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The Vision of Physical Internet in Saudi Arabia: Towards a Logistic Hub in 2030

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Abstract
As a way to diversify its non-oil economy, Saudi Arabia launched a prospective initiative called Vision 2030 to boost its ability to be the biggest Middle Eastern logistic hub. Given its strategic geographic position at the crossroads of important international trade routes, between three continents: Asia, Europe and Africa, Saudi Arabia has a predominant logistical access to the Arabian Peninsula and East Africa, as well as the Asia-Europe trade route. Thanks to the existing infrastructure and all mechanisms already in place to improve logistics in Saudi Arabia, we strongly believe that the Physical Internet presents the right empowerment to these mechanisms by offering improvements in delivery times, costs and environmental impacts.
Keywords: *Physical Internet, Logistics, Logistic Hub, Saudi Arabia*

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1. INTRODUCTION

The economic program, Vision 2030, launched by the Saudi government in April 2016, aims to lift the country out of its historical dependence on oil and diversify its economy. This program is based, in particular, on a transition from the growth relay to the private sector and non-oil activities (Moser et al., 2015). Crown Prince Mohammad Bin Salman drives Saudi Arabia's Vision for the future which is an ambitious blueprint expressing the long-term goals of the country. The plan, Saudi Vision 2030, is structured around 12 operational programs (Moshashai, Leber & Savage, 2018).

The 8th program, called the National Industrial Development and Logistics Program, is the one focused on logistics and since it has not been revealed yet, it could benefit the most from the key characteristics of the Physical Internet. Its objective is to develop the industrial potential of the Kingdom by encouraging the localization of manufacturing production in the country. Thus, the Kingdom would eventually become a major logistics hub between three continents. The development of industrial zones goes through the MODON (Saudi Industrial Property Authority) which currently manages 34 industrial cities and plans the development of 5 additional cities over the next 5 years.

In addition, Saudi Arabia is applying several mechanisms that proved to be successful to make a better logistics network, notably in customs paperwork, making any customs operation faster than ever before. For example, the Saudi government has established four new economic cities, the largest of which is the King Abdullah Economic City (KAEC) which include the largest port in the Red Sea region (Moser et al., 2015).

To accompany this development plan and to be able to face the major challenges of globalization, the State is obliged to remain attentive to innovations. It is in this context that the physical internet is presented as a physical Internet revolution in Saudi Arabia: towards an efficient and sustainable logistics, which aims to significantly improve the economic, environmental and social efficiency and sustainability of the current organization (Alshuwaikhat & Ishak, 2017).

This article attempts to bring the elements of the Physical Internet to the reality of the Saudi logistics sector. It first proposes to highlight the concept and the research projects carried out on the subject, it then looks at an overall presentation as well as a SWOT analysis of the logistic and transport sector in Saudi Arabia, before presenting the prospects for developing a Physical Internet Network in the Saudi context.

2. THE PHYSICAL INTERNET

2.1 Definition

The evolution of current logistical performances must meet contradictory expectations. On the one hand, the respect of the just-in-time philosophy by favoring small and high frequency shipments. On the other hand, the desire to improve environmental performance by reducing greenhouse gas emissions. These goals cannot be achieved without limiting the fragmentation of freight flows. In this sense, increasing collaboration between supply chains or networks is a way to exploit synergies between them and then jointly improve their logistics performance, including transport activities. However, even though horizontal collaboration and bundling of merchandise flows are known concepts, only a few implementations are operational today and there is no evidence of widespread scaling up (Sarraj et al., 2013).

We think that the definition proposed by Ballot et al., (2010) is certainly exhaustive: "The physical internet is a global logistic system taking advantage of the interconnection of supply networks by a standardized set of collaboration protocols, modular containers and intelligent interfaces for increased efficiency and sustainability".

