UIC MIDDLE EAST REGION

UIC Middle East Railways Vision 2050

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CONTENTS

EXECUTIVE SUMMARY 5

MIDDLE EAST RAILWAYS 6

I. MACROECONOMIC OVERVIEW OF THE MIDDLE EAST REGION 7

1. KEY FIGURES 7

1.1. Economic performance 7

1.2. Demographic situation 8

1.3. Investments 10

2. INTERNATIONAL TRADE 11

2.1. Exports: volumes and values 11

2.2. Exports: geography 12

2.3. Imports: volumes and values 13

2.4. Imports: geography 14

3. MACROECONOMIC TRENDS AND FORECASTS 16

3.1. Short term: high heterogeniety 16

3.2. Long term: outpacing global rates 16

4. KEY ECONOMIC CHALLENGES FOR REGIONAL RAIL DEVELOPMENT 17

5. TRADE FLOWS FORECASTS 18

5.1. Intraregional trade flows 19

5.2. External trade flows 21

5.3. Transit trade flows 25

II. OVERVIEW OF EXISTING PROGRAMMES AND PROJECTS 26

1. INTERNATIONAL ORGANISATIONS 26

2. OVERVIEW OF NATIONAL PROGRAMMES AND PROJECTS 30

III. MIDDLE EAST RAIL VISION 2050. KEY POINTS 34

IV. RAIL INFRASTRUCTURE 38

1. INVENTORY OF EXISTING INFRASTRUCTURE AND ITS DEVELOPMENT 38

1.1. Infrastructure parameters for the inventory 38

1.2. Corridor-based approach 42

2. PLANNING OF INFRASTRUCTURE 51

2.1. National and regional prioritising approaches 51

2.2. Going forward: challenges for making infrastructure operational 56

V. RAIL TECHNOLOGIES 57

1. TRAFFIC OPERATIONS 58

2. MAINTENANCE, SAFETY AND SECURITY 60

3. ROLLING STOCK 62

4. BORDER CROSSING 62

5. INTERMODALITY AND CUSTOMER RELATIONS 63

VI. PASSENGER AND HIGH-SPEED RAIL TRANSPORTATION 65

1. INTERNATIONAL PASSENGER CONNECTIONS: CREATING REGIONAL FRAMEWORK 65

2. NATIONAL AND GENERAL BASIC QUALITY CRITERIA FOR PASSENGER OPERATIONS AND SERVICES 66

3. URBAN RAIL SERVICES AND QUALITY CRITERIA 70

VII. RAIL FREIGHT TRANSPORTATION AND HUBS 72

1. MIDDLE EAST RAIL FREIGHT MODEL AND PRIORITIES 72

1.1. Projected freight flows under various scenarios 72

1.2. Freight hubs 76

1.3. Recommendations on optimal parameters of freight corridor performance 78
2. *QUALITY CRITERIA FOR RAIL FREIGHT SERVICES* 79
VIII. ENVIRONMENTAL, SOCIAL AND CORPORATE GOVERNANCE (ESG) **81**
1. *TYPICAL AND REGIONAL QUALITY CRITERIA FOR ESG* 81
1.1. Environmental targets and quality criteria 82
1.2. Social targets and quality criteria 85
1.3. Corporate governance targets and quality criteria 87
2. *FINANCING TOOLS AND COOPERATION WITH DEVELOPMENT INSTITUTIONS* 88
3. *COOPERATION MECHANISMS FOR KNOWLEDGE-SHARING* 89
IX. REGIONAL COOPERATION AND SHIFT TO RAIL **90**
1. *RAME BN & ITC: BACKBONE NETWORK AND MANAGEMENT OF INTERNATIONAL TRANSPORT CORRIDORS* 90
2. *RAME IPA: REGIONAL INFRASTRUCTURE PRIORITISING APPROACH* 91
3. *RAME RAIL+ INTEROPERABILITY FRAMEWORK: MULTIMODAL REGULATORY FRAMEWORK TO ENSURE REGIONAL INTEROPERABILITY* 91
4. *RAME RAIL QUALITY FRAMEWORK* 92
5. *RAME RAIL SUPPORT PROGRAMME AND COOPERATION WITH FINANCIAL INSTITUTIONS* 92
6. *ASSESSMENT OF THE IMPACT OF CORRIDOR-BASED APPROACH ON THE REGIONAL ECONOMIES* 92
X. THE WAY FORWARD: ACTION PLAN **97**
ANNEX 1. MODELLING METHODOLOGY **99**
ANNEX 2. RAME RAIL QUALITY CRITERIA – FULL LIST **100**
ANNEX 3. RAIL TECHNOLOGIES DATABANK **104**

List of figures

Figure 1. Share of the Middle East region in global GDP and population 7
Figure 2. Dynamics of regional GDP in comparison to global GDP, % 8
Figure 3. GDP per capita at purchasing power parity, 2019 constant prices, USD 8
Figure 4. Projected population growth by countries of the Middle East region 9
Figure 5. Density of population and rail network 10
Figure 6. Investment weight in GDP (%) and its dynamics 10
Figure 7. Physical (volumes) and nominal (values) structure of exports 11
Figure 8. Export shares of countries in the Middle East region and structure of exports 11
Figure 9. Export shares of countries in the Middle East region and structure of exports 12
Figure 10. Map of export directions and volumes of the Middle East countries 12
Figure 11. Physical (volumes) and nominal (values) structure of imports 13
Figure 12. Import shares of countries in the Middle East region and structure of exports 13
Figure 13. Import shares of countries in the Middle East region and structure of exports 14
Figure 14. Map of import directions and volumes of the Middle East countries 14
Figure 15. Export to import ratio 15
Figure 16. Projected intraregional trade volumes, m tons (2021 – actual data) 19
Figure 17. Matrix of intraregional trade changes in volumes (2021 to 2050) under the baseline scenario 19
Figure 18. Cumulative external trade flows of the Middle East countries under various scenarios 21
Figure 19. Forecasted exports (left) and imports (right) of the Middle East countries till 2050 (excl. oil and natural gas), m tons (2021 – actual data) 21
Figure 20. Matrix of changes in export volumes from the Middle East region to other countries and regions in the baseline scenario, m tons 23
Figure 21. Matrix of changes in import volumes to the Middle East region from other countries and regions in the baseline scenario, m tons 24
Figure 22. Forecasted transit flows from Asia to Europe (left) and from Europe to Asia (right) of the Middle East countries till 2050, m tons (2021 – actual data) 25
Figure 23. Jordanian Railway Network 30
Figure 24. Five Nation Railway Route 31
Figure 25. Five Nation Railway Route 32
Figure 25. Etihad Rail Network 32

Figure 26. Middle East Railways – existing infrastructure and plans according to official public documents of RAME members 43
Figure 27. Middle East Railways – vision of international railway corridors 2050 43
Figure 28. South and Southeast Asia – Middle East – Europe railway corridor 44
Figure 29. East Asia – Middle East - Africa railway corridor 45
Figure 30. East Asia – Middle East – Europe railway corridor 47
Figure 31. North - South railway corridor 48
Figure 32. Arabian Peninsula – I. R. Iran – Central Asia/ East Asia railway corridor 49
Figure 33. Arabian Peninsula – Europe railway corridor 50
Figure 34. Africa – Arabian Peninsula railway corridor 50
Figure 35. Africa – Middle East – Europe railway corridor 51
Figure 36. Classification of railway infrastructure projects 53
Figure 37. Smart railway technologies and solutions chart 58
Figure 38. Estimation of interoperability and e-interoperability input to Euro-Asian rail freight transit traffic under “the best rail case” option 59
Figure 39. ETA information exchange scheme 61
Figure 40. Standard rail passenger route 67
Figure 41. Average dependency of the public transport share in total mobility on the population size 70
Figure 42. Modelled rail flows in the Middle East region by 2050 under risk scenario (excl. domestic flows) 72
Figure 43. Modelled rail flows in the Middle East region by 2050 under optimistic scenario (excl. domestic flows) 73
Figure 44. Modelled rail flows in the Middle East region by 2050 under baseline scenario with NO CHANGES apart from projects from existing strategic documents 74
Figure 45. Modelled rail flows in the Middle East region by 2050 under baseline scenario with ADDITIONAL LINKS (suggested projects) 75
Figure 46. Major Middle East railway hubs 2050 77
Figure 47. UIC ESG global targets 81
Figure 48. GHG emissions in the rail sector (scope 1), 2020 82
Figure 49. Share of electrified lines in total railway network, 2020 83
Figure 50. Middle East railways electrification/ non-fossil fuels use map: current state and Vision 2050 83
Figure 51. Average monthly salary in the rail sector, 2022 85
Figure 52. Efficiency of train services in selected countries of the Middle East region, 2019 86
Figure 53. Share of women in the rail sector, 2020 86

List of tables

Table 1. Profiles of international organisations related to transport/ rail presented in the Middle East region 27
Table 2. UIC Middle East Railways Vision 2050. Goals, objectives, activities and their references to the needs of members 35
Table 3. Parameters and data needed for rail infrastructure inventory 39
Table 4. RAME IPA Stage 2 criteria and assessment options 54
Table 5. RAME IPA – certifications principles and advisory on financing options 54
Table 6. Intergovernmental documents on international passenger services in referring to all or some countries in the Middle East region 66
Table 7. Middle East Railways basic quality criteria for passenger services 2050 67
Table 8. Middle East Railways basic quality criteria for urban rail services 2050 71
Table 9. Forecasted annual rail freight flows by corridors in 2030 and in 2050 73
Table 10. Suggested parameters of the Middle East railway hubs 2050 77
Table 11. Target parameters of the proposed corridors to ensure their competitiveness 79
Table 12. Middle East Railways basic quality criteria for freight services 2050 79
Table 13. Environmental targets and quality criteria for the railways of the Middle East region 84
Table 14. Social targets and quality criteria for the railways of the Middle East region 87
Table 15. Corporate governance targets and quality criteria for the railways of the Middle East region 87
Table 16. Export effects* from corridor-based approach by countries, baseline scenario, million tons 93
Table 17. Export effects* from corridor-based approach by groups of commodities, baseline scenario, million tons 93
Table 18. Import effects* from corridor-based approach by countries, baseline scenario, million tons 94
Table 19. Import effects* from corridor-based approach by groups of commodities, baseline scenario, million tons 94
Table 20. INTRA-REGIONAL trade effects from corridor-based approach, baseline scenario, million tons 95
Table 21. INTRA-REGIONAL trade effects from corridor-based approach by groups of commodities, baseline scenario, million tons 95
Table 22. Action plan to achieve goals and objectives of the Middle East Railway Vision 2050 97

List of abbreviations

ADB	Asian Development Bank
CCTT	International Coordinating Council on Trans-Eurasian Transportation
CIT	International Rail Transport Committee
EAEU	Eurasian Economic Union
ECE	Economic Commission for Europe
ECO	Economic Cooperation Organization
ESCWA	Economic and Social Commission for Western Asia
ESG	Environmental, social, and corporate governance
EU	European Union
ESCAP	Economic Commission for Asia and the Pacific
GRID	Green, Resilient and Inclusive Development
GDP	Gross Domestic Product
GVA	Gross Value Added
HS	Harmonised System
IsDB	Islamic Development Bank
MENA	Middle East and North Africa
OSJD	Organization for Cooperation of Railways
OTIF	Intergovernmental Organization for International Carriage by Rail
PPP	Public-private partnership
RAME	Regional Assembly Middle East
TEU	Twenty-foot equivalent
UIC	International Union of Railways
USD	United States Dollar
YOY	Year-of-year

EXECUTIVE SUMMARY

The Middle East Railways Vision 2050 is to become the first document aimed at regional cohesion of railway systems and projects.

Starting from the overview of existing economic, social, investment parameters, as well as macroeconomic and trade forecasts, it covers various areas of railways, from infrastructure planning to rail technologies and ESG.

The Vision proposes the positioning of the Middle East Railways 2050: **Middle East Railways are bridges for regional economic and social development, uniting different countries, and enhancing the cooperative potential of the Middle East region.**

This positioning, or Mission, is complemented with goals, objectives, and actions corresponding to the needs of RAME members derived from the dedicated questionnaires and in-depth interviews.

A number of frameworks and cooperative activities proposed within the Middle East Railways Vision 2050:

1) RAME BN & ITC - Backbone network and management of international transport corridors.
2) RAME IPA - Infrastructure prioritising approach.
3) RAME Rail+ Interoperability Framework – multimodal interoperability regulatory approach.
4) RAME Rail Quality Framework – reporting and monitoring, including ESG.
5) RAME Rail Support Programme – including cooperation plan with regional and international development and financial institutions.

Among other, the Vision proposes model of freight flows along future international transport corridors and assess the impact of regional rail developments on the intra-regional trade.

MIDDLE EAST RAILWAYS

Current document refers to the Middle East region which is officially lacking in the Unites Nations geoscheme. It refers to the selected countries in Western and Southern Asia.

At the same time, the scope of the document is larger than the UIC Middle East Regional Assembly as of September 2022, including neighbouring countries that are neither RAME members, nor members of other regional assemblies.

The macroeconomic and demographic analysis includes the following countries:

- Afghanistan,
- Bahrain,
- Iraq,
- Islamic Republic of Iran,
- Israel,
- Jordan,
- Kuwait,
- Lebanon,
- Oman,
- Pakistan,
- Qatar,
- Saudi Arabia,
- Syrian Arab Republic,
- Türkiye,
- United Arab Emirates,
- Republic of Yemen.

For the purposes of trade and consequently freight flows forecast, these countries are considered as one region and flows between these countries are considered as intra-regional. Flows with other neighbouring countries are considered as external ones. To assess total necessary capacities, all types of flows – intra-regional, external and transit – are taken into account. So that finally in case of changes in the regional assembly, the widest possible variety of links would be covered, and the Vision would still be relevant.

I. MACROECONOMIC OVERVIEW OF THE MIDDLE EAST REGION

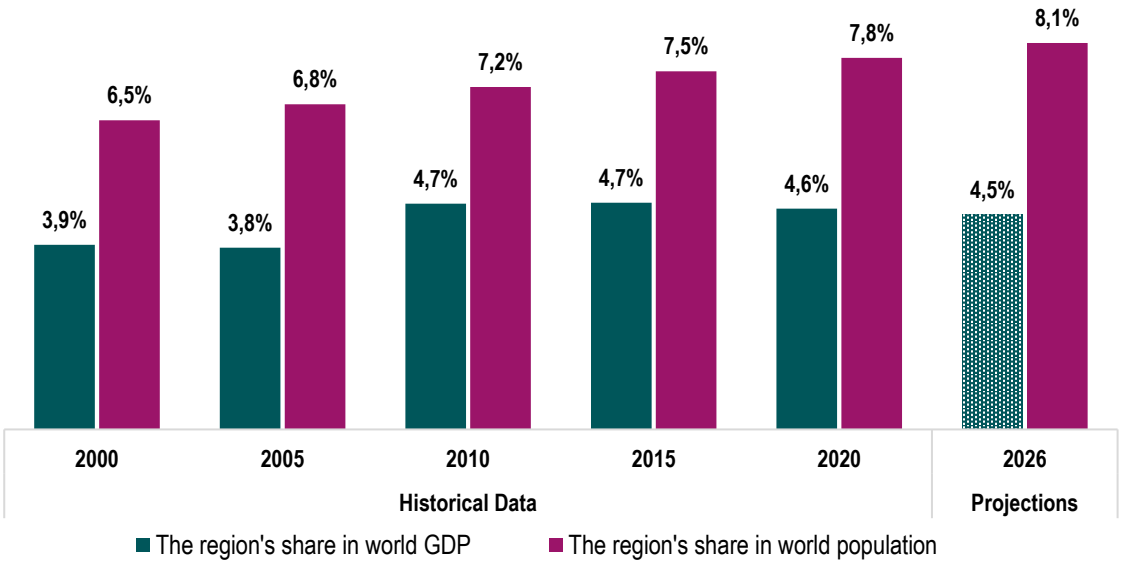
1. KEY FIGURES

1.1. Economic performance

As of 2021, the Gross Domestic Product (GDP) of Middle East region (including Pakistan, Yemen and other countries not being part of UIC RAME) was as high as USD 4.6 trillion. The dynamics of regional economy correlates with global dynamics and, according to International Monetary Fund's forecasts[1], the regional growth is to become higher than global one in the mid-term period. This means that **Middle East region is expected to become of the key development poles in the global scale**.

The share of the region in both global GDP and global population has been constantly growing along the previous decades.

Figure 1. Share of the Middle East region in global GDP and population

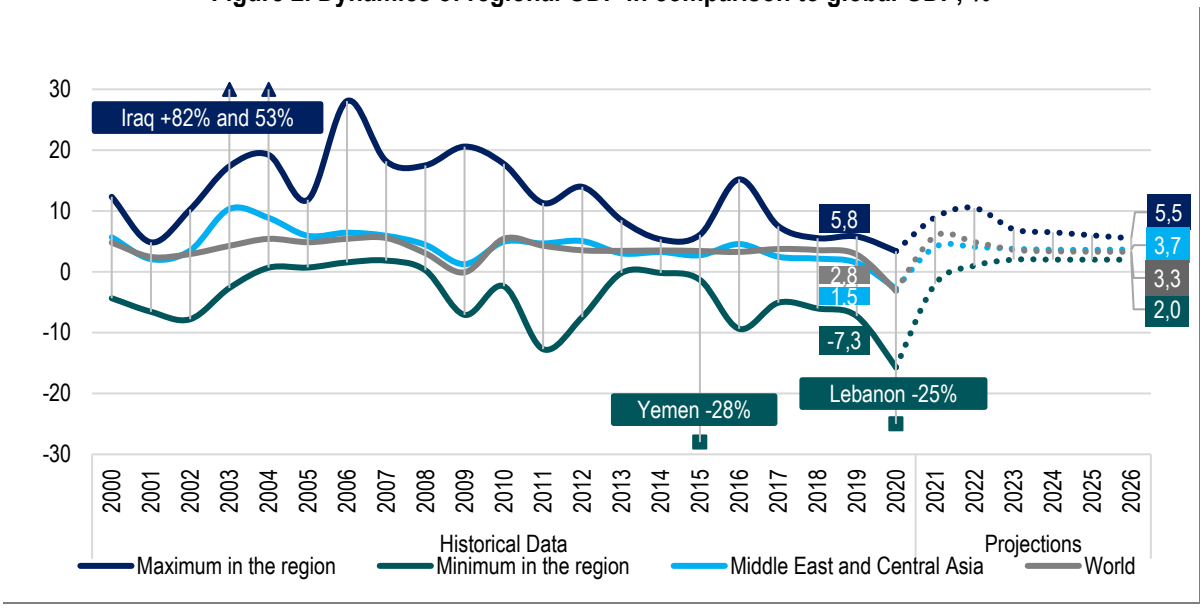


Source: IMF WEO, October 2021, United Nations World Population Prospects 2019, medium scenario

Simultaneously, the countries of the region are characterised by a very high level of **heterogeneity**. The gap between the richest and the poorest countries of the Middle East region reaches 46.2 times difference. This is an important constraint joint and even linked development programmes, also for infrastructure and transport infrastructure. Without the assistance of international and regional development institutions, some countries of the region cannot carry out expensive projects which may be wanted by other countries to ensure highest possible synergy.

[1] IMF WEO October 2021, aggregated forecast for Middle East and Central Asia

Figure 2. Dynamics of regional GDP in comparison to global GDP, %

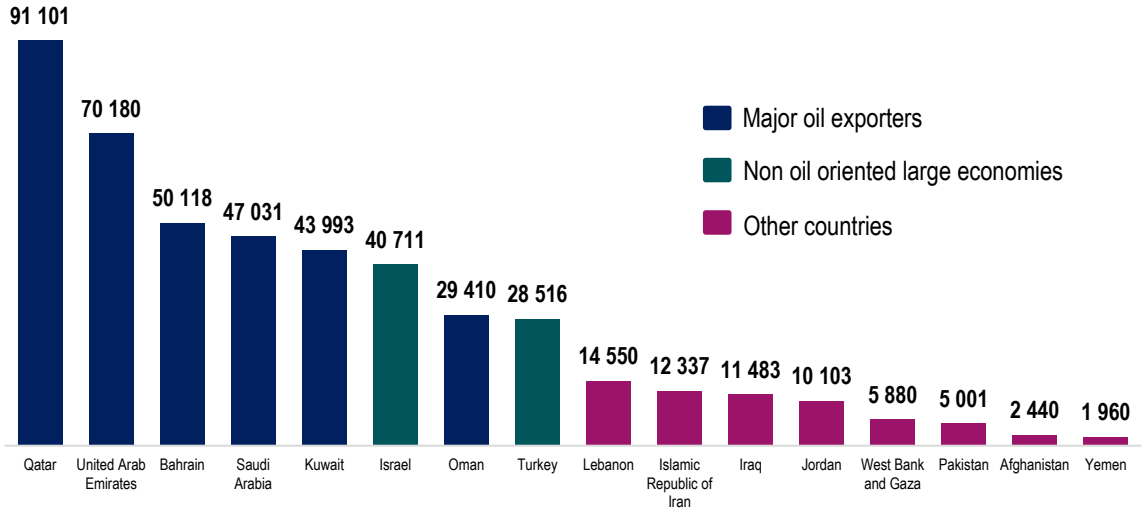


Source: IMF WEO, October 2021

The largest economies of the Middle East region refer to Saudi Arabia (20% of regional GDP), Türkiye (19%), I.R. Iran (14%), UAE (10%), Israel (10%). As of pre-pandemic 2019, these countries form about 73% of regional GDP, and this share is supposed to increase to 84% by 2026, according to available forecasts of international organisations, primarily thanks to increase in shares of Türkiye and I. R. Iran.

The GDP per capita[2] is currently higher in oil producing countries. This defines both the availability of resources for transport enhancements and the demand on passenger transport services.

Figure 3. GDP per capita at purchasing power parity, 2019 constant prices, USD



Source: IMF WEO, October 2021

1.2. Demographic situation

The population of the region, as of 2020, counted 605.1 million (if Pakistan considered as part of the Region, or 384.2 million without Pakistan), or 7.8% of global population.

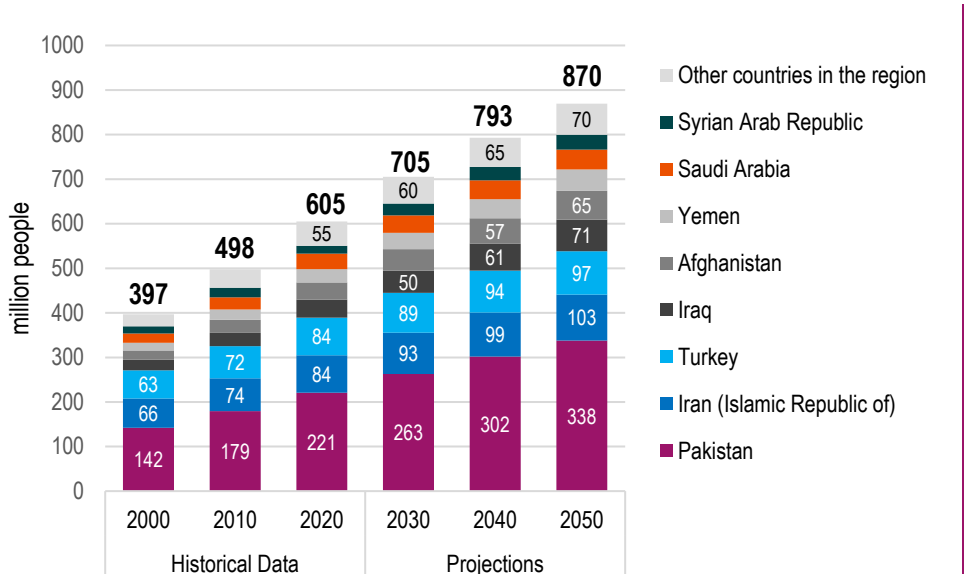
From 2000 to 2020, the population of the region grew by 53%, while global growth referred to 27% and growth in developing countries – to 32%. The relative growth was especially high in Qatar (4.8 times) and UAE (3.2 times).

[2] here referred to GDP per capita in 2019 constant prices

According to United Nations forecasts, the population is to add 264 million persons by 2050 to total 870 million. The highest growth is assigned to Pakistan, Iraq, Afghanistan, also to the Syrian Arab Republic, Islamic Republic of Iran and Yemen.

The Middle East region has a very high demographic potential defining future needs for transport services and supply. Meanwhile, the highest population growth is forecasted in many countries with relatively low levels of economic growth, so the growing demand may not be covered by necessary services and infrastructure.

Figure 4. Projected population growth by countries of the Middle East region[3]

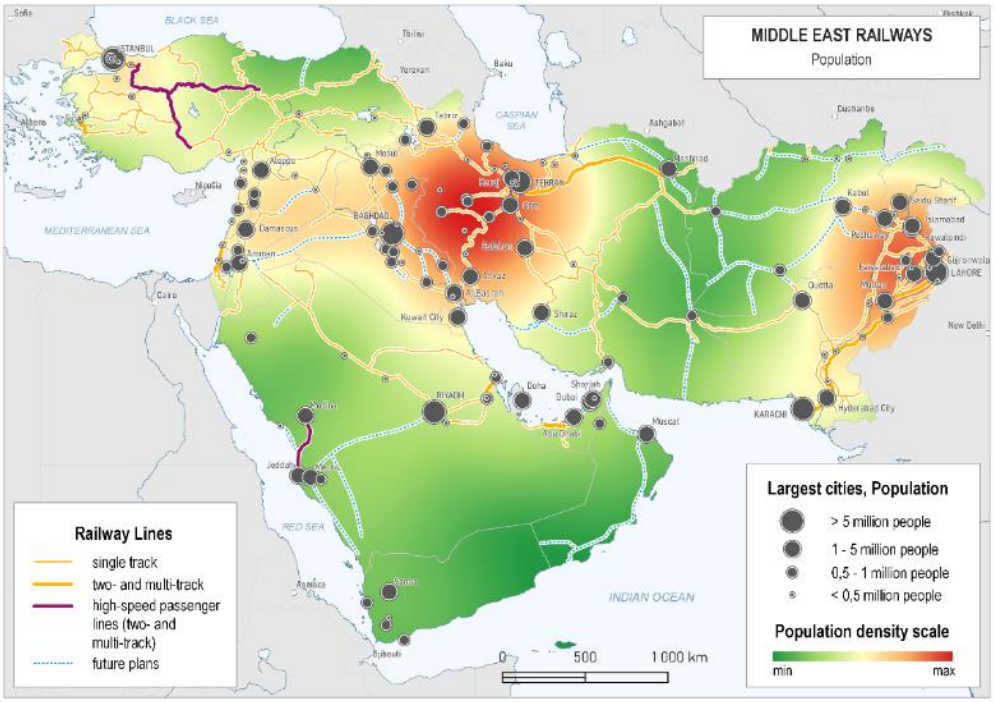


Source: UN WPP, 2019, medium scenario

The density of population varies importantly from country to country. As for 2022, the densest areas are not those most covered by rail services and infrastructure.

[3] including Pakistan

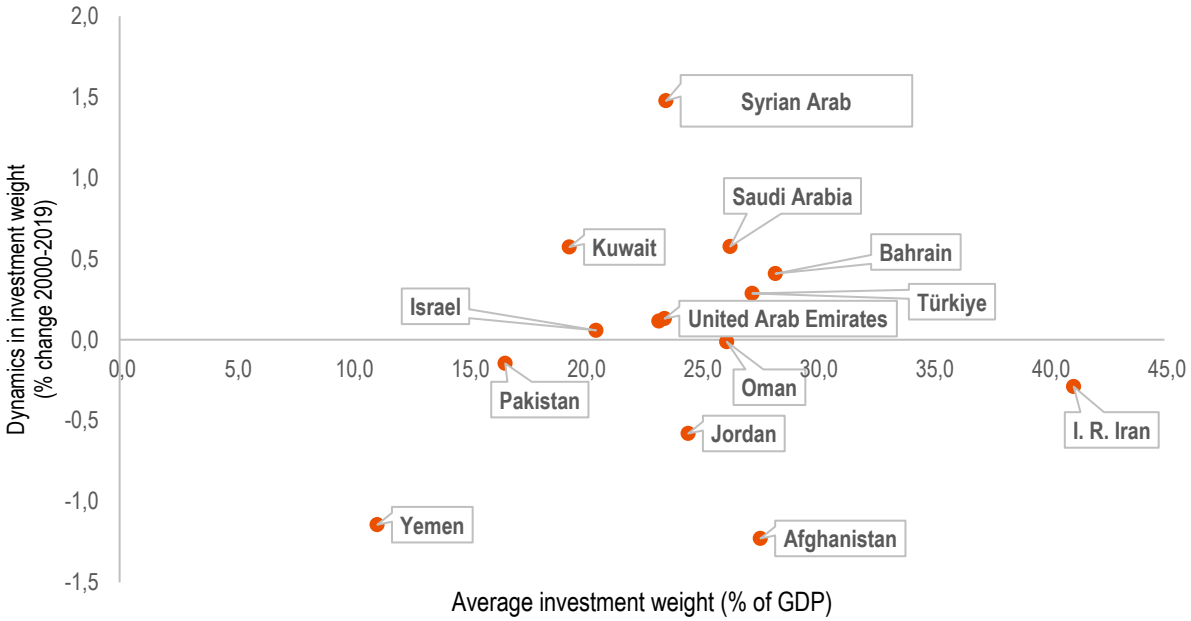
Figure 5. Density of population and rail network



1.3. Investments

Investment activity is important to understand **both economic dynamics and possible consumption of freight services**. The average share of investments in GDP is within 20-30%. And for countries with such share, positive dynamics is observed.

Figure 6. Investment weight in GDP (%) and its dynamics



Source: IMF WEO 2021

2. INTERNATIONAL TRADE

The structure of the international trade of the Middle East countries defines **(a) key directions of freight transport, (b) capacities and possible allocation of cargo to rail (types and volumes of traded goods), (c) priorities in rail and multimodal transport projects (values and directions of traded goods).**

2.1. Exports: volumes and values

Oil dominates the export structure, accounting for almost 60% of the volume and 50% of the value of exports.

In volume terms, **construction materials and prepared foodstuffs** (the largest group of agricultural products) account for more than 10% of exports. However, in value terms, their combined contribution is less than 4%. The dynamics of prepared foodstuffs are also noteworthy - back in 2015, their share in exports was 0.8%. Goods such as gas, machinery and equipment, and textiles also play a significant role (over 5%) in the value of exports.

Figure 7. Physical (volumes) and nominal (values) structure of exports

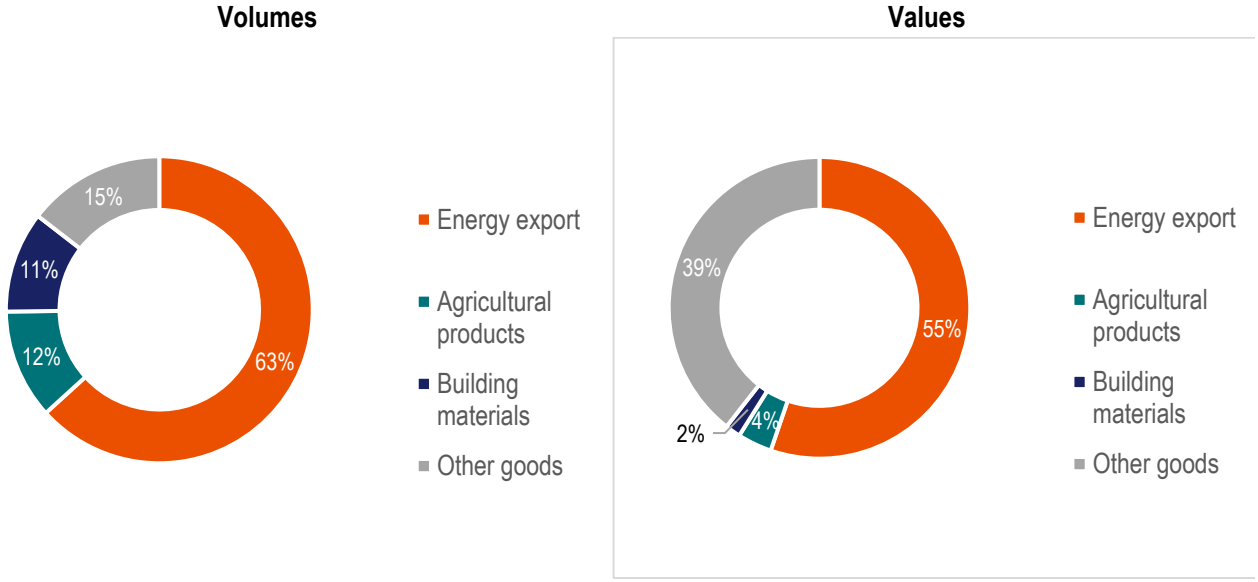
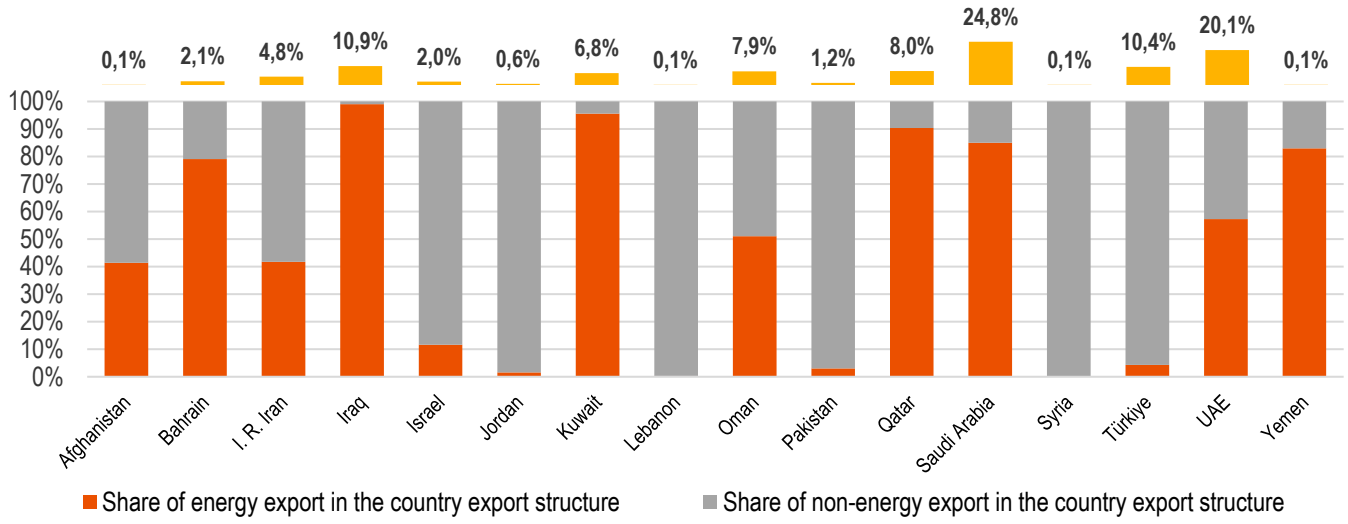


Figure 8. Export shares of countries in the Middle East region and structure of exports



Source: UN COMTRADE

The largest contributors to total physical exports are the large export-oriented economies in the region: Saudi Arabia, UAE, Qatar, Kuwait. The share of exports from Iraq and Türkiye is also high. Syrian Arab Republic, Lebanon, Jordan, Pakistan, Türkiye and Israel are the least dependent on energy exports. At the same time,

Afghanistan, I. R. Iran, Oman and the UAE have highly proportionate physical exports (the share of energy and non-energy goods is about 50/50).

2.2. Exports: geography

China is the most important consumer of goods from the region's major oil-producing economies: Saudi Arabia, Iraq, Oman, Iran and Kuwait. It accounts for about **18% of the region's physical exports and 17% of its value exports**.

Syrian Arab Republic, Bahrain, Iran, Jordan, Oman, Lebanon and Yemen export mainly **within the Middle East region**. However, only around 10% of the countries' total exports are accumulated within the region. Europe plays an important role in trade with the Middle East region. With a 10% share in the structure of physical exports, it accounts for 21% of value exports.

Substantial physical export flows from the region also go to **Japan, South Korea, South-East Asia and Africa**. **Australia and North America** together account for about **12% of physical exports and 8% of value exports**

Figure 9. Export shares of countries in the Middle East region and structure of exports

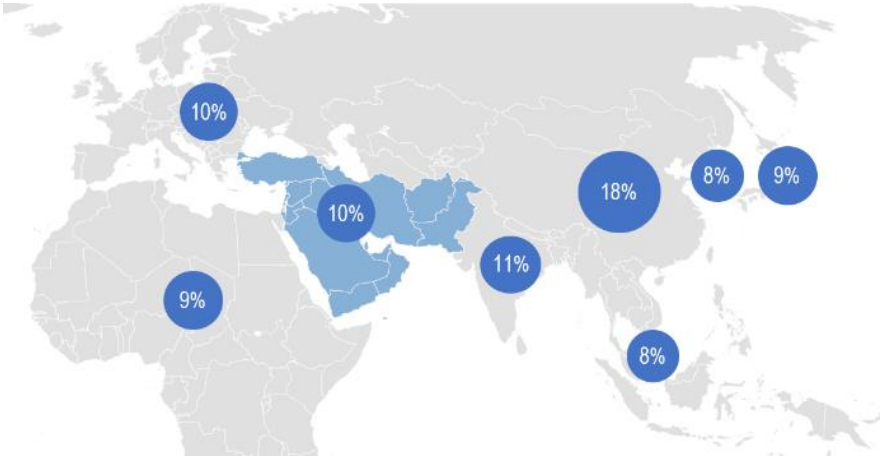
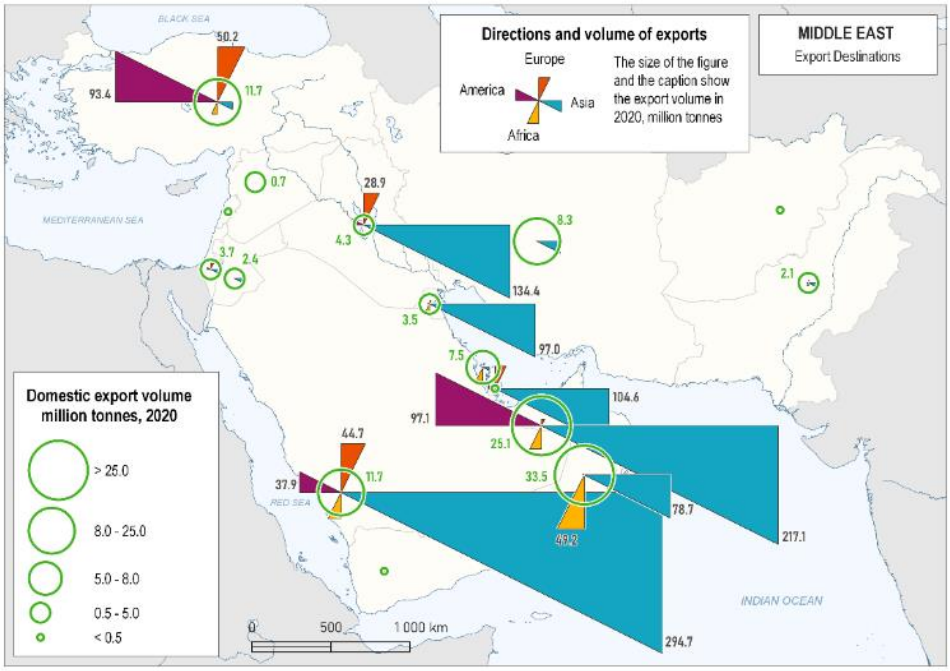


Figure 10. Map of export directions and volumes of the Middle East countries



2.3. Imports: volumes and values

The structure of imports of Middle East countries is more **diversified** than the structure of exports.

