KAPSARC
مركز الملك عبدالله للدراسات والبحوث البترولية
King Abdullah Petroleum Studies and Research Center

Exploring the Effects of Transport Policies on Energy Consumption in Freight Transportation – The Saudi Perspective

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About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit global institution dedicated to independent research into energy economics, policy, technology and the environment across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

This publication is also available in Arabic.

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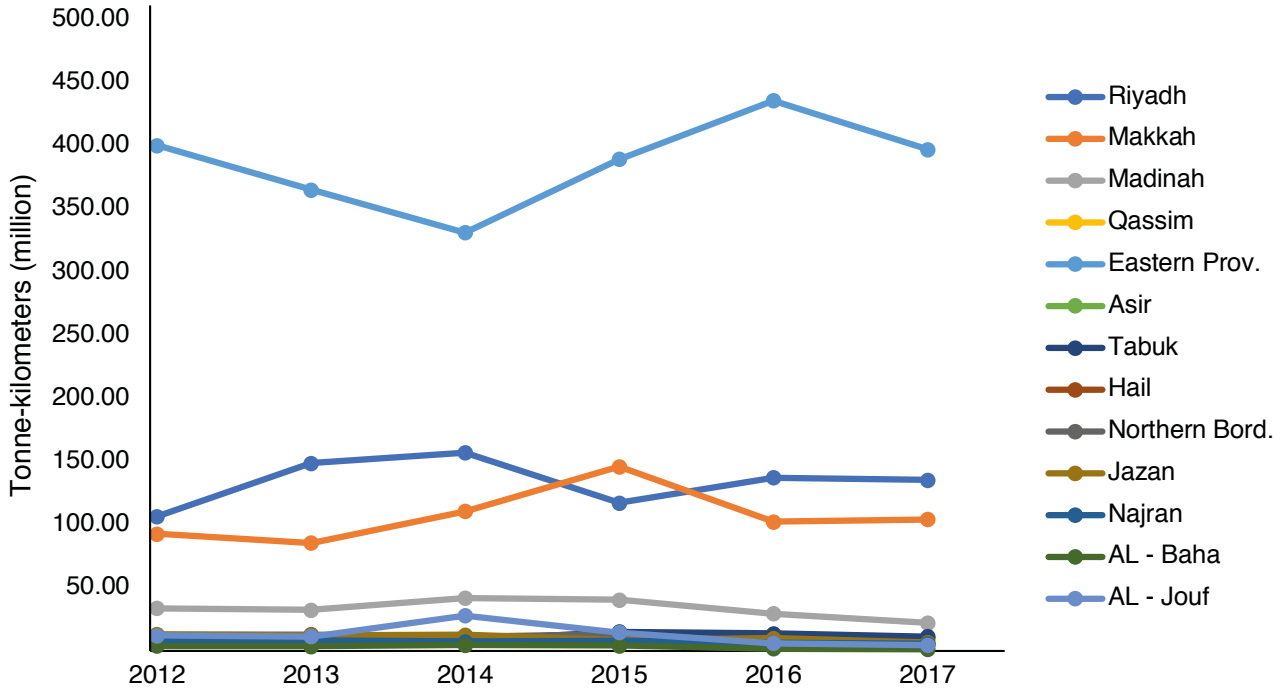
Key Points

Policymakers need to identify future trends in transportation demand as well as planned infrastructure developments. The impact of potential policy, regulatory and technology environments on the entire freight logistics chain needs to be understood more comprehensively. The workshop hosted by KAPSARC discussed the following key points:

- Freight transport development needs to be considered from the perspective of the entire supply chain: from the point of origin to the final destination.
- The Kingdom of Saudi Arabia needs to further develop its freight transport system to include multimodal options in order to meet its objective of becoming a global logistics hub.
- Technological development and changes in societal behavior are causing changes to urban freight transport.
- Global supply chains will be impacted by industrialization, urbanization and demographic shifts.
- It can be valuable for policymakers to utilize quantitative transport analysis tools to help understand the effects of different policies on different countries and regions, given the constant changes in emerging trends.

Figure 1: Saudi Arabia's total tonne-kilometers by province (2012 - 2017).



