

RAILWAY VEHICLES MANUFACTURING IN TÜRKİYE AND THE ROLE OF TURASAŞ

Mustafa Metin YAZAR

RAILWAY VEHICLES MANUFACTURING IN TÜRKİYE AND THE ROLE OF TURASAŞ

Mustafa Metin YAZARⁱ

Turkish Railway Vehicles Industry Inc. General Manager

Abstract

Railways is a transportation model that has been attracting increasing attention in recent years due to its environmental awareness, long-term fixed price guarantee unlike other modes of transportation, being the most suitable type of transportation for heavy tonnage and bulky loads in terms of physical and cost, being reliable, not being affected by bad weather conditions, etc.

The global rail transport industry is growing, pushing the demand of the rolling stock industry to growth in recent years. An increasing momentum is expected to continue in the next few years, due to the increase in both passenger and rail freight transport.

In Türkiye, TCDD Taşımacılık A.Ş. needs 233 high-speed train/high-speed train sets, 125 Electric Train Sets (EMU), 930 electric locomotives, 146 diesel locomotives, 24.000 freight wagons, 62 sets of urban vehicles (Başkentray and Marmaray) by 2050. The total cost of all these vehicles is estimated to be at least 17.4 billion Euros. Investments to be made in rail system vehicles in the medium and long term will contribute greatly to the development of the local and national rail system vehicle industry in our country.

In order to develop the R&D, design and production capabilities of the domestic industry, to manufacture, maintain and repair all kinds of rail system vehicles and their sub-components, based on the domestic and national production and design of rail system vehicles and increasing the rate of domesticity in their critical components, TÜRASASAŞ, which was established as the relevant institution of the Ministry of Transport and Infrastructure by merging of TÜLOMSAŞ, TÜVASAŞ and TÜDEMSAŞ, the three subsidiaries of TCDD, set out with the mission of ensuring stable growth by reaching a wider product range with technology-intensive productions that steer the sector with a new perspective and synergy consisting of the merger of three subsidiaries and it has become the biggest representative of the rail systems sector in our country with its experience of more than a hundred years, knowledge, approximately 4000 trained manpower, integrated facilities producing national and domestic technologies, 2 R&D Centers located in Eskişehir and Sakarya Regional Directorate in a total area of 400 thousand m².

TÜRASASAŞ, which has a wide product range, carries out domestic and national design and production studies of rail system vehicles such as various types of shunting locomotives (diesel electric, diesel hydraulic, electric, hybrid), mainline locomotives (diesel electric, diesel hydraulic, electric), train sets (diesel, electric), suburban trains, wagons (passenger, freight) and TÜRASASAŞ is also working to localize many critical subcomponents of these vehicles, especially systems such as diesel engine, traction motor, traction converter, TCMS (Train Control and Management System) or to increase their localization rates. With the domestic and national production of these works, imports will be prevented and a large amount of foreign currency will be kept in our country. When the maintenance and spare parts costs are taken into consideration, the profit provided by domestic and national production increases even more.

Keywords

Railway, Railway Vehicles, Technology, R&D, Domestic Production

ⁱ ozelkalem[at]turasas.gov.tr

Introduction

In the second half of the 18th century, the first industrial revolution, which irreversibly affected economic and social life, changed people's living standards, consumption habits, priority areas in education and the direction of population movements, and made it necessary to establish a new system in passenger and freight transportation by triggering transportation technology. With the increased production capacity and product variety with the use of machines, horse-drawn cargo vehicles, ships powered by humans and wind power have been insufficient to meet the needs of the extensive marketing network. The search for a system that can carry more loads at once has paved the way for the development of railways and railway vehicles (Cesur, 2021, p.19).

It is expected that railways will be used more intensively in the future due to reasons such as being more environmentally friendly and efficient in energy consumption, being the mode of transportation that is least affected by climate differences and thus showing operational efficiency throughout the year, having much more cost advantages in freight transportation, being an important alternative for high-speed trains and medium-distance passenger transportation, and being a cost-effective option for public transportation compared to other transportation modes (United Nations, 2003, p. 91-92).

While rail system vehicles provide a safe and comfortable journey to their users, they also stand out in transportation systems with their economic and environmental aspects. For example, 23.4% of greenhouse gases emitted to the atmosphere originate from the transportation sector, while the share of rail systems is 3.5%. While 17.2% of freight and 7.4% of passengers are transported by rail systems in Europe, the share of energy consumed in railway transportation systems in the total energy consumption of the transportation sector is at the level of 2%. Compared to 2010, a 50% increase in passenger transportation (passenger-km) by rail systems in European countries is foreseen in 2030 and 100% in 2050. It is estimated that freight transport (ton-km) in rail systems will be at the same level as road freight transport in 2030, and will increase by 50% compared to road freight transport in 2050 (Kalkınma Bakanlığı 2018, p. 20).