In volume terms, imports of **oil and petroleum products, construction materials, foodstuffs and metals** lead the way. In terms of value, the main import groups are **machinery and equipment, vehicles and chemical products**.

Figure 11. Physical (volumes) and nominal (values) structure of imports

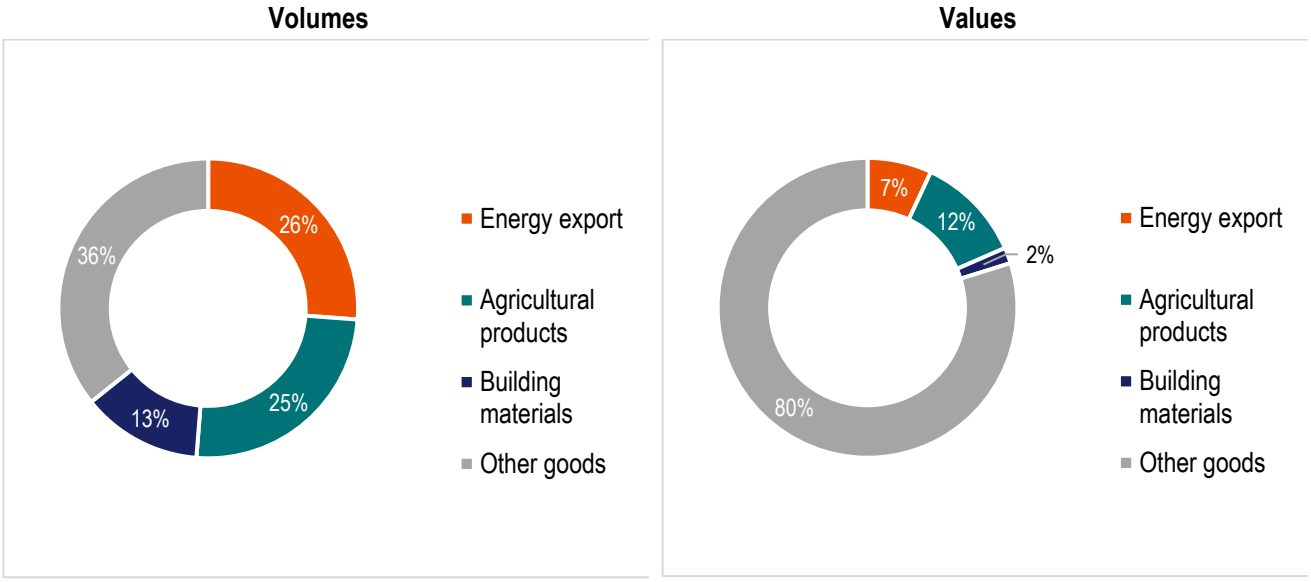
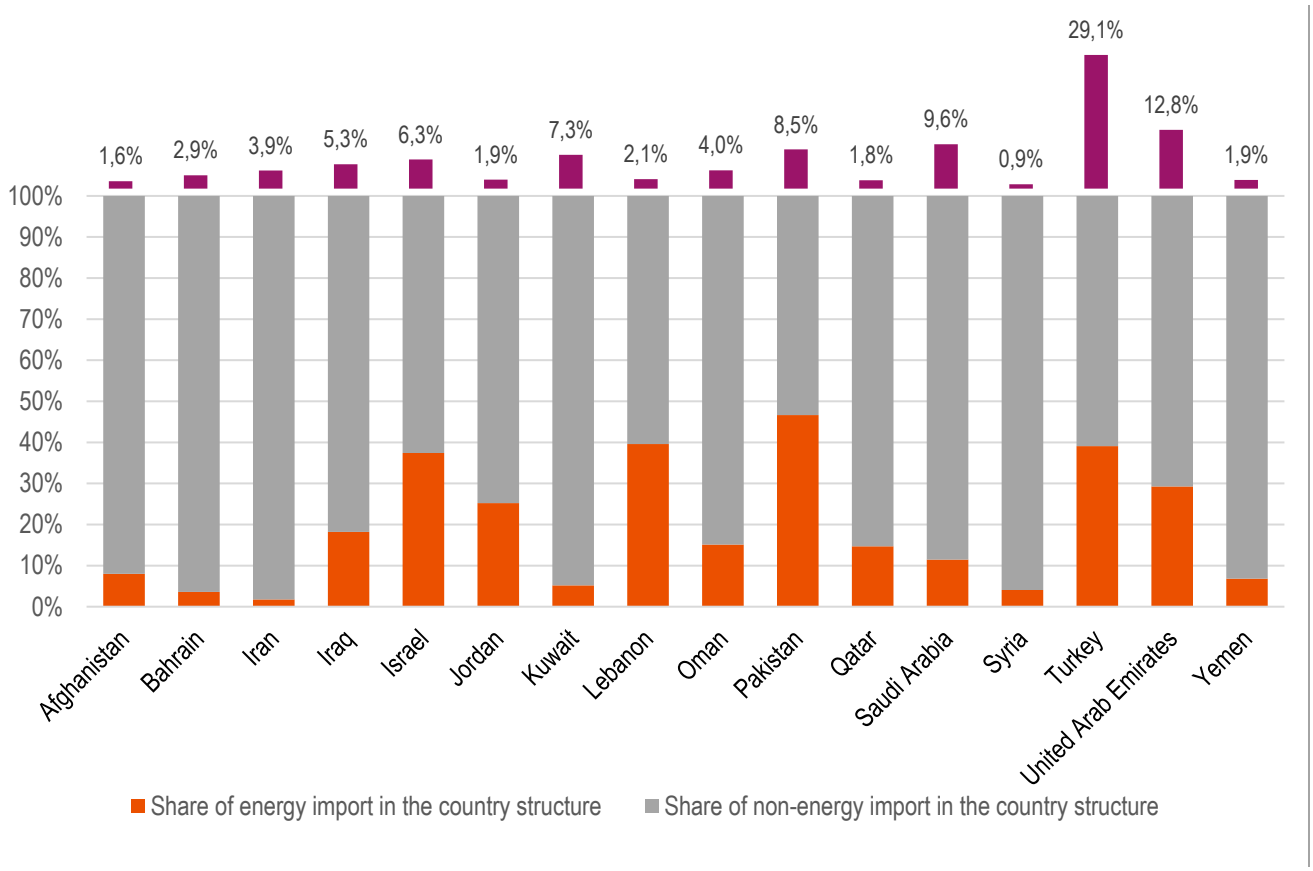


Figure 12. Import shares of countries in the Middle East region and structure of exports



Source: UN COMTRADE

In 2020, total exports from the Middle East region amounted to 1,661 million tons, of which oil and gas exports accounted for 1,097 million tons. **Rail transport plays an insignificant role in the volume of goods exported from the region due to the low level of development of railway infrastructure, as well as the location of the main cargo generation centres near seaports.** For short transport distances, road transport is more attractive due to the lack in quality of rail services. Nevertheless, in a number of countries, rail transport is an integral part of exports. This is particularly true for Türkiye, I. R. Iran and the UAE. The volume of exports by rail can be estimated at no more than 50 million tons. These are mainly transport of construction materials, ferrous metals and chemical products from inland Türkiye to the country's ports, as well as shipments of metal ores, ferrous metals, chemical products and construction materials from inland I. R. Iran to ports and border crossings.

2.4. Imports: geography

Key import flows are formed within the region, and also from European and African countries.

Import opportunities are determined by the region's export earnings, mainly from oil and oil products. The terms of trade (ratio of export and import prices) are highly correlated with global oil prices.

Figure 13. Import shares of countries in the Middle East region and structure of exports

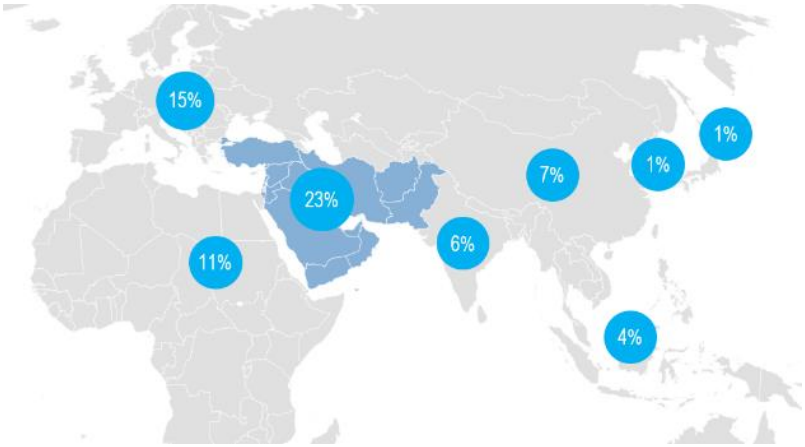
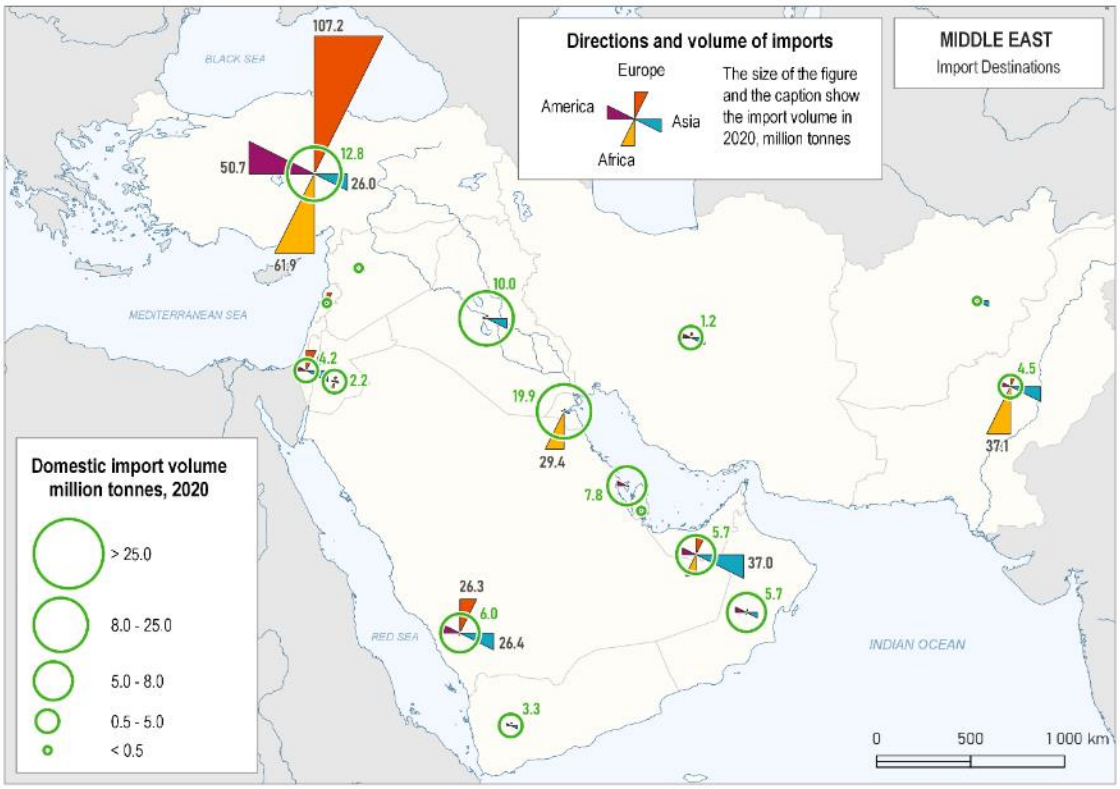


Figure 14. Map of import directions and volumes of the Middle East countries

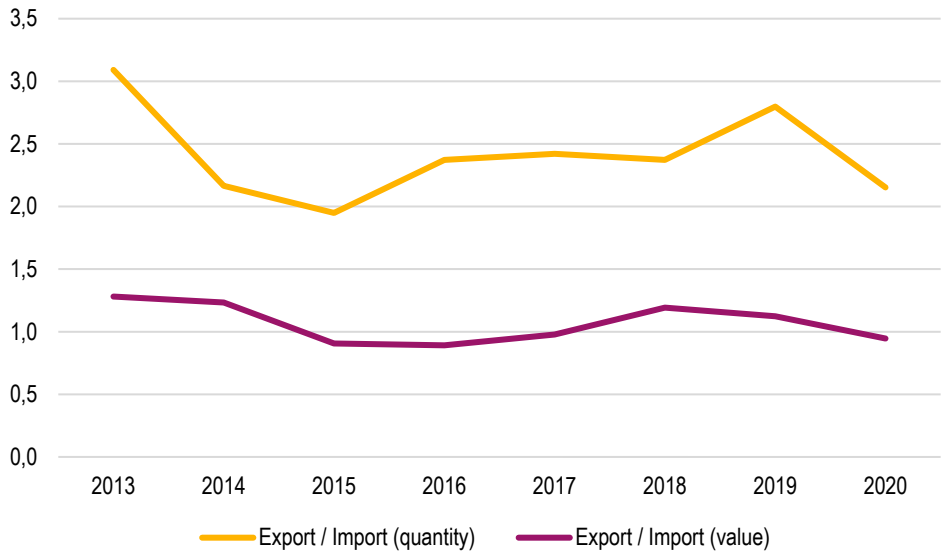


In 2020, total imports into the Middle East region amounted to 771 million tons, of which 220 million tons are imports of oil, gas and oil products. As in the case of exports, rail transport is mainly important in transporting imported goods only in I. R. Iran and Türkiye. In these countries, imported goods such as coal, construction materials, ferrous metals are transported from ports to regions of the countries located away from the seacoast. The total volume of imports by rail in the region does not exceed 35 million tons.

The trade balance in value terms is generally balanced - on average exports exceed imports by only 7% over the period 2013-2020.

At the same time, exports exceed imports on average 2.4 times in volume terms. In **other words, the region exports large volumes of goods with low (relative to imports) added value**. The parameters of imported and exported commodities define their requirements to key transport parameters (time, price, etc.) and further requirements to infrastructure and services.

Figure 15. Export to import ratio



3. MACROECONOMIC TRENDS AND FORECASTS

The current post-covid macroeconomic backdrop raises considerable doubts about growth estimates for the Middle East economies in the coming years due to the possibility of unexpected shocks.

The situation is greatly exacerbated by uncertainties not only in energy markets, but also in food markets: global food prices are rising rapidly, while almost all countries in the region are heavily dependent on cereal imports, primarily from Eastern Europe. This poses significant food security risks to the countries of the Middle East.

Pandemic risks and the threat of new lockdowns contribute to the overall picture of uncertainty. The populations of the countries in the region are unevenly vaccinated, with the percentage of fully vaccinated population in the oil- and gas-exporting countries, for example, ranging from 75-100% of the population, while in the least developed countries of the region the share of vaccinated population barely reaches 30%.

3.1. Short term: high heterogeneity

The World Bank[4] estimates an **average growth rate of 5.2%** for MENA countries (Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, United Arab Emirates and Yemen) in 2022, **but 11 of the 17 countries in the region will never return to pre-pandemic levels**. Meanwhile, the energy-exporting countries of the Gulf Cooperation Council (GCC) will grow at an average rate of **5.9% in 2022 and 3.7% in 2023**. However, the main growth driver is **Saudi Arabia**'s economy, which is expected to grow by around 7% this year. At the same time, emerging exporters will also grow: I. R. Iran by 3.7% in 2022 and 2.7% in 2023 and Iraq by 8.9% and 4.5% respectively. Energy-importing countries in the context of MENA will show growth of 4% in 2022 and 4.5% in 2023, driven largely by the North African countries which are not in the scope of current Vision. As for the target region, the forecast for Jordan is in the 2.1-2.3% range.

PricewaterhouseCoopers[5], on the other hand, is less optimistic about the economic outlook for the Gulf countries: growth in 2022 is forecast at 4.1%, although again Saudi Arabia is expected to show the highest growth rate (4.8% growth). As for the other countries in the region, there is higher growth than the World Bank estimates: 2.7% growth in 2022 for Jordan and 10.5% for Iraq.

3.2. Long term: outpacing global rates

There are both global trends and local factors impacting on the long-term development of the region's countries.

Global trends impacting, among other, on further development of transport in the region:

- energy transition,
- decarbonisation,
- digitalisation.

Local factors:

- geopolitical risks,
- threat of crises due to limited resources (fresh water),
- climate issues.

[4] Gatti, Roberta; Lederman, Daniel; Islam, Asif M.; Wood, Christina A.; Fan, Rachel Yuting; Lotfi, Rana; Mousa, Mennatallah Emam; Nguyen, Ha. 2022. "Reality Check: Forecasting Growth in the Middle East and North Africa in Times of Uncertainty" Middle East and North Africa Economic Update (April), Washington, DC: World Bank. Doi: 10.1596/978-1-4648-1865-3. License: Creative Commons Attribution CC BY 3.0 IGO

[5] PwC: Data and projections: March 2022 URL: https://www.pwc.com/m1/en/publications/middle-east-economy-watch/data-projections-march-2022.html

As dependence on revenues from energy exports is high for most countries in the region, a **green agenda** is becoming relevant for them in the long term. As PwC[6] reviews highlight, while the need for energy from the Middle East is unlikely to disappear in the foreseeable future, cleaner production is increasingly on the agenda of major oil and gas producers, highlighting it as a new competitive advantage in the market. Such producers as Saudi Aramco, Ecopetrol Qatar, ADNOC and others have announced their intentions to reduce greenhouse gas emissions from production and refining by 2022. At the same time, diversification of oil and gas companies' business is one of the main megatrends in the region, which sets the vector for their development in the medium and long term.

For the period from 2022 to 2027, the most dynamic growth is expected by Pakistan (4.6% annually), Yemen (4.75%), Iraq (4.3%), UAE (4%), Israel (3.7%), according to the IMF[7]. Iran (2.2% p.a.), Qatar (2.8%), Afghanistan (3%) and Jordan (3.1%) would grow more slowly than the others. **The average growth rate for the target region in this forecast range is estimated at 3.5%**.

For the long term, CEBR[8] also assesses the development of the Middle East countries, predicting an average annual growth rate of 3.3% for Türkiye over the period 2027 to 2036, about 2.2% for Saudi Arabia, 3.2% for Israel, 2.7% for the UAE, 2.6% for Oman, 3.4% for Qatar, 3.5% for Kuwait, 0.5% for Jordan, 1.5% for Iran, and 5.5% for Yemen.

Population growth in the region will outpace the global rate, with an average population growth rate of 1.2% for the region from 2022 to 2050 compared to 0.7% per annum globally. Over the 30-year forecast period, the population is expected to increase by 41%, led in absolute terms by Pakistan (+117 million people). Above-average population growth will also be characteristic of Iraq, Israel, Syrian Arab Republic, Yemen and Afghanistan. However, the return on this growth may vary due to differences in economic participation across the region. For example, according to International Labour Organisation data, the average labour force participation rate for the MENA region is 52.1% over the age of 25, which is one of the lowest in the world. The participation rate is much higher for oil- and gas-exporting countries: between 70% and 90% for Qatar, Oman, Kuwait, UAE and Bahrain, while Afghanistan, Iran, Iraq, Jordan, Lebanon, Syrian Arab Republic and Yemen demonstrate participation rates below 50%. This is primarily due to the low level of female participation in the economy, which also poses a challenge to the existing systems of most countries in the region.

4. KEY ECONOMIC CHALLENGES FOR REGIONAL RAIL DEVELOPMENT

The current post-covid macroeconomic backdrop raises considerable doubts about growth estimates for Middle Eastern economies in the coming years due to the possibility of unexpected shocks.

Countries of the Middle East region can form a global hub connecting regions and markets. The structure of trade (by commodities and directions) suggests that the role of railways can grow significantly.

At the moment, the Middle East region is in fact not realising its transit potential, due to the lack of competitive infrastructure enabling the delivery of goods and transportation of persons in a short time frame with a high degree of reliability and transparency of service.

Rail transport is a key opportunity for transporting many types of goods both within and between countries in the region, as well as for delivering products to key seaports in the region for onward shipment to other macro-regions of the world.

Macroeconomic background defines following challenges for rail development in the Middle East:

[6] Strategy& | Translating net-zero ambitions into action in the oil and gas industry URL: https://www.strategyand.pwc.com/m1/en/strategic-foresight/sector-strategies/energy-chemical-utility-management/greening-the-barrel.html

[7] IMF: World Economic Outlook, April 2022: War Sets Back The Global Recovery

[8] The Centre for Economics and Business Research

1) Prerequisites for transformation of the Middle East region into a global connectivity hub put together with low average (with exceptions) level of rail infrastructure: **necessity for fast rail enhancements, including new construction, and planning system to ensure maximum efficiency**.

2) High economic heterogeneity of the region: **necessity of cross-regional planning and support from local and international development institutions, necessity to ensure affordable interoperability of regional railway system.**

3) A very high demographic potential: **necessity to plan and deploy passenger services, including mass transit, intercity and high-speed, also in international connections**.

4) Low share of railways in freight transportation put together with high share of intra-Middle East imports: **necessity to connect the hinterlands of littoral States and landlocked countries to key ports, necessity to establish international rail corridors**.

5) Important trade links with African, Asia, European countries: **necessity to plan, construct and jointly manage international rail corridors**.

6) Growing demand for green solutions and sustainability increase in the long term: **necessity to ensure 'green planning' for the region, choice of relevant technologies**.

5. TRADE FLOWS FORECASTS

The forecasting of trade flows in the Middle East allows estimating minimum and maximum future infrastructure load to optimise investment planning, as well as modelling the loading of specific sections and corridors with specific cargo types.

Foreign trade of the countries considered within the Vision was modelled on a country-subregion basis, cross-country (intra-regional) on a country-country basis, and transit on a subregion-world basis. The retrospective series is 8 years long, from 2013 to 2020. The trade models distinguish 11 trade groups for which **three scenarios** are forecasted up to 2050. The *flows for the natural gas and oil commodity groups are excluded* from the trade forecasts, as despite the paramount role of these goods in the foreign trade structure, they do not refer to rail transport.

UN Comtrade direct statistics are used, mirror trade partner data for these countries was used for some countries with lacking statistics for 2018-2020.

Three scenarios are considered to understand bottom and top future trade indicators[9]:

- **Risk scenario**: high probability of debt crises in many countries. Protracted stagnation. Low global economic growth, including China. Low classical energy and fuel prices. Weak demand for energy and ferrous metals in the presence of robust demand for base metals, but no price growth. Scenario assumes the likelihood of geopolitical instability and **lack of resources for large-scale upgrades in the countries of the region**.

- **Baseline scenario**: favourable geopolitical climate, with energy demand rising in Asia, Africa. Demand for ferrous metals declines, demand for non-ferrous metals increases. However, energy demand is maintained in the medium term due to lower speed of energy transition.

- **Optimistic scenario**: high external demand and high prices for basic export commodities. Rapid industrial development, modernisation of old and commissioning of new manufacturing capacity takes place. Inflow of technology and investment in human capital. **Availability of resources for large-scale infrastructure projects**.

[9] All scenarios are largely linked to changes in energy resources consumption and demand, as exports for these commodities define future economic growth.

5.1. Intraregional trade flows

Intraregional trade is estimated at the level of slightly more than 205 million tons in 2021 and the prospects for further growth are dependent on the realisation of scenario assumptions, under which 355 to almost 650 million tons could be reached by 2050.

Figure 16. Projected intraregional trade volumes, m tons (2021 – actual data)

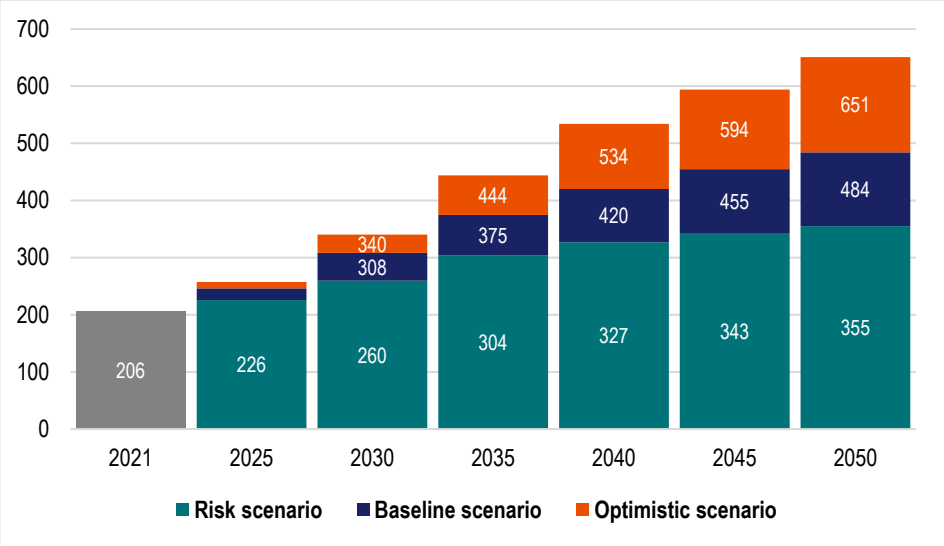


Figure 17. Matrix of intraregional trade changes in volumes (2021 to 2050) under the baseline scenario

2021 – 2050, m tons	IMPORTERS																
	Afghanistan	Bahrain	Iran, Islamic Republic of	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Pakistan	Qatar	Saudi Arabia	Syrian Arab Republic	Türkiye	United Arab Emirates	Yemen	TOTAL
Afghanistan		0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	2 › 4	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	**2 › 4**
Bahrain	0 › 0		0 › 0	0 › 0	0 › 0	0 › 0	0 › 1	0 › 0	2 › 3	0 › 0	0 › 0	4 › 9	0 › 0	0 › 0	3 › 5	0 › 0	**9 › 18**
Iran, Islamic Republic of	6 › 10	0 › 0		18 › 35	0 › 0	0 › 0	4 › 8	0 › 0	2 › 5	3 › 5	2 › 4	0 › 0	0 › 0	2 › 5	10 › 20	0 › 0	**46 › 92**
Iraq	0 › 0	0 › 0	0 › 0		0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	**0 › 0**
Israel	0 › 0	0 › 0	0 › 0	0 › 0		0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	1 › 3	0 › 0	0 › 0	**1 › 3**
Jordan	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0		0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 1	0 › 0	0 › 0	0 › 0	0 › 0	**1 › 2**
Kuwait	0 › 0	0 › 0	0 › 0	0 › 1	0 › 0	0 › 0		0 › 0	0 › 1	0 › 1	0 › 0	1 › 2	0 › 0	0 › 0	0 › 1	0 › 0	**2 › 7**
Lebanon	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0		0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	**1 › 2**
Oman	0 › 0	0 › 1	0 › 0	0 › 1	0 › 0	0 › 0	0 › 1	0 › 0		0 › 1	10 › 24	4 › 11	0 › 0	0 › 0	11 › 24	1 › 2	**27 › 64**
Pakistan	4 › 9	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 1	0 › 0	0 › 1		0 › 1	0 › 1	0 › 0	0 › 0	1 › 3	0 › 0	**7 › 16**
Qatar	0 › 0	0 › 0	0 › 0	0 › 1	0 › 0	0 › 0	0 › 0	0 › 0	0 › 1	0 › 0		0 › 0	0 › 0	0 › 0	1 › 3	0 › 0	**2 › 5**
Saudi Arabia	0 › 0	2 › 7	0 › 0	0 › 1	0 › 0	2 › 5	2 › 6	0 › 0	1 › 3	1 › 3	0 › 0		0 › 0	3 › 6	5 › 12	3 › 8	**19 › 52**
Syrian Arab Republic	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 1	0 › 0	0 › 0	0 › 0	0 › 1		1 › 1	0 › 0	0 › 0	**1 › 4**
Türkiye	0 › 0	0 › 0	1 › 3	11 › 24	10 › 26	0 › 1	0 › 1	2 › 4	0 › 1	1 › 2	1 › 2	2 › 6	4 › 11		1 › 3	2 › 3	**36 › 89**
United Arab Emirates	0 › 1	6 › 14	1 › 2	11 › 24	0 › 0	0 › 1	19 › 44	0 › 0	5 › 12	3 › 7	0 › 0	5 › 15	0 › 0	0 › 1		1 › 2	**53 › 125**
Yemen	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0	0 › 0		**0 › 0**
TOTAL	**10 › 20**	**9 › 23**	**2 › 6**	**41 › 86**	**10 › 26**	**3 › 9**	**26 › 62**	**2 › 6**	**11 › 27**	**10 › 24**	**12 › 31**	**17 › 46**	**5 › 13**	**8 › 19**	**32 › 72**	**6 › 15**	

Key forecasted trade links in 2050 (highest **physical volumes** of trade):

- **Islamic Republic of Iran** – Iraq: trade is based on food, construction materials,
- **Islamic Republic of Iran** – UAE: oil products, construction materials,
- **Oman – Qatar**: construction materials,

- **Oman – UAE**: construction materials and metallurgical products,
- **Saudi Arabia – UAE**: chemical products, construction materials,
- **Türkiye – Iraq**: foodstuffs, metals and chemicals, other commodities (furniture, timber, building materials, etc.),
- **Türkiye – Israel**: metals and construction materials,
- **UAE – Kuwait**: construction materials, other commodities,
- **UAE – Iraq**: oil products and construction materials.

Oil products

Although the countries of the Middle East region specialise in oil production, not all countries within it are net energy exporters (Israel, Türkiye, Jordan, Lebanon, etc.). Moreover, there are also volumes transported to the refineries among the producing countries in the region. This would lead to an increase in trade in oil products in the range of 27–57 million tons by 2050.

Agricultural products

The Middle East does not have much potential for agricultural development due to climatic constraints as well as problems with access to fresh water sources. At the same time, aggregate trade volumes in agricultural products are significant due to the food industry, as well as the harvesting of various fruit and vegetable crops and sugar production. Trade volumes for the group will range between 46 and 76 million tons by 2050.

Chemical products

Chemical products also play an important role in the intraregional trade due to the availability of gas and oil refining technologies. The ability to produce fertilisers, chemicals, plastics and rubbers and the high demand for them in global and regional markets is a strong incentive for additional capacity expansion in the sector. Depending on the implementation of infrastructure projects as well as industrial development, it is possible to increase intraregional trade from 44 to 79 million tons.

Metals

The specifics of trade in metal products refers to the *niche* nature of certain production capacities. Metal exporting and importing countries may specialise in products with different level of processing. The metal sector is one of the most promising industries in the Middle East region. The forecast intraregional trade ranges between 42 and 80 million tons in 2050.

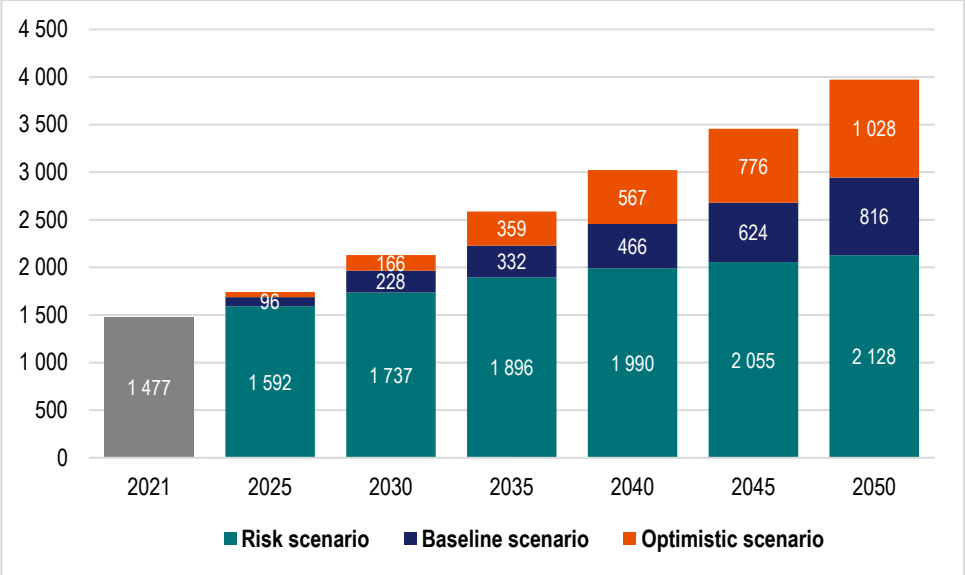
Other commodities

Volumes of other commodities occupy an initial position in the intraregional trade due to the inclusion of the group construction materials, which holds a significant share of the countries' physical trade. Crushed stone, gravel and sand are actively transported between countries in the Middle East. The possibility of various projects in the region could lead to an increase in demand for the group's products from 164 million tons to 302 million tons by 2050.

5.2. External trade flows

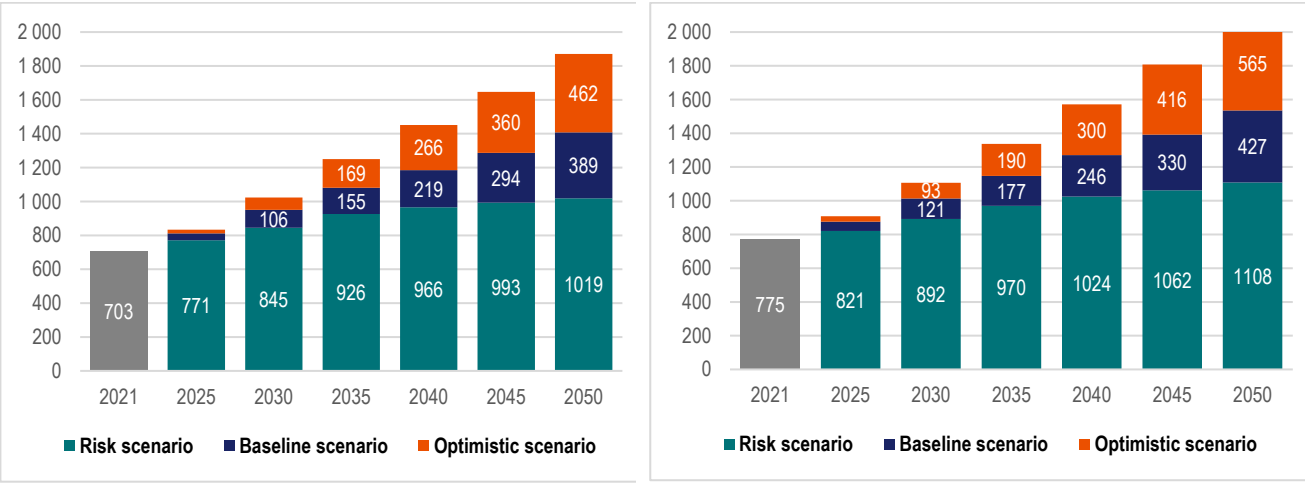
In the outlook to 2050, trade between countries of the Middle East and regions of the world will **trend upwards**: total foreign trade is expected to increase from 2,128 to 3,972 million tons according to the scenario.

Figure 18. Cumulative external trade flows of the Middle East countries under various scenarios, m tons (2021 – actual data)



Cumulative growth is shaped by the positive dynamics of both export and import flows in all scenarios. The growth of total exports from the region to other regions of the world is due to the high demand of these other regions for chemical products, oil products, metals and goods referring to the other commodities group, which includes light industry products, construction materials, etc.

Figure 19. Forecasted exports (left) and imports (right) of the Middle East countries till 2050 (excl. oil and natural gas), m tons (2021 – actual data)



Oil products

A key position in the exported goods of the target countries is oil commodities, which account for about 20% of exports (excluding oil and gas), equivalent to 158 million tons. The prospects for further exports in this case largely depend on global demand for classical energy resources in the world as well as trends in the energy transition. Depending on the scenario, export volumes may fall or rise by 2050 (forecast 167-370 million tons).

Chemical products

The development of the chemicals, fertilizers, rubber and plastics sectors is quite natural given the presence of oil and gas processing in the region and offers the Middle East an opportunity to diversify its export structure. By 2050, exports for the group are expected to be between 219 and 360 million tons and imports between 143 and 239 million tons.

Ores and metals

One of the most promising manufacturing industries in the Middle East could be metallurgy, especially iron and steel. The development of metallurgical clusters in the region is gaining momentum, encompassing most of the Gulf states as well as Türkiye and Iran. The availability of both primary ore processing and rolled steel production capacity, as well as access to energy resources, allows the target region's countries not only to achieve self-sufficiency in intra-regional demand in the coming years, but also to export products of varying degrees of processing. In a scenario perspective, the region's exports could reach 166-277 million tons by 2050.

Agricultural products

As the Middle East is a region with high prospects for demand for agricultural products but difficult climatic conditions for the development of the agricultural sector, there is a need for foodstuff imports. Import volumes by 2050 could reach volumes between 230 million and 601 million tons, depending on population growth in the major economies - Iran, Türkiye, Pakistan, Saudi Arabia - and on demographic stability in other countries.

Exports

The largest exporters among the target countries are the United Arab Emirates, Türkiye, Iran and Saudi Arabia. According to the forecast, exports from these countries will increase by 1.5-2 times by 2050.

Figure 20. Matrix of changes in export volumes from the Middle East region to other countries and regions in the baseline scenario, m tons

2021 -> 2050 m tons	Central Asia	China	Europe	India	Japan	Caucasus	North Africa	Republic of Korea	Russia	Southeast Asia	Other	TOTAL
Afghanistan	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	2 → 4	**2 → 4**
Bahrain	0 → 0	1 → 2	0 → 1	1 → 3	0 → 0	0 → 0	2 → 4	0 → 1	0 → 0	1 → 2	23 → 40	**28 → 53**
Iran, Islamic Republic of	2 → 4	30 → 60	1 → 2	9 → 29	0 → 0	2 → 4	1 → 3	0 → 0	1 → 1	4 → 19	66 → 126	**116 → 249**
Iraq	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	**0 → 0**
Israel	0 → 0	0 → 1	3 → 7	0 → 1	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 1	4 → 10	**8 → 20**
Jordan	0 → 0	0 → 0	0 → 0	3 → 16	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	1 → 7	3 → 9	**8 → 31**
Kuwait	0 → 0	1 → 3	0 → 0	1 → 5	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 1	3 → 7	**5 → 16**
Lebanon	0 → 0	0 → 0	0 → 1	0 → 0	0 → 0	0 → 0	0 → 1	0 → 0	0 → 0	0 → 0	1 → 3	**2 → 6**
Oman	0 → 0	2 → 4	0 → 1	8 → 29	1 → 2	0 → 0	0 → 0	1 → 2	0 → 0	4 → 14	35 → 91	**50 → 141**
Pakistan	0 → 0	3 → 7	2 → 5	0 → 0	0 → 0	0 → 0	0 → 0	0 → 1	0 → 0	1 → 3	15 → 42	**22 → 58**
Qatar	0 → 0	3 → 8	1 → 3	0 → 2	3 → 5	0 → 0	0 → 1	2 → 3	0 → 0	1 → 6	4 → 9	**15 → 36**
Saudi Arabia	0 → 0	13 → 25	5 → 7	10 → 23	1 → 2	0 → 0	3 → 8	1 → 2	0 → 0	9 → 18	35 → 73	**78 → 158**
Syrian Arab Republic	0 → 0	0 → 0	0 → 2	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	1 → 4	**2 → 7**
Türkiye	1 → 3	7 → 13	60 → 90	1 → 3	0 → 1	3 → 5	10 → 24	0 → 0	4 → 6	2 → 6	80 → 142	**169 → 295**
United Arab Emirates	0 → 0	4 → 11	3 → 4	27 → 59	1 → 1	0 → 0	2 → 5	1 → 1	0 → 0	3 → 10	158 → 241	**198 → 333**
Yemen, Rep.	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	**0 → 0**
TOTAL	**3 → 7**	**64 → 134**	**77 → 123**	**62 → 169**	**7 → 11**	**5 → 10**	**18 → 48**	**5 → 10**	**5 → 8**	**26 → 86**	**430 → 801**	

Imports

Imports to the region are mostly supplied by China, Russia, Europe and a group of other countries. The role of South-East Asian countries, as well as India, is expected to increase in the dynamics until 2050.