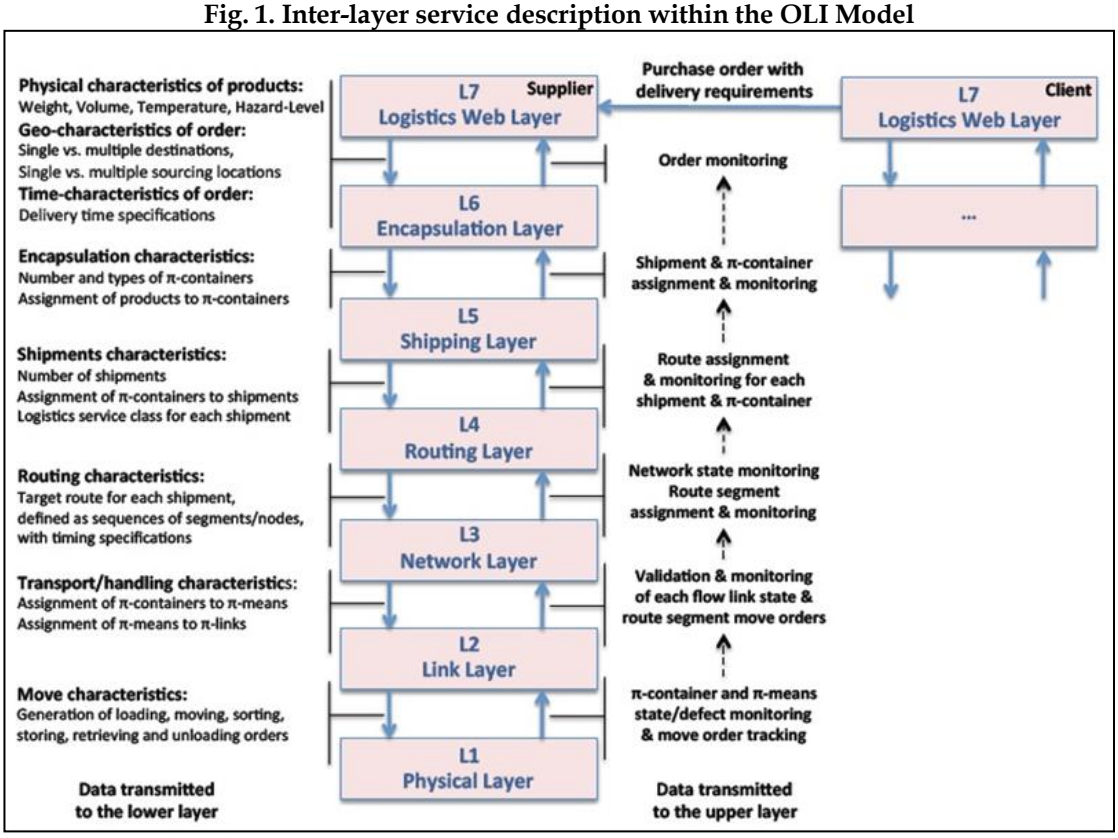
2.2 The Physical Internet as a Layered Model

The physical internet, by mimicking the digital internet's model, sets itself to follow the Open Systems Interconnection model (OSI). It is known that the Internet falls under the OSI model, offering a rich and more rigorous presentation through its seven layers.

This leads to the Open Logistics Interconnection (OLI) Model of the Physical Internet. The purpose of this model is to specify a general framework for the creation of subsequent consistent standards. The model itself does not define a particular service, let alone a protocol.

We can see in figure 1 how these layers interact vertically and how the flow evolves from one layer to the other.

Fig. 1. Inter-layer service description within the OLI Model



Source: Montreuil et al., 2012

The Physical Internet is also based on analogies from the internet a network that can be represented as a graph, as each network can be represented as a graph with a flow, nodes and arcs. These analogies can be seen in table 1.

Table 1. Simple analogies between digital and physical networks (Sarraj et al., 2014)

Network	Internet	Physical Internet	Interconnection function
Flow	Datagram	PI-Container	Encapsulation of merchandise
Node	Router	Hub	Location of orientation (sorting), change of mode, service provider
	Host (unique adress)	Supplier or consumer	Location of containerization and de-containerization
Arc	Wire or wave connection	Transport services	Punctual or regular transport between two nodes

3. BENCHMARK CASE STUDIES

3.1. Mass Distribution in France

The studied mobility web in French context is set to facilitate mass distribution through interconnecting several logistic networks, disserved by different Third-party logistics (3PLs).

As estimated by Ballot et al. (2010), the current logistic networks generate waste by the proliferation of untimely transport between production and storage sites, often dedicated to each organization and generating round trips and possible transformations into obsolescence and product waste. The reliance on service providers, which could improve the functioning of logistics, is a partial solution because of the difficulty for an atomized market to find synergies between customers with multiple and antagonistic requirements. The need for a new architecture is conspicuous, one with a higher sustainability and optimized flow. As a result, The Physical Internet is created as the new architecture to fulfil the need for logistic networks interconnection.

3.2. Routing optimization in Quebec

In Eastern Canada, a study has been made about routing optimization, based on a comparison between conventional logistics systems, the Physical Internet and hybrid model, containing both systems.

