 2- Maglev. 3- National HSR network. 4- Dedicated HSR corridor. 5- Conventional non-electric lines and 6- Conventional electric lines

Then, the political, economic, social, technological, environmental, and legal effects on rail transportation and high-speed trains were examined,

and then the primary factors affecting the future of the transportation sector, the primary drivers of the high-speed rail industry, were extracted from environmental analysis (PESTEL) and interviews with experts. After examining the primary drivers, the factors that have obtained the highest score in uncertainty and importance in the field of rail transportation were extracted and considered as the main drivers. These drivers include:

- 1) The level of access to knowledge from other countries in this area
- 2) The level of participation of domestic investors in the construction and development of high-speed rail lines
- 3) The level of use of foreign investment in this area
- 4) International sanctions
- 5) The impact of the cost of high-speed rail travel compared to other alternative transportation systems
- 6) The importance of achieving and progressing in advanced new sciences and technologies related to high-speed rail transportation
- 7) The level of government support for technological development
- 8) The level of demand for intercity transportation in the future

According to the results of the matrices, the two factors of government support for technological development and international sanctions have the highest and lowest levels of impact and are selected as key forces influencing the future of high-speed rail transportation in the country.

Now, considering the key factors and the experts' opinions on the key factors and considering the technological options, the forward scenarios of the Iranian high-speed rail industry are drawn and described. The two key factors mentioned are used to draw the logic of the future scenarios of this industry. For the factor, the level of government support for technology development, the two sides of the spectrum are: high government support (high budget) / low government support (low budget), and for the factor, international sanctions, the two sides of the spectrum are: the presence of sanctions / and the absence of sanctions. By intersecting these two factors, four areas are formed, which express the future scenario spaces of the Iranian high-speed train. The future scenario spaces of this industry are shown in (Figure 1) under the title of the logic of the future scenarios of the Iranian high-speed rail industry.

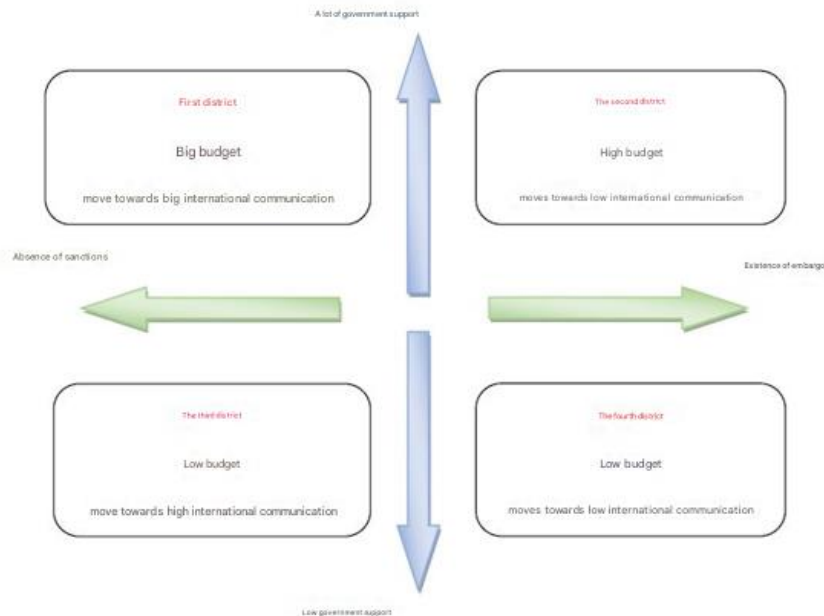


Figure 1- Logic of future scenarios for Iran's high-speed rail industry

Then, according to the consensus of the experts in the panel and the analyses conducted, the technological options in each scenario have been prioritized.

The four future scenarios of Iran's high-speed train are:

Scenario One: Thoroughbred¹(high support, no sanctions), in this scenario, the government supports the launch and development of high-speed trains on a large scale in the country, and now no sanctions are imposed on Iran by foreign countries. Now, without sanctions and with the participation of countries with high-speed rail industry technology and their connection with domestic experts and specialists, the country has been pushed towards progress along with localization, the government's focus is on building dedicated high-speed train networks between the country's major cities. The national high-speed train project is progressing with agility and high speed, with government financial support and international cooperation, like a thoroughbred horse.

Scenario Two: Tamed (high support, sanctions): In this scenario, despite the sanctions that exist, there is great support from the government for the development of technologies. In these circumstances, the existence of sanctions has had the least impact on the country, and this issue is clearly visible at the management and public levels of the country. The existence of sanctions has caused the country to rely on its domestic capabilities and

¹The Thoroughbred is a breed of light horse. Because of their agility and speed, many of them are used in horse racing.

capabilities, and with the support of the government and the efforts of domestic experts, very good achievements have been made in the field of localization of some parts needed by the high-speed train rail industry, and it moves cautiously like a tamed horse.