Figure 21. Matrix of changes in import volumes to the Middle East region from other countries and regions in the baseline scenario, m tons

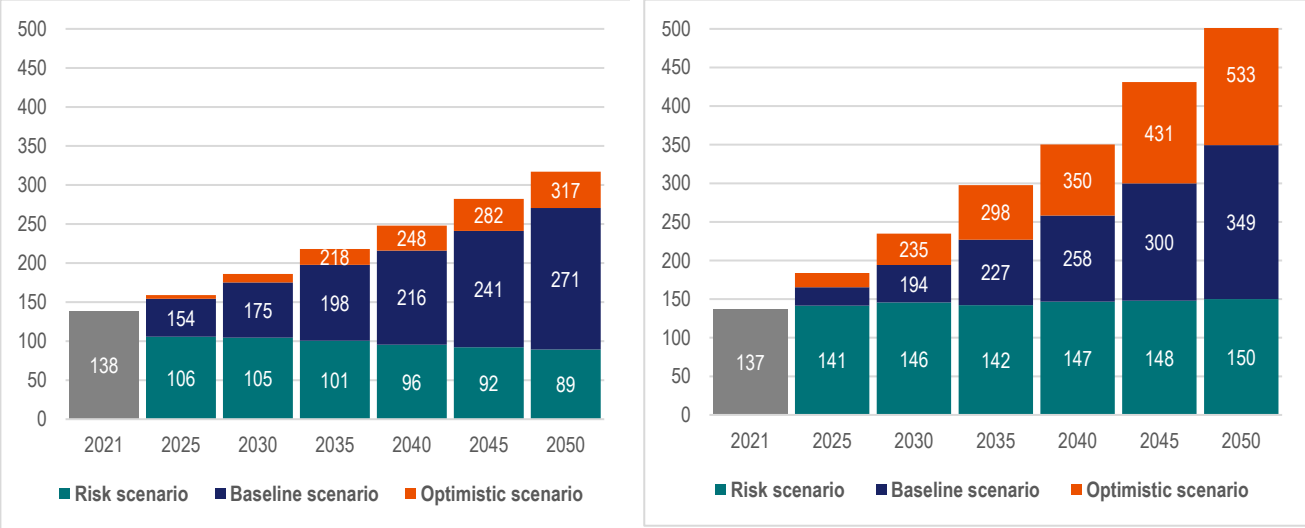
2021 -> 2050 m tons	Central Asia	China	Europe	India	Japan	Caucasus	North Africa	Republic of Korea	Russia	Southeast Asia	Other	TOTAL
Afghanistan	4 → 10	0 → 1	0 → 0	1 → 2	0 → 0	0 → 0	0 → 0	0 → 0	0 → 1	0 → 0	4 → 9	**10 → 23**
Bahrain	0 → 0	1 → 2	1 → 2	1 → 2	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	0 → 1	18 → 39	**21 → 45**
Iran, Islamic Republic of	1 → 3	3 → 7	5 → 6	3 → 6	0 → 0	0 → 0	0 → 0	0 → 0	5 → 10	1 → 2	13 → 22	**31 → 55**
Iraq	0 → 0	4 → 11	2 → 4	2 → 4	0 → 0	0 → 0	0 → 0	0 → 0	0 → 0	1 → 2	24 → 47	**33 → 70**
Israel	0 → 1	4 → 9	12 → 21	2 → 7	0 → 0	0 → 0	0 → 0	0 → 1	5 → 6	0 → 1	32 → 61	**56 → 108**
Jordan	0 → 0	2 → 4	3 → 5	1 → 2	0 → 0	0 → 0	0 → 1	0 → 0	1 → 3	0 → 1	7 → 15	**14 → 31**
Kuwait	0 → 0	1 → 4	1 → 2	1 → 3	0 → 1	0 → 0	0 → 0	0 → 1	1 → 1	0 → 1	24 → 58	**29 → 72**
Lebanon	0 → 0	1 → 1	7 → 14	0 → 0	0 → 0	0 → 0	0 → 1	0 → 0	1 → 2	0 → 1	9 → 19	**19 → 39**
Oman	0 → 0	2 → 4	1 → 2	6 → 14	0 → 1	0 → 0	0 → 0	0 → 1	1 → 2	1 → 2	19 → 36	**30 → 62**
Pakistan	0 → 0	9 → 22	5 → 13	0 → 0	1 → 2	0 → 0	1 → 5	1 → 2	2 → 4	10 → 19	31 → 47	**62 → 114**
Qatar	0 → 0	1 → 4	2 → 5	2 → 7	0 → 1	0 → 0	0 → 0	0 → 0	0 → 1	0 → 2	4 → 10	**11 → 28**
Saudi Arabia	0 → 0	11 → 28	22 → 39	7 → 19	1 → 3	0 → 0	1 → 4	1 → 4	5 → 12	5 → 13	41 → 89	**94 → 211**
Syrian Arab Republic	0 → 0	1 → 2	0 → 1	0 → 0	0 → 0	0 → 0	0 → 1	0 → 0	0 → 0	0 → 1	5 → 12	**7 → 18**
Türkiye	1 → 3	8 → 17	65 → 127	2 → 6	1 → 2	1 → 3	3 → 12	4 → 9	55 → 83	3 → 10	113 → 184	**257 → 454**
United Arab Emirates	0 → 0	11 → 24	9 → 16	16 → 35	2 → 5	0 → 0	0 → 1	1 → 2	6 → 10	4 → 12	35 → 66	**85 → 173**
Yemen	0 → 0	2 → 4	1 → 2	1 → 2	0 → 0	0 → 0	0 → 1	0 → 0	1 → 3	1 → 2	10 → 19	**16 → 33**
TOTAL	**7 → 18**	**59 → 141**	**138 → 260**	**44 → 109**	**6 → 14**	**2 → 4**	**8 → 28**	**391 → 733**	**83 → 139**	**28 → 69**	**391 → 733**	

5.3. Transit trade flows

The Middle East region serves as a bridge for cargo transported from Asia to Europe and from Europe to Asia, and infrastructure development can have a positive impact on trade, cargo flow and inclusion in production chains not only of transit cargo origins and destinations, but also of the Middle East countries themselves.

In 2021 Asia-Europe and Europe-Asia trade, excluding the Middle East region, reached 275 million tons, with flows in both directions almost identical in volume. The risk scenario may have a negative impact on trade from Asia to Europe already in the short to medium term, due to the reduced demand for classic energy resources entering the region, as well as a global slowdown in trade interactions and a lack of incentives to develop and upgrade existing industrial infrastructure. The optimistic scenario would have a positive impact on trade between Europe and Asia, leading to an increase in trade in both directions to 317 and 533 million tons respectively by 2050. Simultaneously, a growth of disparities by directions is likely to appear, this will require balancing actions within the Middle East region.

Figure 22. Forecasted transit flows from Asia to Europe (left) and from Europe to Asia (right) of the Middle East countries till 2050, m tons (2021 – actual data)



Chemical products

The estimate for trade in chemical products in 2021 is 46.7 m tons. In the baseline scenario a doubling of trade volumes can be expected between now and 2050, while the fluctuation corridor for all scenarios is between 33.4 million tons and 107.8 million tons.

Agricultural products

Agricultural and food products as well as grains are particularly important for the fast-growing Asian region. This has resulted in traditionally high cargo volumes in this trade group from Europe to Asia. In 2021, the estimated share of cargoes for these commodities is 19% (8% grains), while 11% of foodstuffs (1% grains) are sent to Europe. Total trade in both directions could reach from 86 to nearly 215 million tons by 2050.

II. OVERVIEW OF EXISTING PROGRAMMES AND PROJECTS

1. INTERNATIONAL ORGANISATIONS

Countries and companies of the Middle East region are members of numerous international organisations of different levels and types. This defines (1) obligations and standards, (2) involvement into existing programmes, (3) financing opportunities.

The key issue to consider is that countries of the region refer to **various transport law systems**: OTIF, OSJD and non-members of any organisation. **This limits the opportunities for regional interoperability, as different standards are applied**. Türkiye, I.R. Iran, Syrian Arab Republic (membership suspended), Iraq (membership suspended), Lebanon (membership suspended), Jordan (associate), Afghanistan, Pakistan are members of OTIF. I. R. Iran is also a member of OSJD. While other countries do not belong to any transport law system. Meanwhile, there are four groups of countries with different rail gauges (the standard UIC gauge of 1,435 mm, which is used in I. R. Iran, Iraq, the Arabian Peninsula countries and Türkiye; the broad gauge of 1,520 mm, which is used in Afghanistan and in neighbouring with the Middle East region post-Soviet countries; 1,676 mm, which is used in Pakistan; and 1,050 mm, which is used in Jordan and Syrian Arab Republic). Such differences emphasise the necessity of uniform interoperability approach. This issue is to be jointly addressed in the Vision 2050.

As for non-rail organisations, specific rail issues are not largely addressed. The following documents should be noted:

1) ECO Railway Network Development Plan – as a subregional programme,
2) TRACECA Strategy Master Plan - as a subregional programme,
3) ADB Strategy 2030 – as guiding principles,
4) Transport sector policy of the Islamic Development Bank – as guiding principles for IsDB members,
5) Transport sector strategy of the Asian Infrastructure Investment Bank – as guiding principles.

Table 1. Profiles of international organisations related to transport/ rail presented in the Middle East region

Organisation	Type	Types of rail-related activities	Region(s)	Connectivity	Border crossing	Rail interoperability	Sustainability	Digitalisation	Financing
ECO	Subregional organisation	Soft	Western and Central Asia						
UN ECE	Multilateral organisation	Soft	ECE member countries						
UN ESCAP	Multilateral organisation	Soft	ESCAP member countries						
UN ESCWA	Multilateral organisation	Soft	ESCWA member countries						
UN CRD	Multilateral organisation	Soft	Global (HQ – Japan)						
TRACECA	Multilateral organisation	Soft	Countries of Europe – the Caucasus – Asia corridor						
Arab Fund for Economic and	Development	Hard	Arab League						

Organisation	Type	Types of rail-related activities	Region(s)	Connectivity	Border crossing	Rail interoperability	Sustainability	Digitalisation	Financing
Social Development	institution		countries						
ADB	Development bank	Hard + soft	Global Focus on Central Asia in CAREC programme						
AIIB	Development bank	Hard + soft	Global						
IsDB	Development bank	Hard + soft	Islamic countries						
The World Bank	Development bank	Hard + soft	Global						
OTIF	Intergovernmental rail organisation	Soft	Eurasia						
OSJD	Intergovernmental rail organisation	Soft	Eurasia						
UIC	Non-governmental international rail	Soft	Global						

Organisation	Type	Types of rail-related activities	Region(s)	Connectivity	Border crossing	Rail interoperability	Sustainability	Digitalisation	Financing
	organisation								

	Lower importance		Indirect financing (research and assistance)
	Highest importance		Direct financing of projects

2. OVERVIEW OF NATIONAL PROGRAMMES AND PROJECTS

Numerous large-scale railway investment projects are currently underway in the Middle East region. The ones **relevant for the regional context only** are briefly described below in an alphabetic order.

Jordanian Railway Network

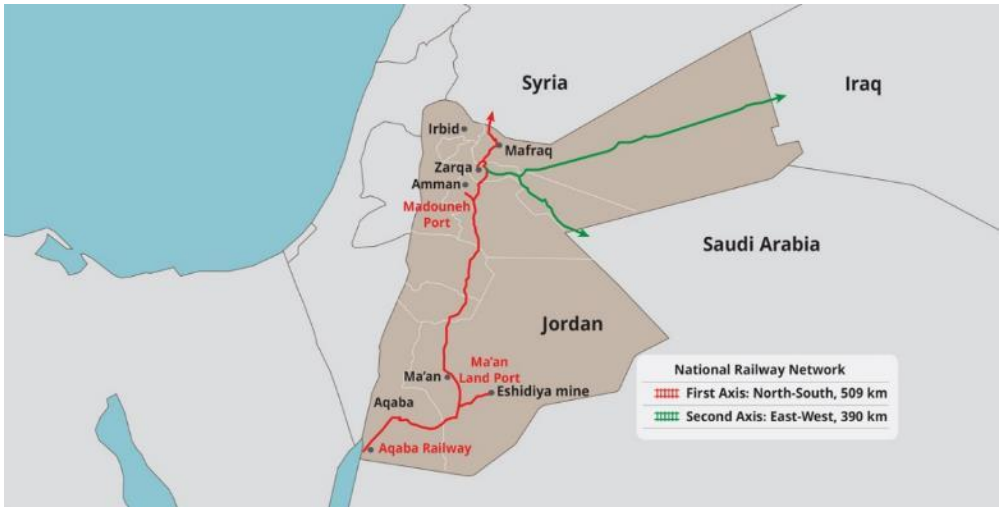
In August 2021, the Jordanian government announced its Economic Priorities Programme for 2021-2023 at a total cost of nearly USD 6 billion, funded by USD 677 million in public capital expenditure and in partnership with the private sector at USD 5.3 billion. The National Rail Project is one of the largest proposed projects, with the private sector contributing USD 2.2 billion and the state taking care of all necessary land acquisition for rail tracks and facilities.

Closer integration between Mediterranean transport markets will make transport connections faster, cheaper and more efficient for citizens and businesses.

As the corridor is the backbone of the project, links with neighbouring countries are envisaged in later stages. The initiative envisages linking the region to Türkiye and Europe on the one hand, and to the Gulf Cooperation Council countries on the other.

The total length of the national rail network under the project is 897 km and consists of two main axes. The North-South axis will be a 509 km line at an estimated cost of USD 4.4 billion, connecting the port of Aqaba on the Red Sea with the capital Amman, the industrial city of Zarqa and the Syrian Arab Republican border. The East-West axis is a branch line from Zarqa to the borders of Iraq and Saudi Arabia, 380 km long at an estimated cost of USD 530 million.

Figure 23. Jordanian Railway Network

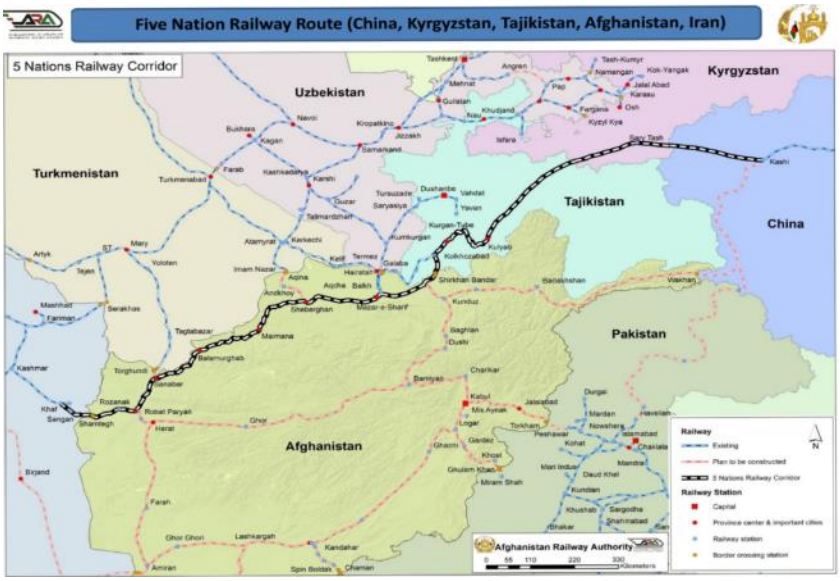


Source: https://strategiecs.com/en/analyses/rail-network-strategy-jordanian-hopes-and-search-for-regional-integration

I.R. Iran – Afghanistan connections

The Khaf – Herat railway, opened in 2020, connects the Chinese railways with I. R. Iran via Afghanistan. The line plays an important role not only in the development of Afghanistan, but also in the development of the rail network for the transit of goods from Central Asia to South Asian and Middle Eastern countries and marks the beginning of the creation of an East-West and North-South international trade corridor.

Figure 24. Five Nation Railway Route



Source: http://casp-geo.ru/strategicheskie-perspektivy-i-znachenie-zheleznoj-dorogi-haf-gerat/

The project is part of the proposed USD 2 billion Five Nations Rail Corridor (FNRC), which will run through China, Kyrgyzstan, Tajikistan, Afghanistan and Iran for about 2,000 km. The project would deepen trade cooperation between the countries as well as increase the transit potential of the countries through which the route passes.

I. R. Iran – Iraq – Syrian Arab Republic connections

A memorandum of understanding has been signed between I. R. Iran and Iraq for a 32-kilometre rail link between the two countries, connecting the Iranian city of Shalamcheh and the Iraqi city of Basra.

Negotiations on the Shalamcheh – Basrah railway had been under way for nearly 20 years, during which time several memorandums were signed. A preliminary agreement to start construction was not reached until June 2021.

The new line will bridge a gap in East – West rail corridors, giving Iraq access to Afghanistan, Pakistan and India. The railway will connect I. R. Iran with Syrian Arab Republic and Mediterranean countries. In the future, it is planned to organise transit freight traffic from Asia to Europe. Freight train traffic will boost trade between the two countries, while passenger trains could carry pilgrims to Karbala in Iraq, a holy place for Shiites, among other things.

Iran is seeking investors to link its ports to Syrian Arab Republic via Iraq's Basra. Port and maritime cooperation in general between Iran and Syrian Arab Republic has been expanding in recent years and the establishment of a direct link between the Islamic Republic of Iran's transport hubs and Syrian Arab Republican ports in Mediterranean Latakia will pave the way for further development of relations. The development of such cooperation requires increased investment in the port infrastructure sector to facilitate the operations of shipping companies.

In February 2021, a direct link was established between Iran's southern port of Bandar Abbas and the Syrian Arab Republican port of Latakia. I. R. Iran and Syrian Arab Republic had previously agreed to connect the Iranian port of Bandar Khomeini (in the southwestern province of Khuzestan) with the Syrian Arab Republican port of Latakia via a railway that runs through Iraq. Both sides signed an agreement back in July 2019 under which Iran will build the Shalamcheh – Basra railway between I. R. Iran and Iraq, through which the port of Bandar Khomeini will later be connected to the port of Latakia in Syrian Arab Republic.

Israel Railway Network

In 2017, the strategic plan for Israel Railways until 2040 was published.

Links with neighbouring countries are envisaged in later stages. The plan envisages linking the national rail network to Lebanon in the north, to Jordan in the east and to Egypt in the south.

Figure 25. Five Nation Railway Route

Source: Israel Railways 2040 Strategic Development Plan

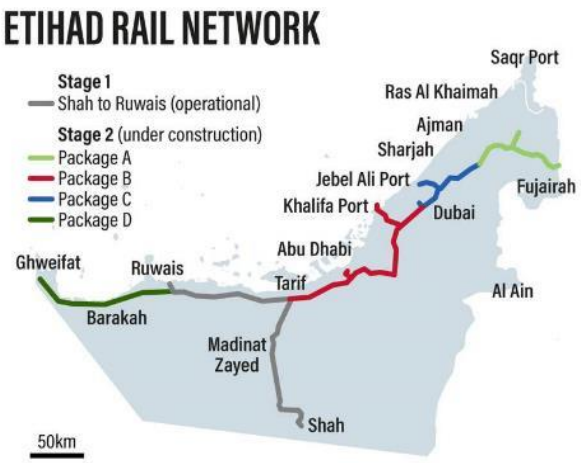
Saudi Arabia - UAE – Oman connection

The Gulf Cooperation Council is building a railway over 2,000 kilometres long to improve transport accessibility in the region. The new railway will connect the main freight generation centres in the UAE, as well as the territories of Saudi Arabia, the UAE and Oman to each other.

The railway has the potential to link the Persian (Arabian) Gulf into a single transport space with high area connectivity, while reducing carbon emissions and ushering in a whole new era of economic development. The project is estimated to cost between USD 100 billion and USD 250 billion. The project could make a significant contribution to the diversification of the Gulf economies.

A key element of this project is the Etihad Railway, an USD 11 billion, 1,200-kilometre freight and passenger railway stretching across the UAE from the Gulf of Oman to the Persian (Arabian) Gulf.

Figure 26. Etihad Rail Network



Source: https://www.thenationalnews.com/uae/2022/03/04/etihad-rail-what-the-route-looks-like/

The first phase of the project involves a freight link between the Shah and Khabshan gas fields and the port of Ruwais. The opening of this railway line took place in 2016. Up to 22,000 tonnes of granulated sulphur are transported daily from Habshan and Shah to Ruwais for the Abu Dhabi National Oil Company.

Construction of the second phase began in 2020 and will extend the network by 605 kilometres from Ghweifat on the Saudi border to Fujairah on the eastern coast of the UAE. Etihad claims that one train journey reduces carbon dioxide emissions by 70-80% compared with travelling by truck. This is important for an economy with one of the highest carbon footprints in the world. These efficiencies have also helped the UAE become the world's leading exporter of sulphur, bringing in 679 million USD. Transporting manufacturing products, which have a fairly high freight intensity, by rail is much more efficient compared to road transport. This allows for a multiple reduction in transport costs when delivering cargo to the port and to the domestic market.

Once completed, the network will connect the country's main industrial ports and trade centres, allowing more than fifty million tonnes of goods to be transported annually through the network. Saudi Arabia and the UAE have the potential to develop other natural resources, such as iron ore, gold, aluminium and silver. Without the development of railway infrastructure, exports of these commodity groups will be marginally feasible.

Turkish high-speed railways

The implementation of rapid and high-speed rail projects through Türkiye's policy of prioritsing rail investments not only contributes to the development of railway technology, but also increases the level of employment in the country.

With the world's eighth-largest commissioning of high-speed railways and the sixth largest in Europe, Türkiye is improving its engineering and technological solutions in this field, and local companies are implementing highly successful projects in advanced rail investments.

By 2023, Türkiye aims to reach a railway network of 17,500 km through the construction of 5,500 km of high-speed and express railway lines. The main outcome of these projects is to increase the share of railways to 3.8% in passenger traffic and 10% in freight traffic.

The commissioning of high-speed railway lines on the Kars-Edirne axis in Türkiye provides significant time savings for traffic between China and Europe via Marmaray, offering a seamless railway connection. The development of this route could significantly increase the transit potential of the region in the container transport segment. Potentially, the opening of the corridor could also increase the traffic between Türkiye and North African countries via Syrian Arab Republic and Israel, provided the appropriate infrastructure is in place along the route.

A new electrified railway line will connect Ankara to one of the country's key ports, increasing transport connectivity in Turkish central regions. Once operational, the railway line will provide a faster and lower-carbon alternative to existing air and road routes between the two cities, helping to meet Türkiye's COP26 climate change commitments as well as to increase the export potential of the pull regions.

All these projects, as well as many others, will drastically change the rail landscape in the Middle East region till 2050.

III. MIDDLE EAST RAIL VISION 2050. KEY POINTS

The positioning (the **mission**) of Middle East Railways:

Middle East Railways are bridges for regional economic and social development, uniting different countries and enhancing the cooperative potential of the Middle East region.

The **goals** for the development of railways in the Middle East region till 2050:

1) To contribute to the largest possible extent to the growth of national economies and societies.
2) To provide stable regional links despite any geopolitical tensions and economic heterogeneity.
3) To be a key actor ensuring environmental and social sustainability in the Middle East region, including the achievement of the United Nations sustainable development goals (SDGs).

Key **objectives** by goals

1. Middle East railways to contribute to the largest possible extent to the growth of national economies and societies.

1) Development of rail infrastructure to be prioritised according to its economic effects for the country of project realisation (first step) and the region as a whole (second step).

2) Knowledge on the appropriate funding and financing tools to be disseminated among all RAME members, regional support system in realisation of rail projects in favour of the whole region to be established.

2. Middle East railways to provide stable regional links despite any geopolitical tensions and economic heterogeneity.

1) Corridor-based approach to be introduced for the development of freight railway transportation in favour of the regional development.

2) Strategic principles and priorities for regional freight planning, quality criteria for rail services to be followed by the railways of the region whenever possible.

3) Cooperative activities for the railways of the region to be planned and carried out in a systematic way by the railways of the region.

3. Middle East railways to be a key actor ensuring environmental and social sustainability in the Middle East region, including the achievement of the United Nations sustainable development goals (SDGs).

1) Rail development in the Middle East region to go in line with the regional macroeconomic and global rail trends to maximise economic and technological efficiency.

2) Basic standards of regional rail passenger services till 2050 to be set as performance indicators and to be followed by the railways of the region whenever possible.

3) Regional ESG-metrics together with dedicated financing tools and cooperation mechanisms for knowledge-sharing for rail projects to be adopted and considered by the railways of the region.

Table 2. UIC Middle East Railways Vision 2050. Goals, objectives, activities and their references to the needs of members

Goals	Objectives and references to 2030 Sustainable Development Goals	Activities	Reference to the needs of RAME members
1. To contribute to the largest possible extent to the growth of national economies and societies	A. Prioritise the development of rail infrastructure according to its economic effects for the country of project realisation (first step) and the region as a whole (second step). 	A.1. Regional monitoring of infrastructure development (including specific tools, such as GIS).	• interoperability • network development • multimodal connectivity
		A.2. Adoption of **regional prioritising methodology for rail infrastructure development.**	• coordination of work along transport corridors • alignment of national rail actions and projects with actions of neighbouring countries
		A.3. Economic and social trend monitoring in relation to rail.	• enhancing passenger mobility and sustainable regional/ urban transportation • development of rail access to the seaports • multimodal connectivity
	B. Establish regional support system in realisation of rail projects in favour of the whole region, to disseminate knowledge on the appropriate funding and financing tools. 	B.1. **Establishment of RAME Rail Support Programme.**	• regional rail funding framework • shift to rail • implementation of novelties and smart railway solutions • general knowledge-sharing
		B.2. Establishment of RAME **Rail Quality Framework.**	• shift to rail • enhancing passenger mobility and sustainable regional/ urban transportation • alignment of national rail actions and projects with actions of neighbouring countries
2. To provide stable regional links despite any geopolitical tensions and economic heterogeneity	C. Introduce corridor-based approach for the development of freight railway transportation in favour of the regional development. 	C.1. **Agreement on the regional rail backbone network.**	• coordination of work along transport corridors • alignment of national rail actions and projects with actions of neighbouring countries • development of rail access to the seaports • enhancing passenger mobility and sustainable regional/ urban transportation

Goals	Objectives and references to 2030 Sustainable Development Goals	Activities	Reference to the needs of RAME members
		C.2. Organising cohesion workshops and cohesion management – **cooperative corridor planning and operating** to define key intermodal missing links or lacking capacities.	• coordination of work along transport corridors • joint/ coordinated rail freight operations • joint/ coordinated passenger operations, including high-speed
	D. Adopt the strategic principles and priorities for regional freight planning, quality criteria for rail services. 	D.1. Forecast of potential rail freight flows along the corridors to prioritise segments and define strategic hubs for the benefit of all RAME members.	• interoperability of rail systems and smooth border crossing • joint/ coordinated rail freight operations • common quality criteria for efficient operations • digitalisation and digital interoperability
		D.2. Definition of optimal quality criteria and dissemination of solutions to harmonise and optimise the border crossing procedures and efficient border crossing technologies.	
	E. Plan and carry out in systematic way cooperative activities for the railways of the region. 	E.1. Agreement on the **RAME frameworks.**	• coordination of work along transport corridors • joint/ coordinated rail freight operations • common quality criteria for efficient operations
3. Railways to be a key actor ensuring environmental and social sustainability in the Middle East region	F. Set as performance indicators the basic quality criteria of regional rail passenger services till 2050. 	F.1. Definition of basic quality criteria and dissemination of solutions aimed at reaching these quality criteria.	• joint/ coordinated passenger operations, including high-speed • enhancing passenger mobility and sustainable regional/ urban transportation common quality criteria for efficient operations • common quality criteria for efficient operations
		F.2. Agreement on cooperative solutions and tools to boost passenger services, international and national.	
	G. Adopt and consider regional ESG targets together with dedicated financing tools and cooperation mechanisms for knowledge-sharing for rail projects.	G.1. Agreement on ESG targets with further implementation within members.	• common quality criteria for efficient operations • new technologies for sustainable transportation • shift to rail
		G.2. Organising a **permanent communication**	• regional rail funding framework

Goals	Objectives and references to 2030 Sustainable Development Goals	Activities	Reference to the needs of RAME members
		**platform with international and national development institutions.**	• shift to rail • implementation of novelties and smart railway solutions • general knowledge-sharing
	H. Set up a list of priority technologies to be studied, developed and applied in the Middle East region. 	H.1. Creation of rail technologies and smart solutions regional databank.	• implementation of novelties and smart railway solutions • enhancing passenger mobility and sustainable regional/ urban transportation • general exchange on information and experience • multimodal connectivity • shift to rail
		H.3. Organising workshops on implementation of priority technologies – with the support of UIC.	

IV. RAIL INFRASTRUCTURE

Objectives for the Middle East Railways 2050 referring to rail infrastructure development:

Objective A. Prioritise the development of rail infrastructure according to its economic effects for the country of project realisation (first step) and the region as a whole (second step).

Objective C. Introduce a corridor-based approach for the development of freight railway transportation in favour of the regional development.

Suggested activities:

A1. regional monitoring of infrastructure development (including specific tools, such as GIS)
A2. adoption of regional prioritising methodology for rail infrastructure development
A3. economic and social trend monitoring in relation to rail

C1. **agreement on the regional rail backbone network**
C2. cohesion workshops – cooperative corridor planning to define key intermodal missing links or lacking capacities.

There are two major aspects of rail infrastructure management in the regional aspect:

1) inventory of existing infrastructure within the region and its parameters,
2) planning of infrastructure development, as well as changes to the parameters of the existing one.

1. INVENTORY OF EXISTING INFRASTRUCTURE AND ITS DEVELOPMENT

At present, the majority of railway projects in the Middle East region are national ones. At first glance they do not seem to require knowledge on the parameters of future projects in the neighbouring countries, and especially in the neighbouring countries of the second or the third order.

Large infrastructure projects in the Middle East countries are primarily focused on increasing freight traffic within the countries themselves, either between major generation and distribution centres or between the manufacturing industry and a seaport for onward shipment of products for export by maritime transport. The projects are not oriented towards a significant increase in transit traffic or export-import traffic with neighbouring countries.

But the analysis of the potential trade flows shows that export and import flows, as well as transit flows may be huge – overpassing 1.9 bn tons. **Unlocking this trade potential is to a large extent a function of railways.**

Despite the fact, that there is a general map of railway infrastructure verified by RAME members and held by RAME secretariat, **a large amount of useful information is currently lacking**. This impact on the quality of decision-making, both for international and for national projects in favour of export and import and transit by rail.

Two issues are suggested in this respect:

1) List of parameters to be monitored as a part of the regular RAME activities to facilitate national and regional rail infrastructure planning.
2) In-depth analysis of existing and planned infrastructure with recommendations on a new regional approach to structure rail projects within a corridor-based approach.

1.1. Infrastructure parameters for the inventory

Understanding physical parameters of rail infrastructure is crucial for all types of modelling that can be recommended as the necessary decision-making tool. Apart from these country-wise parameters, regional overview of infrastructure is necessary to define possibly missing links and to match the parameters of infrastructure at different segments or hubs in different countries to avoid insufficiency or bottlenecking.

This is **also a base for regional transport connectivity agenda that can be both considered within the countries and be presented to international financial institutions**.

The basic parameters list is as follows.

Table 3. Parameters and data needed for rail infrastructure inventory

No	Parameter or aggregated data	Form of data (if applicable)
1.	**Geographical and geometrical parameters of the network - rail network graph[10] in a digital form**	Representation of rail network in a form of segments and nodes + relevant database to complement description of segments and nodes with other parameters. This is a basis for all further studies on rail infrastructure and its possible changes. Possible forms: a) GIS b) Database + scheme/ drawing (in this case detailed description of segments and nodes geographic location is necessary)
2. Physical parameters		
2.1.	**Length of each segment**	Meaning in km
2.2.	**Type of gauge for each segment**	Meaning in mm
2.3.	**Type of traction for each segment**	Electrified or non-electrified, if new traction types are being used, this may be particularly noted
2.4.	**Number of tracks for each segment**	Number
2.5.	**Track loading limit for each segment**	In tons
2.6.	**Maximum speed for each segment**	In km/h
2.7.	**Commercial speed for each segment**	In km/h
2.8.	**Type of transportation (freight, passenger, mixed, high-speed freight, high-speed passenger, high-speed mixed) for each segment**	Type (choice)
2.9.	**Availability of automatic traffic management system for each segment and its type**	Yes/ no + type description
2.10.	**Capacity constraints on segments**	Description
2.11.	**Number of tracks for nodes (stations)**	Number
2.12.	**Transshipment capacity for nodes (if applicable)**	Tons
2.13.	**Available freight facilities at nodes (freight stations)**	Description
2.14.	**Available passenger facilities at nodes (passenger stations)**	Description
3. Traffic		
3.1.	**Number of freight trains per day/ month/ year for each segment (the longest available observation period), if available, in each direction**	Number, including block-trains
3.2.	**Number of block-trains per day/ month/ year for each segment (the longest available observation period), if available, in each direction**	Number
3.3.	**Number of passenger trains per day/ month/ year for each segment (the longest available observation period), if available, in each direction**	Number

[10] https://en.wikipedia.org/wiki/Graph_(discrete_mathematics)

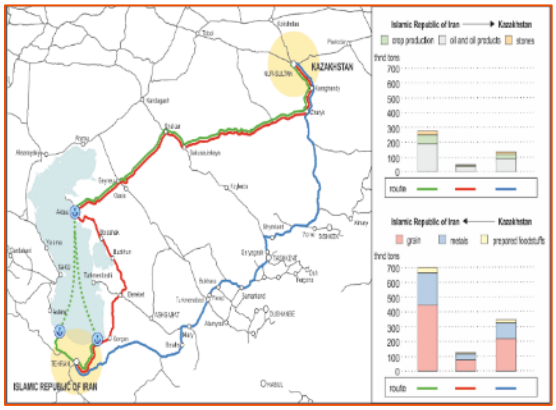
No	Parameter or aggregated data	Form of data (if applicable)
3.4.	**Total volume of transported general cargo by segment**	Tons
3.5.	**Total volume of transported containerized cargo by segment**	Tons
3.6.	**Types of commodities transported by segments**	Description according by HS groups
3.7.	**Total number of transported passengers by segment**	Number
4. **Tariffs**		
4.1.	**Tariffs for specific segments/ directions (if applicable)**	Description
4.2.	**Tariffs for specific commodities by segments (if applicable)**	Description

Unification of data structure allows easier consideration of regional and mutually beneficial projects, as well as better forecasting of incoming and outcoming flows, opportunities and constraints for specific railways even without specific reference to the regional context.

Agreement on regular collection and update of such data allows synchronising the rail statistics approaches on the one hand and organising a joint database and geographic information system for regional planning and modelling on the other hand. Some of the parameters are already being collected, for example, by the United Nations commissions for the Trans-European and the Trans-Asian Railway Network.

Box 1. Use-case: commercialisation of Kazakhstan – Turkmenistan – I.R.Iran railway corridor

Kazakhstan – Turkmenistan – I. R. Iran railway corridor has been recently constructed following the funding provided by international development institutions. After the construction and official launch of the route which, according to the project studies, should have been quickly developed, an additional study on commercialisation had to be launched, as the corridor's performance has not been developing as fast as it had been supposed before.



One of the issues revealed at the beginning of the ESCAP-led study was that the three member countries of the corridor were using different approaches to traffic monitoring, and there was no uniform information on the corridor as a whole. This did not allow correct prioritising of infrastructure enhancement or introduction of new transit services, as well as provision of information for the users of the corridor (producers, shippers, forwarders) on its opportunities and actual performance. To get the correct data on actual and forecasted flows an additional analysis of trade flows had to be carried out to verify the trade and transport statistics. **This resulted in (a) correct positioning of the corridor in comparison to other routes based on total transportation costs, (b) modelling of various options to induce freight flows and, subsequently, revenues for three railways that resulted in choice of key impacting factors and recommendations on the exact actions**.

The results of the study are available at United Nations ESCAP resources.

1.2. Corridor-based approach

A rail corridor refers to interconnected infrastructure characterised by (a) uniform or harmonised technologies, (b) uniform or harmonised tariffs, (c) uniform services.

Prior to technologies, tariffs and services, specific segments and hubs of rail (and often multimodal) infrastructure should be chosen to become elements of the corridors. In Eurasia there are numerous approaches referring to the definition of international transport corridors, and both intergovernmental and sectoral organisations (CIT, OTIF, OSJD, CCTT, UIC) propose the visions of the corridors most of which find there reflection at national and further or corporate levels of railway companies.

The Middle East region does not yet have a holistic approach to international corridors, as most of the member countries and companies are yet focused more on the development of national links. Yet, a corridor-based approach can be beneficial:

- development of international corridors is an opportunity to boost export, import trade flows and benefit from catching transit flows,
- corridors ensure better intraregional links and connectivity thus fostering economic growth and mobility increase,
- agreement on the corridors is a basis for regional project prioritising system that can improve the quality of investments, as well as simplify the financing.

Prior to technologies, tariffs and services, specific segments and hubs of rail (and often multimodal) infrastructure should be chosen to become elements of the corridors. In Eurasia there are numerous approaches referring to the definition of international transport corridors, and both intergovernmental and sectoral organisations (CIT, OTIF, OSJD, CCTT, UIC) propose the visions of the corridors most of which find there reflection at national and further or corporate levels of railway companies.