The cost performance of each of these logistic systems varies under various traffic and load selection scenarios. In networks with low ratio of packing to driving costs, the Physical Internet seems to be the superior logistics system followed by a hybrid system and the conventional system (Fazili et al., 2017).

In addition, from an environmental point of view, the Physical Internet showed substantial reduction in the logistics system carbon foot print from driving and reduces truck traffic on the roads (Fazili et al., 2017).

4. CURRENT LOGISTICS AND ECONOMICS IN SAUDI ARABIA

4.1. Logistics of Saudi Arabia

A broad review of literature offers many diverse opinions on logistics outsourcing in different countries, but little empirical research has been carried out in the Arab world and Saudi Arabia specifically. The kingdom of Saudi Arabia is the largest country in the Middle East and the 12th

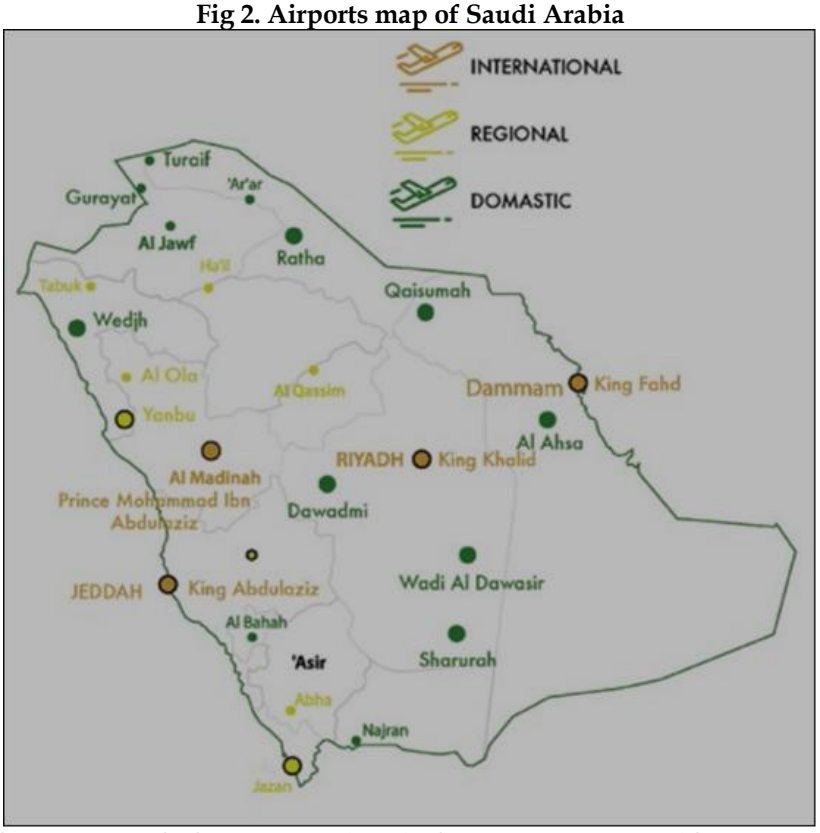
largest in the world with an approximate area of 2.2 million square km. It has the largest gross domestic product (GDP) in the Middle East (Sohail et al., 2005).

Saudi Arabia has an impressive transportation network made of 27 airports and 12 seaports connected with 65000 km of roads and 4130 km of railroads, without including the unpaved roads and the airports with unpaved runways (Ziadah,2018).

All ports are owned and maintained by private sector companies under long-term contracts. As part of Saudi export development initiatives, Saudi Arabia grants a 10-day exemption on export charges and 50% off on port taxes on all exports.

The 27 airports in Saudi Arabia includes four in Riyadh, Jeddah, Dammam and Al-Madinah Al-Munawarah. In 2015, more than 81 million passengers passed through the kingdom with a 9.5% increase over 2014, and air operations reached 646,693. Freight and mail handled reached 1.16 million tons, an increase of 14.1% over the previous year. Air transport is the preferred method of passenger transport in Saudi Arabia due to the distances between major cities. Several major international airlines offer services inside and outside Saudi Arabia (Figure 2).

