The future of Sustainable Logistics in Mexico

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Dr. Mostafa Hajiaghaei-Keshteli,

Associate Professor (Research) of Industrial Engineering

Scientific Records:

- **Top 2% of scientists worldwide, according to Stanford University**
- **Top 0.1% in "Closed-Loop Supply Chain", "Dynamic Routing", and "Humanitarian Logistics" (SciVal.com)**
- **One of the top 8 scholars (#3) in Engineering and Technology in Mexico (research.com)**
- **Ranked #1 in Industrial Engineering in Mexico (ADScientific.com)**

- **H-index: Scopus: 36, G-Scholar: 42**
- **Associate Editor:**

  Journal of Expert Systems with Applications

  Journal of Applied Soft Computing

  Journal of Engineering Application of Artificial Intelligence

- **Instructor**: CSCP, PMP, IRIS, ISO, CDA (UNIDO)

ncias

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Facts

Mexico's strategic logistic node Sistema Nacional de Plataformas Logísticas (SNPL), SCT, SE and IDB (Link)

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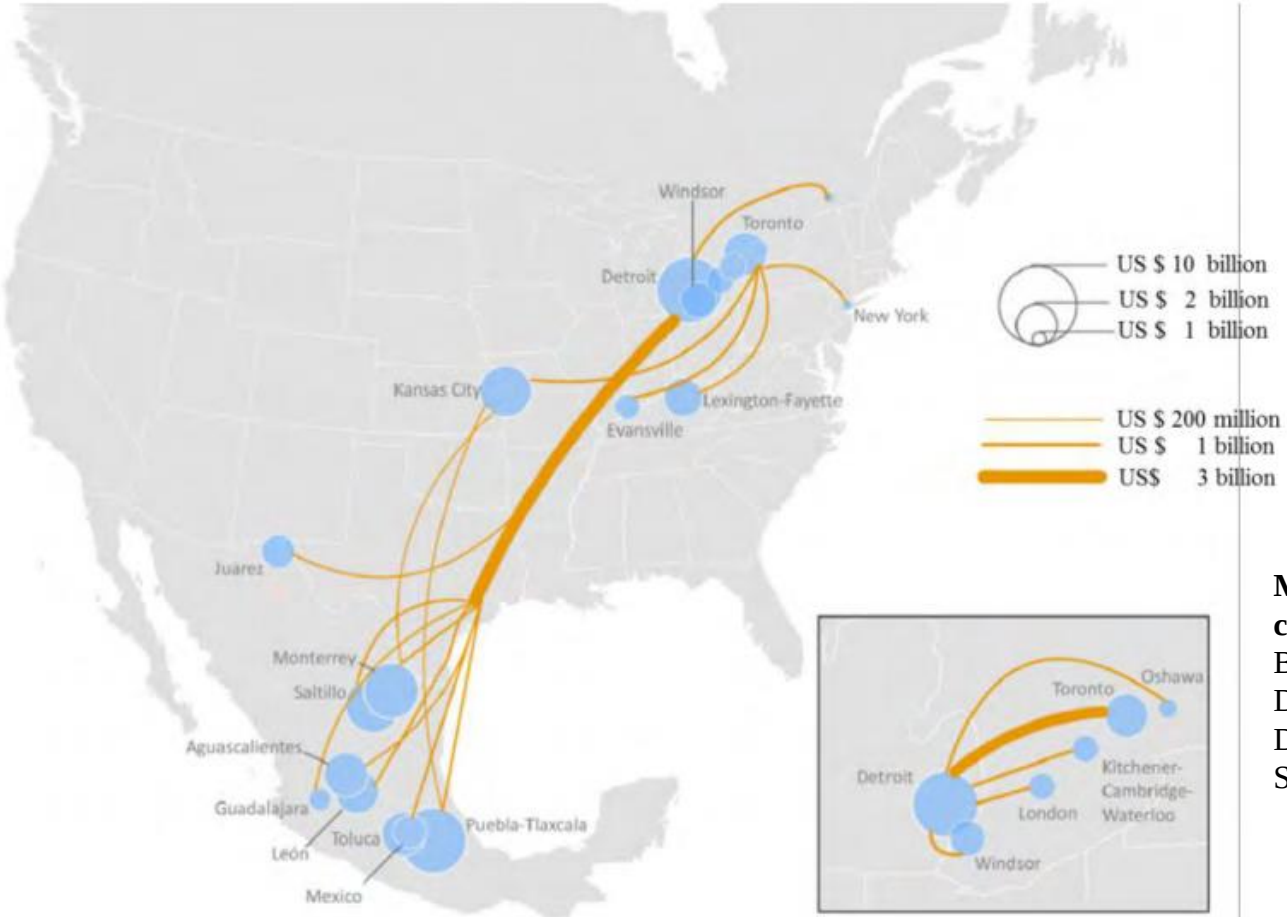