Rail corridors proposed for the development within the Middle East region are derived from the following:

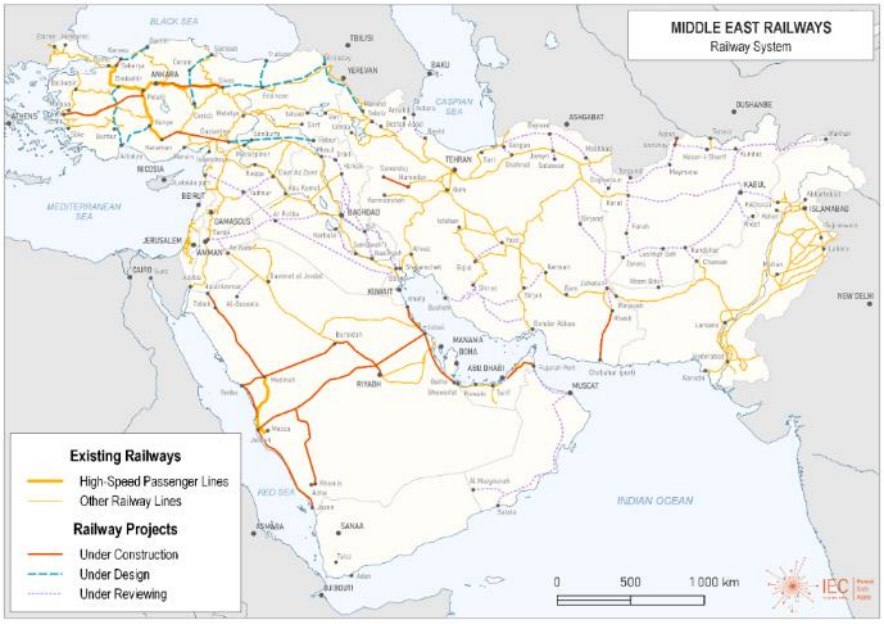
- existing strategic plans of national authorities and railways,
- analysis of the macroeconomic background and trade flows forecasts.

These corridors refer mainly to the freight transportation due to long distances, but they should simultaneously be considered and economic corridors impacting on business mobility, information and financial flows.

Development of rail corridors is feasible only if export-import and transit traffic is actively developed along these routes, i.e. it refers not only to the development of the regional rail infrastructure, but also economic links and partnerships between the countries of the Middle East region, as well as with countries outside the Middle East region gravitating to the corridor. **Coordination of projects between the railway administrations of the different countries in the region is crucial to maximise potential synergies.**

The Middle East is advantageously positioned between the largest markets in terms of population and economy. However, underdeveloped railway infrastructure makes it almost impossible to realise this potential. **Introduction of a corridor-based approach, agreement on a backbone network forming these corridors may become a solution**.

Figure 27. Middle East Railways – existing infrastructure and plans according to official public documents of RAME members

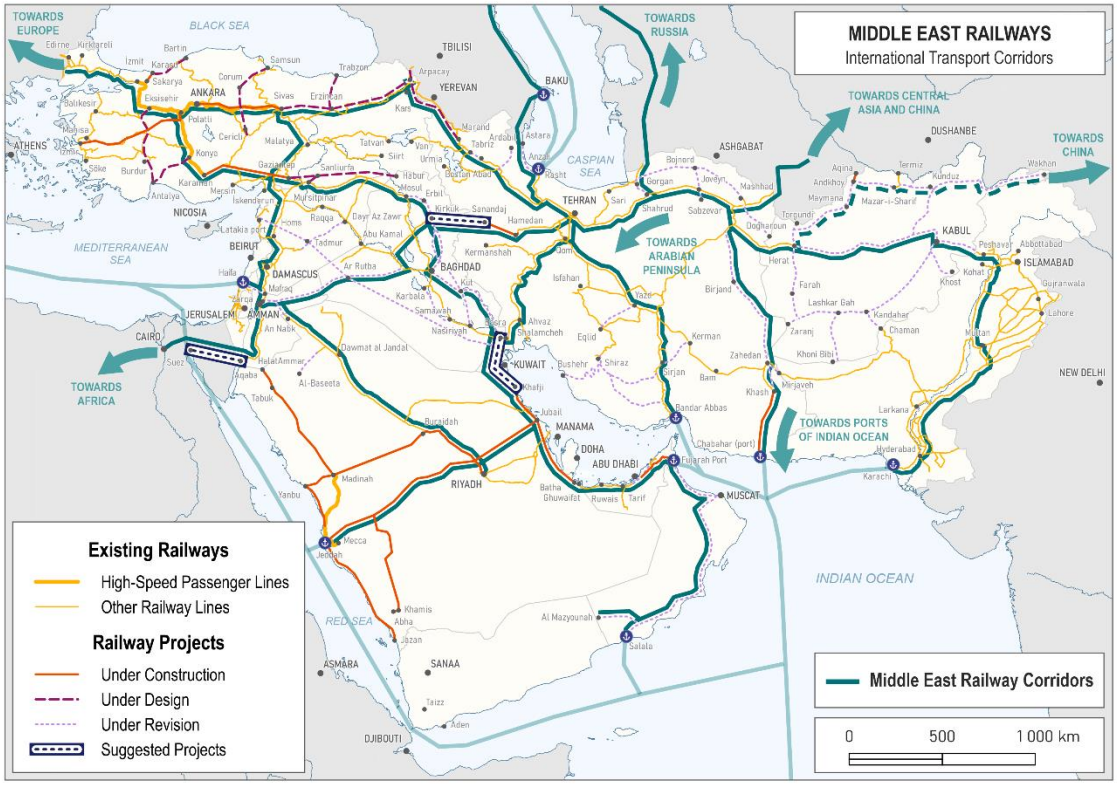


Note: this map is schematic and may not reflect the exact borders of the countries

As it is represented on **Figure 27. Middle East Railways – existing infrastructure and plans according to official public documents of RAME membersFigure 27**, numerous projects are being implemented or are planned for implementation in the upcoming years in the Middle East region. Some of these developments are briefly described in the Part II (Overview of existing programmes and projects) of the Vision. Due to lack of the agreement on the backbone network, these programmes and projects rarely consider their interconnections and possible synergies.

Meanwhile, existing and forecasted trade flows may suggest international corridors for further consideration.

Figure 28. Middle East Railways – vision of international railway corridors 2050



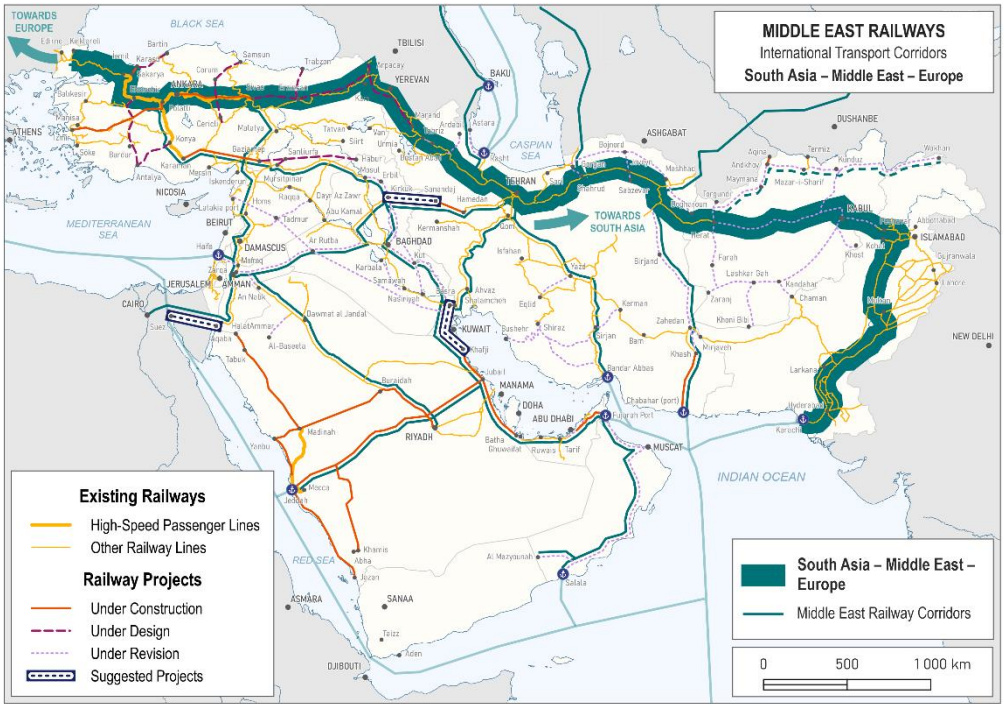
According to the analysis of intraregional and external trade flows, as well as transit, within the Middle East railway system, it is worth considering **eight main corridors**:

1) South Asia and Southeast Asia (maritime) – Middle East – Europe corridor
2) East Asia – Middle East – Africa corridor
3) East Asia – Middle East – Europe corridor
4) North – South corridor
5) Arabian Peninsula – I. R. Iran – Central Asia/ East Asia/ South Asia
6) Arabian Peninsula – Europe
7) Africa – Arabian Peninsula
8) Africa – Jordan – Syrian Arab Republic – Türkiye – Europe.

South and Southeast Asia – Middle East – Europe corridor

This corridor includes the railway segments in Türkiye, I.R. Iran, Afghanistan and Pakistan.

Figure 29. South and Southeast Asia – Middle East – Europe railway corridor



A sustainable international corridor requires the **implementation of several large-scale railway projects**, as well as the modernisation of Iran's infrastructure.

Türkiye's rail infrastructure is mostly ready for overland rail transport along this corridor. In addition, a number of projects on the Ankara - Sivas - Kars route are already underway or are being prepared for implementation. These projects will significantly increase the capacity of this direction and will create conditions for the growth of transit traffic. However, the implementation of a railway project from Kars to the Iranian border with the creation of the Turkish-Iranian border crossing Chesmeh Soraya and further construction in Iran to the city of Marand is required.

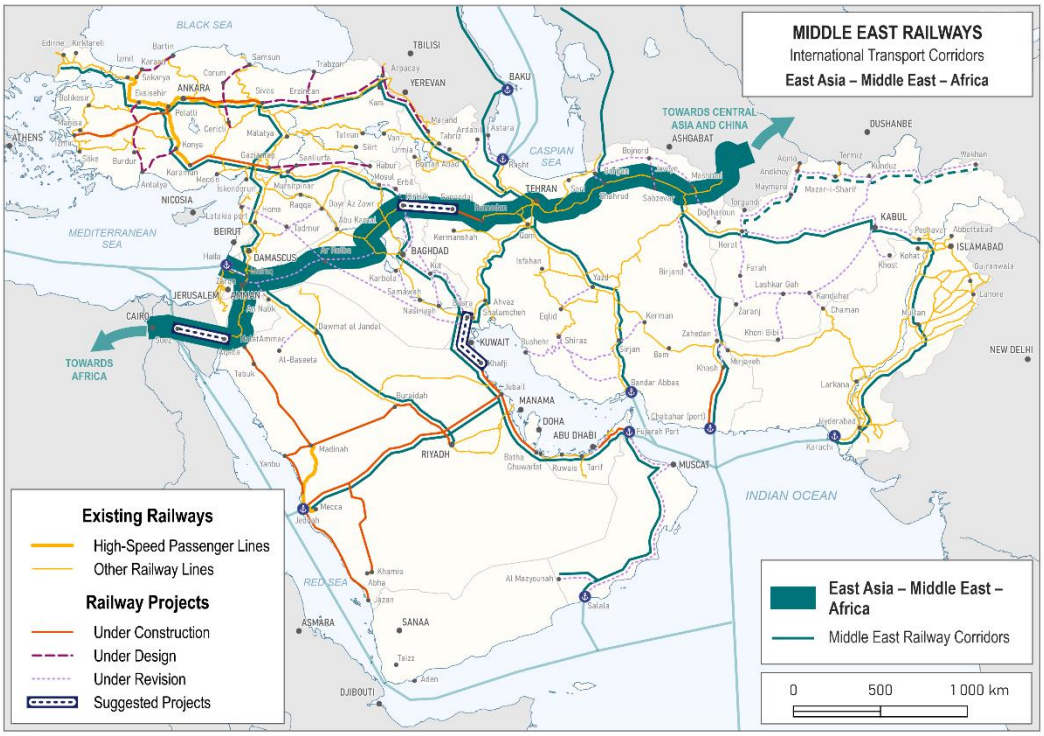
With the exception of the Chesmeh Soraya to Marand section, railway infrastructure exists in Iran along the corridor from Türkiye to Afghanistan. However, for the most part, the railways are single-track, non-electrified lines with **low capacity**. A high volume of transit traffic would require a **targeted upgrade of this infrastructure**, especially between Tabrizand Tehran. The formation of this corridor will require analysis of the number of additional trains that Iran's infrastructure can carry along this route.

The main problem in forming a corridor to/from South Asian countries is the lack of railways in Afghanistan east of Herat. The Iranian and Pakistani rail systems connect to each other much further south, bypassing Afghanistan, but this route would result in significant overrunning of cargo through Iran as well as Pakistan, as the most part of the population and cargo generation and consumption centres are located in the northern part of the country. In order to ensure the competitiveness of the direct rail route it is necessary to significantly reduce the distance and time of transport by rail, which in turn will also affect the potential cost of such a service. In this regard, the Herat - Kabul - Torkham project with links to the Pakistani city of Peshavar and the capital Islamabad is needed. In this way, Pakistan's capital and its major industrial centres will be connected by a direct rail link to the Middle East, Türkiye and European countries. The development of this corridor will strongly depend on the possibility of transporting Indian cargo along this route, which is currently complicated due to the geopolitical situation between India and Pakistan.

East Asia – Middle East – Africa corridor

Creation of the competitive rail services on these connections without additional measures is not only impossible due to the lack of a link between the Middle East and North African railways (Jordan and Egypt via Israel) but also due to the non-optimal existing transport route between China and Jordan.

Figure 30. East Asia – Middle East - Africa railway corridor



Transporting goods by rail between these countries would require crossing 7 national borders and would require a very high overrun of the goods train due to the lack of many important rail links on the direct route. Today, this route would require crossing the territories of Kazakhstan, Uzbekistan, Turkmenistan, Iran, Türkiye and Syrian Arab Republic.

With planned railway projects, the number of national borders on the track can be reduced to 4 and the distance can be reduced by at least 1,000 km.

The possibility of developing transport on this corridor will depend on the implementation of railway construction projects in Afghanistan, Iran, Iraq and Jordan. Though at present, the infrastructure of none of the countries through which this corridor could potentially pass is ready. The key to the corridor's development is the implementation of infrastructure projects in Afghanistan on the route from the Afghan-Chinese border to Herat via Kunduz and Bamiyan. This project requires the construction of more than 1,000 km of railway mainly in high mountainous

conditions, which significantly increases the amount of financial resources required to build such infrastructure. If this line is built, China's railway system would be directly connected to the infrastructure of the Middle East.

Cross-border and transit transport development in the region is severely limited by the lack of a direct rail link between Iraq and Iran. Several infrastructure projects are required in this regard. The easiest option for connecting these rail systems is the Shalamcheh-Basra rail line in the southern part of these countries. This requires only the construction of about 30 km of railway line. However, in order to maximise the transit potential, the geographically better route lies much to the north. The Hamedan - Sandanaj section in I. R. Iran is already under construction and the Kirkuk - Soleimaneh project in Iraq is under discussion. In this regard, it is suggested to consider establishing **a railway line between the cities of Sandanaj in Iran and Soleimaneh in Iraq with a length of about 150 km**, which would make it possible to connect the railway systems of these countries in their northern part. In this case, the capitals of these countries would be connected by a virtually direct rail link without the need for a long transfer distance and would also provide an optimal transit route for a number of corridors, including the corridor between East Asia and North Africa.

Iraqi territory also lacks rail infrastructure at the junction with Jordanian territory. For this reason, a project from Al Ramadi to the Jordanian border and the construction of rail infrastructure to the northern suburbs of the capital Amman on Jordanian territory is required. The total length of this railway line between Iraq and Jordan will be more than 700 km.

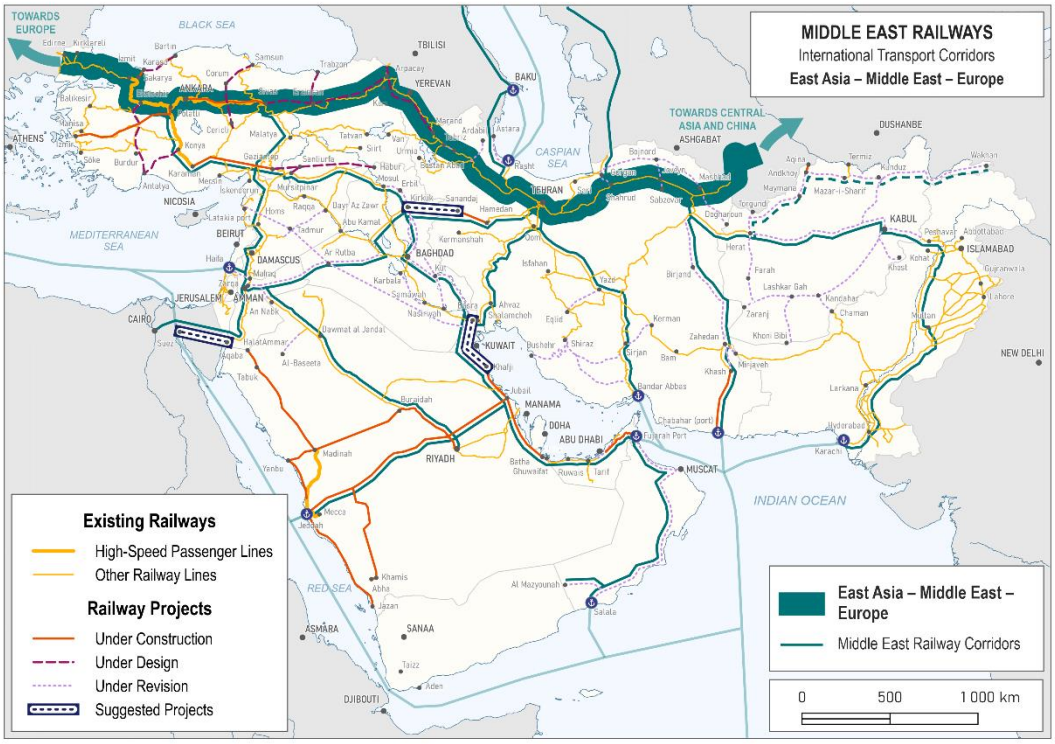
One of the main constraints for the development of rail freight traffic in the corridor is the **lack of a rail connection between Jordan and Egypt**. The rail infrastructure is established in Jordan to the city of Aqaba in the south of the country, which **is only 12 km away from Egyptian territory**. However, the railway between Jordan and Egypt needs to pass through Israel. In addition, there is a need to build a railway on Egyptian territory from Suez city to the border with Israel.

The project can only be realised if a full-fledged railway link is built to Aqaba, opening up opportunities for the development of transit traffic in the area.

East Asia – Middle East – Europe corridor

China-European trade relations have undergone significant structural changes in recent years.

Figure 31. East Asia – Middle East – Europe railway corridor



While overall trade growth in physical volume has been relatively slow, the **share of high value-added goods, which often require faster delivery than existing maritime routes can offer, has increased significantly**. Consequently, the volume of land rail transport between China and Europe has increased more than 8-fold since 2015. However, more than 95% of shipments go via the northern routes, namely through Kazakhstan and Russia. For many reasons, there is now a significant demand for diversification of trade routes between East Asia and Europe. One such route is the Middle Corridor, which runs through Kazakhstan, Azerbaijan, Georgia and Türkiye. This route requires the use of the sea leg of the Aktau-Baku ferry, which leads to the need for 2 modal shifts and hence longer travel times, higher costs and a large number of infrastructure facilities which do not have much extra capacity.

In this respect, the Middle Eastern countries can use their transit potential to organise transport between East Asia and Europe. This requires the possibility of direct rail transport without changing modalities and with the **smallest number of national borders in order to reduce travel times and transport operating costs**. Currently, a freight train can travel to Iran via Kazakhstan, Uzbekistan and Turkmenistan, but this route is not geographically direct and requires crossing a large number of national borders and customs authorities. For this reason, the implementation of projects in Afghanistan that would connect the territories of China and Iran across 2 national borders is critical. **However, the Iranian and Chinese railway systems have the same type of railway gauge, and if the same type of railway gauge (1435 mm) is established in Afghanistan, this route would not require any bogie change or train-to-train transfer at all.**

The potential for increased traffic along this route will also depend significantly on the growth of Iranian railway capacity and the establishment of convenient connections between Turkish and Iranian railways through the **Cheremeh Soraya border crossing**. The main advantage of this route could be the absence of the need to change modality when transporting goods between Asian and European markets and the absence of technological operations at the borders due to the fact that one type of gauge can be used along the whole route. Thus, block trains, for example, between Chinese and European cities, can be dispatched at a relatively high speed and at a lower cost compared to routes requiring a change of modality.

North – South corridor

There is currently a large demand for increased traffic on this route. It is projected that there will be a significant increase in shipments of Russian export products to Asian markets via the Middle East, due to problems with exporting Russian products due to the sanctions regime and bottlenecks in the Russian railway infrastructure in other directions. The development of meridional traffic could take three routes:

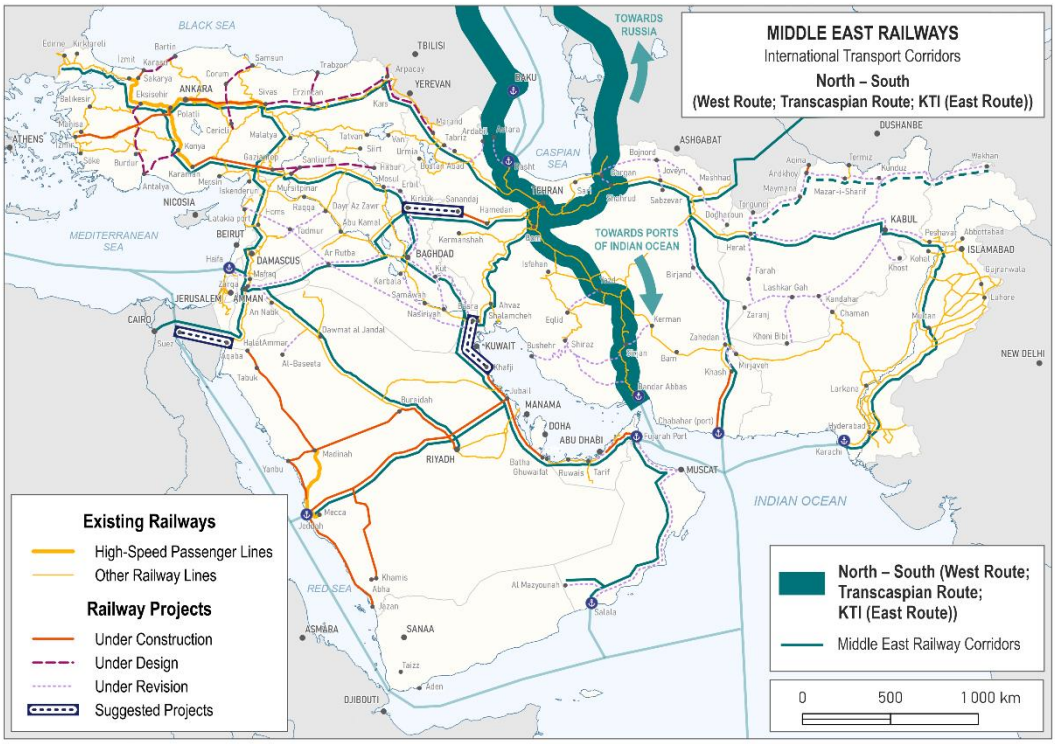
- Russia - Azerbaijan - Iran - Iranian ports (Bandar Abbas and Chabahar),
- Russia - Russian Caspian ports (Astrakhan, Olya, Makhachkala) - Iranian Caspian ports (Anzali, Amirabad) - Iran - Iranian ports to the south ((Bandar Abbas and Chabahar),
- Russia - Kazakhstan - Turkmenistan - Iran - Iranian ports in the south (Bandar Abbas and Chabahar).

The western route through Azerbaijan has the greatest potential due to the high level of infrastructure development in Russia and Azerbaijan. However, this route will only be feasible to transport large volumes if the Iranian rail link between Astara and Resht is implemented. The absence of this railway line makes the transportation of cargo along the route much more difficult and implies the use of road transport in the north of Iran, and hence two additional modal shifts.

The route through the Caspian ports has a high potential to increase traffic especially in the grain and other agricultural cargo segment. The main limiting factors for the development of this route are the need to connect Iran's ports on the Caspian with the country's railway infrastructure; the development of the merchant fleet on the Caspian; and increasing the capacity of some railways on Iranian territory.

The main advantage of the eastern route is the fact that it already has rail infrastructure that allows cargo to be sent by direct rail from Russia to ports in the south of Iran. However, the main limiting factor is the low level of infrastructure capacity in western Kazakhstan, Turkmenistan as well as Iran. Border crossing points also have limited capacity, which significantly reduces the transport capacity of this route and also decreases the competitiveness compared to alternative routes.

Figure 32. North - South railway corridor



As a result, it is suggested that 3 more projects should be considered in addition to the existing projects, which could contribute significantly to increasing the macro-region's connectivity and transit potential:

- Sanandaj– Kirkuk – connecting the territory of Iran and Iraq in their central part,
- Aqaba – Suez – linking the Jordanian and Egyptian territories by a direct railway line, linking the markets of North Africa and the Middle East, as well as South and East Asia,

Basra – Khafji – connecting countries on the Arabian Peninsula to the rest of Asia by direct rail routes.

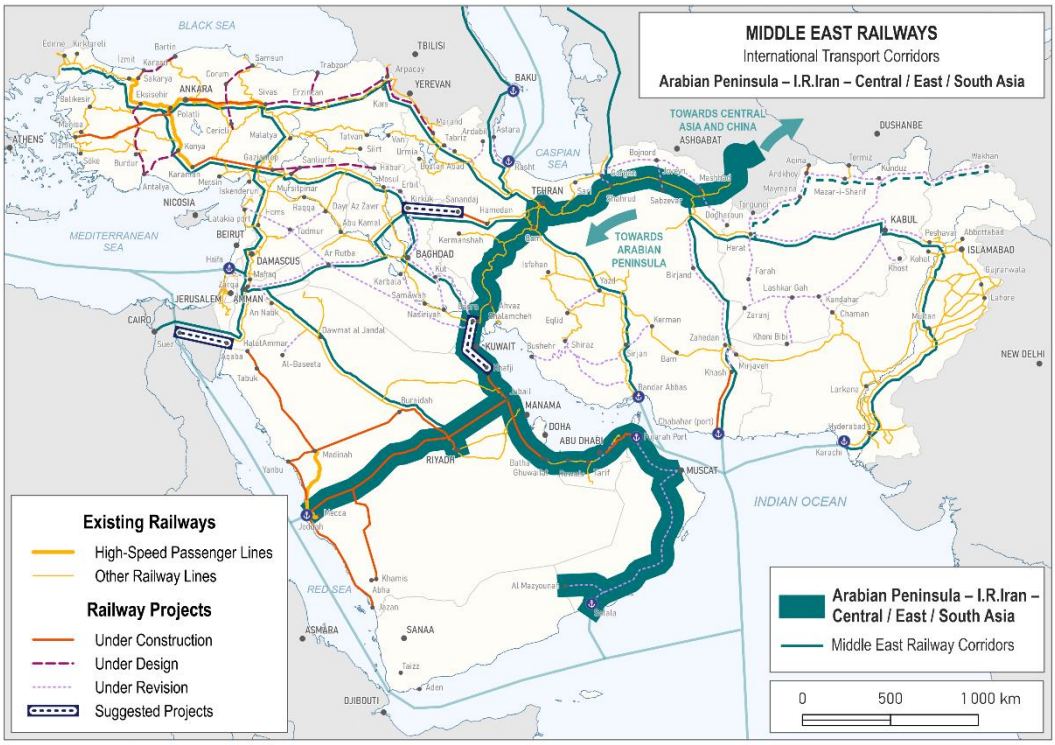
The following corridors are completely new and require extensive construction of new infrastructure or rehabilitation of existing one (like this is the case of Syrian Arab Republic).

Arabian peninsula – I.R. Iran – Central Asia/ East Asia

This is a completely new corridor, which is currently represented by separate segments and plans for national infrastructure sections.

The development of the corridor should considering, on the one hand, a high growth potential of exports and imports between UAE and China, , as well as between Saudi Arabia and these countries and regions, and on the other hand, growing trade flows within the region: UAE and Oman, UAE and Kuwait. This allows suggesting a new transit route that may operate as a holistic system of interconnected segments.

Figure 33. Arabian Peninsula – I. R. Iran – Central Asia/ East Asia railway corridor

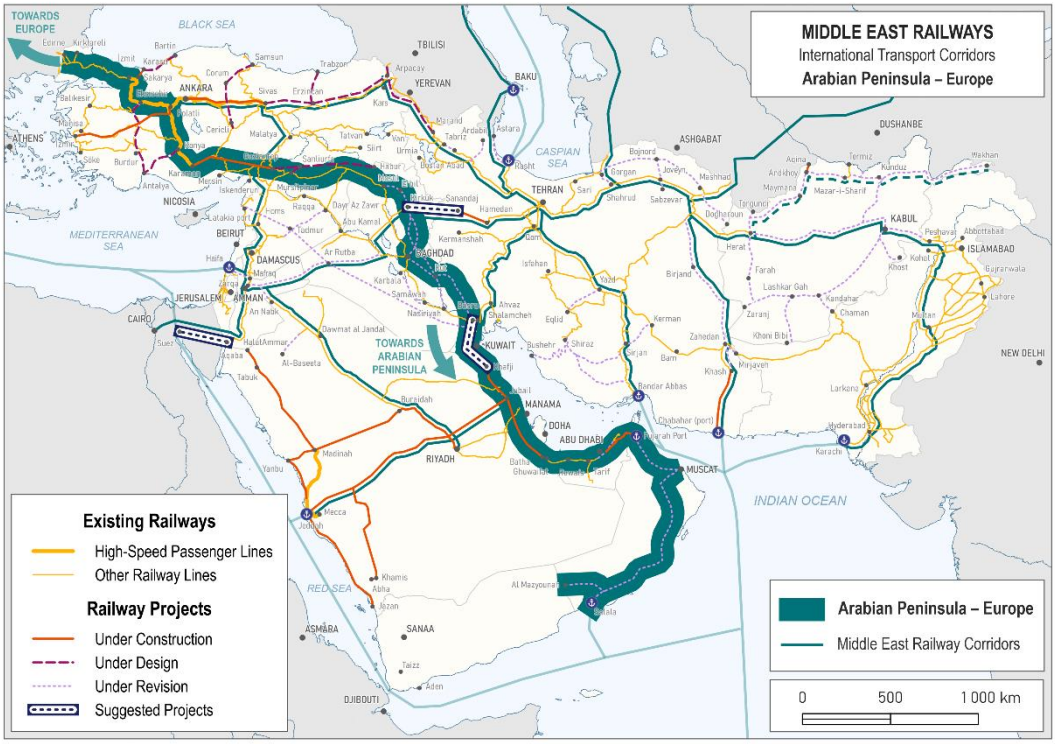


Arabian Peninsula – Europe

This is also a completely new corridor, which connects already existing elements requiring rehabilitation in Iraq and Syrian Arab Republic with actively developing infrastructure in Türkiye and planned one on the East coast of the Arabian Peninsula.

This corridor may be considered as an alternative to maritime routes via Suez channel and also a route to connect countries with forecasted important trade growth: Türkiye and UAE with Syrian Arab Republic and Iraq, UAE with Oman.

Figure 34. Arabian Peninsula – Europe railway corridor

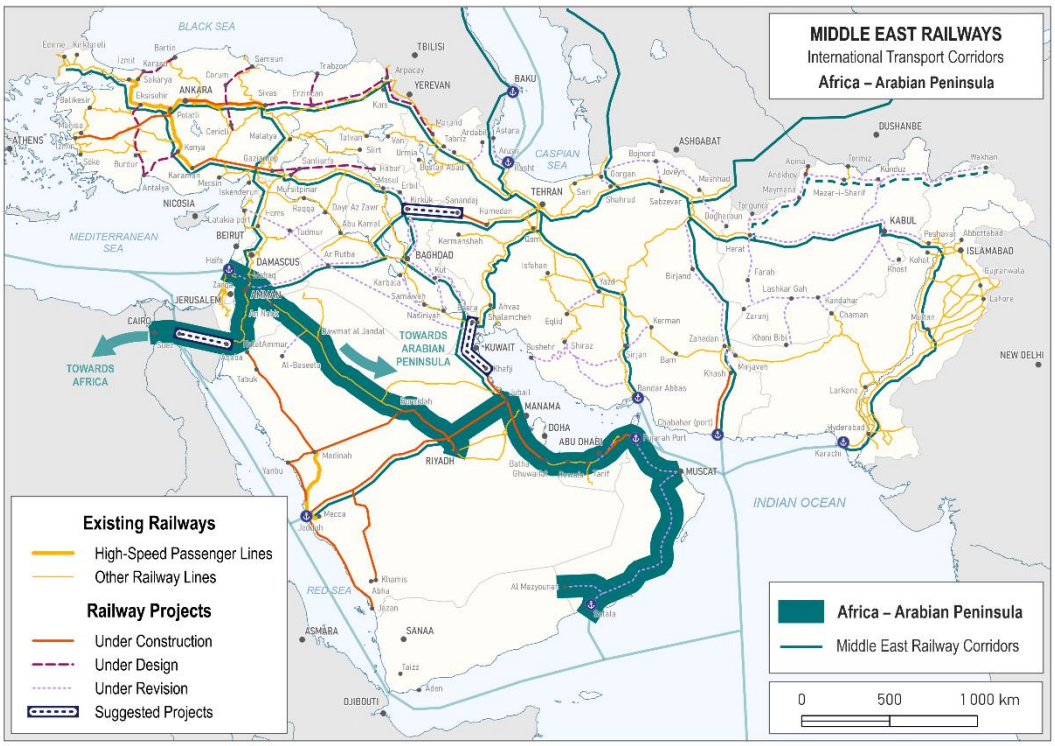


Africa - Arabian Peninsula

This suggested new corridor which by now has only few segments available, can greatly contribute to both intra-regional trade (Saudi Arabia – UAE) and internal national logistics of participating large countries.

It can also unlock the inland transport connectivity for Israel and Jordan.

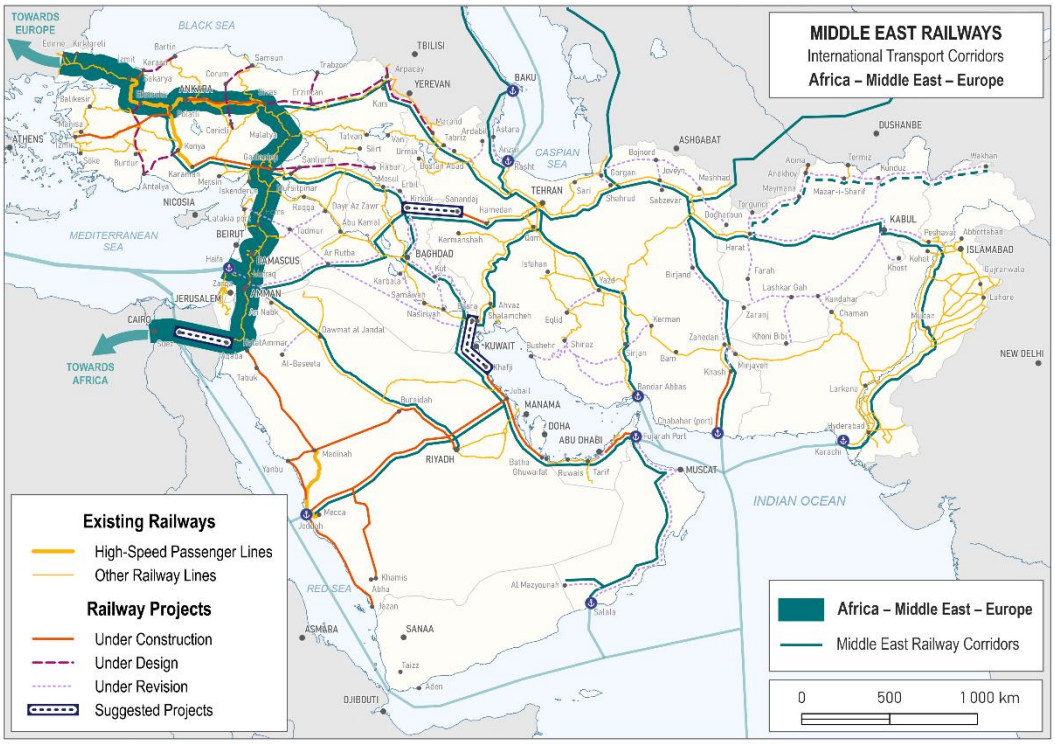
Figure 35. Africa – Arabian Peninsula railway corridor



Africa – Jordan – Syrian Arab Republic – Türkiye – Europe

Important growth of trade flows is forecasted between Türkiye and Syrian Arab Republic, Türkiye and Israel and Türkiye and North Africa. This corridor has got a high potential to accumulate these flows. Besides, this corridor mainly refers to making operational and commercialise the existing infrastructure with only few elements missing.

Figure 36. Africa – Middle East – Europe railway corridor



2. PLANNING OF INFRASTRUCTURE

2.1. National and regional prioritising approaches

The Middle East Railways Vision is not aimed at redefining national strategies and plans of specific companies, its objective being regional harmonisation and advice on possible improvements.

Planning of infrastructure construction, refurbishment and enhancement is a basic element for the future of railways in the region. Having a comprehensive and transparent view of infrastructure needs is a challenge because typically different agencies or departments are responsible for each transport mode in each country, and the task of synchronising their policies is not always successful.

This is also a major problematic issue for funding. Rail infrastructure is expensive and has a very long payback period and even international development banks often tend to avoid these projects in favour of operational ones or rolling stock acquisitions which is much easier to be structured into loans, including specific Islamic finance tools or green finance tools.

Besides, by now, **there is no regional approach to rail infrastructure planning and prioritising. Corridor-based approach to rail network and agreement on the backbone network can be the beginning for a transformation of disconnected national networks to a connected regional one. This will, in its turn, require harmonised regional approach to setting up infrastructure priorities.**

Middle East Railways Vision 2050 suggests the following activities:

1) agreement on the joint infrastructure prioritising approach (**RAME IPA**) for regional rail infrastructure development,

2) implementation of such approach and its use as a first-stage certification of projects to be financed by international development institutions and regional funds.

Prioritising approaches, in their turn, are divided into two stages:

(1) stage 1 – national priorities,

(2) stage 2 – regional priorities.

These approaches proposed correspond to the following requirements:

- possibly limited initial data and constraints in data collection,
- simple methodology suitable for various countries and companies,
- focus primarily on international rail freight projects or projects with international (regional) impact), but not limited to them.

This methodology is not suitable for urban mobility projects.

RAME IPA Stage 1: national prioritising and classification approach

It is suggested to use the World Bank's Infrastructure Prioritization Framework[11] (IPF) as a basis for national prioritising and classification approach. It is a tool for prioritising infrastructure projects based on financial, economic, social and environmental indicators, which are combined into two indices - socio-environmental (SEI) and financial-economic (FEI) - and considers them along with public budget constraints for a particular sector. The IPF is a type of multi-criteria analysis. The essence of the mechanism is to construct a composite index and rank it:

$$Index = f(SEI, FEI)$$

To apply such methodology to the rail systems of the Middle East in a simplified way it has been modified and simplified to fit the requirements listed above.