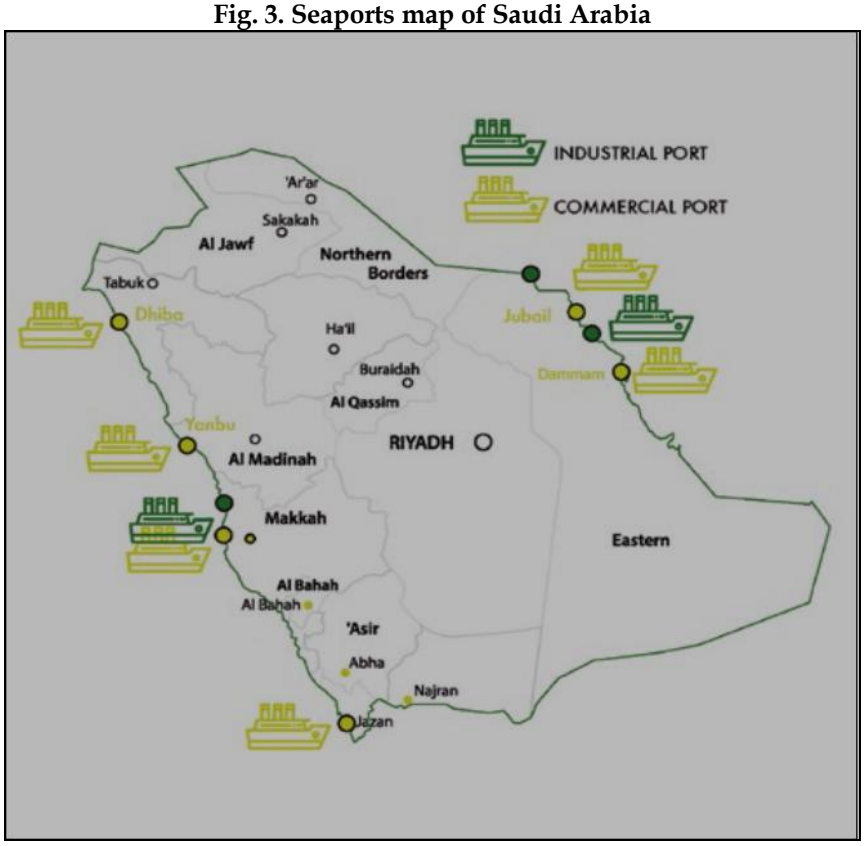
Fig 2. Airports map of Saudi Arabia



Source : https://www.ic.gov.sa/en/invest-in-saudi-arabia/transportation-network/

Saudi Arabia is the most important red sea gateway. Its seaports are among the top container terminal in operational productivity internationally. Saudi Arabia has the enormous seaport network in the Middle East, including twelve seaports, eight of which are container-shipping ports especially: King Fahad Jubail Industrial Port, Jeddah Islamic Port, King Fahad Yanbu Industrial Port, King Abdul Aziz Port in Dammam, Jubail Commercial Port, Yanbu Commercial Port, Jazan Port and Dhiba Port (Figure 3). All seaports are administrated and operated by private enterprises for long-term contracts. The kingdom has implemented export development measures, exempting exported goods from storage costs for 10 days and reducing port fees for all exports by 50%[1]. Elentably (2015) argued that these main seaports in KSA perform 95% of commodities' exports and imports although 55% of the cargos handled are exported. Moreover, annually more than 5 million Twenty-Foot Equivalent Unit (TEUs) are processed and also 11,000 ships attend the kingdom's ports (Op. Cit., p: 507).