Source: KAPSARC calculations based on data from GaStat.

Summary for Policymakers

The freight sector is at the heart of global economic activity, one of the biggest energy consumers globally and a key contributor to emissions in the transport sector. It is estimated that over 12% of all global energy consumption is related to freight transport. In the past decades, the increase in freight mobility has been largely served by road, maritime shipping and, increasingly, air transportation, with less emphasis on alternative modes.

The increase in freight movement has meant the continued growth of fossil fuel use in freight transportation. However, this growth is moderating as more countries try to curb their use of fossil fuels in transportation. The United States (U.S.), the European Union (EU), China, Latin America and the Middle East contribute the most to freight transport activity. Because of this, research on the impact of regulatory, technological and political changes in these countries' freight transportation sectors has become increasingly important.

As part of its economic diversification plans, Saudi Arabia aims to become a key player in global logistics. Its strategic location on the Red Sea, close to the Suez Canal, allows it to provide the shortest route for a majority of vessels moving between Asia, the U.S. and the EU. However, this objective cannot be realized with Saudi Arabia's existing freight transport network. Investments in increased connectivity via multimodal infrastructure, specifically freight rail, would increase throughput and the utilization of the Kingdom's freight network. Currently, the country has limited inland freight transport options. Road freight accounts for 90% of land freight transport, due to the country's limited rail infrastructure. To achieve its goal of becoming a global logistics hub, Saudi Arabia should develop its freight rail infrastructure to connect its western and eastern coasts, connect the Saudi rail network with the pending Gulf Cooperation Council (GCC) rail network to increase rail coverage, and embrace digitization and technological innovation.

The U.S., EU and China are key consumers of transport freight activity, especially freight transport. In the U.S., technological, environmental and economic trends are impacting freight transportation. The transport sector in the EU is being shaped by the growing population and increased economic activity of its member states, and an increase in fuel emissions policies. The continued growth of China's economy will continue fueling its freight activity. Changes in China's economic structure, from a focus on lower value-added to higher value-added goods, may also lead to structural changes in its modes of freight transportation.

It is import to deliver tailor-made transportation policies that take into account the type of economy in a given country, its existing infrastructure (road or rail), the connectivity of its economy to other countries, the typology of its cities and regions and their demographic profiles. The KAPSARC Transport Analysis Framework (KTAF) was introduced with this in mind, as a platform to assess policy impacts and allow policymakers, planners and economic actors to access information on the future of freight transportation activities. The KTAF platform analyzes freight transportation in over 5,000 urban cores in over 200 regions in 33 countries, allowing for an understanding of the impact of public policy measures on different regions around the world.

Background to the Workshop

Recent changes in transport policies and regulations globally have influenced transportation modal shares. There is the expectation of a continued reshaping of internal and external global freight flows in accordance with established production and supply chains. These changes are particularly interesting for Saudi Arabia, with its ambitious objective of not only being a major energy provider in the freight sector but also becoming a global freight transportation hub, connecting the GCC and greater Asia to Africa and Europe. The goals set out in Saudi Vision 2030, the country's plan to diversify its economy, are ambitious and require dedicated infrastructure planning and execution.

It is important to understand freight transport activity on all levels, from local to global networks. Hence, this workshop explored the role of Saudi Arabia and key countries in the freight transport sector, including China, India, the EU and the U.S.

The workshop explored freight transportation activity by focusing on topics including:

- Understanding current and future freight transportation demand in global and local networks.
- The link between future transportation demand in China, India, the U.S. and the EU and Saudi Arabia's objective of becoming a global logistics hub.
- Identifying and analyzing strategic policy, regulatory and technological changes in land and sea transportation to build future scenarios for freight transportation.
- The assessment of possible futures in the global supply chain.