This methodology should not substitute detailed cost-benefit analysis or wider economic effects assessment, as it does not cover all criteria, but it can be used as a basis for regional prioritising.

RAME IPA suggests using the same formula, where

Socio-environmental (SEI) criteria are:

- change in the level of environmental emissions in absolute terms (CO2 equivalent emissions),
- number of people living in the project's area of influence (direct connections for linear infrastructure, place of location for hubs and terminals),
- total revenues of industrial enterprises located in the project's area of influence (direct connections for linear infrastructure, place of location for hubs and terminals).

The criteria are normalised from 0 to 1 (or 0 to 100)[12] and summed up with coefficients. All coefficients are equal to 1.

Changes in coefficients apply in the following cases:

1) coefficient for change in the level of environmental emissions becomes 1.5 with no changes for other coefficients if a specific project refers either to high-risk areas, or to changes in existing infrastructure in favour of higher sustainability (electrification, upgrade of infrastructure to new traction, targeted eco-upgrade of infrastructure, etc.),

[11] https://thedocs.worldbank.org/en/doc/844631461874662700-0100022016/original/160423InfrastructurePrioritizationFrameworkFinalVersion.pdf

[12] a standard linear rationing formula is used: $\widetilde{x_i} = \frac{x_i - x_{i\,min}}{x_i\,max - x_{i\,min}}$

2) coefficient for number of people living in the project's area of influence becomes 1.5 and coefficient for total revenues of industrial enterprises located in the project's area of influence becomes 0.5 for dedicated rail passenger projects,

3) coefficient for total revenues of industrial enterprises located in the project's area of influence becomes 1.5 and coefficient for number of people living in the project's area of influence becomes 0.5 for dedicated rail freight projects.

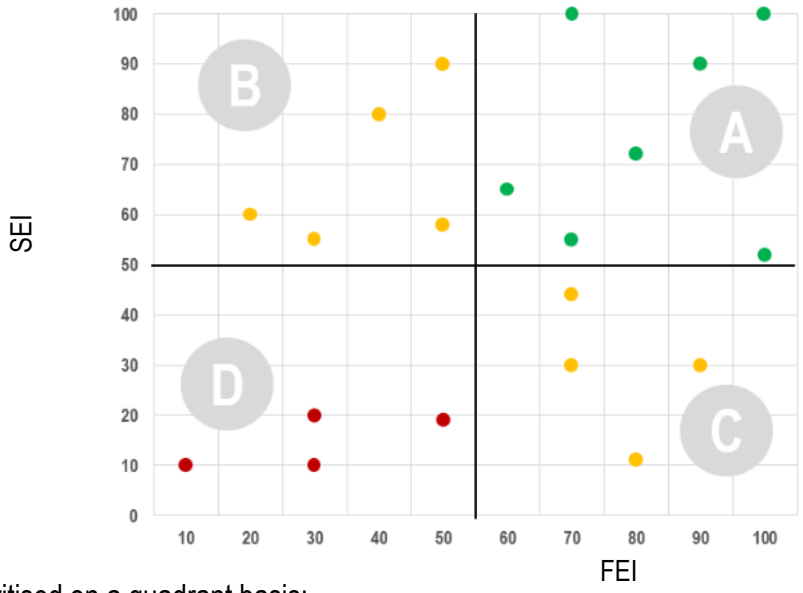
Financial-economic criteria (FEI) are:

- internal rate of return of the project,
- simple payback period of the project,
- share of extra budgetary funding.

The criteria are normalised from 0 to 1 (or 0 to 100) and summed up with coefficients equal to 1 for all projects.

Projects are further on classified according to the values of SEI and FEI.

Figure 37. Classification of railway infrastructure projects



Projects are prioritised on a quadrant basis:

A. projects with the highest priority, as they are effective from both socio-economic and financial points of view (the project is effective for both the state and the population, as well as for business).

B. projects that are more effective from a socio-economic point of view for the state and the population, e.g. improve the connectivity of the countries of the regions and/or comply with the ESG agenda. However, such projects may require additional budget support, as indirect effects may prevail over direct effects.

C. Projects that are more financially efficient, e.g. have a quick return on investment, are highly profitable and do not require significant government support. Such projects may have a smaller radius of impact on the economy and population, but have larger direct effects.

D. projects that require additional research at this stage of appraisal and prioritisation to refine the parameters and possible effects *OR requalification at stage 2 of RAME IPA*, as they may have a high regional importance.

RAME IPA Stage 2: regional prioritising and certification approach

Stage 2 is very simple and refers to qualitative analysis and simple sum up. Maximum meaning is 5.

Stage 2 cannot be completed without Stage 1.

Table 4. RAME IPA Stage 2 criteria and assessment options

No	Criteria	Options	Attributed value
1.	**Does this project contribute to the achievement of the UN SDGs, higher environmental and social sustainability?**	1) projects classified A and B at Stage 1 2) projects not classified A and B, but having a specifically high importance (confirmed in national strategic or other documents) 3) other options	1) 1 2) 0.5 3) 0
2.	**Is this project a part of the Middle East backbone rail network?**	1) yes, a missing link 2) yes, upgrade/ enhancement of existing infrastructure 3) no	1) 1 2) 0.5 3) 0
3.	**Is this project a part of the region's international transport corridors?**	1) yes, it ensures direct connections between capitals or economic centres/ development of hubs in the capitals or centres 2) yes, this is a border crossing infrastructure 3) yes, but it does not ensure direct connections between capitals or economic centres development of hubs in the capitals or centres, neither is it a border crossing infrastructure 4) no	1) 1 2) 0.5 3) 0.3 4) 0
4.	**Is this project a part of a larger economic/ social project?**	1) yes, it comes together with the development of special economic zones, areas, public spaces or cities, production areas 2) this is a part of a multimodal transport project/ border crossing enhancement project 3) no, it is a standalone rail project	1) 1 2) 0.5 3) 0
5.	**Is the project financially efficient?**	1) projects classified A and C at Stage 1 2) projects with guaranteed funding 3) other options	1) 1 2) 0.5 3) 0

Certification procedure refers to (1) confirmation of project priority, (2) breakdown by type of possible funding.

Such certification can be shared by RAME with development banks and institutions, as well as national and regional funds to confirm the priority of projects together with the recommendations on financing forms.

Table 5. RAME IPA – certifications principles and advisory on financing options

No	Stage 1 classes	Stage 2 assessment results	Certification results for the Middle East region	Financing tools and comments
1.	**A**	4-5	A-Certified – 1st priority for the region	• National subsidies grants, guarantees and equity • Green finance • Islamic finance (musharakah, mudarabah)
2.		2.5-3.5	B-Certified – second best option for the region	

No	Stage 1 classes	Stage 2 assessment results	Certification results for the Middle East region	Financing tools and comments
				• Loans from development banks • PPP
3.		0-2	Not certified: status – national priority project	To be considered as a national project with low regional impact • National subsidies grants, guarantees and equity • Green finance • Islamic finance (musharakah, mudarabah) • PPP
4.	B	4-5	A-Certified – 1st priority for the region	• National subsidies grants, guarantees and equity • Green finance • Loans from development banks
5.		2.5-3.5	B-Certified – second best option for the region	
6.		0-2	Not certified: status – national priority project	To be considered as a national project with low regional impact and need to review the economic parameters of the project
7.	C	4-5	A-Certified – 1st priority for the region	• PPP • Islamic finance (musharakah, mudarabah, Ijarah) • Loans from development banks
8.		2.5-3.5	B-Certified – second best option for the region	• PPP • Islamic finance (musharakah, mudarabah, Ijarah) • Loans from development banks
9.		0-2	Not certified	Revision of the project in terms of economic, social and environmental impact required: rescaling or combination with other projects may be considered
10.	D	4-5	B-Certified – second best option for the region	• Subsidies and grants from international development institutions/ national funds
11.		2.5-3.5	Not certified	Full revision of the project is required
12.		0-2	Not certified	

Neither prioritising nor certification is not aimed at excluding any of the projects. Non-certified projects are subject to revisions or may be carried out despite non-conformity to regional priorities.

2.2. Going forward: challenges for making infrastructure operational

Prioritising of infrastructure projects and even their realisation is not enough to get the results for the economies and the societies of countries. Making regional infrastructure operational refers to the choice of harmonised standards, technologies, but primarily to transport law, rules, documents and guidelines.

Lack of uniform transport rules is a major issue for the Middle East Railways. By 2050, following and even anticipating the implementation of specific projects, the railways and the countries should agree on the implemented procedures, as by now most of the countries do not belong to any of the international intergovernmental organisations. **Middle East region has got a unique opportunity to test a completely new and ambitious approach by forming its own new modern system of rules and regulations that could be further on used for other regions. This system does not necessarily have to apply to inherited European and Asian systems, but it may be based on actual and future digital solutions, fintech and the most modern technologies.**

As a way forward to a specific **Middle East rail and rail+[13] interoperability framework** the following is to be done by the members and the authorities of the countries:

1) Agree on the goals, objectives and the scope of the framework. Form an intergovernmental/ inter-agency commission to ensure effective decision-making process.

2) Structure the areas to be covered by documents.

3) Compare the needs with existing documents of inter-agency organisations (OTIF, OSJD), define usability of existing approaches based on (a) available technologies, (b) forecasted directions of flows. Application of regulations should not become an inhibiting factor for regional rail transportation, it should vice versa simplify the process and be suitable with technological shifts, prioritising, among other, use of electronic data and not aggregated information in paper form.

4) Define the necessity for specific regional documents and ensure their fast elaboration.

The process to reach baseline agreements, with focus on freight (as international flows do already exist unlike for passenger transportation) should be limited to one year.

Such base for further intra-regional operations will drastically change and enhance the potential of the railways of the Middle East allowing to reach the trade figures of the optimistic scenario.

This does not mean that countries and railways belonging to the existing organisations will have to suspend their memberships or reject existing documents.

[13] Referring to multimodal transportation involving railways

V. RAIL TECHNOLOGIES

Objectives for the Middle East Railways 2050 referring to rail technologies:

Objective H. Set up a list of priority technologies to be studied, developed and applied in the Middle East region.

Suggested activities:

H.1. Regional priority technologies databank.
H.2. Workshops on implementation of priority technologies.

Today, the railway transport of the Middle East region has a relatively small importance for the national economies, not only due to the low capacities, but also due to insufficient technological development.

There is, of course, a large variety of technologies that can be implemented, but the Vision 2050 focuses on those that may be crucial for the Middle East railways (the so called smart railway solutions):

1) interoperability,
2) digitalisation,
3) border crossings (international rail connections),
4) sustainability and environmental impact.

These technologies are structured by the processing areas:

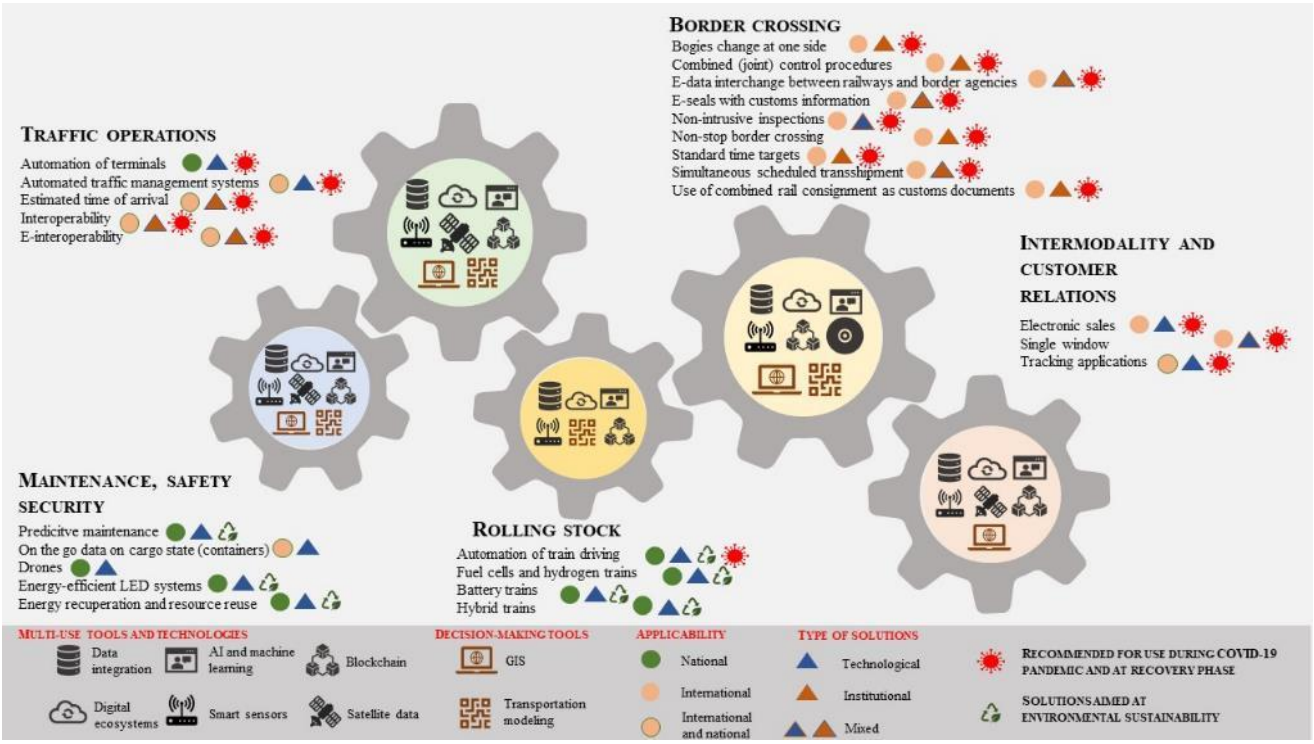
- traffic operations,
- maintenance, safety and security,
- rolling stock,
- border crossing,
- intermodality and customer relations.

In case the technologies are simultaneously referring to (a) interconnectivity, (b) communication and (c) intelligence they may be considered as smart railway technologies, or **smart railway solutions**.

Despite the fact that smart solutions refer mainly to technological issues, there is a wide scope of institutional solutions and actions that are necessary for successful implementation of technologies.

Development and application of smart tools and solutions start from most developed railway networks or routes (areas) with highest demand for innovative solutions. But *global innovative trends* refer to the general development of the society, so they will most probably reach all countries, though they will be applied at different levels. Countries and railways currently lacking innovative solutions and technologies may even benefit from a shorter way to them thanks to avoiding a long transformation of previously used technologies.

Figure 38. Smart railway technologies and solutions chart



Source: Smart railway solutions, ESCAP

1. TRAFFIC OPERATIONS

Technological smart solutions for the area of traffic operations refer mainly to automation or integration of system elements.

They require a relatively *high level of technological basis*, as well as *high financial requirements*. But lack of such solutions can *inhibit development of sustainable rail operations* (like network speed limits and lower capacity).

Started in 2015-2016 with intensive growth of international container traffic by rail, international rail connectivity trend in 2018-2019 had a very positive dynamics with growing number of countries participating in international connectivity initiatives and realization of coherent connectivity policies led by different countries (such as One road, one belt starting from China and later spread on the whole Eurasian space, or TEN-T programme in the EU that currently includes numerous projects in neighbouring non-EU countries, and EAEU coordinated transport policy developing primarily from interaction of national customs authorities).

One important part of international connectivity is physical (infrastructural) connectivity achieved via new construction or infrastructure upgrade projects. Another part is **interoperability of existing infrastructure**. Three issues have been developing actively along the recent years: interoperability including e-interoperability, traffic management systems and facilitation of border crossing procedures. Such solutions as harmonisation of interoperability and especially electronic interoperability are less depending on the current level of technological development (unless no new systems are imposed).

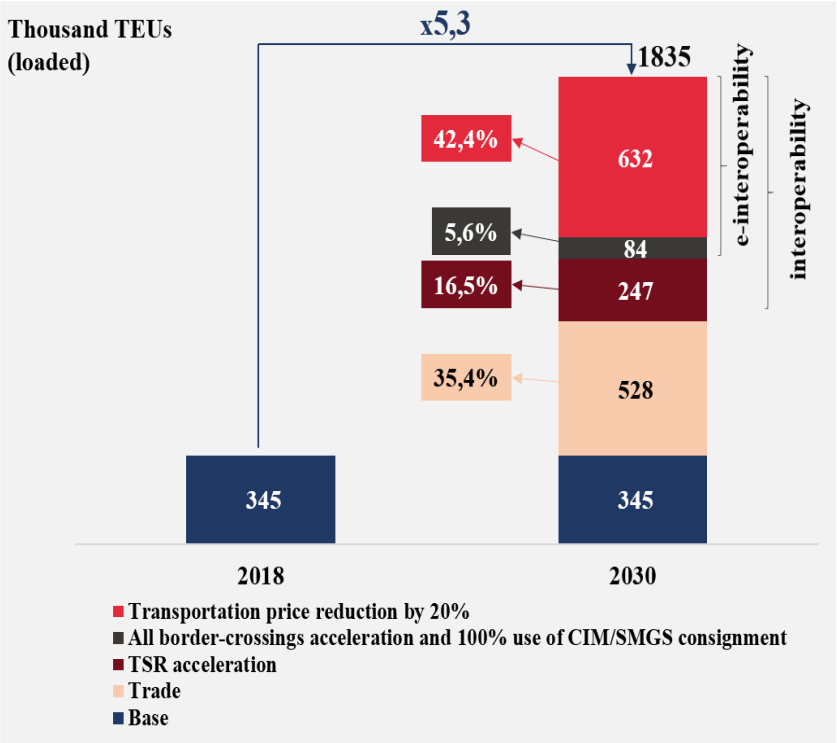
E-interoperability might be the most interesting solution that impacts directly on international transportation and at the same time does not require any changes in national systems and is more about the form, than about the content. But it requires strong international cooperation and important institutional work at the national level.

In the EU international interoperability, infrastructural and operational, is imposed by European regulation (the railway packages), but international interoperability outside the EU is being developed on a volunteer basis. Approaches, rules and regulations for the Middle East region in this regard are yet to be developed. A concrete

mechanism is proposed in the Part IV of this document.

Assuring international interoperability is long-term process which involves many international governmental and non-governmental organisations. International routes cannot become fully operational within a short time, but the planning period of the Middle East Railways Vision 2050 is quite comfortable for such process, so **interoperability and e-interoperability related technologies should be fully applied in the Middle East region by 2050**.

Figure 39. Estimation of interoperability and e-interoperability input to Euro-Asian rail freight transit traffic under "the best rail case" option



Source: Eurasian corridors: development potential, UIC, 2020. TSR refers to Trans-Siberian Railway

Traffic management systems are aimed at raising the efficiency of overall transportation by centralizing traffic control, automating and integrating signalling and safety systems, establishing uniform geopositioning system and thus assuring intelligent and automated management of traffic.

Establishment of traffic management systems allows faster and automated exchange of information, faster operations, and more efficient use of the network (as well as locomotives). Traffic management system is a must for rapid and especially high-speed transortation.

In the EU equipment of railway networks with European Traffic Management System (ERTMS) is imposed by the regulations and financed via different European financing tools. Over the recent years a large part of infrastructure upgrade projects was linked to establishing ERTMS.

Import developments of traffic management system at national level is also observed in Asian countries, but there is no international uniform programme for such technologies.

Apart from efficient national operations, traffic management systems contribute to intensification of cross-border operations thanks to better performance and information exchange.

In this regard a new future railway mobile communication system (FRMCS) as a part of future Global Rail Traffic Management System with larger data coverage and higher data transfer opportunities is being developed by UIC.

Box 2. Use-case: FRMCS

FRMCS (Future Railway Mobile Communication System) is the future worldwide telecommunication system designed by UIC, in close cooperation with the different stakeholders from the rail sector.

The new system is a successor of GSM-R that lacks the capacity to transmit the volumes of data needed today. Although the railway supply industry has guaranteed continued support for GSM-R until 2030, a new one has to be prepared and rolled out in a test mode before the end of GSM-R sufficiency.

A new system should empower the railway industry to better leverage the potential given by modern communication technology. Unlike ERTMS, FRMCS will decouple applications, services and transport to allow independence and transport bearer flexibility

Still it should be noted that deployment of FRMCS which is actively on-going over the recent years requires a high level of *non-rail communication services*.

For many members of the Middle East railways deployment of simpler signalling and traffic control systems is by now a more vital issue.

2. MAINTENANCE, SAFETY AND SECURITY

Unlike operations, maintenance, safety and security refer *mainly no national issues*. The tendency to shift from maintenance to predictive maintenance requires introduction on numerous smart tools (like smart sensors combined with analytical systems), so despite obvious benefits of such systems they are not yet widely scalable.

One specific solution that refers to international traffic is information on the state of the cargo that is being transported. This solution is based on such tools as smart sensors, data integration, satellite information and is usually applied for high value-added cargo transported in containers. This solution is less technological than institutional, as it requires agreements of different countries to pass the containers with special sensors. The interested parties for such solution are shippers and cargo owners. So it may be recommended to further consider such solution within corridor-based international working groups (like it is currently done within CCTT-UIC BIRC group).

Low reliability of railways in comparison to other transportation modes, and first of all, deep sea, is considered by many market players a key drawback. Over the recent years numerous studies and initiatives were aimed at finding the solutions for this issue.

Two aspects of reliability are addressed: physical reliability of infrastructure and operations and non-physical reliability of shipments.

Physical reliability.
Following issues have been trending on various railway markets:

- shift from maintenance to predictive maintenance;
- automation of mainline and shunting operations, including driving;
- use of new digital tools for data-driven maintenance and operations: drones, sensors, e-seals, etc.

Predictive (condition-based) maintenance is a data-driven maintenance technology that uses real-time data collected from rolling stock or any engineering systems/ mechanisms and predicts necessary maintenance and repair actions with help of *sensor technology, data analytics and machine learning (artificial intelligence)*. Over the past years trends on shifting from maintenance to predictive maintenance have been developing in Europe, Asia and other parts of the world, Middle East is not an exclusion form this. Condition-based maintenance can lead to an overall reduction of at least 10 to 15% in maintenance costs[14]. Still predictive or condition-based maintenance

[14] As evaluated by McKinsey
https://www.mckinsey.com/~/media/mckinsey/industries/travel%20transport%20and%20logistics/our%20insights/the%20rail%20sectors%20changing%20maintenance%20game/the-rail-sectors-changing-maintenance-game.ashx

requires a high level of digitalisation, as well as significant financial resources, so that it cannot be easily scalable in all countries yet.

Autonomous freight trains and general automation of operations is another trend arising from use of artificial intelligence in the railway environment. Automation results in lower operating costs, shorter journey times, improvement of the efficiency of scheduling and elimination of bottlenecks.

A wide variety of other tools like drones for network maintenance and security, sensors to get real-time information on rolling stock or containers positioning and condition, electronic seals are being widely implemented. The common thing for such tools is that they are all *data-driven*. That means that ***physical reliability of railway systems is more and based on data-driven solutions***.

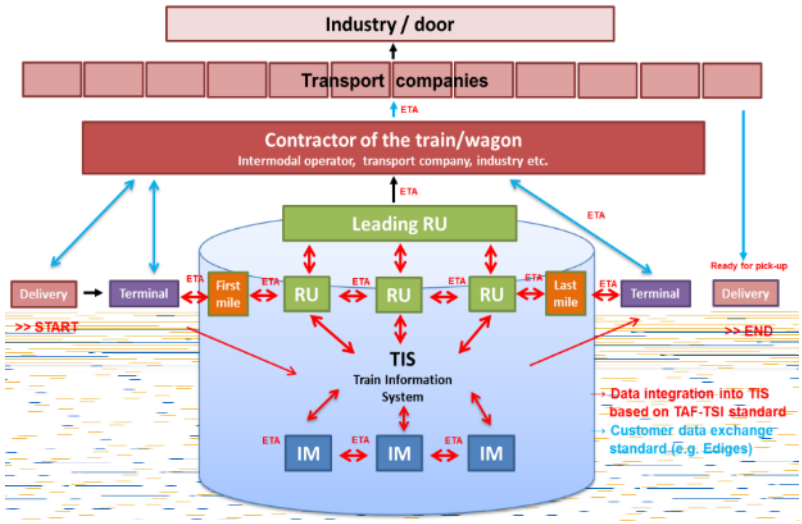
Non-physical reliability.
Following issues have been trending:

- calculation of estimated time of arrival (ETA), also with use of artificial intelligence (AI);
- e-data interchange, including pre-arrival informing;
- construction of trusted digital ecosystems for transportation and cargo data sharing.

Lower reliability and lower traceability of cargo are key drawbacks for railways that decrease the competitiveness in comparison to other transportation modes. And the most state-of-the-art solutions for improving non-physical reliability are also ***data driven***.

Many countries and railway companies have already developed a high level of digitalisation allowing getting real-time data on cargo flows and specific cargoes that are transported, but the key issue that is currently being addressed by stakeholders is ***data communication and exchange***. Numerous initiatives appeared in recent years both in Europe and in Asia.

Figure 40. ETA information exchange scheme



Source: ELETA presentation/ UIRR.

One of major European projects in this field led by UIRR with RailNetEurope as a technical partner and co-funded under Connecting Europe Facility (CEF) is ELETA which was launched in September 2017 and aims to demonstrate the advantages of exchanging the Estimated Time of Arrival (ETA) data within the whole rail supply chain management.

More and more intergovernmental and national activities consider development of **digital ecosystems** that allow trustworthy e-data exchange between participants of logistics chains, authorities, and customers. In 2019 EAEU has adopted a strategy for development of digital corridors and digital ecosystems. EU policy (led by DG Move)

requires at a minimum data (semantic) interoperability. In China there is a governmental blockchain-based e-data exchange system LOGINK. It is connected to similar systems in Japan and the Republic of Korea called NEAL-NET. **Such approach is to be adopted for the Middle East railways as well**.

These are advanced solutions that are mainly used within countries with high rail freight transit potential to maximise transit opportunities and to assure competitiveness of railways in comparison to sea, air and roads. They are **also coherent with corridor approach** and so they can be recommended as one of the unifying solutions for all types of corridor management mechanisms at least to some extent, as such approach is based not on the high level of technological development, but rather in international standardisation and communications.

3. ROLLING STOCK

Solutions referring to rolling stock also tend to be used at national level. Their applicability depends a lot on local factors, such as specificity of network, local requirement, technological level and financial opportunities.

Current trends link rolling stock production technologies with sustainability, but these technologies are not among fast solutions, as they require test and procurement phases.

Since 2016 *hydrogen trains* of European manufacturers were tested in Germany and in 2018 entered into commercial operations. Similar tests are being conducted in other European countries. In Asia fuel cells and hydrogen technology is being developed in several countries for urban and suburban rail transportation. Such examples can be found in China, Malaysia and Japan

As for freight transportation, hydrogen shunters are being used in European countries, but there is still no example for fuel cell and hydrogen technology used for mainline locomotives. In 2017 Indian Railways have announced plans to build a hydrogen fuel cell and battery powered 300kW broad-gauge locomotive[15]. Meanwhile, preliminary estimations for European cases show that for long range freight transport total cost of ownership for hydrogen locomotives can be higher than for other technologies[16]. This issue is yet a subject for further estimations, also for Asian countries, considering that a high cost of ownership may be a significant obstacle for the technology.

In the Middle East use of such technologies may be linked to the availability of gas in many countries.

Battery-powered locomotives are much more common for freight transportation, as they have been used to serve mines since long ago. They are limited in use for mainlines, but applicable for shunting with lower costs of ownership than hydrogen locomotives. In recent years such technologies were widely applies for passenger locomotives, trainsets and railcars.

Hybrid rolling stock is probably the most scalable solution for different types of railway market, also under active development in the European and Asian countries in recent years. Hybrid trains or locomotives use an on board rechargeable energy storage system (RESS), placed between the power source and the traction transmission system connected to the wheels. This technology is applicable for both diesel and electric locomotives.

Apart from rolling stock, various green technologies for maintenance and engineering systems have been actively spreading globally for different types of railway projects (LED, water and energy recuperation, etc.). These technologies are becoming a must for rail projects and a part of environmental responsibility of railway companies.

4. BORDER CROSSING

Border crossing is a core processing area for international railway traffic and a key element of international railway connectivity. Over the past years national authorities and railway companies have intensified their efforts to assure faster procedures not only by increasing the capacity of infrastructure, but also by removing existing so called soft

[15] https://www.railjournal.com/locomotives/indian-railways-to-build-fuel-cell-battery-locomotive/
[16] https://shift2rail.org/wp-content/uploads/2019/05/Study-on-the-use-of-fuel-cells-and-hydrogen-in-the-railway-environment_final.pdf

constraints.

Key issues under development are:

- customs – railways interaction interfaces,
- pre-arrival information,
- international data exchange,
- simplified customs and control procedures,
- non-intrusive checks,
- move from documents to e-data and creation of digital ecosystems with distributed data.

A number of studies on this issue has been published by ESCAP with focus on Trans-Asian Railway Network which refers also to many countries of the Middle East region:

1) Study on enhancing interoperability for facilitation of international railway transport, 2015
2) Efficient Cross-Border Transport Models, 2015
3) Study on border crossing practices in international railway transport, 2018.
4) In 2018 ESCAP issued a dedicated study: on border crossing practices in international railway transport covering the most state-of-the-art solutions and their use along Trans-Asian Railway Network[17].

Solutions related to border crossing are different from other areas, as *they are rather institutional than technological* (with some exception). Such solutions *require intensive international cooperation and harmonisation*, they do not fully depend on the level of technological development and do not require such financing resources as other areas. These solutions, thus, can be used in most countries regardless their technical or financial opportunities.

5. INTERMODALITY AND CUSTOMER RELATIONS

Intermodality and customer relations are currently boosted by use of digital technologies, but they also refer to *institutional (inter-stakeholders) cooperation*. They can be used in different countries, but the format of the same solutions may differ: they may be manual or automated, they may consider physical integration of information from different stakeholders or just one dedicated contact centre for customers.

Active development of container transit by railways in Eurasia in 2015-2019 resulted in growing concurrence with maritime transportation. This caused railways to *invest in customer relations* and relevant solutions. In case of active rail network development in the Middle East region, as supposed by the Vision 2050, these trends will become relevant for the Middle East Railways as well.

Mostly developed solution in this regard is one-window services. For example, the core idea of international infrastructure management entity in Europe – RailNetEurope (RNE) is a One-Stop-Shop principle that ensures competitive rail freight services on the European infrastructure. Railway undertakings are not allowed to be members of RNE. The marketing strategy is focused on uniform access rules, clear charging principles, clear information for operators and one-window services. Besides, each corridor within RNE has its own information, published and constantly updated details. A B2B example of one-window approach for is a logistics services provider UTLC ERA jointly owned by Russian Railways, Belarusian Railways and Kazakhstani Railways that was founded in the present form in 2018.

One-window solutions are more and more being developed at national and corporate levels by different countries and companies, but *these developments mainly refer to European railway market, while RAME members still have a potential to develop such solutions in the nearest future*.

A list of priority rail technologies with their description and allocation by costs, complexity and effects is proposed

[17] https://www.unescap.org/resources/study-border-crossing-practices-international-railway-transport

in the **Annex 3**.

VI. PASSENGER AND HIGH-SPEED RAIL TRANSPORTATION

Objectives for the Middle East Railways 2050 referring to passenger and high-speed technologies:

Objective F. Set as performance indicators the basic quality criteria of regional rail passenger services till 2050.

Suggested activities:

F.1. definition of basic quality criteria and dissemination of solutions aimed at reaching these quality criteria.
F.2. agreement on cooperative solutions and tools to boost passenger services, international and national.

Passenger transportation in the Middle East region refers to three key issues:

1) regional (international) passenger transportation, including high-speed,
2) national passenger transportation, including high-speed,
3) urban mobility.

Despite the fact, that Vision 2050 mainly focuses on the region and international connections and does not intent to evaluate or change national programmes and projects, it proposes basic quality criteria of services and a list of actions to follow by all RAME members.

1. INTERNATIONAL PASSENGER CONNECTIONS: CREATING REGIONAL FRAMEWORK

International passenger services are yet not developed in the Middle East region, while some of the countries have already become important aviation hubs in both regional and international scale. This is partly linked to long distances and lack of inherited network, as it is the case for post-Soviet countries for example.

Currently there are passenger services between 7 countries of the Middle East region only: Türkiye, I.R. Iran, Pakistan, Jordan (suspended) and Syrian Arab Republic (suspended). There are also suspended connections between Pakistan and India and existing ones between Türkiye and Azerbaijan which is not a member of RAME.

Nevertheless, development of international transport corridors linked with economic development along these routes may result in growth of international mobility (also business mobility) and further demand for passenger services.

Middle East Railways Vision 2050 supposes creation of a connected regional passenger system. This requires additional actions of RAME members to cope with the following problems and constraints:

- lack of documents on international operations, and first of all, border-crossing procedures,
- lack of documents concerning ticketing and reservations,
- non-existence of uniform ticketing and reservation platform to assure easier ticket sales and booking and non-existence of handbook on yield management,
- lack of documents in the form of standards, international solutions or guidelines promoting easy internationally proved algorithms of actions for railway administrations, operators and railway undertakings to easily establish, suspense and develop new international passenger services.

The situation with the legal framework is similar to rail freight problematic, and it should be considered in a similar way.

Table 6. Intergovernmental documents on international passenger services in referring to all or some countries in the Middle East region

No	Name of the document	Year of issue	Issuing body	Type of document	Application
1.	Convention on the Facilitation of Border Crossing Procedures for Passengers, Luggage and Load-luggage Carried in International Traffic by Rail	2019	**UN ECE**	Convention	International
2.	Agreement on Use of Coaches in International Traffic (PPW)	2009	**OSJD**	Agreement	International
3.	Recommendations on pre-requisites for improvement of international rail passenger services and international rail passenger traffic	1997	**OSJD**	Leaflet	International
4.	Service instructions to the Agreement on International Railway Passenger Traffic by Rail	1951 (2019)	**OSJD**	Instructions	International
5.	Uniform Coding of International Passenger Rail Routes	2008	**OSJD UIC**		International

As it can be seen from the **Table 6**, existing documents with the exception of the ECE convention are not relevant to most of RAME members and they do not cover all aspects of international passenger services.

As well as for international rail freight operations along the transport corridors**, the Middle East regional legal framework, rules and guidelines are to be established following the same recommended algorithm**. By 2050 this framework should exist and be functional based on the most state-of-the-art technologies and solutions.

2. NATIONAL AND GENERAL BASIC QUALITY CRITERIA FOR PASSENGER OPERATIONS AND SERVICES

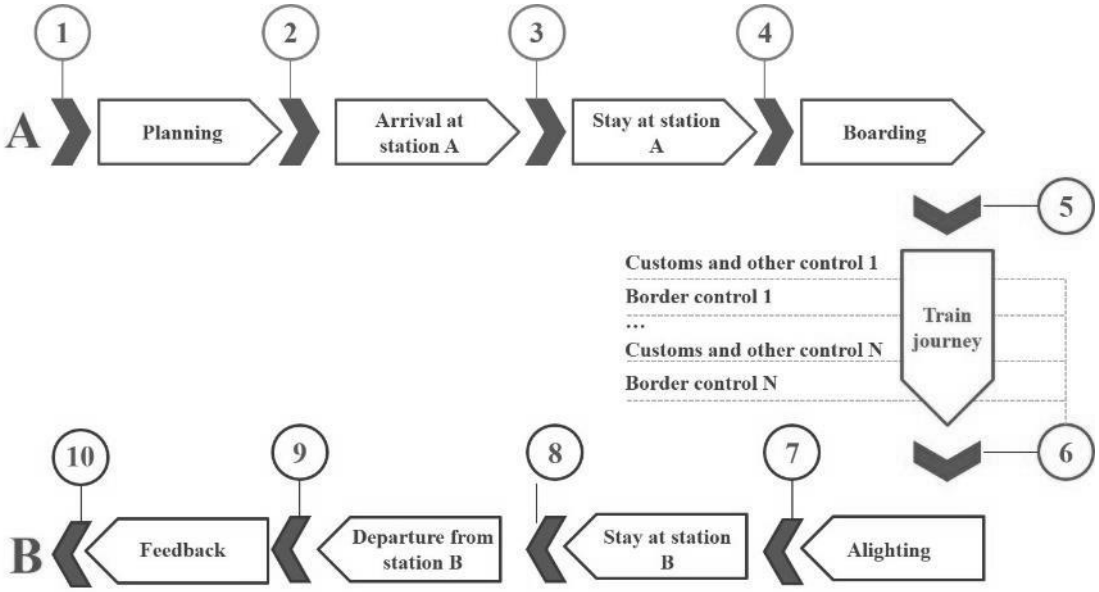
National passenger services, including high-speed, also require regulatory framework, but it is much more dependent on national rather than on regional or international approaches. The COVID-19 pandemic showed a drastic prevalence of local and national solutions upon any official international documents.

Meanwhile, in many countries of the Middle East regions important passenger projects are underway, and they will most probably importantly change the role of railways for social mobility.

Considering this, it is suggested to structure regional basic quality criteria for rail passenger services (including high-speed) from passengers' needs rather than from the point of view of railway managers, operators and administrators.

A well-known and widely implemented structure of a passenger's route (standard path) is used.

Figure 41. Standard rail passenger route



The basis for the quality criteria:

- awareness,
- physical accessibility,
- accessibility for foreign users,
- sufficiency of information at rail premises,
- affordability of services,
- fast and easy security check (if necessary),
- fast and easy control procedures while boarding and at border crossings (for international trains),
- convenient intermodal connections with priority for the pedestrians,
- collection of feedback from users.