Scenario Three: Unbridled (low support, no sanctions): The conditions in this scenario are called the area of dependence. In such a way that there is no support from the government in terms of investment and funding; on the other hand, there are no sanctions, in these circumstances some domestic private companies have invested in the country's rail industry and have received help from countries with technology.

Scenario Four: Miniature Horse (low support, presence of sanctions): The worst possible situation prevails in this scenario. The existence of sanctions and the lack of support from the government will lead the country to a tense atmosphere in which no progress will be made. In this situation, the status quo should be maintained as much as possible and then consider electrifying the lines and increasing the speed through HSR lines. Sanctions against Iran have challenged the rail transport industry to import the necessary parts and equipment. This scenario remains a miniature horse in the field of high-speed trains in the country, which is used for limited tasks, although it is very popular.

Discussion and Conclusion

This study aims to explain the future scenarios of the country's high-speed rail transport sector, despite various uncertainties related to the transition from current rail transport systems to advanced and high-speed transport, and the development of the rail transport industry.

In this study, the political, economic, social, technological, environmental and legal effects on rail transport and high-speed trains were examined and, using futures research methods, importance/uncertainty matrix, structural analysis, MICMAC cross-analysis, the key factors affecting the future technologies of the high-speed rail transport industry were identified. Then, technological options were obtained through interviews and consensus of experts and the analyses carried out, and the scenarios for the future of this industry were developed using the GBN method. After examining seventeen effective factors, and analyzing the MICMAC software, two key factors were finally obtained: government support in providing budget and sanctions. Key factors and technological options including: HSR dedicated corridor, international HSR lines, national HSR network, Maglev, conventional electric lines and conventional diesel lines were examined by the expert panel and based on that, the scenarios for the future of this industry were developed. The four scenarios

obtained in this study include: 1- Thoroughbred, 2- Unbridled, 3- Tamed, 4- Miniature Horse.

Considering the scenarios developed in this study, if sanctions continue to be imposed on the country, the system should have a long-term supportive view towards the localization of technology, so that the country can achieve technology that is only available to a small number of countries, which will bring national authority to Iran in addition to financial benefits.

Policy Suggestions

In general, it can be said that based on the review of all scenarios, the following suggestions are presented:

- New lines that are to be built should be built based on high-speed train standards, and in addition, in order to increase the efficiency of existing lines, it is necessary to prioritize electrifying these lines.
- Considering the prioritization of the railway industry in the scenarios, the country should first move towards single dedicated corridors between metropolitan cities. This dedicated corridor can serve as a pilot to familiarize managers and people with the implementation of such projects in the country, so that officials can move towards creating a national high-speed train network with greater confidence and a more prepared mindset in accordance with the country's needs.
- In order to improve the current lines, the railway industry should move towards electrification and upgrading the lines. (HSR dedicated corridor, conventional electric lines, national HSR network, conventional diesel lines, international HSR lines, Maglev).
- To carry out high-speed rail industry projects, government support is needed, and this governance perspective must be long-term.
- To accelerate high-speed rail industry projects in the country, science and technology centers, in addition to government support, must freely communicate with other research centers in other parts of the world. The country's foreign relations must move in a direction where we can interact with the world and import the parts needed by the country's railway industry. Having these conditions is dependent on having free international relations without sanctions.

References

- Danaei Fard, Hassan; Alvani, Seyed Mahdi; Azar, Adel. (2017). Quantitative Research Methodology in Management: A Comprehensive Approach. Tehran, Saffar Publishing.
- Fathi, Mohammad Reza; Maleki, Mohammad Hassan; Moghadam, Hossein. (2018). Futures Study of Investment and Financing in the Iranian Rail Transportation Industry (Machinery and Equipment Section). *Futures Study of Management*. No. 2 (113) 33-54.

- Watson, Inara. (2021). High-Speed Railway.__Chapter in Encyclopedia . July 2021Encyclopedia 1(3):665-688. DOI: 10.3390/encyclopedia1030053.
- zare, zinab; hosin ghazleyagh, iman. (2022). negangi asibshenasaneh bah ayandeh jayegah iran dar raghabatenpehei jeoekonomiki manteghesyi ba takid bar savahel mokran. (Conference on the development of Makran coasts. governance and emphasis on diplomacy and sea-based economy). <https://civilica.com/doc/1651997>