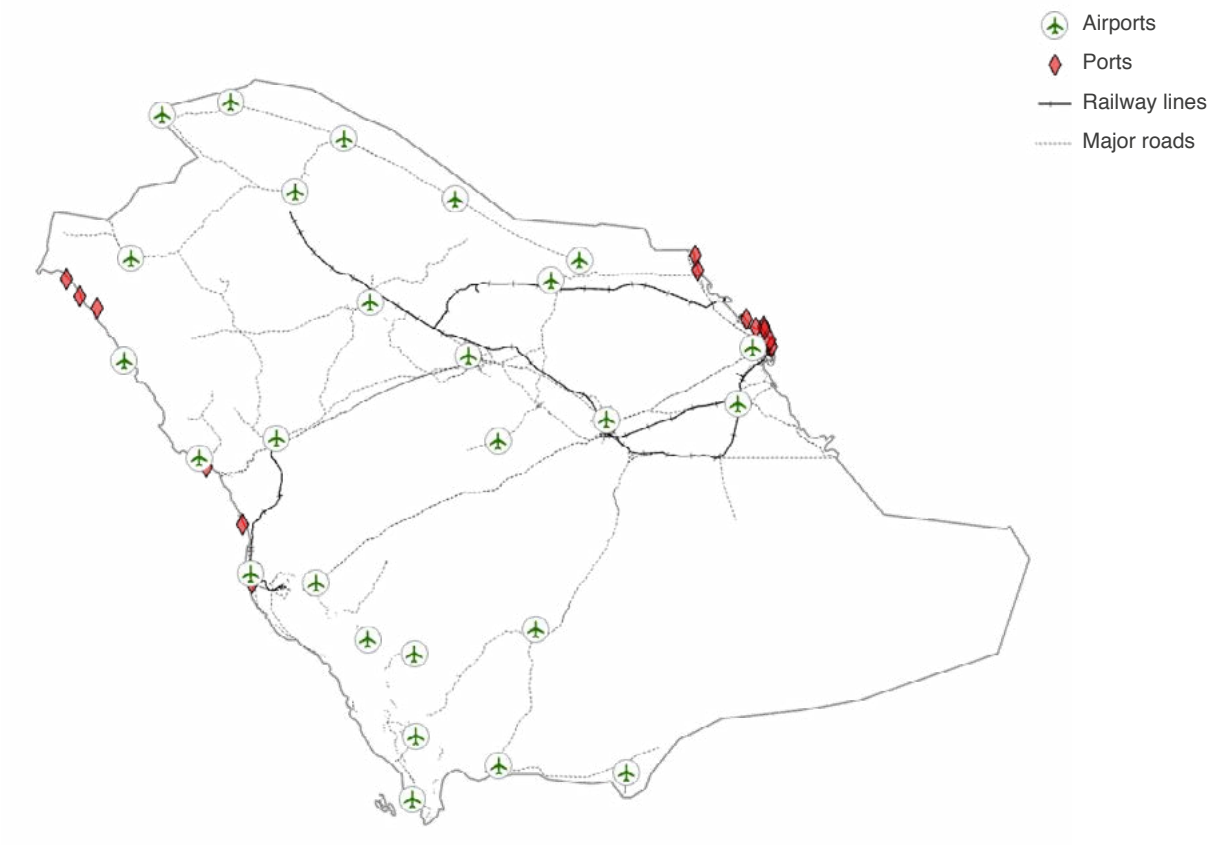
The Implications of Saudi Arabia's Strategic Goal for Freight Transport

With increasing global trade, Saudi Arabia has set itself an objective to become a key player in global logistics, as set out in Saudi Vision 2030. Its strategic location connecting Asia, Africa and Europe allows it to increase the competitiveness of its ports and develop a logistics freight hub. However, the current freight transport network in Saudi Arabia is insufficient to achieve this goal and needs further development. Investments in increased connectivity via multimodal infrastructure, specifically freight rail, would increase trade throughput and the utilization of Saudi Arabia's freight network.

The following were identified as priorities to ensure the attainment of this goal:

- Develop the Saudi Landbridge Project by connecting freight rail between the Kingdom's western and eastern coasts.
- Connect the Saudi rail network with the pending Gulf Cooperation Council (GCC) rail network to increase coverage.
- Enhance digitization and technological innovation.

Figure 2: Current freight transport connections in Saudi Arabia.



Source: KAPSARC based on Open Street Maps data.