The global rolling stock market size was valued at \$60.4 billion in 2019 and is estimated to reach \$73.8 billion by 2026. This corresponds to a constant compound annual growth rate of about 3% during the forecast period. The latest rail industry statistics show that the global rail network is over 1.3 million km worldwide in 2019. The United States of America (USA) has the world's largest rail network, followed by Russia, China, India, Canada, Germany, France and Japan. Due to various benefits such as cost-effectiveness, speed and reliability, the global rail transport industry is growing, and pushing the demand of the rolling stock industry to growth in recent years. An increasing momentum is expected to continue in the next few years, due to the increase in both passenger and rail freight transport.

In Türkiye, TCDD Taşımacılık A.Ş. needs 233 high-speed train/high-speed train sets, 125 Electric Train Sets (EMU), 930 electric locomotives, 146 diesel locomotives, 24.000 freight wagons, 62 sets of urban vehicles (Başkentray and Marmaray) by 2050. The total cost of all these vehicles is estimated to be at least 17.4 billion Euros. Investments to be made in rail system vehicles in the medium and long term will contribute greatly to the development of the local and national rail system vehicle industry in our country.

TÜRASAŞ

In order to develop the R&D, design and production capabilities of the domestic industry, to manufacture, maintain and repair all kinds of rail system vehicles and their sub-components, based on the domestic and national production and design of rail system vehicles and increasing the rate of domesticity in their critical components, With the Presidential Decision No. 2186 published in the Official Gazette dated 04.03.2020 and numbered 31058, it has been decided to establish Turkish Railway Vehicles Industry Inc. (TÜRASAŞ), with the status of an economic state enterprise and headquartered in Ankara, as the relevant institution of the Ministry of Transport and Infrastructure, by merging TULOMSAŞ, TÜVASAŞ and TÜDEMSAŞ, the three subsidiaries of TCDD.

The establishment purpose of TÜRASAŞ is as follows;

- Developing the R&D, design and production capabilities of the domestic industry, manufacturing, maintenance and repair of all kinds of rail system vehicles and sub-components, with the aim of increasing the domestic production and design of rail system vehicles in a domestic and national way and increasing the rate of domesticity in their critical components,
- Fulfilling its purposes and activities directly or through the institution, subsidiary, enterprise, affiliate and other units,
- In line with its aims and activities, it carries out the project and prototype works of all kinds of rail system vehicles and components, using its own financial resources, without being tied to any order, in order to primarily meet the needs of our country,

In order to achieve its visionary goals in accordance with its founding purpose, together with its three Regional Directorates, has set out with the mission of achieving stable growth by reaching a wider product range with its more than 100 years of experience and knowledge in the railway sector, the synergy formed by the merger of three subsidiaries, and a new perspective, with technology-intensive productions that shape the sector. TÜRASAŞ has become the largest representative of the rail systems sector in our country with its experience of more than a hundred years, knowledge, approximately 4000 trained manpower, integrated facilities producing national and domestic technologies, and 2 R&D Centers located in Eskişehir and Sakarya Regional Directorate in a total area of 400 thousand m².

TÜRASAŞ, which is the largest producer of our country on a sectoral basis in the rail system vehicles sector, produces products such as new generation locomotives, diesel and electric train sets, passenger wagons, freight wagons and the critical subsystems of these products, passenger and freight wagon bogies, traction converter, traction motor, diesel engine, TCMS (Train Control and Management System) in international standards.

TÜRASAŞ Eskişehir Regional Directorate, which has been operating since 1894, fulfills an important mission in the sector by meeting the production, maintenance and repair needs of our country's railway vehicles and their subcomponents (various types of diesel-electric, diesel-hydraulic and electric locomotives, freight wagons, diesel engines, traction motors, etc.) in international standards with its experience and knowledge.

TÜRASAŞ Sakarya Regional Directorate, which has been operating since 1866, has focused on planning activities for domestic and national production of needed high-speed train sets, electric train sets, metro and light rail system vehicles by using its knowledge, experience and infrastructure opportunities more efficiently.

While various types of freight wagons are produced in accordance with the International Union of Railways (UIC) Standards and TSI (Technical Specification for Interoperability) in TÜRASAŞ Sivas Regional Directorate, which has been operating since 1939, maintenance-repair and revisions of freight wagons are carried out within the framework of the ECM (Entity in Charge of Maintenance) Maintenance Management System Maintenance Supply Function.