Fig. 3. Seaports map of Saudi Arabia

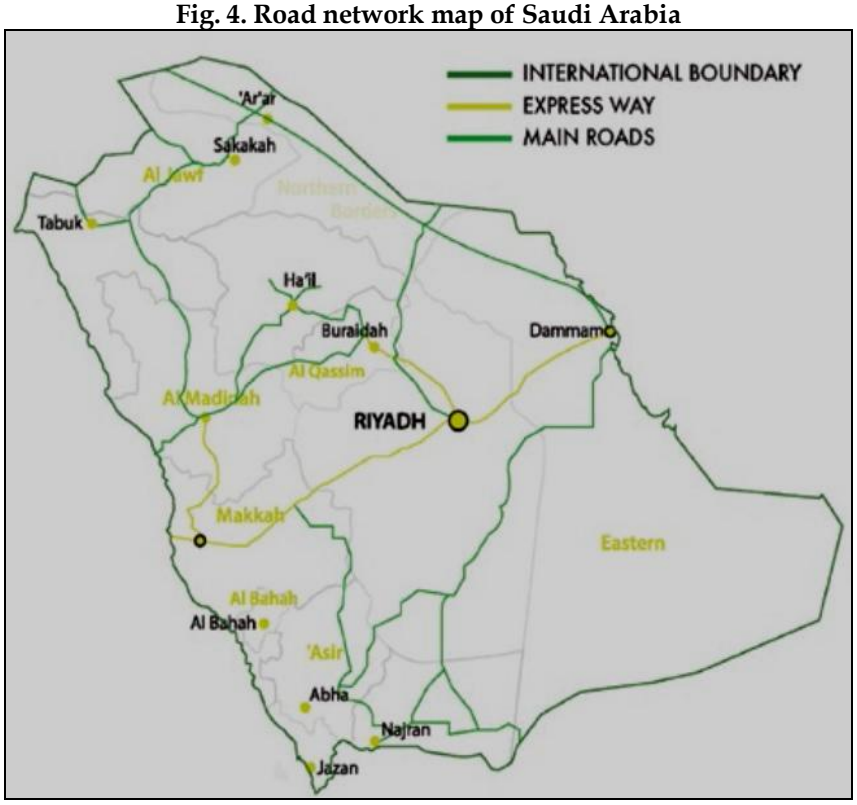


Source : https://www.ic.gov.sa/en/invest-in-saudi-arabia/transportation-network/

[1] https://www.ic.gov.sa/en/invest-in-saudi-arabia/transportation-network/

Saudi Arabia has a very developed country-wide road network where the total length of roads is about 1,60,000 km linking major Saudi regions and serving major urban area (Figure 4). In addition, the Kingdom has 1,02,000 km secondary roads connecting main cities with districts or regions and 3,74,000 km branch roads linking secondary roads and serving cities, settlements and rural zones.

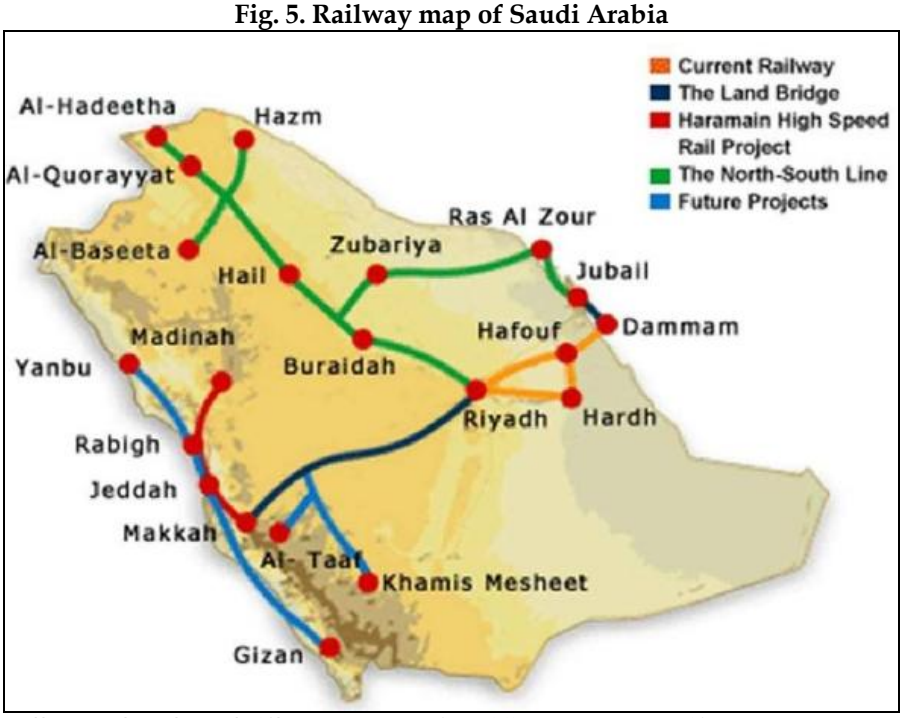
Fig. 4. Road network map of Saudi Arabia



Source : https://www.ic.gov.sa/en/invest-in-saudi-arabia/transportation-network/

The kingdom Railroads transportation services is about a network of 1,423 km of railway between the two towns Dammam and Riyadh, either directly or via Abqaiq and Hofuf. The Saudi Railways Organization transports annually 1.1 million passengers and deals over 3.4 million tons of cargo. Saudi Arabia targets an extension of its railway network from Riyadh to Jeddah, from Al-Hadeetha in the far North Via Al-Quorayyat and Hail to Riyadh, between Dammam and Jubail and between Zubariya and Jubail via Ras Al-Zour (Figure 5). The estimated global investment for the expansion of the railroad track network between 2005 and 2040 is about $100 billion.