There are currently 10 ports in Saudi Arabia: six on the western Red Sea coast and four on the eastern Arabian Gulf coast. Eight of the 10 ports are commercial and three are industrial ports. The Red Sea ports are located along the route to the Suez Canal, the access point that serves as the shortest path for ships sailing the Asia-Europe routes. The Jeddah Islamic Port has the highest container throughput and serves more than 50% of the Kingdom's exports and imports.

Saudi Arabia has 21 airports, with only three cargo freight handling airports: King Abdulaziz International Airport in Jeddah, King Khalid International Airport in Riyadh and King Fahd International Airport in Dammam.

In Saudi Arabia, trucks account for 90% of land freight traffic. This is due to the country's prevalence of roads and the limited connectivity of freight rail. Freight rail transport in Saudi Arabia developed in the 1950s as a way to connect the landlocked capital of Riyadh with King Abdulaziz Port in Dammam. There are an estimated 4,175 kilometers (km) of rail linking Dammam with Riyadh and the northern city of Hail. No rail link connects the western coast to the eastern coast. This means that seven ports, including the key port in Jeddah, are connected inland only via road freight.

Saudi can allow for multimodal freight transport. Rail consumes around 70% less fuel than road freight and emits an estimated 75% less carbon dioxide (CO_2). A GCC rail network connection would allow for more movement of goods from neighboring ports to Saudi Arabia and vice versa. This would affect the competitiveness of the ports in the Arabian Peninsula. Furthermore, rail transport would reduce delivery times between the eastern and western coasts. These time savings would be valuable to freight shippers.

Another key element to consider when developing the freight transport system, and maritime logistics chain, is the incorporation of digital technologies to improve efficiencies in freight transport. These efficiencies would reduce the costs of transport.

Global Perspectives on Current and Future Freight Transport Demand

Global freight activity has been increasing due to improved living standards in emerging countries, an increase in integrated global supply chains and the reindustrialization of developed countries. This increase in freight activity has been reflected in the rise of oil consumption by road freight transport. In developed economies, road freight oil consumption continues to increase, even as oil demand for passenger vehicles has begun to plateau and, in some cases, decline. However, in many developing and emerging economies, the pace of oil demand growth from the road freight sector has begun to outstrip that of the passenger vehicle sector. Traditionally, policymaking and research have largely focused on passenger transportation and urban infrastructure, while freight transportation research has received less attention. However, freight transport is a key contributor to overall energy consumption and CO2 emissions in the transport sector. To give an understanding of the current state of global freight transportation, examples are drawn from key economies such as China, the United States (U.S.) and the European Union (EU).

The freight transportation sector in China is expected to grow for the next decade, even under a scenario of slower economic growth. It is expected that China's gross domestic product (GDP) growth per capita will slow, reaching around US$17,000 (in 2015 dollars) by 2030. This expected slowing of GDP growth in China is less adverse than the slowdown in GDP growth per capita in the United Kingdom, the U.S. and Japan when their freight activity began to decline. In other words, freight movement in China will not peak before the country completes its later stages of industrialization. However, China could reduce the volume and intensity of its freight transport through coordinated urban planning, using new materials, developing high-tech industries and expanding its service sector. Changes to the country's economic structure may also lead to structural changes in its modes of freight transportation, including an increased share for rail, more automotive transportation, and the increased use of containers in an integrated freight transport system.

In the U.S., societal, technological, environmental and economic trends are impacting freight transportation. These trends are changing the magnitude and pattern of U.S. freight demand. For example, the rise of online same-day delivery services has affected the warehousing and delivery patterns in U.S. urban freight transport. Unit energy consumption per vehicle has decreased in the U.S.; however, total freight transport energy consumption has increased. Investigating these trends in the U.S. requires an analysis of both supply-side and demand-side policies. Further, it is important to address the country's social, economic and technological transformation, since the trends identified above are producing counterbalancing effects, and it is important to determine the net effects of these trends.