Table 7. Middle East Railways basic quality criteria for passenger services 2050

No	Stage	Issues	Middle East Railways 2050 quality criteria – check list	International benchmark (available international tools, best practice cases and guidelines for passengers and railway companies)
1.	**Planning**	1.1. information on existing network and services	□ information on routes, services and prices is available online prior to booking	○ www.raileurope.com and similar commercial Internet resources
		1.2. railway accessibility, also concerning booking procedures and language	□ information on on routes, services and prices is available in foreign languages (at least English is obligatory), □ information on booking, whether or not booking is not made online, is available in foreign languages □ special booking modes for persons with reduced mobility (PRM) are proposed	○ UIC PRM assistance booking tool[18]; ○ UIC Leaflet 145[19]; ○ European Regulation (EC) 1371/2007 on rail passengers' rights and obligations

[18] https://uic.org/projects/prm-assistance-booking-tool-398
[19] https://www.shop-etf.com/en/recommendations-for-the-organisation-of-assistance-services-for-persons-with-reduced-mobility-8868

No	Stage	Issues	Middle East Railways 2050 quality criteria – check list	International benchmark (available international tools, best practice cases and guidelines for passengers and railway companies)
		1.3. ticket prices and their affordability	□ ticket prices are modelled against the existing demand and purchasing power □ whenever possible various categories of prices are proposed for different segments □ yield management (dynamic prices) is applied	○ UIC MERITS (Multiple East-West Railway Integrated Timetable Storage) and UIC-DRTF (UIC Database for Rail Tariffs and Fares); ○ yield management systems by different railway undertakings: Abellio, KORAIL, ÖBB, Renfe, RZD, SNCF, Thalys, etc.
		1.4. ticket sales and access to reservation system, also cancellation rules	□ cancellation rules are available for users prior to booking, also in foreign languages (at least English), □ ticket sales are accessible online □ ticket sales are available via agents □ ticket sales are available via other railways of the region	○ European Regulation (EC) 1371/2007 on rail passengers' rights and obligations; ○ UIC MERITS (Multiple East-West Railway Integrated Timetable Storage) and UIC-DRTF (UIC DATABASE FOR RAIL TARIFFS AND FARES) (PRIce and Fare Information Storage); ○ Hermes data transfer platform[20]; ○ Automated passenger transportation management system EXPRESS-3 (Russian Federation, CIS, Latvia, Lithuania, Estonia)[21]
2.	**Arrival at station of departure**	1.1. accessibility	□ station entrance is accessible to PRM □ information at station at arrival stage is clear for foreign passengers (at least duplicated in English)	
		1.2. intermodality and cooperation with other transportation modes	□ pedestrian accesses are prioritised with mo more than 150m walk or travelators □ access to station with large luggage is possible	○ UIC, UITP and IATA intermodality projects: Door2Door and Air+Rail ○ UIC Stations for high speed systems: Toolbox for the design and/or renovation of major interchanges[22].
3.	**Stay at station of departure**	1.1. accessibility	□ station is accessible to PRM, including toilets and all facilities □ station is accessible for foreign users (pictograms prioritised, information at least in English is obligatory)	○ see p.1.2.; ○ Accessibility map for stations (SNCF[23]); ○ Mobile application for persons with reduced mobility (SNCF, Adif, RZD, etc.)
		1.2. control procedures	□ control procedures take less than 20 min for all types of services and number of passengers, including queuing time □ control procedures do not impose deviation of passengers' routes or changes in services	○ UNECE Convention on the Facilitation of Border Crossing Procedures for Passengers, Luggage and Load-luggage Carried in International Traffic by Rail[24]
		1.3. information	□ location of information is checked within focus-groups to match decision-making points	○ UIC IRS 10181 ○ Reference information for international passengers travelling on railway during

[20] http://www.hitrail.com/
[21] https://www.vniizht.ru/index.php?id=319
[22] https://www.shop-etf.com/en/toolbox-for-the-design-and-or-renovation-of-major-interchanges
[23] https://www.accessibilite.sncf.com/informations-et-services/accessibilite-gare-par-gare/
[24] https://www.unece.org/fileadmin/DAM/trans/conventn/Rail_border_crossing_procedures_for_passengers_2019_e.pdf

No	Stage	Issues	Middle East Railways 2050 quality criteria – check list	International benchmark (available international tools, best practice cases and guidelines for passengers and railway companies)
			□ infromatiomn is available in foreign languages, at leas in English, □ information is dynamic for train departures □ information is accessible for PRM (visually impair, etc.) □ information is available online (applications, etc.)	FIFA Confederations Cup 2017 and FIFA World Cup 2018 events in the Russian Federation
		1.4. security	□ security check takes no more than 10 minutes regardless the queue □ security procedures do not impose deviation of passengers' routes or changes in services	○ Station security and station business: handbook on effective solutions (UIC leaflet); Rules of behavior for passengers and visitors at railway stations, platforms and trains and in emergency situations (UIC leaflet)
		1.5. station quality	□ station matches UIC station quality criteria	○ UIC IRS on Station Quality
		1.6. special commerce linked to intercountry traffic	□ if allowed by local regulation, duty-free shops are available	○ Duty-free shops at railway stations (RZD[25], MTR[26])
4.	**Boarding**		□ electronic ticket control □ boarding is accessible for PRM	○ UNECE Convention on the Facilitation of Border Crossing Procedures for Passengers, Luggage and Load-luggage Carried in International Traffic by Rail; ○ Reference information for international passengers travelling on railway during FIFA Confederations Cup 2017 and FIFA World Cup 2018 events in the Russian Federation; ○ UIC Electronic Ticket Control Database (ETCD); ○ Pre-boarding control procedures at stations (Eurostar, Allegro trains)
5.	**Train journey**	5.1. accessibility	□ trains are accessible for PRM	○ see p. 1.2
		5.2. information	□ passengers are informed along the route in a physical and digital ways □ information is available in foreign languages (at least in English)	○ Specification for passenger information displayed electronically in trains (UIC Leaflet); ○ Reference information for international passengers travelling on railway during FIFA Confederations Cup 2017 and FIFA World Cup 2018 events in the Russian Federation
		5.3. security	□ security checks on board are absent or minimised	○ Rail High Speed Network Security Handbook (UIC Leaflet); ○ Security of International passenger transport within East-West Corridor (UIC Leaflet)
		5.4. services	□ passengers are pre-informed on services on board	○ European Regulation (EC) 1371/2007 on rail passengers' rights and obligations;

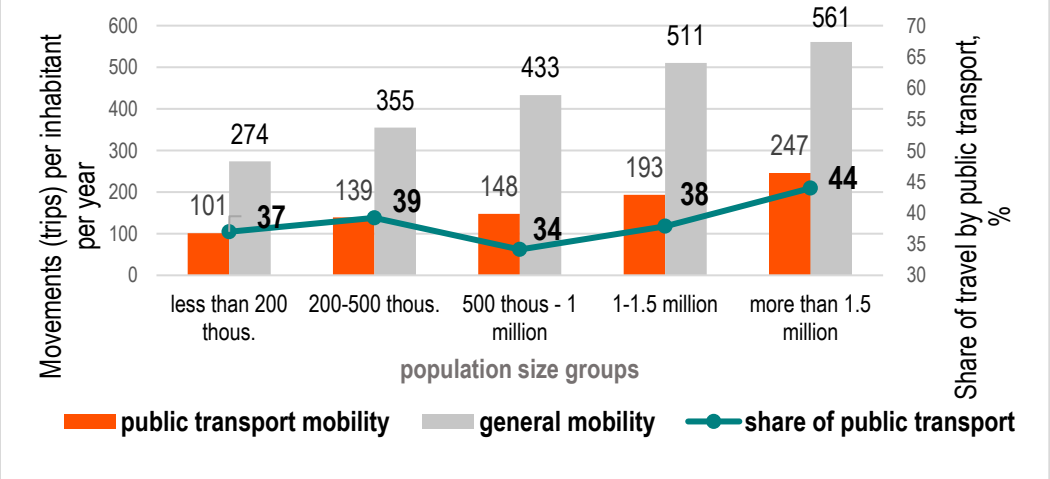
[25] https://nextstation.org/IMG/pdf/4_-_ppt_-_the_first_in_europe_duty_free_shop_at_the_railway_station_-_andrey_martynyuk.pdf
[26] http://www.mtr.com.hk/en/customer/main/hong-kong-west-kowloon-station-shops-offers.html

No	Stage	Issues	Middle East Railways 2050 quality criteria – check list	International benchmark (available international tools, best practice cases and guidelines for passengers and railway companies)
			□ digital applications are available □ restauration facilities are available	○ Reference information for international passengers travelling on railway during FIFA Confederations Cup 2017 and FIFA World Cup 2018 events in the Russian Federation
6.	**Border-crossing**		□ control procedures carried out in the daytime only	○ UNECE Convention on the Facilitation of Border Crossing Procedures for Passengers, Luggage and Load-luggage Carried in International Traffic by Rail
7.	**Alighting**	See p. 4		
8.	**Stay at station of arrival**	See p. 3		
9.	**Departure from station of arrival**	See p. 2		
10.	**Feedback**		□ feedback ford are available in the trains □ feedback forms are available at stations □ feedback forms are available in a digital form (online, applications, etc.) □ feedback forms are available in foreign languages (at least in English) □ feedback is regularly collected and analysed	○ European Regulation (EC) 1371/2007 on rail passengers' rights and obligations; ○ OSJD SMPS

3. URBAN RAIL SERVICES AND QUALITY CRITERIA

Urban rail services – commuter cross-city trains, light rail transport, tramways – are gaining a larger share in the urban transport mix in many countries all over the world. Considering high population density and demographic forecasts in many countries of the Middle East region, as well as environmental sustainability of rail transport, its role should be emphasised in the regional Vision along with regional and long-distance rail transportation.

Figure 42. Average dependency of the public transport share in total mobility on the population size



Source: InfraEconomy Group based on big data analysis for more than 30 cities

All basic quality criteria referring to the passenger rail services are as well relevant to urban services. What is different are governance, management and financing issues, though to a far extent this refers more to transport administrations or city authorities rather than to operating companies.

Table 8. Middle East Railways basic quality criteria for urban rail services 2050

	TARGETS	QUALITY CRITERIA
PLANNING	Planning of urban rail services linked to social trends, urban development and general transport services	□ **consideration and monitoring of demographic, employment and other social parameters** □ **consideration and monitoring of demographic, employment and other social parameters** □ **planning of urban services in connection to regional, national, international services**
OPERATIONS	Conformity to pre-set and approved by the authorities parameters	□ **setting up target characteristics for each route (capacity, frequency, fares, design) in partnership with local authorities**
GOVERNANCE	Competition for the route and not on the same route	□ **avoidance of competition of various operators on the route**[27]
FINANCING AND FINANCIAL SUPPORT	Sustainable financing considering high demand for subsidies and governmental support	□ **avoidance of low taxation in favour of other means of support (loss compensation subsidies, subsidies and soft loans for infrastructure development and vehicle renewal)**

Rail-based urban mobility should be promoted in the Middle East region, though the exact parameters can only be proposed for each specific case.

Urban mobility is a key 'meeting area' among railways and local authorities and extensive dialogue on standards, quality criteria, governance and financing issues should be encouraged.

.

[27] For trams, LRT and other urban-only transports

VII. RAIL FREIGHT TRANSPORTATION AND HUBS

Objectives for the Middle East Railways 2050 referring to rail freight:

Objective D. Adopt the strategic principles and priorities for regional freight planning, quality criteria for rail services Suggested activities:

D.1. forecast of potential rail freight flows along the corridors to prioritise segments and define strategic hubs for the benefit of all RAME members.

D.2. definition of optimal quality criteria and dissemination of solutions to harmonise and optimise the border crossing procedures and efficient border crossing technologies.

1. MIDDLE EAST RAIL FREIGHT MODEL AND PRIORITIES

1.1. Projected freight flows under various scenarios

Three scenarios derived from the trade forecasts are used to model the freight flows until 2050. The modelling methodology is briefly described in Annex 1.

As the level of uncertainty due to global geopolitical changes is very high, **only top and bottom projections are proposed in the current Vision** corresponding to the pessimistic and the optimistic scenarios. Such approach allows analysis of both basic needs in infrastructure capacities and maximum volume of required investments.

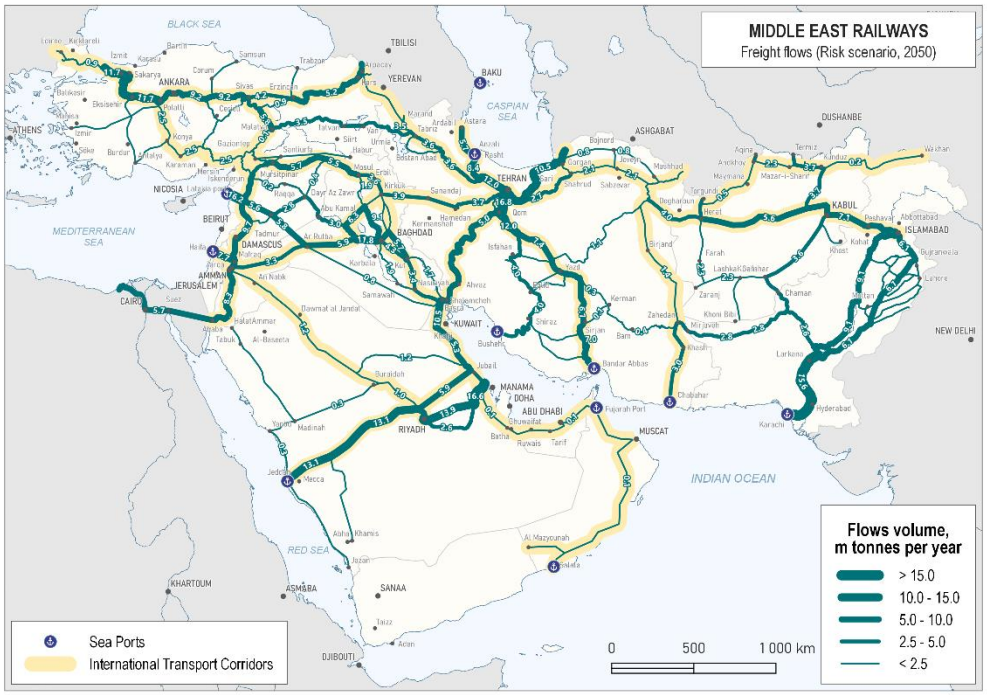
However, **additional comparison for a baseline scenario is provided to consider effects from the proposed new rail links**.

Risk scenario

By 2030, **just over 2% of the possible freight base** will be shifted to rail, a significant share total flows will refer to the trade links between neighbouring countries.

By 2050 the share of rail will slightly increase, and the highest shift to rail will be attributed to the segments connected to the seaports.

Figure 43. Modelled rail flows in the Middle East region by 2050 under risk scenario (excl. domestic flows)

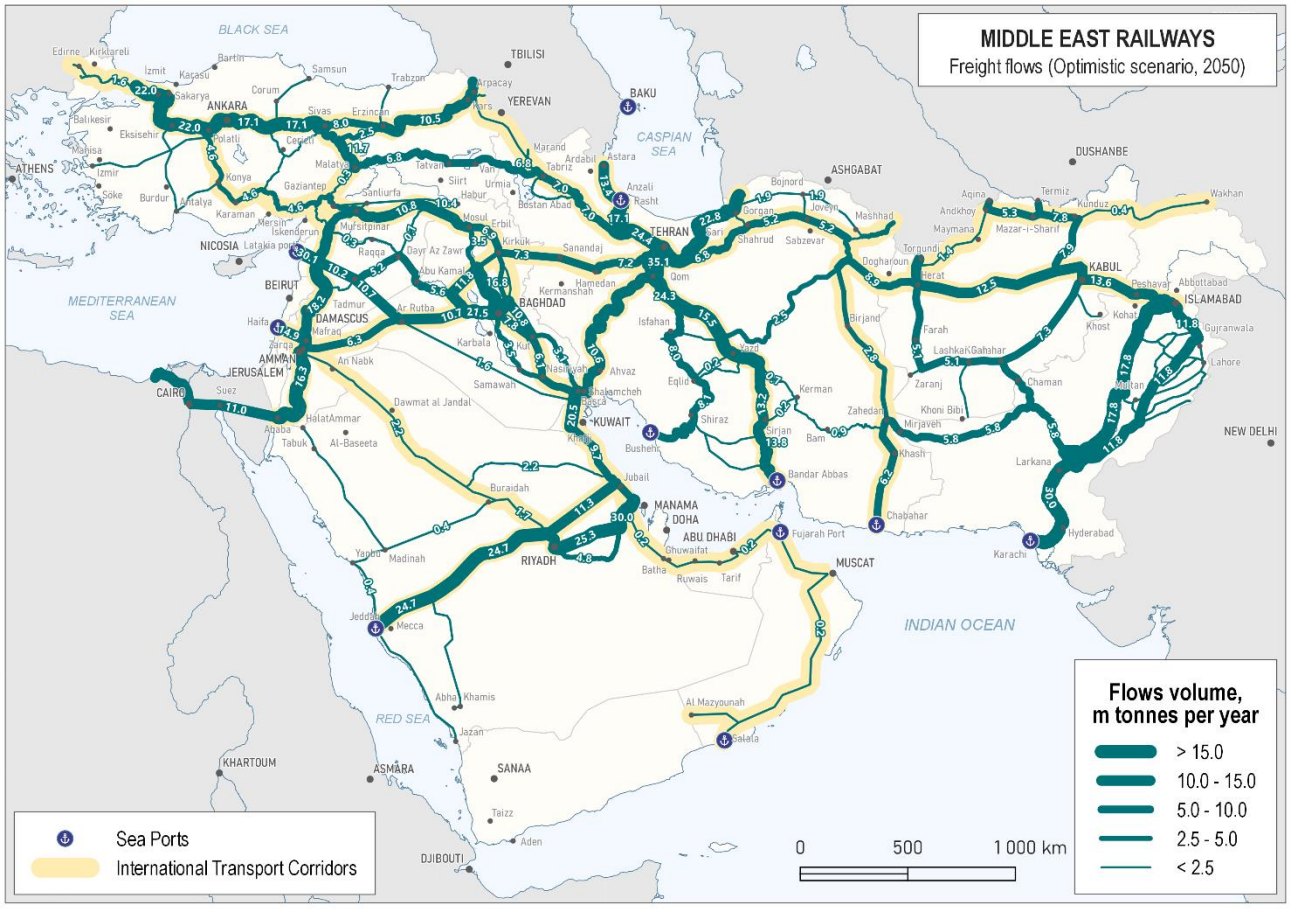


Optimistic scenario

It is assumed that trade relations of the Middle East countries will grow at the fastest pace, which will predetermine a higher level of demand for transport services. In order to realise this trade scenario, accelerated development of the rail and port infrastructure will be necessary, as **the currently planned transport capacities do not have reserves to meet this volume of demand for export-import traffic**. The potential traffic demand for many projects will exceed 3 million tons in 2030. Railways will also remain the most in-demand projects in this scenario, aiming to increase freight traffic towards ports.

The optimistic scenario predicts significantly higher levels of freight traffic in 2050 for most railway projects. A number of segments would have freight traffic volumes over of 10 million tons. The volume of transport by rail can reach **5% of the potential freight base**, and on some links within the region, rail transport could take **up to 25%** of total freight demand.

Figure 44. Modelled rail flows in the Middle East region by 2050 under optimistic scenario (excl. domestic flows)



Based on the modelling results, total forecasted volume of freight flows can be assessed for each corridor under various scenarios.

Table 9. Forecasted annual rail freight flows by corridors in 2030 and in 2050

Corridor	Total forecasted volume of freight flows, 2030, m tons		Share of external connections, 2030		Total forecasted volume of freight flows, 2050, m tons		Share of external connections, 2050	
	Risk	Optimistic	Risk	Optimistic	Risk	Optimistic	Risk	Optimistic
South Asia - Middle East - Europe	7.49	9.87	69%	69%	**8,35**	**16,81**	**63%**	**65%**
North - South	5.59	7.19	78%	78%	**8,79**	**18,63**	**65%**	**65%**
Africa - Middle East - Europe	4.54	5.73	63%	64%	**7,05**	**13,43**	**63%**	**66%**

Corridor	Total forecasted volume of freight flows, 2030, m tons		Share of external connections, 2030		Total forecasted volume of freight flows, 2050, m tons		Share of external connections, 2050	
Arabian Peninsula - I. R. Iran - Central East/ South Asia	4.23	5.31	62%	61%	**5,59**	**11,08**	**61%**	**62%**
East Asia - Middle East - Europe	3.33	4.22	53%	58%	**5,31**	**9,79**	**48%**	**62%**
East Asia - Middle East - Africa	3.24	4.21	59%	54%	**5,11**	**10,59**	**60%**	**49%**
Arabian Peninsula - Europe	2.14	2.72	60%	60%	**3,06**	**5,78**	**60%**	**61%**
Africa - Arabian Peninsula	1.47	1.86	74%	73%	**2,29**	**4,42**	**71%**	**75%**

Apart from a high share of external (out-of-region) connections, it is still noticeable that the corridors are extremely **important for intra-regional trade**.

Baseline: comparison of fully connected network and network with missing links

Figure 45. Modelled rail flows in the Middle East region by 2050 under baseline scenario with NO CHANGES apart from projects from existing strategic documents

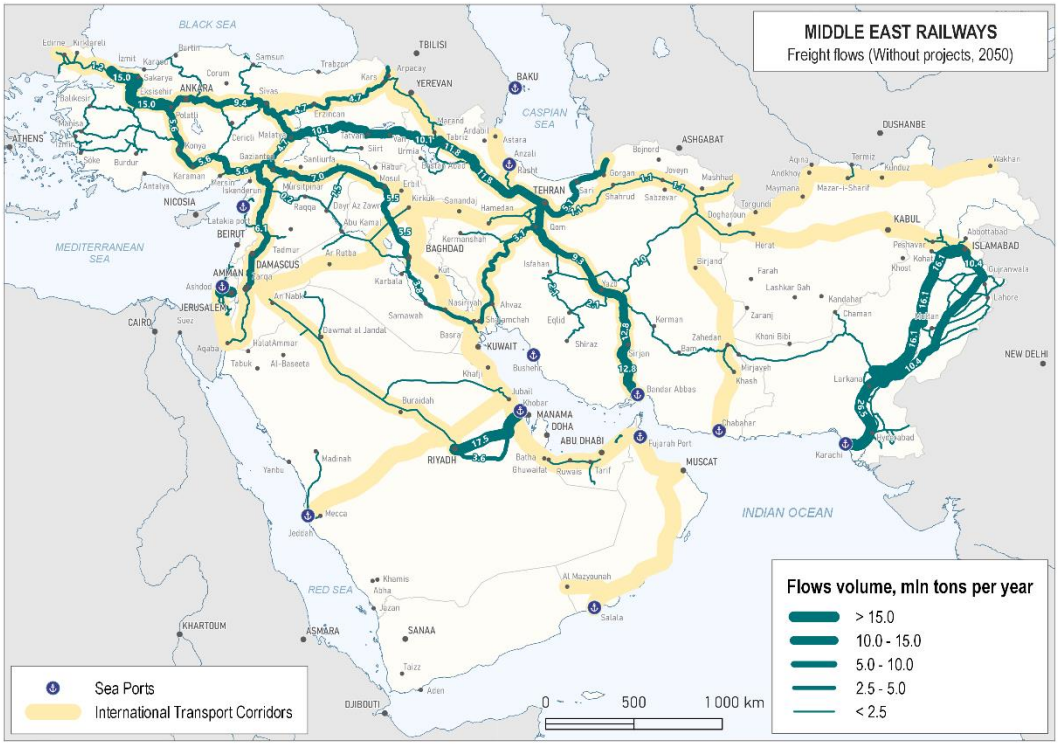
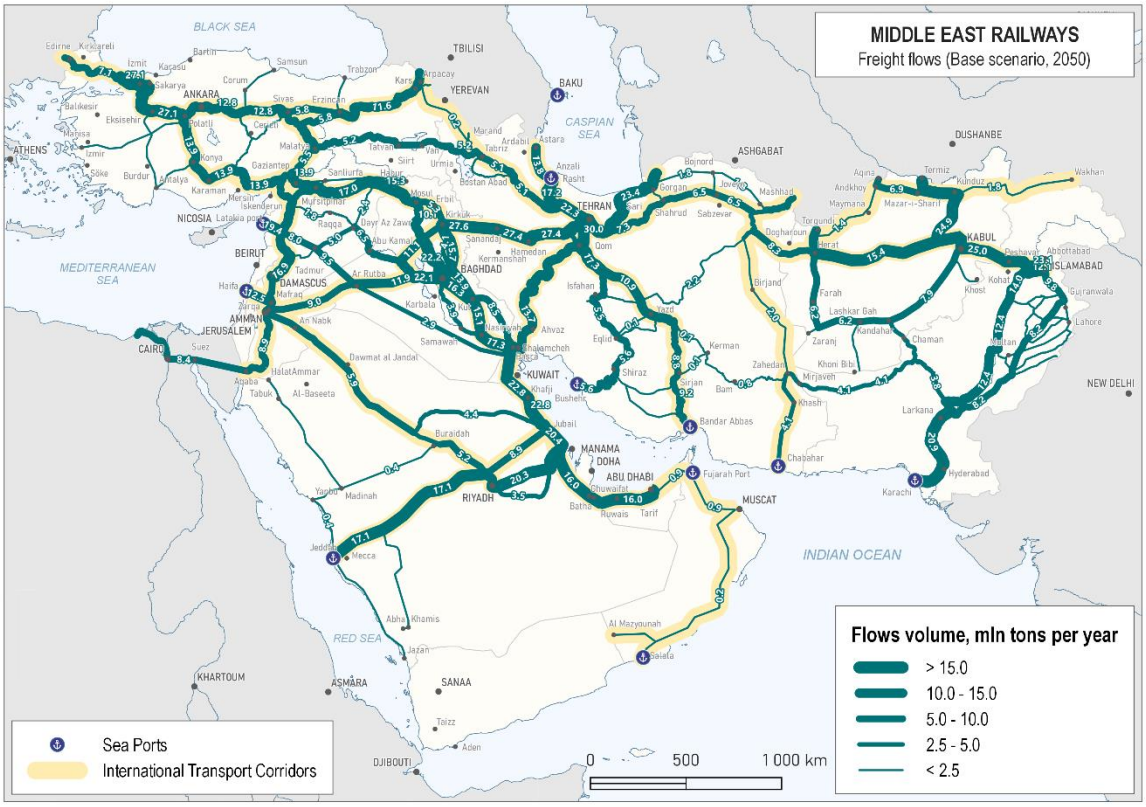


Figure 46. Modelled rail flows in the Middle East region by 2050 under baseline scenario with ADDITIONAL LINKS (suggested projects)



The comparison of partially connected and fully connected network under the same economic scenario in 2050 shows **important positive impact of the proposed links not only on the flows directly passing through these links of the countries of their localisation, but also on freight flows in distant countries that may even not be first-order neighbours**.

In the Eastern part of the Middle East region construction of new segments in Afghanistan may be beneficiary to relieve the congested capacities of Iran's and Pakistan's capacities (further on a specialisation for each route may be proposed based on the detailed analysis and forecast of the exact groups of commodities transported). Simultaneously this allows formation of a new meridian corridor for East – West routes bringing additional flows on the Iranian and Turkish networks.

Construction of new links in Iraq, Syrian Arab Republic and on the East and West of Arabian Peninsula results in drastic increase of connectivity and related freight flows in Saudi Arabia, UAE and further on the links from these countries to the North and North-West reaching Türkiye.

Suggested links to Africa may, among other revive rail freight in Jordan and in Israel and double the flows to the North of these countries.

The **flows described above are induced by rail enhancements**. This results in positive economic effects for all countries of the Middle East region evaluated and described in further chapters.

1.2. Freight hubs

The main points through which export-import cargo flows will leave the Middle East region will remain **seaports**. In many countries, projects are already underway to debottleneck the ports, both in terms of additional production capacity and the expansion of storage infrastructure and road and **rail approaches**.

At the same time, the development of rail transport will have a significant impact on the **connectivity of inland regions of the countries** and allow efficient delivery of different types of cargo (containerised, bulk liquid cargo) from points of cargo generation within the country to transport hubs located in ports. Unlike road transport, rail transport can provide lower costs for delivery of most types of cargo, especially when modern facilities for handling goods are available, both at freight generation centres and seaports.

In the period up to 2050, the trade potential of the region is extremely high, requiring the establishment of a large number of **container terminals and infrastructure for bulk cargo handling in seaports**. In addition, a developed logistics port infrastructure could additionally attract transit cargo, which would load both regional ports and linear infrastructure.

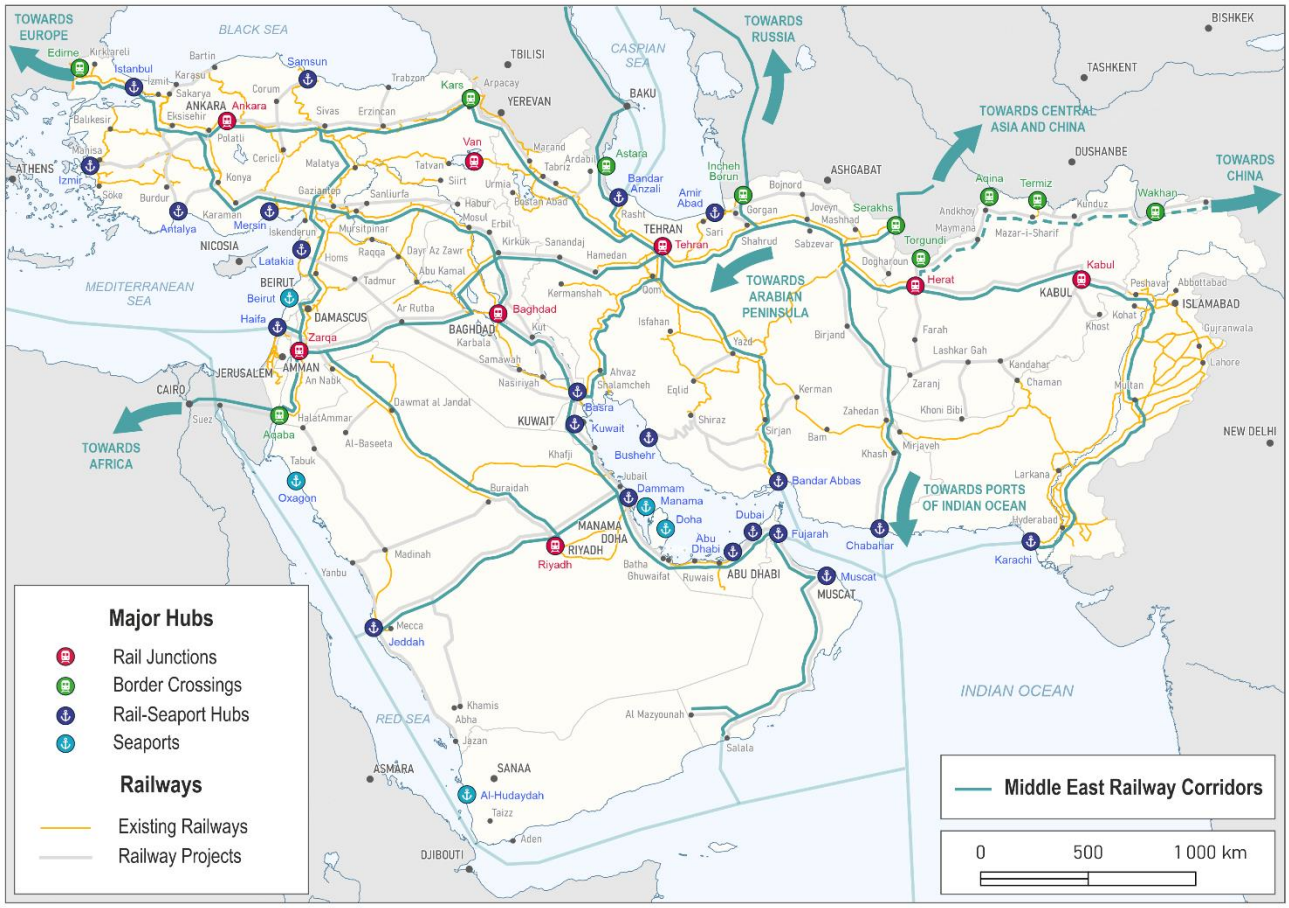
The development of linear railway infrastructure will open up opportunities for the development of **port railway terminals on the eastern Mediterranean coast**. A large number of port infrastructure development projects are already underway in the Arabian Peninsula, primarily in Saudi Arabia and the UAE. The creation of railway infrastructure in conjunction with transport and logistics centres in ports will maximise the production potential of the countries and increase the competitiveness of producers from these countries in global markets.

Besides ports, sufficient transport and logistics infrastructure at **border crossing points** is necessary for the efficiency of logistics chains passing through the countries of the Middle East region. **Lack of modern logistics infrastructure at country borders can lead to significant reductions in potential cargo flows**, longer transportation time, and reduced reliability and transparency of cargo operations. Particularly of high importance are those rail border crossings where there is a **change of gauge or a change in freight train technology** (train size, electrification). The est**ablishment of transport and logistics centres at such border crossings can have a significant impact on reducing the time of freight operations and total transport costs for shippers**.

A significant increase in the regional transport connectivity will be possible not only through the development of transport and logistics centres at entry/exit points, but also through the availability of sufficient logistics capacities **at freight generation centres as well as at hubs where freight flows from many transport routes converge**. The functionality of such transport hubs may primarily refer to **organisation of regular container fast connections both to other regional hubs and to ports and border crossings**. Major transport hubs where several transport corridors converge must be provided with the necessary terminals to **handle container cargo**.

Transport and logistics hubs can be established **in conjunction with industrial infrastructure** to increase their efficiency, providing new industrial plants with a high level of transport connectivity and hubs with a guaranteed cargo base. Such industrial sites can be established **either near port terminals or in conjunction with hubs located in inland areas at major transport junctions**. The high potential synergy effects make the proximity of transport, logistics and industrial infrastructure extremely beneficial for all parties involved, including the country where the projects are implemented.

Figure 47. Major Middle East railway hubs 2050



The table below provides suggested optimal parameters of rail hubs based on (a) the modelled traffic in 2050, (b) location, (c) types of cargo, (d) proximity to major cargo generation areas.

Table 10. Suggested parameters of the Middle East railway hubs 2050

KEY HUBS	TYPE	SIZE*	CONTAINER TERMINAL	BULK CARGO TERMINAL	INDUSTRIAL (PRODUCTION) INFRASTRUCTURE
Abu Dhabi	Seaport	Large	+	+	+
Al-Hudaydah	Seaport	Small	-	+	-
Amir Abad	Seaport	Small	-	+	-
Antalya	Seaport	Medium	+	+	-
Bandar Abbas	Seaport	Large	+	+	+
Bandar Anzali	Seaport	Medium	+	+	-
Basrah	Seaport	Large	+	+	+
Beirut	Seaport	Medium	+	+	+
Bushehr	Seaport	Medium	+	+	+
Chabahar	Seaport	Medium	+	+	+
Dammam	Seaport	Large	+	+	+
Doha	Seaport	Large	+	-	-
Dubai	Seaport	Large	+	+	-
Fujarah	Seaport	Large	+	+	+
Haifa	Seaport	Large	+	+	+
Istanbul	Seaport	Large	+	+	+
Izmir	Seaport	Large	+	+	+
Jeddah	Seaport	Large	+	+	+
Karachi	Seaport	Large	+	+	+
Kuwait	Seaport	Medium	+	+	+

KEY HUBS	TYPE	SIZE*	CONTAINER TERMINAL	BULK CARGO TERMINAL	INDUSTRIAL (PRODUCTION) INFRASTRUCTURE
Latakia	Seaport	Large	+	-	-
Manamah	Seaport	Medium	+	-	-
Mersin	Seaport	Large	+	+	+
Muscat	Seaport	Large	+	+	+
Oxagon (Neom)	Seaport	Medium	+	-	+
Samsun	Seaport	Large	+	+	+
Ankara	Junction	Large	+	+	+
Aqaba	Junction	Medium	+	+	+
Aqina	Border crossing	Small	+	-	-
Astara	Border crossing	Medium	+	+	-
Baghdad	Junction	Large	+	+	+
Edirne	Border crossing	Large	+	+	+
Herat	Junction	Medium	-	+	+
Incheh Borun	Border crossing	Large	+	+	-
Kabul	Junction	Large	+	+	+
Kars	Junction	Medium	+	-	-
Riyadh	Junction	Large	+	+	+
Serakhs	Border crossing	Small	+	-	-
Tehran	Junction	Large	+	+	+
Termiz	Border crossing	Medium	+	-	-
Torgundi	Border crossing	Medium	+	-	-
Van	Junction	Medium	+	+	-
Wakhan	Border crossing	Small	-	-	-
Zarqa	Junction	Medium	+	+	+

*Small - up to 3 million tonnes, medium - 3-10 million tonnes, large - more than 10 million tonnes

1.3. Recommendations on optimal parameters of freight corridor performance

To compete with alternative routes for the delivery of goods, the infrastructure managers and rail operators need to provide optimal freight train service parameters. The transportation speed should allow for shorter delivery times compared to maritime routes and competitive overland routes. In addition, shifting freight to the corridors will only be possible if the cost to shippers is commensurate with the alternative routes.

If transportation costs along the corridors are more than 1.5 times higher than along alternative routes, the demand for corridors will be extremely low and will not allow rail construction projects to achieve economic efficiency.

The greatest competition with alternative routes is predicted on the East Asia – Middle East – Europe corridor, so a sufficiently high level of freight train speed of at least 500 km/day is required. This speed would allow for a transport time of 20-22 days between the Chinese and European markets, which is 2 times faster than delivery by sea. Transport cost should be at $320 per tonne, which would be equivalent to $6-7,000 per FEU for container transport. With these pricing parameters, there would be a marginal difference in transport cost compared to maritime delivery, allowing the route to compete on East Asia – EU connections.

Other corridors should provide average speeds of 400-500 km per day, and approximately 1.5 times higher for container trains. **This is significantly higher than what the existing rail infrastructure in the Middle East region can provide at present.** The cost of transport on most corridors in the target state should be between $300 and $400 per tonne. The highest value would be in the South Asia - Middle East – Europe corridor, where the target cost would be more than $500 per tonne. This is due to the long haulage distances, as well as the large number of national borders to be crossed. This factor will make it difficult to compete with the developed maritime routes in this direction. At the same time, the corridor makes a significant contribution to increasing connectivity in the Middle

East region and has the potential to attract transit traffic in terms of those goods for which short delivery times are critical.

Table 11. Target parameters of the proposed corridors to ensure their competitiveness

CORRIDORS	AVERAGE TRANSPORTATION SPEED, KM/DAY	TRANSPORTATION PRICE[28], USD PER TONNE
Africa – Arabian Peninsula	550	323
Africa - Middle East – Europe	380	316
Arabian Peninsula – Europe	500	292
Arabian Peninsula – I.R.Iran – Central/East/South Asia	450	425
East Asia – Middle East – Europe	500	322
East Asia – Middle East – Africa	350	454
North – South	300	358
South Asia – Middle East – Europe	450	536

2. QUALITY CRITERIA FOR RAIL FREIGHT SERVICES

Similar to passenger services, rail freight services can be allocated by elements and relevant quality criteria may be proposed. These criteria may be used for both national and international services.

These criteria consider different levels of rail freight system in various countries and do not impose drastic changes like full market liberalisation or other polemic issues.

Table 12. Middle East Railways basic quality criteria for freight services 2050

	TARGETS	QUALITY CRITERIA
PLANNING	Planning of freight services based on actual and future demand	□ consideration and monitoring of trade flows forecasts by groups of commodities □ PMI (Purchasing Managers' Index): regular surveys among key national and regional producers (also not using rail) and shippers
INFORMATION	Full and reliable information	□ uniform statistics[29] (see relevant chapter) □ reliable and publicly available customer information for shippers, also in foreign languages (at least in English) □ information on the estimated time of arrival for shippers along the route
CHARGING AND PRICING POLICY	Attractive charging system assuring balanced logistics along the routes	□ uniform and simplified tariff system publicly accessible for potential customers □ yield management in terms of stimulating or inhibiting tariffs for specific commodities
SERVICES	Adjusted product range and easy-in-use services	□ one-stop-shop approach for shippers/ forwarders □ internal platform for authorised customers with statistics/ cargo tracking/ path request (if applicable) and similar tools □ priority conditions for block-trains (container trains) with high-value added commodities (if no block-trains are available,

[28] In 2022 prices, evaluation of tariffs has not been modelled within the Vision

[29] Even if not published it may still be necessary for planning and for communications with strategic partners

	TARGETS	QUALITY CRITERIA
		mixed trains with regular schedule can be a substitution)
RELIABILITY POLICY	Reliable transportation	□ **cargo tracking** □ **regular schedule** □ **time-fixed processes**
QUALITY ASSESSMENT AND MANAGEMENT	Regular adjustment of performance and management based on feedback from customers	□ **regularly adjusted KPIs** □ **regular feedback from clients (dedicated form accessible n national language and at least in English)** □ **regular feedback from internal staff on the management process**
ENVIRONMENTAL SUSTAINABILITY	Promotion of more sustainable way of transportation	□ **information for customers on CO2 emissions** □ **check for optimal choice of technologies in terms of environmental impact (see relevant chapter)**

VIII. ENVIRONMENTAL, SOCIAL AND CORPORATE GOVERNANCE (ESG)

Objectives for the Middle East Railways 2050 referring to ESG:

Objective G. Adopt and consider regional ESG targets together with dedicated financing tools and cooperation mechanisms for knowledge-sharing for rail projects.