In recent years, TÜRASAŞ has made significant progress in meeting the requirements of the European Union with its priorities in innovation, design, high technology, qualified human resources and qualification.

As a competitive organization, within the framework of its targets to open up to alternative markets, activities aimed at domestic and foreign customer demands are increasingly carried on, and significant increases are achieved in the product variety and the number of customers with the new generation railway vehicles introduced to the market.

Various production and design projects have been carried out within TÜRASAŞ so far. Within the scope of the Strategic Partnership Agreement made with Wabtec Transportation (GE) Company, “Next Generation European Platform Diesel Electric Locomotive” was manufactured together with Wabtec Transportation (GE) Company. With the Strategic Partnership Agreement, the locomotives produced in TÜRASAŞ facilities were exhibited for the first time in an international fair and took their place in the market.

Between 2013 and 2015, the production of a total of 72 Electric Locomotives with HYUNDAI ROTEM company was completed and delivered to the General Directorate of TCDD.

In the First National Diesel Electric Shunting Locomotive, which was designed and produced with national solutions, a new 6-cylinder engine was used and the diesel engine and traction converter were designed and produced locally and nationally.

TÜRASAŞ manufactures various types of freight wagons in accordance with customer demands, in accordance with European Union (EU) standards, with TSI certificate, new technology, 100% domestic design and 85% domestic rate.

Within the scope of passenger wagon production, 12 Generator Wagons in 2006 and 14 TVS 2000 type passenger wagons were exported to Iraq in 2014. In 2013, the first TSI certified 30 sleeping passenger wagons in the EU region were manufactured and exported to Bulgaria.

38 Light Rail Vehicles were produced for Bursa Municipality with Siemens, 275 Light Rail Vehicles were produced with Hyundai Rotem for Marmaray project, 84 Metro vehicles and 75 Electric Array (Suburban) Vehicles were produced for Istanbul Metropolitan Municipality. In addition, it has exported locomotives to the USA, Germany, England, Iran and Iraq countries, various types of Passenger Wagons, locomotive and diesel engine parts to France, Germany and Thailand, Freight Wagons to Germany, Iraq and France, Freight Wagon Bogies for Austria. Production of Railway Maintenance Vehicles for Swiss Railways continues.

R&D Activities

The word innovation means innovation that adds value. Information turns into money with innovation, money turns into information with research and development studies, and if this money is used for innovation, a continuity in innovation can be ensured. Continuous innovation is necessary to maintain competitiveness. In this context, TÜRASAŞ continues its R&D studies at full speed in order to maintain this cycle and keep up with the innovation era in the railway sector.

As it is known, TÜRASAŞ, an institution full of firsts, that successfully produced the first national locomotives of Turkish Railway history, the Karakurt and Bozkurt locomotives, and the First Turkish Automobile, Devrim, is also the first public institution to have the title of R&D Center. Within the scope of the company's future goals, studies have been started for the establishment of an R&D Center, and as a result of the inspections carried out in 2017 by the Ministry of Industry and Technology within the scope of the "Law on Supporting Research, Development and Design Activities" numbered 5746, it was entitled to receive the title of R&D Center. R&D studies are carried out by two R&D Centers located in Eskişehir and Sakarya Regional Directorates.

TÜRASAŞ, which has a wide product range, carries out domestic and national design and production studies of rail system vehicles such as various types of shunting locomotives (diesel electric, diesel hydraulic, electric, hybrid), mainline locomotives (diesel electric, diesel hydraulic, electric), train sets (diesel, electric), suburban trains, wagons (passenger, freight) and TÜRASAŞ is also working to localize many critical subcomponents of these vehicles, especially systems such as diesel engine, traction motor, traction converter, TCMS (Train Control and Management System) or to increase their localization rates.

TÜRASAŞ has the following qualifications in terms of design capability:

- Conceptual Feasibility Studies
- Analysis with Finite Element Method
- Industrial Design
- Mechanical and Electrical Design
- Appropriateness of Design Outputs in Terms of Analysis
- Risk Analysis

Today, in line with the increasing demands in the mainline and shunting locomotive sector, diesel-electric and electric vehicles have started to replace diesel-hydraulic vehicles. Since the traction system is electronic in diesel electric and electric vehicles, the problems such as abrasion, friction and breakage that may occur in the mechanical parts are less than the diesel hydraulic system and a longer life is promised. The complex structure of the power transmission systems together with the complicated parts used in diesel hydraulic systems both require expertise in maintenance-revision processes and considerably reduces the localization rate of the parts. Considering all these advantages, various projects have been developed by TÜRASAŞ in order to meet the diesel electric and electric vehicle needs in our country.