In Europe, the underlying population and economic activity trends, the change in technology models for energy demand and supply, and the increase in policies related to emissions and fuel standards are key in shaping the freight transportation sector. Since 2017, the EU has been heavily reliant on road transportation, which has accounted for about 71% of its total freight transport. Whereas rail transport in the EU is declining, accounting for only about 16.5% of the bloc's total freight transport. Inland waterways and coastal shipping shares account for some 6.3% and 6.1% of the EU's total freight transport, respectively. The European Commission's EU reference scenario projections estimate that

the EU's freight transport activity is expected to increase about 50% from 2015 levels by 2050, with a significant increase in rail. Further, energy demand in freight transport is expected to grow some 25% from 2015 levels by 2050.

It is important to note that models sometimes fail to take into account disruptions in trends, which can affect freight transport analyses, especially with accelerated technology changes, firmer environmental policies and changes in societal behavior. Key trends in technology to keep in mind include the use of hydrogen in freight transport, automated vehicles and road pricing effects.

Policy and Technology Analysis – Tools That Aid in Policymaking

The aforementioned trends in global transportation also need to be analyzed from the perspective of a climate-constrained world. New policies and regulations are being implemented in an environment of fast-changing motorized transport technology, and global logistics and transport activities are increasingly being streamlined.

In 2017, almost 55% of global oil consumption was from the transport sector. More than half of this 55% was from freight transportation. In descending order of magnitude, the U.S., the EU, China, Latin America and the Middle East have the highest freight transport activity globally. Because of this, research into the impact of regulatory, technological and political changes on the freight transportation sector of these countries has become increasingly important.

Research has focused on bridging the gap between prospective and normative scenarios. Existing research has tended to focus on the former, which sketch out differing visions of a desired future through a mix of modeling and qualitative analysis, while the latter, which are currently underrepresented, assess how a set of policies and regulatory measures would impact a pre-specified future. This might be because normative scenarios require a strategic vision and modeling approach based on local perspectives and extrapolate them to explain the global perspective.

Economies experiencing high growth in primary and secondary activities will see higher internal demand for locally produced commodities, along with increased exports and imports of higher value added commodities. There will be an increased need for all modes of freight transport in these economies if their household incomes continue to grow. However, meeting this increased need is highly dependent on the evolution of national and regional rail transportation and road infrastructure. For example, Saudi Arabia plans to heavily increase the national connectivity of its rail infrastructure and its connectivity with other GCC countries. As such, its demand for road vehicles for freight transportation will likely not be as high as its demand for rail rolling stock. Other economies, which are more reliant on road infrastructure, may see an increased demand for road rolling stock over all categories (light- medium- and heavy-duty vehicles).

Economies experiencing fast tertiary sector growth should see a decrease in the movement of locally produced commodities and an increase in the movement of freight from centralized platforms that source primary and secondary products from around the world. These economies will probably see a high demand for high capacity freight vehicles and more urban low duty vehicles.

Another major worldwide trend is the rise of the global climate change debate. For the past few years, the environmental debate around transport activities has grown. Many local authorities are acting on this debate by introducing new policy measures and regulations to improve the livability of cities and regions. It is important to deliver tailor-made policies that take into account the type of economy in a given country, its existing infrastructure (road or rail), the connectivity of its economy to other economies, the typology of its cities and regions and demographic makeup.

On this point, the KAPSARC Transport Analysis Framework (KTAF) platform enables the analysis of freight transportation for over 5,000 urban cores in over 200 regions in 33 countries. This platform allows researchers to assess policy impacts.

It also allows policymakers, planners and a wide array of economic actors to assess the impact of public policy measures on different regions around the world through accessing information on the future of freight transportation activities.

Future Outlook of Global Supply Chains

There is a realization in the freight transportation industry that being part of a successful global supply chain is necessary in order to remain relevant and competitive (efficient and cheap). The evolution of the concept of 'supply network,' where each stakeholder controls their supply chain and creates value for every actor involved in the ecosystem with the aim of better serving their customers, needs to be considered.

Several factors will impact the future of global supply chains, including the industrialization and urbanization of emerging economies, changing demographics, disruptive technologies, geopolitical developments, global trade and climate change.