Suggested activities:

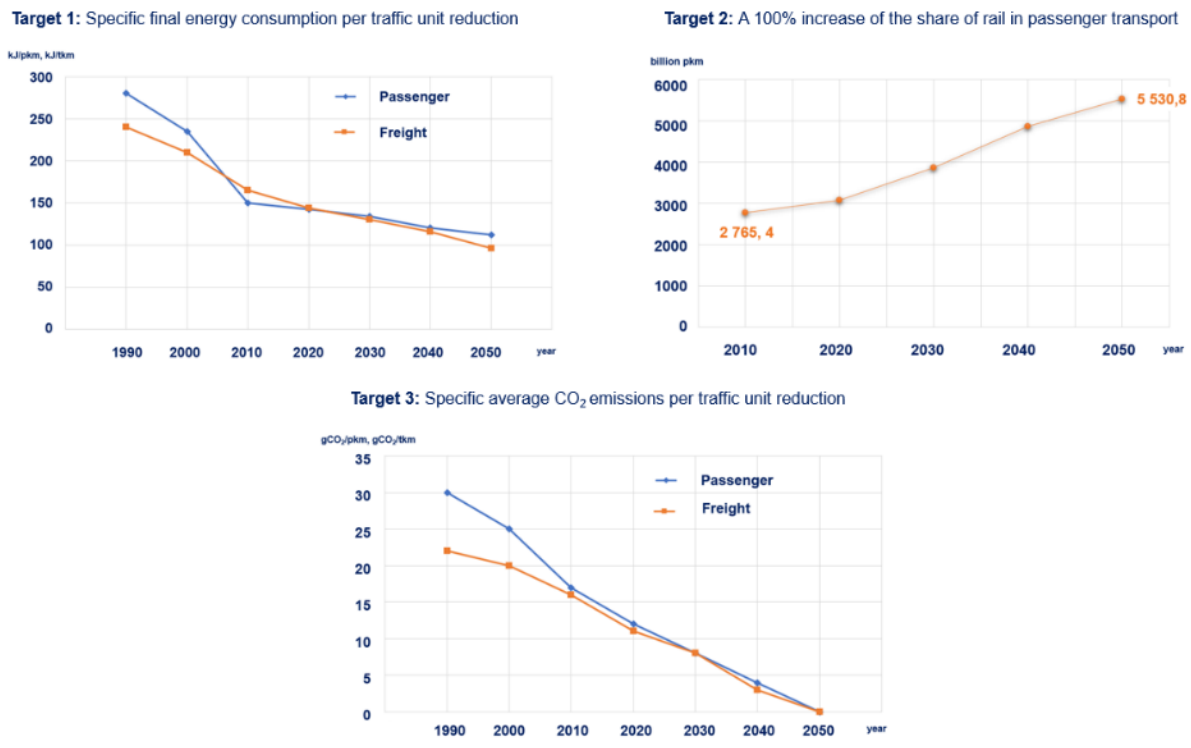
G.1. Agreement on ESG targets with further implementation within members.
G.2. Organising a permanent communication platform with international and national development institutions.

1. TYPICAL AND REGIONAL QUALITY CRITERIA FOR ESG

Rail has an essential role in contributing to many sustainable development goals. Firstly, it is the most environmentally friendly transportation mode. In 2019 global CO_2 emissions from the transportation sector reached 8,5 Gt. Rail transport accounts for 1.2% of direct CO_2 emissions produced by the transport sector (IEA data). Secondly, rail has a significant social impact on the social mobility. Finally, rail is at the forefront of the corporate governance system improvement. In terms of global rail sustainability, there are 3 global targets by 2050[30]:

- to reduce specific **final energy consumption per traffic unit** by 60% compared to 1990 level,
- to achieve a **100% increase of the share of rail in passenger transport** compared to a 2010 baseline,
- to substantially **reduce CO_2 emissions** in comparison with 1990 level.

Figure 48. UIC ESG global targets



Source: UIC[31,32]

The Middle East countries have great potential to further improve rail sustainability indicators.

[30] https://uic.org/IMG/pdf/briefing_note_new_declaration_v1.0.pdf
[31] https://uic.org/IMG/pdf/handbook_iea-uic_2017_web3.pdf
[32] https://uic.org/IMG/pdf/low_carbon_rail_challenge_technical_report.pdf

Vision 2050 refers to the ESG targets that are applicable to the heterogeneous countries aimed primarily at sustaining constant positive changes and relevant corporate policies rather than at achieving the exact indicators that can be set up individually.

The Middle East rail performance assessment could be based on the following ESG parameters.

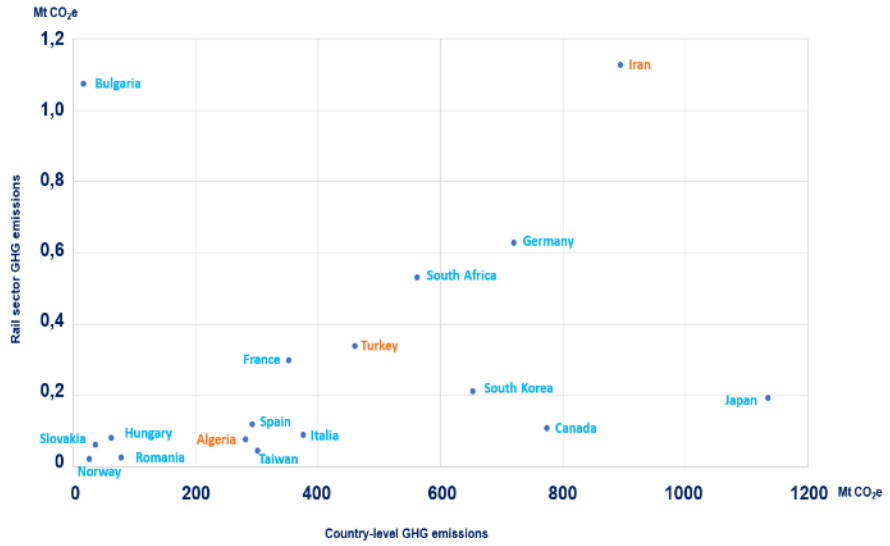
- **Environmental indicators**: Greenhouse Gas (GHG) emissions, share of lines with non-fossil traction types in total railway network length, electricity share in railway energy consumption, railway energy efficiency, continuous cycle of constant eco-improvements.
- **Social metrics**: accessibility of rail mobility, affordability of rail mobility, rail safety, share of cancelled and delayed trains, average wages in the sector.
- **Corporate governance**: policies for managing ESG risks and opportunities, general risk management in favour of resilience, policies of access to information, policies of active feedback.

1.1. Environmental targets and quality criteria

The Middle East Railways Vision 2050 suggests the following environmental metrics and targets:

- to substantially **reduce rail sector CO_2 emissions**,
- to **improve energy efficiency**,
- to **increase share of lines with non-fossil fuel-based traction types**,
- to ensure a **continuous cycle of constant eco-improvements**.

Figure 49. GHG emissions in the rail sector (scope 1), 2020



Source: CAIT[33], UIC[34]

Several countries of the Middle East region (UAE, Saudi Arabia) pledged to become carbon neutral by 2050 or 2060[35][36]. In the Middle East, there is a great potential **to reduce GHG emissions** from railways, that could decline because of increasing energy efficiency and railways electrification.

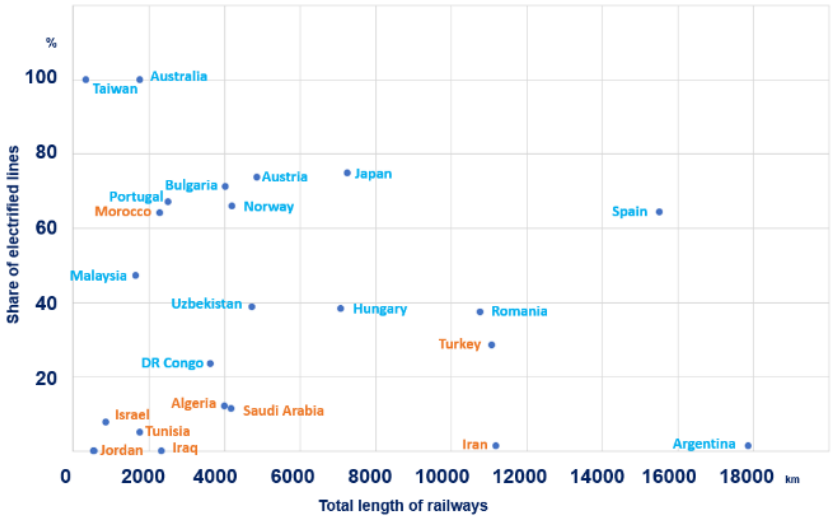
Rail requires 12 times less energy than other transportation modes, making it the most efficient alternative[37]. **Energy efficiency** could be further improved by reducing energy consumption or decarbonising energy supply. Nevertheless, alongside with reducing direct GHG emissions, the Middle East railways need to continue **boosting passenger and freight trains energy efficiency**.

At the same time, achievement of carbon neutrality requires important investments and use technologies that might not yet be accessible for all railways of the region. In this case, **it is recommended to consider the best**

[33] https://datasets.wri.org/dataset/cait-country
[34] https://uic-stats.uic.org/
[35] https://www.reuters.com/world/middle-east/uae-launches-plan-achieve-net-zero-emissions-by-2050-2021-10-07/
[36] https://www.bbc.com/news/world-middle-east-58955584
[37] https://www.iea.org/reports/rail

available options for new projects and for refurbishment.

Figure 50. Share of electrified lines in total railway network, 2020

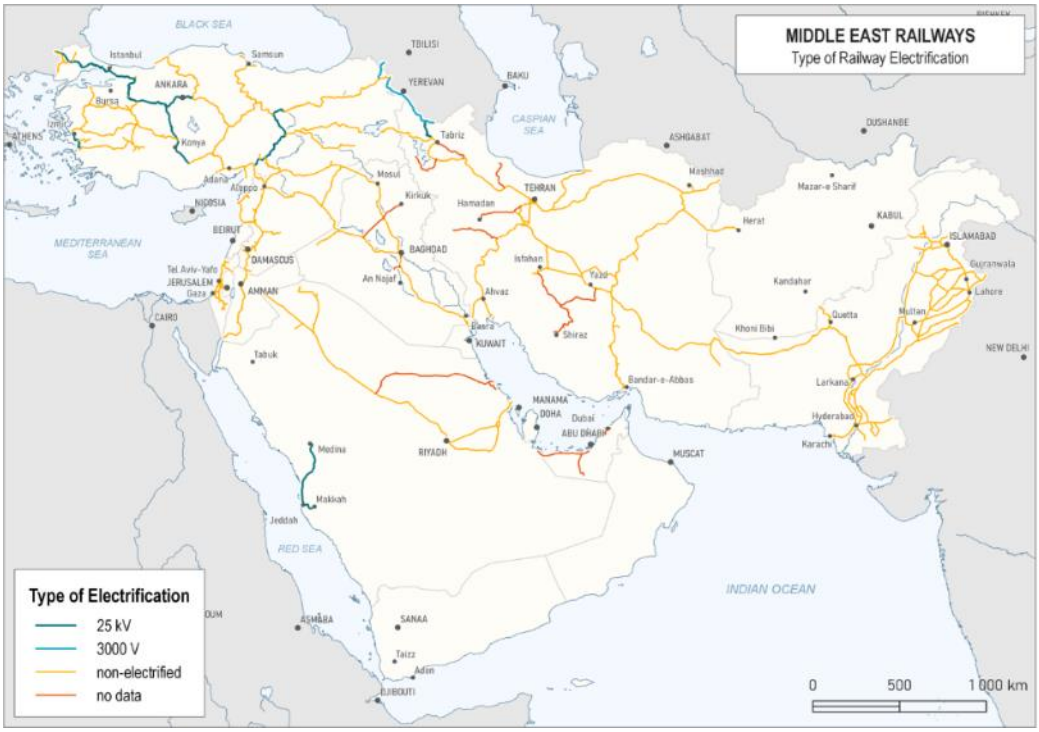


According to IEA, 75% of passenger movements and 50% of freight rely on electricity[42]. The global market volume for railway electrification is expected to rise at a CAGR of 0.7% per year until 2025[43]. In the Middle East, high prevalence of diesel locomotives, technological barriers, and significant costs are still the main reason of a **low railway electrification share across the region**.

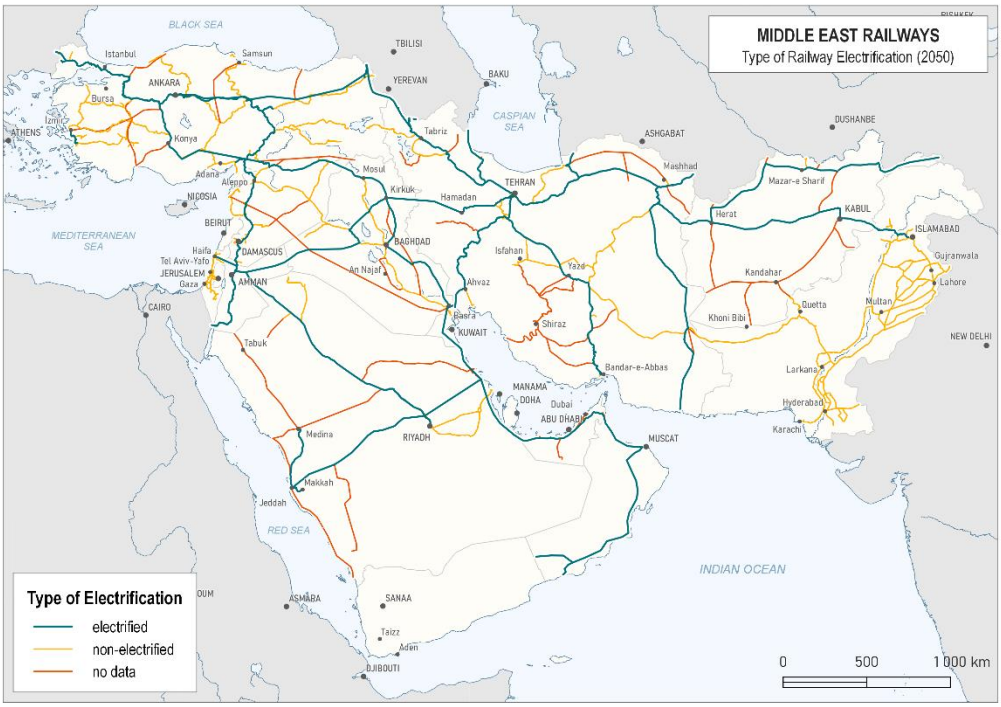
Source: SAR[38],TCDD[39], UIC[40][41]

The Middle East maps illustrate the current state of railways electrification and its prospects through 2050.The Middle East Railways Vision 2050 suggests **electrifying new projects and international corridors or switch to non-fossil fuels (hydrogen, batteries)**. All of these options are expensive, that is why it is suggested to concentrate on the projects referring to regional priorities (backbone network), that, in its turn, may boost trade and economic growth.

Figure 51. Middle East railways electrification/ non-fossil fuels use map: current state and Vision 2050



[38] https://www.sar.com.sa/
[39] https://www.tcdd.gov.tr/en/organizational/reports
[40] https://uic-stats.uic.org/
[41] https://uic.org/IMG/pdf/uic-railway-statistics-synopsis-2022.pdf
[42] https://iea.blob.core.windows.net/assets/fb7dc9e4-d5ff-4a22-ac07-ef3ca73ac680/The_Future_of_Rail.pdf
[43] https://www.railwaypro.com/wp/worldwide-rail-electrification-remains-at-high-volume/



Source: UIC RAME, authors' projections

Among all proposed metrics, the key one is a continuous cycle of eco-improvements. This principle allows consideration of different levels of technological development in the region, budgetary constraints and different national goals. This principle is further on to be reflected in the corporate policies and described in detail.

Table 13. Environmental targets and quality criteria for the railways of the Middle East region

TARGETS	MIDDLE EAST AVERAGE (2020)	GLOBAL AVERAGE (2020)	INTERNATIONAL BEST OPTION BENCHMARK	QUALITY CRITERIA FOR THE MIDDLE EAST RAILWAYS
Decrease in GHG emissions and pollutants	**0.5**[44] Mt CO_2-e	0.6 Mt CO_2-e	**0**[45] [46] Mt CO_2-e	☐ to ensure **constant annual reducing of the rail sector CO_2 and NO_x emissions**
Shift to non-fossil fuel based traction solutions (electric, hydrogen, batteries).	**18.6**[47] [48] % electrified	44.0 % electrified	**100**[49] [50] % electrified	☐ to electrify or to introduce **new non-fossil traction services on the segments of the international transport corridors** by 2050
Increase in energy efficiency	**-**	-	**-**	☐ to ensure **implementation of the most efficient (among available ones) energy-saving solutions** for new railway projects and refurbishment
Continuous cycle of eco-improvements	**-**	-	**-**	☐ **to implement within the corporate policies the principle of continuous cycle of eco-**

[44] Algeria, I.R. Iran, Türkiye
[45] https://uic.org/sustainability/energy-efficiency-and-co2-emissions/railway-climate-responsibility-pledge
[46] Carbon neutrality benchmark includes Scope 1 and Scope 2
[47] Assuming that under construction projects will be electrified
[48] Algeria, Iran, Egypt, Israel, Jordan, Morocco, Saudi Arabia, Tunisia, Turkey, UAE
[49] https://www.business-standard.com/article/economy-policy/economic-survey-railways-target-100-electrification-by-dec-2023-122013100926_1.html#:~:text=The%20Indian%20Railways%20(IR)%20has,said%20economic%20survey%202021%2D22.&text=16%3A38%20IST-,The%20Indian%20Railways%20(IR)%20has%20set%20a%20target%20of%20100,said%20economic%20survey%202021%2D22.
[50] India target benchmark

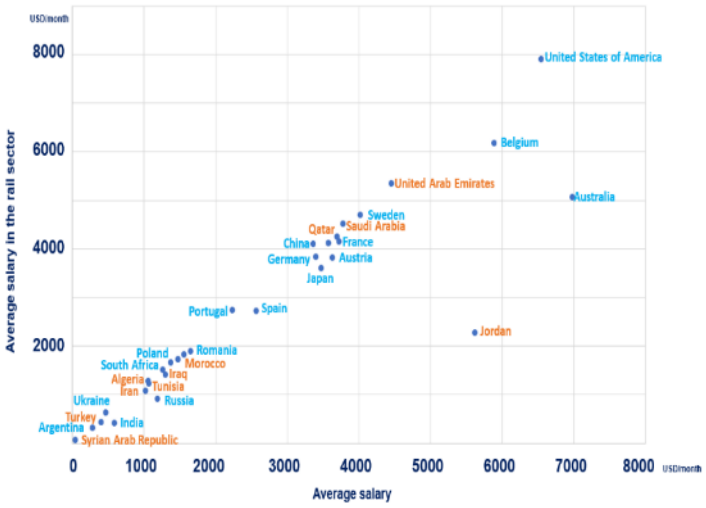
TARGETS	MIDDLE EAST AVERAGE (2020)	GLOBAL AVERAGE (2020)	INTERNATIONAL BEST OPTION BENCHMARK	QUALITY CRITERIA FOR THE MIDDLE EAST RAILWAYS
				improvements: new targets should appear upon successful achievement of previous ones according to available technologies and budgets

1.2. Social targets and quality criteria

The Middle East Railways Vision 2050 suggests the following social metrics and targets:

- to ensure **compliance of sectoral wages** with national average,
- to ensure **accessibility and affordability** of rail passenger services,
- to ensure **reliability of passenger rail services**,
- to ensure positive impact of railways on the **cohesion of territories** within the countries and within the region,
- to improve **safety** of rail services,
- to ensure **non-discriminatory principles of recruitment** for all types of staff.

Figure 52. Average monthly salary in the rail sector, 2022

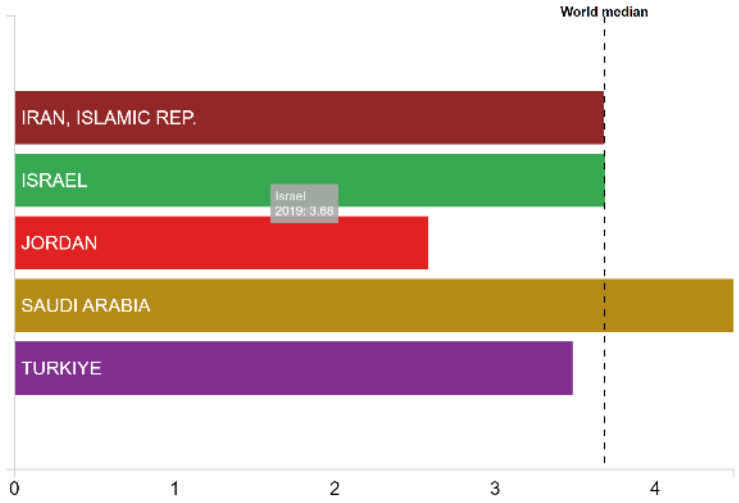


Source: Salary Explorer, World Salaries[51], Talent[52]

Average salary significantly affects the railway employment attractiveness to local communities. Average wage index includes a huge range of railway jobs – from locomotive drivers to rail engineers. The Middle East countries' average salary in the rail sector is 1.2 times less than the global result. Also, average wages in the rail sector are on average 15% lower than average salaries in the Middle Eastern economies. However, some Middle East countries' rail wages levels are among ones of the world's best that indicates the possibility of a **slight salary increase and a gender pay gap reduction**[53].

[51] https://worldsalaries.com/average-rail-engineer-salary-in-biskra/algeria/
[52] https://au.talent.com/salary?job=rail
[53] https://www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/@publ/documents/publication/wcms_762534.pdf, https://www.ilo.org/beirut/media-centre/news/WCMS_732556/lang--en/index.htm

Figure 53. Efficiency of train services in selected countries of the Middle East region[54], 2019

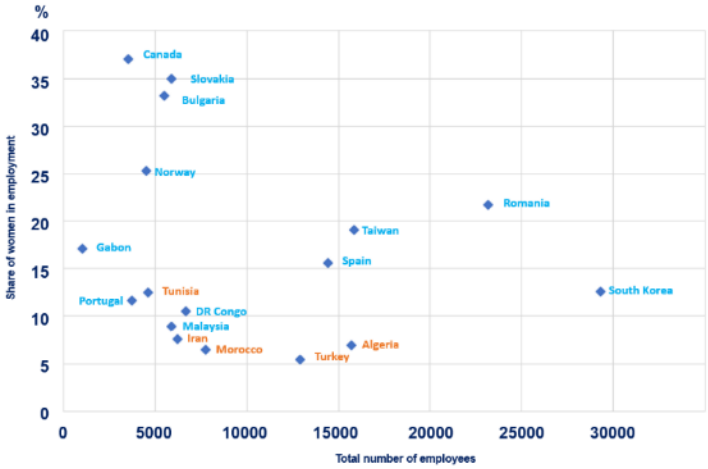


Passenger train delays and cancellations rate determines the railway service sustainability and reliability. To support a modal shift to rail transport it is important to deliver **reliable mobility services to passengers**. Despite the Middle East & North Africa region's medium score (3.7/7) in the World Bank Train Services Efficiency Index that assesses numerous metrics like frequency and punctuality, the Middle East countries' average share of cancelled and delayed passenger trains is twice higher than the global average[55].

The global goal consists in keeping the rail punctuality share above 90%[56] [57]. Rail punctuality correlates with railway safety. It should be noted that the global rail accidents per million passenger-km ratio exceeds the Middle East countries' average by 3 times. At the same time, to improve rail safety, the Middle East countries need to address the underlying grievances - **derailments and accidents of persons caused by rolling stock in motion**.

Source: the World Bank[58]

Figure 54. Share of women in the rail sector, 2020



Source: UIC[59] [60]

Non-discriminatory employment ensures the chances of upward social mobility. According to the *Women in rail* survey, the global female share accounts for 16% with a vast majority working as junior managers[61]. In the Middle East this indicator stands at 11.7%.

[54] Selected by data availability

[55] https://govdata360.worldbank.org/indicators/h485674a6?country=IRN&indicator=41365&countries=ARE,DZA,EGY,ISR,JOR,MAR,OMN,QAT,SAU,SYR,TUN,TUR&viz=bar_chart&years=2019&indicators=944

[56] Sweden, Germany, UK average target benchmark

[57] https://www.theguardian.com/global/2014/mar/30/network-rail-punctuality-targets-fine-trains, https://www.railjournal.com/regions/europe/db-long-distance-punctuality-well-below-target-in-2018/, https://www.researchgate.net/publication/360390965_A_Methodology_for_Monitoring_Rail_Punctuality_Improvements

[58] https://govdata360.worldbank.org/indicators/h485674a6?country=IRN&indicator=41365&countries=ARE,DZA,EGY,ISR,JOR,MAR,OMN,QAT,SAU,SYR,TUN,TUR&viz=bar_chart&years=2019&indicators=944

[59] https://uic.org/support-activities/statistics/

[60] https://uic-stats.uic.org/

[61] https://womeninrail.org/wp-content/uploads/2014/04/WR-Industry-Survey-Report-December-2015.pdf

Table 14. Social targets and quality criteria for the railways of the Middle East region

TARGETS	MIDDLE EAST AND NORTH AFRICA AVERAGE (2020)	GLOBAL AVERAGE (2020)	QUALITY CRITERIA FOR THE MIDDLE EAST REGION
Compliance of sectoral wages to national average	2.2[62] USD/ month	2.6 USD/ month	☐ to ensure that railway wages are at least **in line with national averages with the aim of entering the top half** (annual plans are recommended)
Improvement of accessibility of rail services	-	-	☐ to ensure **accessibility of rail services and mobility to PRM and to foreigners** referring to quality criteria (annual plans are recommended)
Improvement of affordability of rail services	-	-	☐ to ensure **affordability of rail services** referring to quality criteria (annual plans are recommended)
Increase in reliability of passenger rail services	44.1[63] cancelled and delayed trains, %	17.9 cancelled and delayed trains, %	☐ to ensure **constant annual improvement in punctuality until reaching 100% level** (annual plans are recommended)
Increase in role of railways for territorial cohesion	-	-	☐ to **continually improve geographical accessibility to rail services – in partnership with the authorities** (document on the role of railway company in national transport equity is recommended)
Improvement of safety of rail services	0.6[64] rail accidents, per m passenger-km	0.1 rail accidents, per m passenger-km	☐ to **annually improve safety of rail services** (annual plans are recommended)
Guarantee for non-discriminatory employment	11.7[65] women share in employment, %	17.8 women share in employment, %	☐ to **ensure non-discriminatory employment and professional growth** (internal policy document is recommended)

1.3. Corporate governance targets and quality criteria

The Middle East sustainable governance targets refer to the following:

- to implement **dedicated corporate policies for managing ESG risks and opportunities**,
- to turn general risk management in favour of **higher resilience**,
- to implement **policies of general access to information and active feedback**.

Table 15. Corporate governance targets and quality criteria for the railways of the Middle East region

TARGETS	DIRECTIONS	QUALITY CRITERIA INITIATIVES FOR THE MIDDLE EAST RAILWAYS
1. To implement dedicated rail policies for managing ESG risks and opportunities	1.1. Emission and pollution standards	☐ to specify **internal policies and processes for reporting** ☐ to provide **annually a standard annual emissions reporting form**
	1.2. Fuel economy standards	☐ to elaborate **corporate standards assuming constant eco-improvements**
	1.3. Railway circular practices	☐ to elaborate and to implement main rail components (rail, ballast, wooden and concrete sleepers, and copper wires) **recycling policies and programs**[66] ☐ to establish **green procurement processes**
2. Risk management system to ensure higher resilience	2.1. Choice of business models	☐ to prioritise larger **alternativity (larger variety, multi-options) approach rather than economic optimality (one best option)** approach
	2.2. Compliance	☐ to introduce **corporate compliance policies for (a) partnerships and contracts, (b) supply chain management** – to ensure compliance of the chosen third parties with the principles of work of the railways (also referring to ESG: emissions, non-discimination, etc.)

[62] Algeria, I.R.Iran, Iraq, Jordan, Morocco, Qatar, Saudi Arabia, Syrian Arab Republic, Tunisia, Türkiye, UAE (2022 data)
[63] Algeria, Israel, Morocco
[64] Algeria, Iran, Israel, Türkiye
[65] Algeria, Iran, Morocco, Tunisia, Türkiye, UAE
[66] https://uic.org/IMG/pdf/reuse_project_final_report.pdf

TARGETS	DIRECTIONS	QUALITY CRITERIA INITIATIVES FOR THE MIDDLE EAST RAILWAYS
3. To implement decision-making policies of information sharing and active feedback	3.1. Communications transparency	☐ to establish **sharing framework for information (a) among employees – on the principles of work, (b) information for investors and partners, (c) public information for customers**[67] ☐ to specify **information security policy** ☐ to introduce **multilingual information management** at least for international activities and for public information
	3.2. Active feedback	☐ to introduce **regular feedback collection** from employees to serve as a decision-making basis

2. FINANCING TOOLS AND COOPERATION WITH DEVELOPMENT INSTITUTIONS

Achievement of United Nations Sustainable Development Goals requires additional investments of USD 230 billion on an annual basis only in Arab countries[68]. Some Middle East countries (like UAE) have already pledged to elaborate their own taxonomy of sustainable activities to provide certainty to companies, banks, and investors[69]. Rail is already one of the most sustainable transportation modes, but still requires additional measures to increase its sustainability[70]. Thus, climate finance appears to be an appropriate leverage for investors and rail operators.

Green financing refers to two major options:

1) financing of development institutions (loans),
2) green bonds.

Financing of development institutions

Loans from development banks are applicable for projects with significant economic, social and environmental impact, especially for international ones. Rail electrification project as well as more generally projects aimed at shifting to rail or reducing negative impact on he environment are eligible for such funding. Lending is carried out on more attractive terms compared to the terms of obtaining financing from commercial banks, since the implementation of the project (business development) is of strategic interest to the country/combination of countries. Under this approach, the bank, as a development institution, assumes part of the risk for the purpose of providing financing on attractive terms, fulfilling its primary function of carrying out large-scale tasks aimed at solving structural economic problems. Transparent project certification and prioritising system may serve as a basis for financial decision-making (both for international and national development institutions, the Green Climate Fund and sovereign wealth funds).

Green bonds

Green bonds as a tool do not have a single legal definition and are essentially classic open market bonds, with the only difference being the intended use of the funds raised to finance activities that are environmentally friendly.

This financing instrument has already been used in various countries primarily to finance large-scale urban transport projects.

The advantages of the green bonds:

- liquidity (demand from new investors),
- funding options at below market rates,
- medium/long term fundraising period (crucial for rail projects).

The limitations to consider:

- issue complexity due to necessary compliance with all specific requirements (green certification),

[67] https://www.networkrail.co.uk/wp-content/uploads/2022/03/Catalogue-of-NR-Standards-Issue-123.pdf
[68] https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/AFEDReport-financingSDinArabCountries2018-.pdf
[69] https://www.nortonrosefulbright.com/en-me/knowledge/publications/0dfd1e7a/roadmap-for-sustainable-finance-in-the-uae
[70] https://docs.google.com/spreadsheets/d/1cSpZrzASFdIj6M4O8-1p7V2yp0mCjSR6/edit#gid=1930977678, https://fsr.eui.eu/the-observer-green-finance-and-sustainability-which-role-for-railways/

- additional costs and resources necessary for specific reporting.

Success in green bonds issue is linked to permanent and high-quality ESG reporting. The recommendations on the quality criteria provided above are in this regard recommended to become a base for such reporting resulting in unform harmonised approach in use by the Middle East Railways by 2050.

ESG targets together with agreement on the backbone network and rail projects certification are a basis to establish communication with development institutions.

3. COOPERATION MECHANISMS FOR KNOWLEDGE-SHARING

At present, ESG cooperation mechanisms are not sufficiently developed in the Middle East region. However, they are extremely important for knowledge-sharing and positive experience acquisition. Railways ESG development requires a well-rounded approach to collaboration with non-governmental entities and national rail operators, financial institutions and authorities.

The following cooperation initiatives and projects are suggested:

1) joint elaboration of the regional standard emissions reporting form and template corporate policy for reporting,
2) establishment of *regional partnership* for promoting alternative low-carbon fuels (LNG, electricity, liquid biofuels, green hydrogen),
3) joint elaboration of the regional corporate standards assuming constant eco-improvements,
4) joint elaboration of the template corporate policies to ensure non-discriminatory employment and professional growth,
5) agreement on dedicated financing framework and working group for regional cross-border rail lines electrification and regional rail cohesion projects,
6) joint development of the Middle East rail safety framework (guidelines),
7) joint elaboration of the template rail risk management policy aimed at higher resilience,
8) joint elaboration of the information sharing and feedback policies followed by the databank of relevant tools and solutions,
9) organisation of the Middle East Green Rail Finance Centre aimed at certifying railway projects for green financing and serving as a main communication platform with financial instutions.

IX. REGIONAL COOPERATION AND SHIFT TO RAIL

Objectives for the Middle East Railways 2050 referring to regional cooperation and shift to rail

Objective B. Establish regional support system in realisation of rail projects in favour of the whole region, to disseminate knowledge on the appropriate funding and financing tools.

Objective E. Plan and carry out in systematic way cooperative activities for the railways of the region.

Suggested activities:

B.1. establishment of RAME Rail Support Programme.
B.2. adoption of regional prioritising methodology for rail infrastructure development (RAME IPA).

E.1. agreement on the RAME frameworks.

The main areas for regional cooperation to achieve the Vision 2050 of the railway system in the Middle East are proposed as follows:

1) **RAME BN & ITC** - Backbone network and management of international transport corridors.
2) **RAME IPA** - Infrastructure prioritising approach.
3) **RAME Rail+ Interoperability Framework**.
4) **RAME Rail Quality Framework** – reporting and monitoring, including ESG.
5) **RAME Rail Support Programme** – including cooperation plan with regional and international development and financial institutions.

1. RAME BN & ITC: BACKBONE NETWORK AND MANAGEMENT OF INTERNATIONAL TRANSPORT CORRIDORS

Objectives

To ensure inventory of rail infrastructure and monitoring of its development, to facilitate construction of international transport corridors and their efficient management.

What needs to be done

1) Agree on rail network inventory list and start regular data collection with annual cohesion workshops,

2) agree on the regional rail backbone network (rail to initiate actions of the national authorities, as the BN agreement be international) and start regular monitoring and update with annual cohesion workshops,

3) agree on the basic parameters of corridors 2050 and elaborate action plans to achieve these parameters (including all issues related to infrastructure gaps and financing),

4) establish dedicated permanent working groups on corridor development and *management*.

Tools/ solutions

- International intergovernmental and sectoral agreements,
- annual cohesion workshops,
- bilateral and multi-lateral Memoranda on corridor development followed by inter-rail agreements,
- working groups.

Benefits of cooperation

- Basis for regional rail cohesion and uniform information environment,

- basis for prioritising and general rail-related decision-making,
- *facilitation for capacity planning and more efficient investments*,
- basis for *interaction with development institutions*.

2. RAME IPA: REGIONAL INFRASTRUCTURE PRIORITISING APPROACH

Objectives

To ensure harmonised planning and investment decision-making.

What needs to be done

1) Test and, if necessary, adjust the proposed methodology,

2) organise workshops and discussions with development and financial institutions, financing centres to agree on the methodology and validity of certification for facilitation of financing,

3) establish RAME assessment/ certification centre to cooperate with the development and financial institutions,

4) elaborate national and corporate documents guiding the implementation.

Tools/ solutions

- Dedicated methodology,
- dedicated centre,
- workshops with development and financial institutions.

Benefits of cooperation

- *Facilitation of rail financing*,
- increase in quality and harmonising of regional rail planning.

3. RAME RAIL+ INTEROPERABILITY FRAMEWORK: MULTIMODAL REGULATORY FRAMEWORK TO ENSURE REGIONAL INTEROPERABILITY

Objectives

To ensure regional interoperability of railways adopted to the heterogeneity and simultaneously to modern technologies.

What needs to be done

See relevant chapter.

In addition, establishment of **Middle East Railway Agency** is to be considered.

Tools/ solutions

- Intergovernmental agreements,
- working body.

Benefits of cooperation

- Facilitation of international rail transport within the region,
- fostering multimodal connections and easier shift to rail,
- basis for the operations along international corridors.

4. RAME Rail Quality Framework

Objectives

To significantly increase quality of rail services and to harmonise the approaches for heterogenous regional system, to *shift to the concept of continuous improvements*.

What needs to be done

1) Test and, if necessary, adjust the proposed quality criteria for various services (freight, passenger, urban) and ESG (see overall list in Annex 2),

2) agree on the regional implementation of quality framework (monitoring, frequency, reporting).

3) implement quality framework in corporate documents

4) ensure regular feedback and annual analysis (check lists collected from railways).

Tools/ solutions

- Quality criteria check lists,
- workshops.

Benefits of cooperation

- Shift to rail thanks to quality improvement,
- harmonisation of regional rail services despite heterogeneity,
- promotion of railways as responsible employers,
- increase in resilience of railway companies (one of the factors for *investors*).

5. RAME Rail Support Programme and cooperation with financial institutions

Objectives

To establish regional rail funding framework coping with heterogeneity of countries in favour of regional rail network development, to establish permanent cooperation with financial institutions.

What needs to be done

1) Start actions for RAME BN & ITC and RAME IPA,

2) establish new international intergovernmental/ sectoral working body/ dedicated rail finance centre managing regional rail support programme: financial support of priority (certified) projects,

3) structure available financing tools and their application principles,

4) involve financial institutions into regular participation in the activities of the working body.

Tools/ solutions

- international agreement,
- working body.

Benefits of cooperation

- facilitation of rail financing,
- faster completion of corridors in countries with low or inaccessible financing for rail development.

6. Assessment of the impact of corridor-based approach on the regional economies

The change in projections based on the baseline (average between top and bottom) scenario in 2050 is made in accordance with the assumption of realisation of an interconnected railway network in the Middle East region (construction of corridors with indicated operational parameters). Decrease of the TTC (Total Transportation Costs) value and leads to increase in trade flows. Improvements in logistics affect both external and intra-regional flows.