Firstly, with the E1000 type Electric Shunting Locomotive Project, the first step was taken both in the world of electric vehicles and in the design of the national traction system. The project realized with TUBİTAK RUTE was supported 100% by TUBİTAK KAMAG and was successfully completed. Thus, information on how an electric locomotive works was obtained and the traction system, which is one of the most critical systems of a railway

vehicle, was localized and became an important input for other projects such as the E5000 type Electric Mainline Locomotive Project, which will be the first locomotive to have TSI certificate in Türkiye. Later, the studies on the DE10000 type locomotive, a diesel electric shunting locomotive, were started. In the project, which was designed and produced locally and nationally, a high locality rate was targeted. In this context, together with the traction system information obtained from the E1000 type locomotive project, local and national traction systems were used in this project as well. In addition to the traction system, TÜRASAS brand TLM6V185 type diesel engine and domestic and national vehicle software were used in this project. Both the vehicle and the subsystems used in the vehicle are largely prevented from dependence on imports, and the increase in our own knowledge increases our self-confidence and paves the way for new innovative projects. The software work that started with the DE10000 type Locomotive Project has also been a big step towards the digitization of locomotives. It is considered that it is an inevitable result that the technology trend of the railway sector concentrates on "Machine to Machine" and "Internet of Things", which have matured in many sectors recently. As TÜRASAS, projects are being developed to equip our rail system vehicles with communication and control systems suitable for this technology in order to be ready for this direction. Train control and communication software developed by TÜRASAS are also indicators of concrete steps taken in this direction. Thanks to the data received from more than 200 sensors through the systems used in diesel electric shunting locomotives, now both the mechanics can access the relevant data digitally while driving, and the maintenance and fault detection can be done more easily thanks to the data recorded during use. In addition, when necessary, fault detections can be controlled by expert personnel with remote access, and on-site intervention can be performed on the vehicles. With the developments to be applied to these systems in the future, it is aimed to evolve the communication between both roadside and in-vehicle equipment into intelligent systems.

In recent years, the increase in product diversity in the railway sector and the complexity that has arisen due to the increasing number of projects cause some problems such as high production costs and long delivery times. In order to overcome these problems, it is observed that international locomotive manufacturers around the world have created a product family thanks to platform-based product development systems. In this context, the National Locomotive Platform Development Project with CoCo Axle Assembly was initiated in order to develop a platform-based product. Within the scope of the project, "Development of a National Locomotive Platform with CoCo Axle Assembly" will be carried out according to the various energy modes (electric, diesel-electric and dual-mode) that our country needs, with the gains obtained from the E5000 National Electric Mainline Locomotive Project. At the end of the project, three types of locomotives will be built on a common platform and the first step will be taken to create a product family.

Within the scope of the ongoing projects, studies are continuing on the National Suburban Train Set, the National Electric Train Sets (160 km/h and 225 km/h), the E 5000 National Electric Locomotive Project and the V8-1200 HP Original Engine Project with a 70% locality rate.

Along with these projects, the design and development projects of Hybrid Locomotive, TLM16V185 type Diesel Engine Modernization, Sleeping Wagon, VIP Sleeper Wagon, Traction Converter, Locomotive Monitoring System /TLMS, Fire Fighting Wagon, Sgmmns 40', Sggrs 80' Type Platform Wagon, K Type composite disc lining and block linings are continuing.

Important R&D Projects

National Electric Train Set Project (160 km/h)

In our country, investments in railways have started to be given weight again since the 2000s. In addition to high-speed train services, modernization and maintenance and repair works are increasing in mainline trains and lines. In addition to the development and increase in the line infrastructure, the preferences in which technological and environmental qualities stand out in the vehicle fleet are also extremely important. With the increase in main lines with increasing electrification rate, diesel train sets will be replaced by electric train sets on main lines. Diesel sets will be evaluated in secondary lines.

Road tests of Domestic and National Electric Train Sets with an aluminum body at 160 km/h operating speed are continuing. It will be delivered to TCDD Transportation at the end of the road tests and certification process. 3 train sets in 2022 and 19 train sets in 2023 and 2024 will be delivered to TCDD Taşımacılık A.Ş. Supply processes for mass production continue.

High Speed Train Project (225 km/h Electric Train Set with Operating Speed)

The first time on the Ankara - Eskişehir line, which is the High Speed Train (HST) line that was put into service, was made on 13 March 2009. This time, Türkiye became the 6th country in Europe and 8th in the world using high speed trains. Following the first HST line, a commercial voyage trial of the Ankara - Konya HST line was carried out on 13 June 2011. It was recorded that the train reached a speed of 287 km/h in this trial. The line was opened on August 23, 2011. Then, on 25 July 2014, Ankara - Istanbul HST and Istanbul - Konya HST lines (until Pendik) were put into service. On March 12, 2019, with the completion of the railway line between Gebze and Halkalı within the scope of the Marmaray project, HST services began to be made up to Halkalı, passing under the Bosphorus.