Fig. 5. Railway map of Saudi Arabia



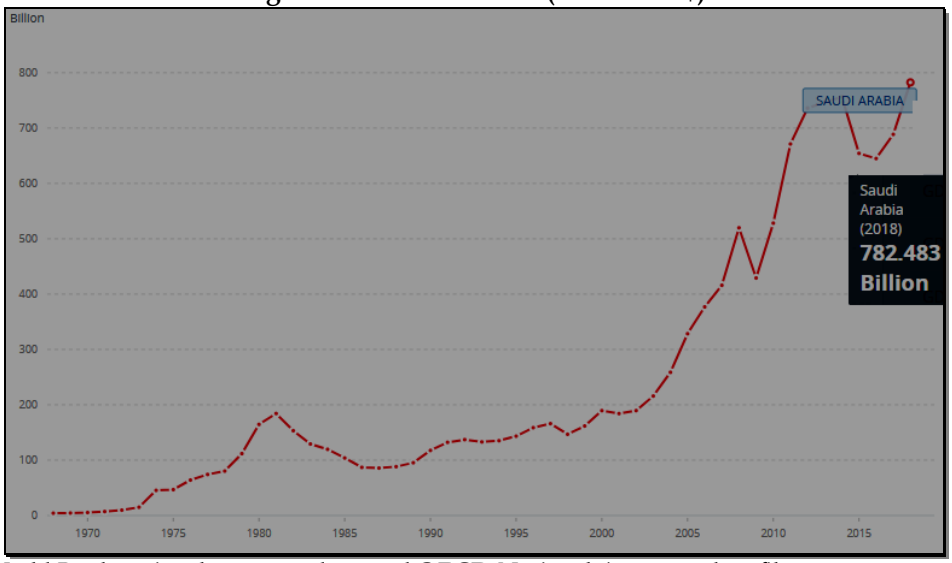
Source : https://uic.org/com/IMG/pdf/presentation_of_middle_east_region.pdf

4.2 Economic situation in Saudi Arabia

To become a logistic hub, Saudi Arabia needs to be an investment hub, and turn its economy around towards openness to foreign investments and focus further on non-oil economy.

On the macro-economic front, since 2015 the Kingdom has been facing a double deficit situation. According to the World Bank and the IMF, The Gross Domestic Product (GDP) in Saudi Arabia has been reduced from 4.1 % in 2015 to 1.7 % in 2016 and reached 782.48 billion US dollars in 2018 (Figure 6). The GDP of the kingdom averaged $243.68 Billion over the period 1968-2018 and covered 1.26 % of the world economy. International rating agencies downgraded Saudi Arabia's sovereign rating (Fitch: A +, Moody's: A1), but put it on a stable outlook due to a still stable fiscal position, high levels of liquidity and large reserves of extractable oils at low cost.

Fig.6. Saudi Arabia GDP (current US$)



Source: World Bank national accounts data, and OECD National Accounts data files.

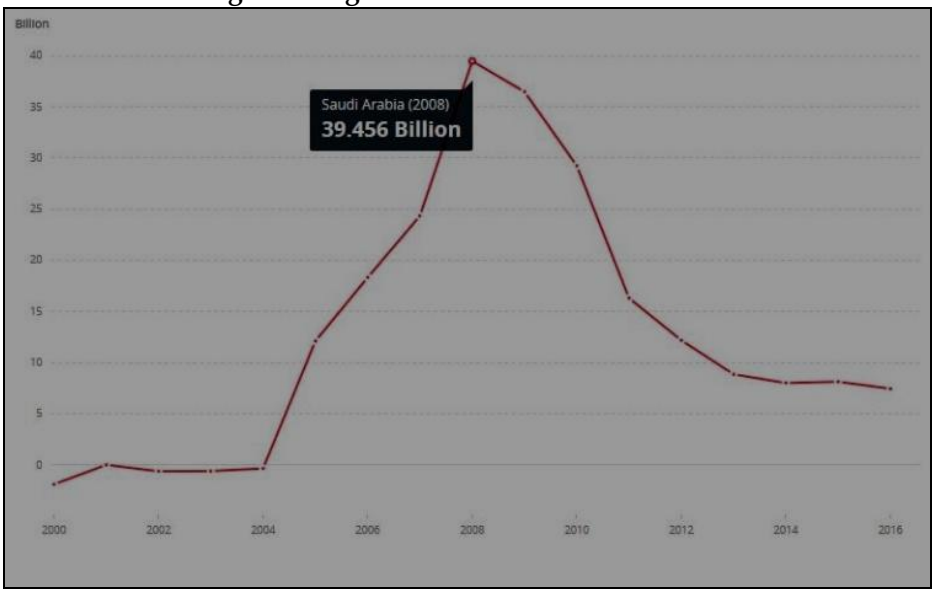
On the banking and financial front, in 2015-2016, Saudi Arabia experienced an episode of liquidity crisis caused by the drop-in oil revenues, the freezing of government spending, significant payment arrears and an issuance policy of debt on the local market. The measures taken by the authorities to resolve this situation (international debt policy, relaxation of certain prudential measures), however, made it possible to end it by the end of 2016, and, if the profitability of banks has been heavily impacted, the Saudi banking sector is nonetheless well regulated and sufficiently capitalized to cope with this crisis.