Table 16. Export effects* from corridor-based approach by countries, baseline scenario, million tons

EXPORTS (MILLION TONS)	2050		% DIFFERENCE	ABSOLUTE DIFFERENCE
	BASELINE SCENARIO	INTERCONNECTED NETWORK (CORRIDORS)		
Central Asia	7	8	13%	0.9
China	134	139	3%	4.4
Europe	123	128	4%	5.0
India	169	169	0%	0.0
Japan	11	11	0%	0.0
South Caucasus	10	12	21%	2.0
North Africa	48	55	14%	6.6
Russia	8	10	26%	2.2
Southeast Asia	86	97	12%	10.7
Rep. of Korea	10	11	4%	0.4
Other countries	801	801	0%	0.0
Total exports	**1 408**	**1 441**	**2%**	**32.2**

*Oil and gas excluded

Expansion of corridors and improvement of logistics can increase total export flow to other subregions by 2%. The main flow will be directed to India, Europe, China and other countries. In case suggested links are considered, high potential directions may be extended to South Caucasus, Southeast Asia, Russia and North Africa.

Table 17. Export effects* from corridor-based approach by groups of commodities, baseline scenario, million tons

EXPORTS (MILLION TONS)	2050		% DIFFERENCE	ABSOLUTE DIFFERENCE
	BASELINE SCENARIO	INTERCONNECTED NETWORK (CORRIDORS)		
Agricultural products	98	112	14%	14.0
Grains	12	13	3%	0.4
Metal ores	78	78	0%	0.1
Ferrous and non-ferrous metals	144	153	6%	8.6
Oil products	269	271	1%	1.4
Chemical products	285	286	0%	1.0
Transport and machinery	27	27	0%	0.1
Coal	1	1	2%	0.0
Other products	493	500	1%	6.6
Total exports	**1 408**	**1 441**	**2%**	**32.2**

*Oil and gas excluded

Imports are assessed in a similar way.

Table 18. Import effects* from corridor-based approach by countries, baseline scenario, million tons

IMPORTS (MILLION TONS)	2050		% DIFFERENCE	ABSOLUTE DIFFERENCE
	BASELINE SCENARIO	INTERCONNECTED NETWORK (CORRIDORS)		
Afghanistan	23	41	80%	18
Bahrain	45	45	0%	0
Iran, Islamic Rep.	55	71	28%	16
Iraq	70	95	36%	25
Israel	108	108	0%	0
Jordan	31	32	2%	1
Kuwait	72	73	1%	1
Lebanon	39	39	1%	0
Oman	62	62	0%	0
Pakistan	114	125	9%	11
Qatar	28	29	2%	1
Saudi Arabia	211	212	1%	2
Syrian Arab Republic	18	21	22%	4
Türkiye	454	464	2%	9
United Arab Emirates	173	176	2%	3
Yemen, Rep.	33	33	0%	0
Total imports	**1 536**	**1 626**	**6%**	**90**

*Oil and gas excluded

Most of the import will be formed by the flows from China, Europe and South Caucasus.

Table 19. Import effects* from corridor-based approach by groups of commodities, baseline scenario, million tons

IMPORTS (MILLION TONS)	2050		% DIFFERENCE	ABSOLUTE DIFFERENCE
	BASELINE SCENARIO	INTERCONNECTED NETWORK (CORRIDORS)		
Agricultural products	172	191	11%	18.8
Grains	184	189	3%	5.3
Metal ores	83	83	0%	0.0
Ferrous and non-ferrous metals	292	308	6%	16.3
Oil products	131	134	2%	3.1
Chemical products	186	197	6%	10.8
Transport and machinery	62	66	7%	4.5
Coal	56	57	0%	0.2
Other products	369	400	8%	31.3
Total imports	**1 536**	**1 626**	**4%**	**90**

*Oil and gas excluded

Total imports change is mostly provided by such groups as Agricultural products, Ferrous and non-ferrous metals, Chemical products – the largest impact on the forecast result.

Table 20. Intra-regional trade effects from corridor-based approach, baseline scenario, million tons

TRADE (MILLION TONS)	2050		% DIFFERENCE	ABSOLUTE DIFFERENCE
	BASELINE SCENARIO	INTERCONNECTED NETWORK (CORRIDORS)		
Afghanistan	3.7	11	195%	7.2
Bahrain	18	18	0%	0.0
Iran, Islamic Rep.	92	126	37%	34.1
Israel	3.4	3.4	0%	0.0
Jordan	2.3	2.8	21%	0.5
Kuwait	7	8	7%	0.5
Lebanon	2	2	2%	0.0
Oman	64	65	1%	0.3
Pakistan	16	27	70%	11.3
Qatar	5	6	7%	0.4
Saudi Arabia	52	55	6%	3.1
Syrian Arab Republic	4	5	20%	0.8
Türkiye	89	100	13%	11.7
United Arab Emirates	125	140	12%	14.9
Yemen, Rep.	0.1	0.1	0%	0.0
Total trade	**484**	**569**	**17%**	**84.7**

*Oil and gas excluded

The highest absolute growth will refer to the United Arab Emirates, Islamic Republic of Iran, Türkiye, Pakistan, while many countries may benefit from important relevant increase in transported volumes boosting their economies.

Table 21. . Intra-regional trade effects from corridor-based approach by groups of commodities, baseline scenario, million tons

TRADE (MILLION TONS)	2050		% DIFFERENCE	ABSOLUTE DIFFERENCE
	BASELINE SCENARIO	INTERCONNECTED NETWORK (CORRIDORS)		
Agricultural products	59	76	29%	17.2
Grains	3	4	33%	1.0
Metal ores	25	26	3%	0.9
Ferrous and non-ferrous metals	60	67	12%	7.1
Oil products	39	50	30%	11.6
Chemical products	55	62	14%	7.8
Transport and machinery	13	16	24%	3.1
Coal	1	3	159%	1.9
Other products	230	264	15%	34.3
Total trade	**484**	**569**	**17%**	**84.7**

*Oil and gas excluded

General conclusions on the implementation of the corridor-based approach:

- **The implementation of infrastructure projects in the region will have the largest impact on intra-regional trade growth (+85 million tons) and import flows (+90 million tons).**

- The key boosted commodities will be **Agricultural products, Ferrous and non-ferrous metals, Chemical products, Oil products and Other products** (e.g. construction materials).
- There will be a significant increase in trade with countries in the Middle East region that have **significant consumption and resource bases**, **but currently lacking connecting infrastructure**.
- **Increased trade among the countries of the region will provide logistical security of supply, and drastically increase connectivity of the economies in the Middle East region.**

X. THE WAY FORWARD: ACTION PLAN

Action plan to achieve goals and objectives of the Middle East Railway Vision 2050 combines framework approach and non-framework activities referring to the indicated objectives.

The action plan suggests regular revision of forecasts, as well as the general regional vision to ensure its applicability.

Each framework requires additional in-depth studies to specify the exact parameters and arrangements. Additional studies on technological and operational solutions and cooperative (commercial) systems for freight, passenger and urban rail, as well as for combined transport are as well recommended.

Table 22. Action plan to achieve goals and objectives of the Middle East Railway Vision 2050

	DIRECTIONS/ ACTIONS	2023	2024-2025	2026-2027	2027-2030	2040	2050
RAME BN & ITC							
1.	Agree on rail network inventory list.						
2.	Start regular data collection.						
3.	**Agree on the regional rail backbone network (rail to initiate actions of the national authorities, as the BN agreement be international).**						
4.	Agree on the basic parameters of corridors 2050 and elaborate action plans to achieve these parameters.						
5.	Start regular monitoring and update with annual cohesion workshops						
6.	Establish dedicated permanent working groups on corridor development and management.						
7.	**Update corridor vision.**						
RAME IPA							
1.	Test and, if necessary, adjust the proposed prioritising methodology.						
2.	Organise workshops and discussions with development and financial institutions, financing centres to agree on the methodology and validity of certification for facilitation of financing.						
3.	**Establish RAME assessment/ certification centre to cooperate with the development and financial institutions.**						
4.	Elaborate national and corporate documents guiding the implementation						
RAME Rail+ Interoperability Framework							
1.	Agree on the goals, objectives and the scope of the framework. Form an intergovernmental/ inter-agency commission to ensure effective decision-making process						
2.	**Consider establishment of a Middle East Railways Agency.**						
3.	Structure the areas to be covered by documents						
4.	Compare the needs with existing documents of inter-agency organisations (OTIF, OSJD), define usability of existing approaches based						

	DIRECTIONS/ ACTIONS	2023	2024-2025	2026-2027	2027-2030	2040	2050
	on (a) available technologies, (b) forecasted directions of flows						
5.	Define the necessity for specific regional documents and ensure their fast elaboration						
RAME Rail Quality Framework							
1.	Test and, if necessary, adjust the proposed quality criteria for various services (freight, passenger, urban) and ESG.						
2.	**Agree on the regional implementation of quality framework** (monitoring, frequency, reporting).						
3.	Implement quality framework in corporate documents.						
4.	Ensure regular feedback and annual analysis (check lists collected from railways).						
RAME Rail Support Programme							
1.	**Establish new international intergovernmental/ sectoral working body/ dedicated rail finance centre managing regional rail support programme: financial support of priority (certified) projects.**						
2.	Structure available financing tools and their application principles.						
3.	Involve financial institutions into regular participation in the activities of the working body.						
Non-framework activities							
1.	Ensure economic and social trend monitoring in relation to rail – to update and monitor RAME BN and to ensure implementation of RAME IPA.						
2.	Forecast of potential rail freight flows along the corridors to prioritise segments and define strategic hubs for the benefit of all RAME members – to update and monitor RAME BN and to ensure implementation of RAME IPA						
3.	Creation and update of rail technologies and smart solutions regional databank						
4	Organising workshops on implementation of priority technologies						

ANNEX 1. MODELLING METHODOLOGY

Modelling of freight traffic on the prospective regional railway network was carried out using the Infraforecast software.

The input data for the model:

1) Forecasts of intra-regional and external trade volumes for the countries of the Middle East region.

2) The transport network graph of the Middle East region, including major roads, railway routes and sea lines. Each edge of the graph corresponds to two parameters: the average speed at which a vehicle travels through this section and the rate (transportation price) per tonne that corresponds to this section. In addition to the edges, the graph has loading and unloading points, which are the start and end points of the itinerary, as well as transhipment points, which occur at points of transfer from one mode of transport to another (e.g. seaport).

Data collected from carriers and operators, seaports and various official documents:

- rates (transportation price)
- average speed of vehicles has been collected from carriers and operators.
- time required for loading, unloading and reloading of goods at railway stations.

The model uses a **total transportatioan cost approach**: the sum of the rates and costs of frozen assets capital, i.e. the potential financial loss to the shipper while the cargo is in transit. The cost of frozen assets (working capital) depends on the commodity prices, the time in transit and the credit rates.

$$C_w = \frac{P_w}{365} * T * r$$

where C_w – working capital
P_w – wholesale price,
T – shipping time (days),
r – the lending rate (e.g. 7% is the average rate for the Chinese businesses).

The working capital in the model is calculated based on the time that is summed up from all edges of the graph and the loading, unloading and transhipment locations along the specific route. In addition, for each connection, the average value of goods by commodity groups is laid down.

Model functions:

Forecasting changes in the allocation of freight flows by different routes (itineraries) for each connection depending on the ratio of total transportation costs between possible itineraries.

For future years, forecasted trade data in tons, forecasted average cost of goods, infrastructure changes, which ultimately translate into changes in average speeds in different sections of the transport graph or the creation of new transport routes, as well as anticipated changes in fares, are used.

Model output:

Traffic forecasting has been carried out for two base years: 2030 and 2050 under three macroeconomic scenarios - baseline, risk and optimistic. The forecast assumes that in 2030 all projects under consideration will be implemented, except for the new railway lines within Afghanistan (due to complexity and extremely high costs) which are considered in 2050.

The results of the modelling and traffic forecast presume no crucial technological, geopolitical or other constraints to international rail transport.

ANNEX 2. RAME RAIL QUALITY CRITERIA – FULL LIST

Rail freight transport

	TARGETS	QUALITY CRITERIA
PLANNING	Planning of freight services based on actual and future demand	□ consideration and monitoring of trade flows forecasts by groups of commodities □ PMI (Purchasing Managers' Index): regular surveys among key national and regional producers (also not using rail) and shippers
INFORMATION	Full and reliable information	□ uniform statistics[71] (see relevant chapter) □ reliable and publicly available customer information for shippers, also in foreign languages (at least in English) □ information on the estimated time of arrival for shippers along the route
CHARGING AND PRICING POLICY	Attractive charging system assuring balanced logistics along the routes	□ uniform and simplified tariff system publicly accessible for potential customers □ yield management in terms of stimulating or inhibiting tariffs for specific commodities
SERVICES	Adjusted product range and easy-in-use services	□ one-stop-shop approach for shippers/ forwarders □ internal platform for authorised customers with statistics/ cargo tracking/ path request (if applicable) and similar tools □ priority conditions for block-trains (container trains) with high-value added commodities (if no block-trains are available, mixed trains with regular schedule can be a substitution)
RELIABILITY POLICY	Reliable transportation	□ cargo tracking □ regular schedule □ time-fixed processes
QUALITY ASSESSMENT AND MANAGEMENT	Regular adjustment of performance and management based on feedback from customers	□ regularly adjusted KPIs □ regular feedback from clients (dedicated form accessible n national language and at least in English) □ regular feedback from internal staff on the management process
ENVIRONMENTAL SUSTAINABILITY	Promotion of more sustainable way of transportation	□ information for customers on CO2 emissions □ check for optimal choice of technologies in terms of environmental impact (see relevant chapter)

[71] Even if not published it may still be necessary for planning and for communications with strategic partners

Rail passenger transport

No	Stage	Issues	Middle East Railways 2050 quality criteria – check list
1.	**Planning**	1.5. information on existing network and services	□ **information on routes, services and prices is available online prior to booking**
		1.6. railway accessibility, also concerning booking procedures and language	□ **information on on routes, services and prices is available in foreign languages (at least English is obligatory),** □ **information on booking, whether or not booking is not made online, is available in foreign languages** □ **special booking modes for persons with reduced mobility (PRM) are proposed**
		1.7. ticket prices and their affordability	□ **ticket prices are modelled against the existing demand and purchasing power** □ **whenever possible various categories of prices are proposed for different segments** □ **yield management (dynamic prices) is applied**
		1.8. ticket sales and access to reservation system, also cancellation rules	□ **cancellation rules are available for users prior to booking, also in foreign languages (at least English),** □ **ticket sales are accessible online** □ **ticket sales are available via agents** □ **ticket sales are available via other railways of the region**
2.	**Arrival at station of departure**	1.3. accessibility	□ **station entrance is accessible to PRM** □ **information at station at arrival stage is clear for foreign passengers (at least duplicated in English)**
		1.4. intermodality and cooperation with other transportation modes	□ **pedestrian accesses are prioritised with mo more than 150m walk or travelators** □ **access to station with large luggage is possible**
3.	**Stay at station of departure**	1.7. accessibility	□ **station is accessible to PRM, including toilets and all facilities** □ **station is accessible for foreign users (pictograms prioritised, information at least in English is obligatory)**
		1.8. control procedures	□ **control procedures take less than 20 min for all types of services and number of passengers, including queuing time** □ **control procedures do not impose deviation of passengers' routes or changes in services**
		1.9. information	□ **location of information is checked within focus-groups to match decision-making points** □ **infromatiomn is available in foreign languages, at leas in English,** □ **information is dynamic for train departures** □ **information is accessible for PRM (visually impair, etc.)** □ **information is available online (applications, etc.)**
		1.10. security	□ **security check takes no more than 10 minutes regardless the queue** □ **security procedures do not impose deviation of passengers' routes or changes in services**
		1.11. station quality	□ **station matches UIC station quality criteria**
		1.12. special commerce linked to intercountry traffic	□ **if allowed by local regulation, duty-free shops are available**
4.	**Boarding**		□ **electronic ticket control** □ **boarding is accessible for PRM**
5.	**Train journey**	5.5. accessibility	□ **trains are accessible for PRM**
		5.6. information	□ **passengers are informed along the route in a physical and digital ways** □ **information is available in foreign languages (at least in English)**
		5.7. security	□ **security checks on board are absent or minimised**
		5.8. services	□ **passengers are pre-informed on services on board** □ **digital applications are available** □ **restauration facilities are available**
6.	**Border-**		□ **control procedures carried out in the daytime only**

No	Stage	Issues	Middle East Railways 2050 quality criteria – check list
	crossing		
7.	**Alighting**	See p. 4	
8.	**Stay at station of arrival**	See p. 3	
9.	**Departure from station of arrival**	See p. 2	
10.	**Feedback**		□ **feedback forms are available in the trains** □ **feedback forms are available at stations** □ **feedback forms are available in a digital form (online, applications, etc.)** □ **feedback forms are available in foreign languages (at least in English)** □ **feedback is regularly collected and analysed**

Urban rail

	TARGETS	QUALITY CRITERIA
PLANNING	Planning of urban rail services linked to social trends, urban development and general transport services	□ **consideration and monitoring of demographic, employment and other social parameters** □ **consideration and monitoring of demographic, employment and other social parameters** □ **planning of urban services in connection to regional, national, international services**
OPERATIONS	Conformity to pre-set and approved by the authorities parameters	□ **setting up target characteristics for each route (capacity, frequency, fares, design) in partnership with local authorities**
GOVERNANCE	Competition for the route and not on the same route	□ **avoidance of competition of various operators on the route**[72]
FINANCING AND FINANCIAL SUPPORT	Sustainable financing considering high demand for subsidies and governmental support	□ **avoidance of low taxation in favour of other means of support (loss compensation subsidies, subsidies and soft loans for infrastructure development and vehicle renewal)**

ESG

TARGETS	QUALITY CRITERIA FOR THE MIDDLE EAST RAILWAYS
Environmental	
Decrease in GHG emissions	□ **to ensure constant annual reducing of the rail sector CO2 and NOx emissions**
Shift to non-fossil fuel based traction solutions (electric, hydrogen, batteries).	□ **to electrify or to introduce new non-fossil traction services on the segments of the international transport corridors by 2050**
Increase in energy efficiency	□ **to ensure implementation of the most efficient (among available ones) energy-saving solutions for new railway projects and refurbishment**
Continuous cycle of eco-improvements	□ **to implement within the corporate policies the principle of continuous cycle of eco-improvements: new targets should appear**

[72] For trams, LRT and other urban-only transports

TARGETS	QUALITY CRITERIA FOR THE MIDDLE EAST RAILWAYS
	upon successful achievement of previous ones according to available technologies and budgets
Social	
Compliance of sectoral wages to national average	□ to ensure that railway wages are at least in line with national averages with the aim of entering the top half (annual plans are recommended)
Improvement of accessibility of rail services	□ to ensure accessibility of rail services and mobility to PRM and to foreigners referring to quality criteria (annual plans are recommended)
Improvement of affordability of rail services	□ to ensure affordability of rail services referring to quality criteria (annual plans are recommended)
Increase in reliability of passenger rail services	□ to ensure constant annual improvement in punctuality until reaching 100% level (annual plans are recommended)
Increase in role of railways for territorial cohesion	□ to continually improve geographical accessibility to rail services – in partnership with the authorities (document on the role of railway company in national transport equity is recommended)
Improvement of safety of rail services	□ to annually improve safety of rail services (annual plans are recommended)
Guarantee for non-discriminatory employment	□ to ensure non-discriminatory employment and professional growth (internal policy document is recommended)

Governance

TARGETS	DIRECTIONS	QUALITY CRITERIA INITIATIVES FOR THE MIDDLE EAST RAILWAYS
1. To implement dedicated rail policies for managing ESG risks and opportunities	1.1. Emission and pollution standards	□ to specify internal policies and processes for reporting □ to provide annually a standard annual emissions reporting form
	1.2. Fuel economy standards	□ to elaborate corporate standards assuming constant eco-improvements
	1.3. Railway circular practices	□ to elaborate and to implement main rail components (rail, ballast, wooden and concrete sleepers, and copper wires) recycling policies and programs[73] □ to establish green procurement processes
2. Risk management system to ensure higher resilience	2.1. Choice of business models	□ to prioritise larger alternativity (larger variety, multi-options) approach rather than economic optimality (one best option) approach
	2.2. Compliance	□ to introduce corporate compliance policies for (a) partnerships and contracts, (b) supply chain management – to ensure compliance of the chosen third parties with the principles of work of the railways (also referring to ESG: emissions, non-discrimination, etc.)
3. To implement decision-making policies of information sharing and active feedback	3.1. Communications transparency	□ to establish sharing framework for information (a) among employees – on the principles of work, (b) information for investors and partners, (c) public information for customers[74] □ to specify information security policy □ to introduce multilingual information management at least for international activities and for public information
	3.2. Active feedback	□ to introduce regular feedback collection from employees to serve as a decision-making basis

[73] https://uic.org/IMG/pdf/reuse_project_final_report.pdf

[74] https://www.networkrail.co.uk/wp-content/uploads/2022/03/Catalogue-of-NR-Standards-Issue-123.pdf

ANNEX 3. RAIL TECHNOLOGIES DATABANK

Note: to ensure convenient use this databank separately is available in a form of a digital table.

No	Area	Solution	Description	Effects	National/ international applicability	Type	Technical base requirements	Financial requirements	Special international legal framework requirements	Requirements of special bilateral (multilateral) international agreements apart from international ogranizations	Multi-agency (yes/no)	Fast solution (yes/no)	Use cases by countries (non-exhaustive list)	Direct effect on rail resilience	Usability during COVID-19 and at recovery phase	Links to other solutions or tools
1	Border crossing	**Bogies change at one side**	organisations of bogies changes procedures at one side of border crossings for container (block) trains: in one country for each direction according to bilateral agreements	Decrease of transportation time	International	**Institutional**	**Low**	**Low**	Yes	Yes	No	Yes	Belarus - Russian Federation border; Russian Federation - China border	**Yes**	**Very high**	
2	Border crossing	**Combined (joint) control procedures**	Coordination and integration of the border crossing formalities for customs, border security and passport control as well as transport, sanitary, food safety, veterinary, phytosanitary and other inspections	Time economy and predictability	National	**Institutional**	**Low**	**Low**	No	No	Yes	Yes	Russian Federation:Zabaykalsk Kazakhstan: Dostyk, etc,	No	**Very high**	Electronic data interchange between railways and border agencies

No	Area	Solution	Description	Effects	National/ international applicability	Type	Technical base requirements	Financial requirements	Special international legal framework requirements	Requirements of special bilateral (multilateral) international agreements apart from international ogranizations	Multi-agency (yes/no)	Fast solution (yes/no)	Use cases by countries (non-exhaustive list)	Direct effect on rail resilience	Usability during COVID-19 and at recovery phase	Links to other solutions or tools
3	Border crossing	**Electronic data interchange between railways and border agencies**	Electronic data interchange (EDI) providing preliminary and legally considered as official information on the cargo the transportation process	Drastic decrease of transportation time and increase in reliability	International	**Mixed digital**	**High**	**Medium**	Yes	Yes	Yes	No	India (Indian Railways), Tukey (TCDD), Russian Federation (Russian Railways) INTERTRAN project	**Yes**	**Very high**	Data integration tool; AI tool; Blockchain; Sensors; Electronic data interchange; E-seals; E-interoperability
4	Border crossing	**E-seals with customs information to reduce checks**	Electronic input of rail and customs information into a special locking seal used for each containter which may be carried either all along the route (if relevant legal framework exists) or along the territory of specific changes with further changes to local equipment	Important decrease in customs control time and increase in security level	International	**Mixed digital**	**Medium**	**Medium**	Yes	Yes	Yes	Yes	Kazakhstan, Russian Federation, China	**Yes**	**Very high**	Data integration tool; E-interoperability
5	Border crossing	**Information exchange and simplification between railways**	Establishment of bilateral and multirateral agreements between railways on data interchange parameters and rules aimed at simplification	Increase in reliability and speed of international transportation	International	**Institutional**	**Low**	**Low**	Yes	Yes	No	No	INTERTRAN project	**Yes**	**Very high**	E-interoperability; Blockchain

No	Area	Solution	Description	Effects	National/ international applicability	Type	Technical base requirements	Financial requirements	Special international legal framework requirements	Requirements of special bilateral (multilateral) international agreements apart from international ogranizations	Multi-agency (yes/no)	Fast solution (yes/no)	Use cases by countries (non-exhaustive list)	Direct effect on rail resilience	Usability during COVID-19 and at recovery phase	Links to other solutions or tools
			and acceleration of procedures, even if electronic data interchange is not available													
6	Border crossing	**Non-intrusive inspections**	Implementation of technical systems mainly based on X- and gamma-ray radiography to scan containers	Increase in speed of control procedures, less dependence on human factor and higher level of security	International	**Mixed**	**High**	**Medium**	No	Yes	Yes	Yes	China	**Yes**	**Very high**	E-interoperability
7	Border crossing	**Non-stop border crossing (if no break of gauge)**	Non-stop border crossing with "declare at home, release at destination" clearance model, ususally applied for areas with uniform legal framework (another option is customs clearance at logistics hubs instead of the border crossing stations)	Time economy and predictability	International	**Institutional**	**Low**	**Low**	Yes	Yes	Yes	Yes	EAEU, EU areas	**Yes**	**Very high**	E-interoperability
8	Border crossing	**Standard time targets**	Introduction of standard time limits for border crossing control and technical procedures	Higher predicatbility and reliability	International	**Institutional**	**Low**	**Low**	Yes	Yes	Yes	Yes	OSJD Standards time targets	**Yes**	**Very high**	Interoperability

No	Area	Solution	Description	Effects	National/ international applicability	Type	Technical base requirements	Financial requirements	Special international legal framework requirements	Requirements of special bilateral (multilateral) international agreements apart from international ogranizations	Multi-agency (yes/no)	Fast solution (yes/no)	Use cases by countries (non-exhaustive list)	Direct effect on rail resilience	Usability during COVID-19 and at recovery phase	Links to other solutions or tools
9	Border crossing	**Simultaneous scheduled transshipment (container trains)**	Simultaneous transshipment of containers for border crossing stations with break of gauge for two trains following different directions	Time economy and predictability	International	**Technical and technological**	**Low**	**Medium**	No	No	No	No	Brest - Malaszewicze border crossing	No	**High**	Bogies change at one side; Interoperability; E-interoperability; E-data interchange
10	Border crossing	**Use of combined rail consignment considered as customs document**	Use of combined (electronic) CIM/SMGS consignment & other options for combining the documents	Time and costs economies	International	**Institutional**	**Low**	**Low**	Yes	Yes	Yes	Yes	numerous examples for transit transportation	No	**Very high**	Interoperability; E-interoperability
11	Intermodality and customer relations	**Electronic sales**	Sales of international transportation services to customers via specific electronic platforms	Promotion of shift to rail by increasing competitiveness of railways in comparison to sea and asssuring better market conditions for the market players	National and international	**Mixed digital**	**High**	**Medium**	No	Yes	Yes	No	China: LOGINK platform; Russian Railways: electronic sales platform	No	**Very high**	Data integration tool; AI tool; Sensors; Electronic data interchange; E-interoperability
12	Intermodality and customer relations	**Single window**	Creation of single window for rail and non-rail services within railway corridors (for all services or parts of them, also for border crossinng issues, may be organized at different levels of automation and digitalisation)	Improvement of customer experience to promote shift to rail	National and international	**Institutional**	**Medium**	**Medium**	No	Yes	Yes	No	EAEU: UTLC ERA	**Yes**	**Very high**	Data integration tool; AI tool; Sensors; Electronic data interchange; E-interoperability

No	Area	Solution	Description	Effects	National/ international applicability	Type	Technical base requirements	Financial requirements	Special international legal framework requirements	Requirements of special bilateral (multilateral) international agreements apart from international ogranizations	Multi-agency (yes/no)	Fast solution (yes/no)	Use cases by countries (non-exhaustive list)	Direct effect on rail resilience	Usability during COVID-19 and at recovery phase	Links to other solutions or tools
13	Intermodality and customer relations	**Tracking applications**	Elaboration of cargo tracking and control applications for customers	Increase in reliability of railways	National and international	**Mixed digital**	High	Medium	No	Yes	Yes	No	all major Euro-Asian transit operators	No	Very high	Data integration tool; AI tool; Sensors;Electronic data interchange; E-seals; E-interoperability
14	Maintenance, safety and security	**Drones**	Use of drones to assure unmanned remote network (incl stations and terminals) supervision, safety and security control	Decrease of human factor and necessity for human resources	National	**Technical and technological**	Low	Low	No	No	No	Yes	applied in many ESCAP member countries (China, India, Russian Federation, etc.)	Yes	Very high	AI tool
15	Maintenance, safety and security	**Energy-efficient LED systems**	Use of LED technolgies for both infrastructure and rolling stock	Increase in environmental and economical sustainability	National	**Technical and technological**	Low	Medium	No	No	No	No	applied in most ESCAP member countries	No	Low	
16	Maintenance, safety and security	**Energy recuperation and resource reuse**	Use of energy recuperation (from brakes for operations), water reuse, less waste technologies (for stations and terminals for infrastructure)	Increase in environmental and economical sustainability	National	**Technical and technological**	Medium	Medium	No	No	No	No	applied in many ESCAP member countries (China, India, Russian Federation, etc.)	No	Low	
17	Maintenance, safety and security	**Predictive maintenance**	Techniques to help determine the condition of in-service equipment (infrastructure) in order to estimate best maintenance time	Cost decrease and reliability increase	National	**Technical and technological**	High	High	No	No	No	No	applied in many ESCAP member countries (China, India, Russian Federation, etc.)	No	Low	Data integration; AI; Sensors

No	Area	Solution	Description	Effects	National/ international applicability	Type	Technical base requirements	Financial requirements	Special international legal framework requirements	Requirements of special bilateral (multilateral) international agreements apart from international ogranizations	Multi-agency (yes/no)	Fast solution (yes/no)	Use cases by countries (non-exhaustive list)	Direct effect on rail resilience	Usability during COVID-19 and at recovery phase	Links to other solutions or tools
18	Roilling stock	**Battery trains**	Battery locomotives to work on both electrified and non-electrified network	Higher environmental sustainability and continous network use	National	**Technical and technological**	**High**	**High**	No	No	No	No	China, India, Japan, Russian Federation; widely used to serve mines	No	Low	
19	Roilling stock	**Fuel cells and hydrogen trains**	Locomotives using fuel cells and hydrogen technology to serve both electrified and non-electrified network	Higher environmental sustainability and continous network use	National	**Technical and technological**	**High**	**High**	No	No	No	No	China, Malaysia, Japan	No	Low	
20	Roilling stock	**Digital automatic coupling**	Automatic commection of freight cars, as well as their electricity, data and compressed air lines, without use of human force	Time and cost reduction, decreasing the impact of the human factor	National	**Technical and technological**	**High**	**High**	No	No	No	No	EU: Austria, Germany, France; Switzeland (tests in 2020-2022)	**Yes**	**Very high**	Data integration; AI; Sensors
21	Roilling stock	**Hybrid trains**	Hybrid trains or locomotives use an on board rechargeable energy storage system (RESS), placed between the power source and the traction transmission system connected to the wheels. This technology is applicable for both diesel and electric locomotives	Higher environmental sustainability and continous network use	National	**Technical and technological**	**High**	**High**	No	No	No	No	applied in many ESCAP member countries	No		

No	Area	Solution	Description	Effects	National/ international applicability	Type	Technical base requirements	Financial requirements	Special international legal framework requirements	Requirements of special bilateral (multilateral) international agreements apart from international ogranizations	Multi-agency (yes/no)	Fast solution (yes/no)	Use cases by countries (non-exhaustive list)	Direct effect on rail resilience	Usability during COVID-19 and at recovery phase	Links to other solutions or tools
22	Traffic Operations	**Automated traffic management system**	Transport control system (signalling, automatic break and speed control) with uniform "network - train" communication system based on mobile data transfer	Speed acceleration (a must have for high speeds), safety improvement	National and international	**Technical and technological**	**High**	**High**	Yes	No	No	No	EU ERTMS, FRMCS; China, India, Russian Federation	**Yes**	**High**	Interoperability; E-interoperability; Smart sensors; Satellite navigation technologies
23	Traffic Operations	**Automation of terminals**	Automation of processes at railway (logistics) terminals: as processes as loading, stacking, transporting and storing cargo	Higher resilience	National	**Technical and technological**	**High**	**High**	No	No	No	No	China: Chengdu hub; EU: Austria, Germany, Italy	**Yes**	**Very high**	Data integration tool; AI tool; Sensors; Electronic data interchange
24	Traffic Operations	**Automation of train driving (automatic train operations, ATO)**	Humanless driving (for shunting or mainline operations)	Capacity, reliability, energy efficiency, flexibility, safety, and cost effectiveness improvement	National	**Technical and technological**	**High**	**High**	No	No	No	No	Australia: Rio Tinto iron ore railways, the Netherlands (Port of Rotterdam), MOVINGRAIL project (EU); China	**Yes**	**High**	Automated traffic management system; Smart sensors; Satellite navigation technologies
25	Traffic Operations	**Electronic interoperability**	Compatibility of electronic data of different railway systems	Acceleration of transportation, cost reduction, speeding up of control and border crossing procedures	National and international	**Institutional**	**High**	**High**	Yes	No	Yes	No	INTERTRAN project	**Yes**	**Very high**	Data integration tool; Electronic data interchange between railways and border authorities; ETA; Transportation modeling

No	Area	Solution	Description	Effects	National/ international applicability	Type	Technical base requirements	Financial requirements	Special international legal framework requirements	Requirements of special bilateral (multilateral) international agreements apart from international ogranizations	Multi-agency (yes/no)	Fast solution (yes/no)	Use cases by countries (non-exhaustive list)	Direct effect on rail resilience	Usability during COVID-19 and at recovery phase	Links to other solutions or tools
26	Traffic Operations	**Estimated time of arrival (ETA)**	Calculation of estimated time of arrival with transmission of infromation to transportation process participants and/ or customers	Higher predicatbility and reliability, higher resilience	National and international	**Institutional**	**High**	**Medium**	No	Yes	Yes	No	ELETA project (EU)	**Yes**	**Very high**	Data integration tool; AI tool; Sensors; Electronic data interchange; E-interoperability
27	Traffic Operations	**Interoperability**	Compatibility of different railway systems and their specific elements (not limited to operations, but also including rolling stock, infrastructure, etc.) to assure safe and uninterrupted operations along the network	Acceleration of transportation, cost reduction, improvement of safety	National and international	**Institutional**	**Medium**	**High**	Yes	No	No	No	widely used along TAR	**Yes**	**Very high**	Transportation modeling
28	Multi-use: decision-making	**Geographic information systems (GIS)**	Systems providing infromation on railway network and/ or traffic with data linked to geospatial information	Tool for both decision-making (capacity assessment) and customer inforning	National and international	**Mixed digital**	n/a	n/a	n/a	n/a	n/a	n/a	widely used along TAR	**Yes**	**Very high**	Tracking applications; Satellite navigation; ETA
29	Multi-use: decision-making	**Transportation modeling**	Mathematical representation of all or part of a transport system used to test solutions, forecast traffic and assess impact of different factors. May be combined with	High quality decision-making with decreased role of human factor	National and international	**Mixed digital**	n/a	n/a	n/a	n/a	n/a	n/a	widely used in international organisations and development banks; UIC study "Eurasian corridors: development potential" is based on modeling	**Yes**	**Very high**	Interoperability; E-interoperability; AI and machine learning

No	Area	Solution	Description	Effects	National/ international applicability	Type	Technical base requirements	Financial requirements	Special international legal framework requirements	Requirements of special bilateral (multilateral) international agreements apart from international ogranizations	Multi-agency (yes/no)	Fast solution (yes/no)	Use cases by countries (non-exhaustive list)	Direct effect on rail resilience	Usability during COVID-19 and at recovery phase	Links to other solutions or tools
			economic modeling and effects assessment.													
30	Multi-use: digital	**Artificial intelligence (AI) and machine learning**	Creation systems designed to intelligently manage rail processes based on the concept of machines being able to carry out tasks in a smart way	Higher reliability and resilience, decrease of human necessary resources	National and international	**Mixed digital**	n/a	n/a	n/a	n/a	n/a	n/a	widely used along TAR	**Yes**	**Very high**	Data integration tool; Sensors; Electronic data interchange; E-interoperability
31	Multi-use: digital	**Blockchain**	Data system construction technology based on growing list of records, called blocks, that are linked using cryptography. It assures resistance to data modification (once recorded a block cannot be changed without alteration of all subsequent blocks) and is a key element for creation of trustwoth digital systems	Higher reliabiltity and creation of trusrworth environment, time and cost decrease	National and international	**Mixed digital**	n/a	n/a	n/a	n/a	n/a	n/a	China: LOGINK platform	**Yes**	**Very high**	Data integration tool; AI tool; Sensors; Electronic data interchange; E-interoperability

No	Area	Solution	Description	Effects	National/ international applicability	Type	Technical base requirements	Financial requirements	Special international legal framework requirements	Requirements of special bilateral (multilateral) international agreements apart from international ogranizations	Multi-agency (yes/no)	Fast solution (yes/no)	Use cases by countries (non-exhaustive list)	Direct effect on rail resilience	Usability during COVID-19 and at recovery phase	Links to other solutions or tools
			(called ecosystems), including payment options for the participants													
32	Multi-use: digital	**Data integration**	Shift from separate work of different railway systems to data integration from many areas, objects or devices resulting in new knowledge or ability to achieve new results, as well as being a basis for AI	Higher reliability and resilience, improvement of interactions and basis for AI	National and international	**Mixed digital**	n/a	n/a	n/a	n/a	n/a	n/a	widely used along TAR	**Yes**	**Very high**	AI tool; Sensors; Electronic data interchange; E-interoperability
33	Multi-use: digital	**E-seals**	Electronic seals for containers either containing information on the cargo or just serving as smart locks automatically passing information on safety and/ or security problems	Higher reliability and facilitation of control procedures	National and international	**Mixed digital**	n/a	n/a	n/a	n/a	n/a	n/a	Russian Federation: e-seals as a must have tools to transport sanctioned goods in transit	**Yes**	**Very high**	Data integration; Electronic data interchange; E-interoperability

No	Area	Solution	Description	Effects	National/ international applicability	Type	Technical base requirements	Financial requirements	Special international legal framework requirements	Requirements of special bilateral (multilateral) international agreements apart from international ogranizations	Multi-agency (yes/no)	Fast solution (yes/no)	Use cases by countries (non-exhaustive list)	Direct effect on rail resilience	Usability during COVID-19 and at recovery phase	Links to other solutions or tools
34	Multi-use: digital	**Satellite navigation technology**	Use of data from satellites (GPS, GLONASS) as a part of traffic management systems	Traffic safety and reliabity improvement	National and international	**Technical and technological**	n/a	n/a	No	No	No	No	Russia (as a part of traffic management system developed by NIIAS), STARS project (EU)	**Yes**	**Medium**	Automated traffic management system; Data integration
35	Multi-use: digital	**Smart sensors**	Sensors for infrastructure or rolling stock connected to communication systems and passing infromation of the state of the object or the environment	Higher reliability and resilience, improvement of interactions and basis for automated traffic management systems	National and international	**Mixed digital**	n/a	n/a	n/a	n/a	n/a	n/a	widely used along TAR	**Yes**	**High**	Data integration tool; AI tool; Electronic data interchange; E-interoperability; Automated traffic management systems

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