With the experience gained in the National Electric Train Set Production Project with a speed of 160 km / h in order to meet the high-speed train need of our country, the design studies of the Electric Train Set Project with a speed of 225 km / h have been started. The design work is targeted to be completed in 2022, and work on its production has also begun. The preliminary design studies for the project have been completed. Technical negotiations with potential manufacturers (subcontractors) continue. Prototype production will start in 2023. A total of 8 sets are planned to be produced in 2024 and 2025.

E 5000 National Electric Locomotive Project

Work continues to eliminate foreign dependency in the production of Electric Mainline Locomotive with national design and advanced technology. With the E 5000 National Electric Locomotive Project, it is aimed to gain design capability in the production of Electric Mainline Locomotive and to reduce the foreign dependency of our country in this field with a high domestic rate. The prototype vehicle manufacturing process continues, and the supply process for the mass production of 20 locomotives for TCDD Taşımacılık AŞ is also continuing.

The design and production experience gained from these projects provides an advantage in terms of both cost estimates and technical know-how for new projects to be addressed.

National Suburban Vehicle Project

As of 2021, the project has been started. Each series to be designed and produced within the scope of the project will have 4 vehicles, 1000 passenger capacity and two driver cabins. Industrial design, concept design and preliminary design studies have been completed in the project, and detailed design studies are continuing. In the project, which continues to supply equipment, suppliers of critical equipment in terms of design and deadlines have been determined.

TLM16V185 Type Heavy Diesel Engine Modernization and Original Engine Project

Within the scope of the project started in December 2018, two separate projects are carried out in parallel. Within the scope of the first project, efforts are being made to modernize TLM16V185 type diesel engines, which are the diesel engines of DE24000 type diesel-electric locomotives used by TCDD Taşımacılık AŞ, and improve their specific fuel consumption and other performance values with domestic opportunities.

Within the scope of the second project, the design and production of an original 8-cylinder engine with a maximum specific fuel consumption of 200g/kWh and a power of at least 1200 hp, the license rights of which belong to our country, are carried out. The project, which is 100% supported within the scope of TÜBİTAK KAMAG 1007, is carried out in cooperation with TÜRASAŞ Eskişehir Regional Directorate and TÜBİTAK RUTE.

K Type Composite Brake Shoe Development Project

The aim of this project is to domestically produce rail vehicle linings and shoes with high friction coefficient, high heat resistance, high strength, noiseless, unaffected by weather conditions, harmless to human health, in accordance with UIC standards. A high rate of savings will be achieved with the use of domestic K Type Composite Brake Shoe in railway vehicles. The project is carried out in cooperation with TÜRASAŞ Sakarya Regional Directorate and TÜBİTAK RUTE.

Domestic and National Coco Platform Locomotive Project

Within the scope of the protocol signed with TÜBİTAK RUTE, the E-5000 National Electric Main Line Locomotive platform, which is currently being carried out in cooperation with TÜBİTAK, is the national and domestic design and production of a new Co-Co type diesel electric main line locomotive with TSI certificate. The project will be carried out in cooperation with TÜRASAŞ Eskişehir Regional Directorate and TÜBİTAK RUTE.

Battery Powered Shunting Vehicle Project

In order to be used in the transportation services of facilities such as railway port enterprises, etc., both on the road and on the railway, the Electric Shunting Vehicle, powered by a rechargeable battery, has been designed and manufactured with domestic and national means. It has been commercialized and put on the market.

Freight Wagon R&D Projects

TÜRASAŞ R&D Centers have TSI Certified design capability in EU standards for all freight wagons such as tank, platforms, containers, grains, ballasts, car-carrying required by operators and freight wagon bogie types in Y25 classic, “H” type, “s” or “ss” speed regimes in the domestic and international markets and Eskişehir and Sivas Regional Directorates

also have the production capability for all freight wagon and bogie types due to their infrastructure. In freight wagons, 85-90% domesticity has been reached, depending on the wagon type and cost. On the other hand, design and production studies are carried out with industry-university collaborations for special-purpose freight wagons such as fire extinguisher wagons and elevator waste ballast transport wagons.

K Type Composite Brake Shoe Development Project

The aim of this project is to domestically produce rail vehicle linings and shoes with high friction coefficient, high heat resistance, high strength, noiseless, unaffected by weather conditions, harmless to human health, in accordance with UIC standards. A high rate of savings will be achieved with the use of domestic K Type Composite Brake Shoe in railway vehicles. The project is carried out in cooperation with TÜRASAF Sakarya Regional Directorate and TÜBİTAK RUTE.