Thus, as the seventh program in Vision 2030, the Strategic Partnerships Program has for objective to develop and deepen economic partnerships with the countries considered as strategic and potential actors in the success of the Vision 2030. Among these countries, we count major partners especially: United States, China, Japan, South Korea, Great Britain, France, Germany and Russia.

In the turn of the new millennium, Saudi Arabia has also changed its position towards foreign investments from being non-existent up until 2004, to reach a peak of 39.456 billion dollars in 2008. These investments are a major contributor to the development of the transport and logistics sector, according to World Bank publications.

However, these investments are in decline since 2008 as we see in figure 7 and Saudi Vision 2030 is one of the programs to remediate this trend.

Fig. 7. Foreign investments in Saudi Arabia



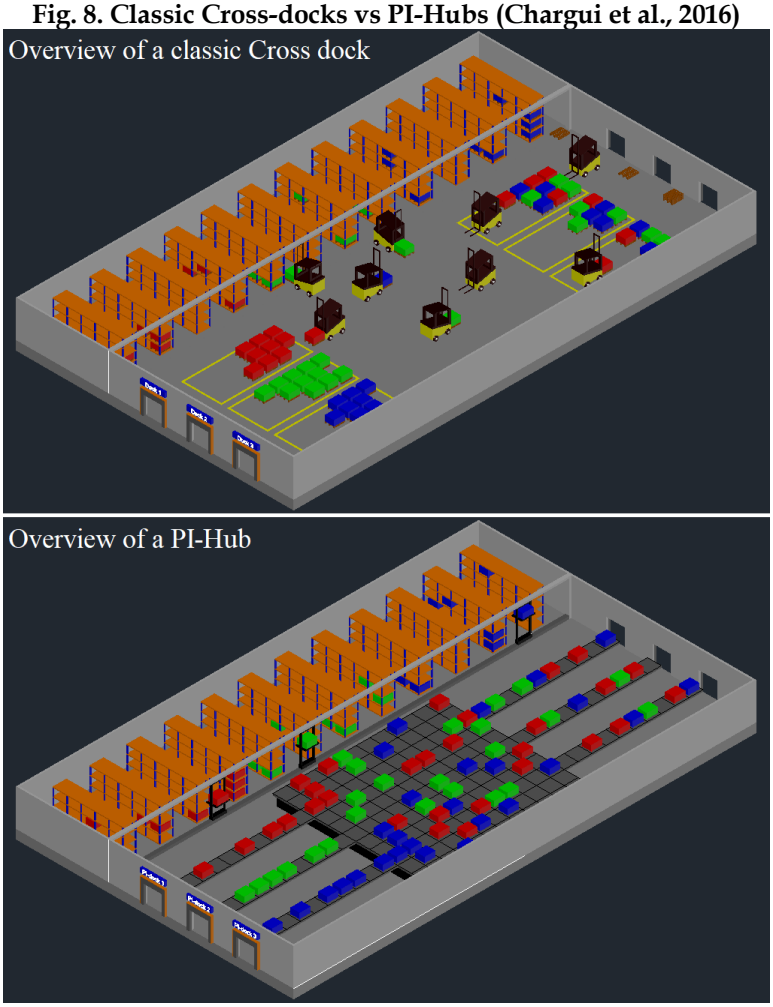
Source: World Bank national accounts data, and OECD National Accounts data files.

5 PERSPECTIVES OF THE PHYSICAL INTERNET IN SAUDI ARABIA

5.1 The transition to PI-Hubs

The PI-Hub, shown in figure 4, is an automated cross-dock, keeping the same inter-arrival time between incoming and outgoing trucks and the same level of incoming PI-Containers and requests. The characteristics used in the cross-dock facility are also the same as for the first model (the surface, the distances and the number of incoming and outgoing docks). However, instead of using forklifts, automated loading and unloading resources (PI-docks) connected to a sorting area (PI-sorters) using PI-conveyors are considered (Chargui et al., 2016).