The future of transport will be highly dependent on six critical elements in transport infrastructure development and planning, including: reliability, responsiveness, resilience, resources, relationship and risk. For example, long-term research projects need to address the question of how to design and build rail infrastructure and rolling stock to make them more resilient to severe climate impacts and extreme weather conditions and/or disasters, such as high temperatures, flooding, storms and landslides. Technology and innovation can enable greater competitiveness in cost reductions, increased product quality and service and growth. In the planning and development phases, 'co-innovation' enables actors/stakeholders to collectively acquire new and share existing knowledge in order to improve the competitiveness of the entire freight transport logistics chain.

About the Workshop

The KAPSARC Transport and Urban Infrastructure workshop, held in Riyadh in July 2019, hosted more than 30 experts in the areas of transport, freight, rail, road, shipping, transport technology development and the environment. The workshop aimed to facilitate a discussion on the effects of transport policies on energy consumption in freight transport from the Saudi perspective. It was held under a modified version of the Chatham House Rule, under which participants consented to be listed below without any of the content in this briefing being attributable to any individual attendee.

List of participants:

John Abraham – Company Principal, HBA SPECTO

Nouf Aburas – Senior Researcher, Saudi Aramco

Abdulaziz Ahmad – Energy Markets Analyst, Saudi Aramco

Amer Amer – Transport Chief Technologist, Saudi Aramco

Anvita Arora – Program Director, KAPSARC

Abdullah Balhaddad – Former VP, Saudi Railways Organization

Yagyavalk Bhatt – Research Associate, KAPSARC

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Tim Breemersch – Transport & Mobility, KU Leuven

Rania Dial – Ph.D. Student, University of Toulon

Dan Evans – IHS Markit

Wade Hansen – Director of Business Development, The Greenbrier Companies

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Majid Al-Moneef – Secretary General, Supreme Committee on Hydrocarbons

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Dimpy Suneja – Professor, Dialogue and Development Commission

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Xiaokun (Cara) Wang – Associate Professor, VREF Center of Excellence for Sustainable Urban Freight Systems at Rensselaer Polytechnic Institute

Monique van Wortel – Seconded National Expert, Shift2Rail

About the team

Anvita Arora

Anvita is program director for Transport and Urban Infrastructure at KAPSARC. Previously, she was the CEO of Innovative Transport Solutions. Anvita holds a Ph.D. from the Indian Institute of Technology Delhi, India.

Yagyavalk Bhatt

Yagyavalk is a senior research analyst at KAPSARC. His research interests include evaluating Indian energy policies with a focus on renewable energy. He worked previously as a researcher, providing sustainable development and decentralised renewable energy system solutions to rural areas of north India.

Dongmei Chen

Dongmei is a research fellow at KAPSARC focused on China-related policy studies and partnership coordination. She has over 20 years' experience in the energy and climate field in China, acting as head of the Institute of Industrial Productivity China Office and director of the Climate Change and Energy Program for WWF China before joining KAPSARC.

Hector Lopez-Ruiz

Hector is a research fellow specializing in transportation economics. He holds a Ph.D. in Economics from the University of Lyon.

Abdelrahman Muhsen

Abdelrahman is a research associate and a certified GIS Professional (GISP). He holds an M.Sc. in Geomatics Engineering from the University of Calgary, Canada. His research interests focus on transportation, spatial analytics and geo-information management.

Nora Nezamuddin

Nora is a research associate focusing on transport economics, policy and modeling. She holds an M.Sc. in Maritime and Air Transport Management from the University of Antwerp in Belgium, and a B.Sc. and B.A. in Business Administration and International Relations from The American University in Washington, D.C.

About the Project

The Kingdom of Saudi Arabia aims to become a global logistics hub by developing its transportation infrastructure to increase its economic diversification. This is one of the main priorities for Saudi policymakers, as stated in the Kingdom's National Transformation Program and the plan for the KSA Logistic Hub. The KAPSARC Transport Analysis Framework (KTAF) aims to assess the current status and future of freight transportation in Saudi Arabia from global and local perspectives. It does this by establishing a baseline of the current global freight network. It is then used to assess possible future scenarios to meet different policy objectives. Finally, it builds scenarios of the costs, benefits and risks associated with the development of freight within the country.

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