With the domestic and national production of the projects mentioned above, imports will be prevented and a large amount of foreign currency will be kept in our country. When the maintenance and spare parts costs are taken into consideration, the profit provided by domestic and national production increases even more.

In addition to the ongoing R&D projects, studies are also carried out on potential projects for future forecasts. Considering the future trends, it is thought that the orientation towards alternative energy sources will increase due to the predictions that the energy sources obtained from fossils will not be able to meet the energy needs, together with the increasing population. Political instability in fossil fuel-rich countries also creates uncertainties in fuel price and supply. This situation also leads people to seek alternative energy sources. New fuel technologies such as LNG, hydrogen and algae are seen as alternative energy sources and different studies are carried out in many countries to integrate them into usage areas.

There is also the opinion that by 2050, hydrogen will be the primary source to meet the energy needs of trains. Hybrid models, in which hydrogen fuel cells replace the currently used diesel generators, are also among the future trends. Hydrogen fuel cell hybrid vehicles are seen as a good alternative for rural areas without a catenary line. It is expected that transportation costs will decrease significantly as the use of alternative energy sources becomes more widespread with the developing technology (Goulding & Morrell, 2019).

According to SCI Verkehr data in the image below, it is expected that by 2024, multiple train sets driven by alternative energy sources such as hydrogen or batteries will show a 6% improvement (SCI Verkehr GmbH, 2020). This can be considered as an important development for a short period of time. It is obvious that this percentage will increase much more in the long projection.

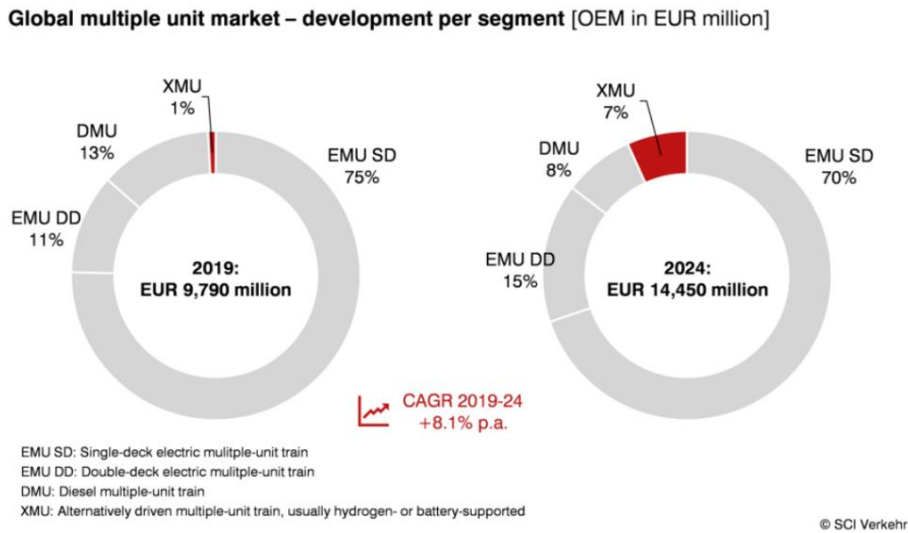


Figure 1. Global multi-train set market - development by segment

The increasing population, which causes the search for alternative energy sources, also causes rapid urbanization and results in an increase in the demand for mobility day by day. Thus, in addition to energy efficient systems, which are among the future trends, systems that will save people time come to the fore. Digitalized and autonomous systems can be given as examples. With these systems, it is thought that benefits such as minimizing the margin of human error, early detection of problems and early intervention, lowering of production, service and operating costs, lower voyage intervals and higher operating speed will provide benefits such as transporting more passengers. When the Railway Sector Report prepared by the Ministry of Transport and Infrastructure of the Republic of Türkiye is examined, it is seen that autonomous operations are more advantageous than manual operations in many ways (Table 1) (Strateji Geliştirme Başkanlığı, 2022).

Driverless autonomous systems can be described as safer as they minimize human-induced errors in manual operations. Again, with the elimination of the need for the train operator in autonomous systems, there is a decrease in personnel costs. At the same time, the loss of time that occurs in operator shift changes in manual operations can be avoided.