Fig. 8. Classic Cross-docks vs PI-Hubs (Chargui et al., 2016)



The average speed used for the PI-conveyors is 2.77 m/s (10 km/h). In the PI-cross dock, manual forklifts for storing and retrieving products in the temporary warehouse are replaced by an automated storage and retrieval system (AS/RS) that is connected directly to the sorting area with three storage and retrieval machines. When a truck arrives to an incoming dock, the PI-dock unloads automatically the products which will be moved to the PI-sorters using PI-conveyors. Trucks' orders are served using the available products in the PI-Hub. The required PI-Containers are picked up using the AS/RS system and then they come through the sorting area (PI-sorters) and to the PI-dock through PI-conveyors. However, if the requested quantity is not enough to serve the truck and if there is a truck being unloaded in an incoming PI-dock then the PI-Containers arrive directly from that incoming PI-dock to the outgoing PI-dock where the PI-Container is requested (Chargui et al., 2016).

5.2 The transition to PI-Containers

The PI-Containers are easy to handle, store, transport, seal, snap to a structure, interlock together, load, unload, build and dismantle.

The PI-Containers have the following characteristics:

- Coming in various modular sizes, from cargo container sizes down to tiny sizes.
- Easy to handle, store, transport, seal, clench, interlock, load, unload, construct, dismantle, panel, compose and decompose.
- Made of environment friendly materials, with minimal off-service footprint.
- Minimizing packaging materials requirements through the enabling of fixture-based protection and stabilization of their embedded products.
- Coming in various usage-adapted structural grades.
- Having conditioning capabilities (e.g. temperature) as necessary.
- Sealable for security purposes.

5.3 SWOT Analysis

The analysis of the main characteristics, shown in table 2, of the internal and external environments of the Saudi logistics sector makes it possible to identify multiple assets that have so far been little exploited, because the sector still suffers from several deficiencies that affect it at different levels: economic, technological, environmental, legislative and social. These problems find their way into the foundations of the Physical Internet.

Indeed, the Physical Internet envisages a universal interconnectivity that will be concretized on a set of collaboration protocols, allowing all Saudi logistic actors to adjust their services to universal standards. This will have repercussions on several elements: the improvement of the quality of the service, the human skills and the working conditions; reinforcement of the maturity of the principals and transparency on the market; as well as the consolidation of the laws governing the sector. The standardization of collaboration protocols will also allow a fair circulation of physical and moral entities to ravage the world.

The Physical Internet offers an efficient and resilient open global system, through the efficient and reliable distribution of encapsulated goods to a multitude of open Pi-Hubs around the world. This will lead to a significant reduction in logistical costs for Saudi market players, due mainly to the adoption of multimodal transfer, lower transport costs with the removal of detours at warehouses and lower storage costs.

On the other hand, the homogeneity of intelligent technologies and the use of automation on a global scale, proposed by the Physical Internet, presage an optimization of the current logistical costs.

Table 2. SWOT analysis for Saudi logistics

Strengths	Weaknesses
• A quarter of the world's oil reserves and OPEC's largest producer • Major economic and regional role • Economy in the process of diversification strengthened by the Saudi Vision 2030 program • Solid financial position due to low debt and considerable assets • Robustness of the banking system	• High dependence on the hydrocarbon sector, low job creation, and increasing domestic demand for energy • High unemployment rate of nationals • Fragility of governance darkening the business climate • Unstable geopolitical environment Economy dependent on public expenditure
Opportunities	**Threats**
• Saudi Arabia benefits from a strategic geographical position, within a conjuncture point of three continents: Asia, Europe and Africa • The creation of a Public Investment Fund: the new domestic assets under management of the Public Investment Fund are expected to reach 20% of the total portfolio by 2020 • Implementation of a privatization program: BOO (Build, Operate, Own,) and BOT (Build, Operate, Transfer) models will be generalized for infrastructure construction.	• Legislation protecting the interests of principals is distinguished by its fragility • Access to land is one of the main obstacles in the sector • The national economy is characterized by vulnerability to EU, asian and north american countries. • Competition from public logistics structures is tough • Human and financial investments in research and development are very limited

6. CONCLUSIONS

In order to benefit from the benefits of resource sharing, the Physical Internet must be adopted on a universal scale. Hence the idea of studying development prospects in an emerging country such as Saudi Arabia. The study of the internal and external environments of the Saudi logistics sector has shown that the Physical Internet will be a continuity to the ambitions mentioned in the Saudi national strategy for the development of logistics competitiveness.

The Saudi Vision 2030, through its 8th program, regarding logistics development, must take into consideration the Physical Internet as a model to adopt, even partially, to be a competitor of advanced logistics networks implemented in the European Union for example, also considering the Physical Internet as model to adopt.

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