Table 1. Gains to be Provided in Some Features with Autonomous Operation

Feature	Manual Operation	Autonomous Operation
Reaction time (sec.)	>0,5	0,05
The time interval between two trains traveling in the same direction on the same track (sec.)	100	80
Emergency braking distance (mt.)	100	80
Energy consumption (kWh/km)	30	28
Train operator working time (hours)	<6	24

To summarize briefly, rapid urbanization and increasing population directly affect transportation modes all over the world and shape the trend of future needs. In order to meet the increasing demand, systems that will increase energy efficiency about alternative

energy sources and systems that will save both financially and time in order not to make people suffer come to the fore. As TÜRASAŞ, these trends are closely followed, and it is among the Company's objectives to develop new R&D projects for future expectations in line with both the knowledge gained from ongoing R&D projects and the R&D studies to be carried out.

Manufacturing and Maintenance of Rail System Vehicles in Türkiye

In addition to the countries that play a major role in the railway sector and the world's giant vehicle manufacturers, there are also many public affiliates and private companies, together with TÜRASAŞ, which is a railway vehicle manufacturer in our country.

Joint projects were carried out with GE TRANSPORTATION, ALSTOM, SIEMENS and HYUNDAI ROTEM companies. Diesel shunting locomotives, diesel-electric mainline locomotives, diesel-hydraulic mainline locomotives, electric suburban trains, electric train sets and Diesel Train Set (DMU) vehicles are produced and cared for at TÜRASAŞ facilities with domestic means.

Established in 2006 with the partnership of HYUNDAI ROTEM, TCDD and domestic companies, EUROTEM can manufacture a wide range of railway vehicles from suburban trains to subway vehicles.

Durmaray, located in Bursa, carries out project, design, software, assembly, testing and commissioning activities in the field of urban rail vehicle system production.

Bozankaya company, on the other hand, can produce low-ceiling trams with double-sided driving feature in its factories established in Ankara and Germany, and manufactures stainless steel - aluminum material bodies and lower parts for the world's leading rail system manufacturers.

TCDD Taşımacılık AŞ, which is responsible for the operation and maintenance of railway vehicles in our country, was established in 2017 after TCDD was split into two. TCDD Tasimacilik AS is responsible for the operation and maintenance of High Speed Trains, locomotives, conventional train sets and freight and passenger wagons owned by the company on TCDD lines.

The maintenance and repairs of railway vehicles are generally carried out in TCDD-affiliated workplaces, in factories such as TÜRASAŞ and ADF. Apart from these, High Speed Trains are contracted by High Speed Train manufacturers in order to ensure both new technologies and maximum safety.

The largest vehicle inventory in the sector belongs to TCDD Taşımacılık A.Ş, which is the largest railway train operator. In addition, Railway Train Operators (DTİ) also have their own railway vehicles. In addition, companies that carry out freight transportation outside of DTİs (3rd parties) also have their own wagons, and these wagons are carried by DTİs that carry out the transportation.

Considering that rail system investments with advanced technology will increase in Türkiye, it is of great importance to develop domestic and national production within the annual 2 billion Euro rail system sector, to reduce foreign dependency and to create export potential. The Covid pandemic process has shown that countries that attach importance to domestic and national production and produce technology do not have problems in their production and supply processes.

In the Eleventh Development Plan (2019-2023), published by the Presidency of the Republic of Türkiye, Strategy and Budget; for domestic and national production of rail system vehicles; includes the following objectives; Establishing a National Brand, making necessary arrangements for the procurement of national vehicles, inventory work in rail system vehicles, demand and supply planning, determination of public-private production structure and capabilities, design and production of critical components in rail system vehicles with national means, Increasing the institutional capacity of public and private sector organizations producing rail system vehicles and spare parts by working with universities and developing marketing opportunities, creating training programs for the design and production of rail system vehicles.

In the TÜRASAŞ 2022-2026 Strategic Plan, which we have prepared in order to reach the targets in the Eleventh Development Plan and other upper policies and documents, and to create the road map of our company, 5 main objectives and sub-targets have been determined to achieve these objectives;

- Developing domestic and national projects in the Rail System Vehicle sector
- Designing and producing critical components with national means
- Increasing market share and brand awareness in national and international markets
- Increasing production performance
- Improving the after-sales service process

In order for us to realize our goals and objectives, it should be aimed to make the purchases of the institutions that need the Rail System vehicles as public procurement, and while the technical specifications of the rail system vehicles are being prepared, it should be aimed to produce the sub-systems that constitute an important part of the vehicle costs, as well as the domestic production of the vehicle itself. For this reason, domestic production should be required as a mandatory requirement for critical sub-components such as bogie, vehicle body, train control and management system, traction system, brake system, door system, transformer system for rail system vehicles, instead of the percentages of the locality condition required in the tenders. Electrical-electronic hardware, software and algorithm development, testing and verification work packages should definitely be added to the vehicle and subsystem domestic production criteria. Thus, the rail system vehicle sector in our country will continue to grow and develop. The organization that will lead the execution of these activities should undoubtedly be TÜRASAŞ.

TÜRASAŞ has the knowledge, experience and trained manpower to realize both country and company goals by working in cooperation with customers, suppliers, universities, research centers and other stakeholders, increasing its corporate capacity, creating sales, marketing and branding strategies, and developing foreign market and export opportunities.

Conclusion and Evaluation

Considering that rail system investments with advanced technology will increase in Türkiye, it is of great importance to develop domestic and national production within the annual 2 billion Euro rail system sector, to reduce foreign dependency and to create export potential. The Covid pandemic process has shown that countries that attach importance to domestic and national production and produce technology do not have problems in their production and supply processes.

In order for us to achieve the objectives and targets in the TÜRASAŞ 2022-2026 Strategic Plan, as well as the targets for Rail Systems Vehicle production in the Eleventh Development Plan (2019-2023) published by the Presidency of the Republic of Türkiye Strategy and Budget Department, it should be aimed to make the purchases of the institutions that need the Rail System vehicles as public procurement, and while the technical specifications of the rail system vehicles are being prepared, it should be aimed to produce the sub-systems, which constitute a significant part of the vehicle costs, as well as the domestic production of the vehicle itself. For this reason, domestic production should be required as a mandatory requirement for critical sub-components such as bogie, vehicle body, train control and management system, traction system, brake system, door system, transformer system for rail system vehicles, instead of the percentages of the locality condition required in the tenders. Electrical-electronic hardware, software and algorithm development, testing and verification work packages should definitely be added to the vehicle and subsystem domestic production criteria. Thus, the rail system vehicle sector in our country will continue to grow and develop. The organization that will lead the execution of these activities should undoubtedly be TÜRASAŞ.

References

- Cesur, Erol (2021). Effects of Traction Workshop on Sivas's Socio-Economic, Socio-Cultural Structure and Reflections in the Press.
- Kalkınma Bakanlığı. (2018). On Birinci Kalkınma Planı: Raylı Sistem Araçlarında Yerli Üretim Çalışma Grubu Raporu (Republic of Türkiye Ministry of Development Rail System Vehicles Domestic Production Working Group Report) (Accessed: 15.05.2022) <https://www.sbb.gov.tr/wp-content/uploads/2020/04/RayliSistemAraclarindaYerliUretimCalismaGrubuRaporu.pdf>
- Lynne Goulding, & Morrell, M. (2019). Future of rail 2050. Arup Foresight. (Accessed: 15.05.2022) <https://foresight.arup.com/publications/future-of-rail-2050-2/>
- SCI Verkehr GmbH. (2020). World market for multiple units: End of diesel trains initiated? World market for multiple units: end of diesel trains initiated? (Accessed: 16.05.2022) <https://www.sci.de/en/data-trends/document/world-market-for-multiple-units-end-of-diesel-trains-initiated>
- Strateji Geliştirme Başkanlığı. (2022). 12. Ulaştırma ve Haberleşme Şûrası Sektör Raporları (12th Transport and Communications Council Sector Reports). T.C. Ulaştırma ve Altyapı Bakanlığı, Strateji Geliştirme Başkanlığı. (Accessed: 16.05.2022). <https://sgb.uab.gov.tr/uploads/pages/suralar/12-ulasirma-ve-haberlesme-surasi-sektor-raporlari.pdf>
- United Nations. (2003). Economic and Social Commission for Asia and The Pasific, The Restructuring of Railways (Accessed: 30.05.2022) <https://www.unescap.org/sites/default/files/RailwayRestructuring.pdf>

About Author

**Mustafa Metin YAZAR | Turkish Railway Vehicles Industry Inc. |
General Manager | [ozelkalem\[at\]turasas.gov.tr](mailto:ozelkalem@turasas.gov.tr)**

He was born in Osmaniye in 1967. He graduated from Istanbul Technical University in 1990 as a Geomatics Engineer. He completed his master's degree in Transportation Engineering in 1993. Between 1996-2019, he undertook various tasks in the areas of transportation infrastructure development and implementation, such as planning, system design, design, coordination, implementation, maintenance management, and operation in Public Transportation and Rail System Projects at Istanbul Metropolitan Municipality and Metro Istanbul A.Ş., and in the private sector between 1992-1996. In 2019, he resigned from his position as Deputy General Manager at Metro Istanbul AŞ and assumed the duties of General Manager and Chairman of the Board of TCDD Teknik A.Ş. Mr. YAZAR was appointed as the General Manager and Chairman of the Board of Directors of TÜRASAŞ in August 2020 and speaks English.