Main automotive logistics centers in North America Brookings Analysis of Economic Development Research Group. Data: Moody's Analytics, INEGI, Statistics Canada (Link)

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Location of car manufacturing plants in Mexico (and Puebla in the red circle)

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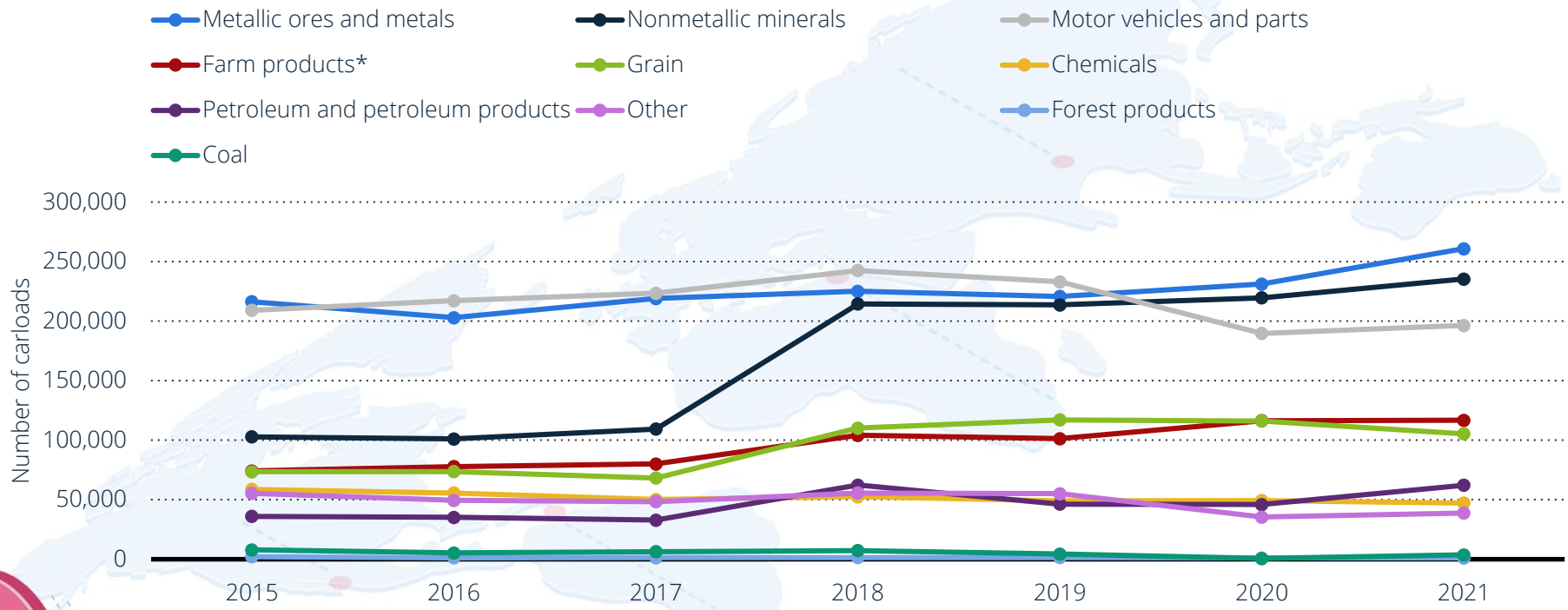
Number of carloads hauled by Mexican railways from 2015 to 2021, by type (in units)



Note(s): Mexico; 2015 to 2021
Further information regarding this statistic can be found on page 8.
Source(s): AAR; ID 559289

statista

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Mexico **GDP** from transport (Mexican Pesos) Trading Economics (Link)

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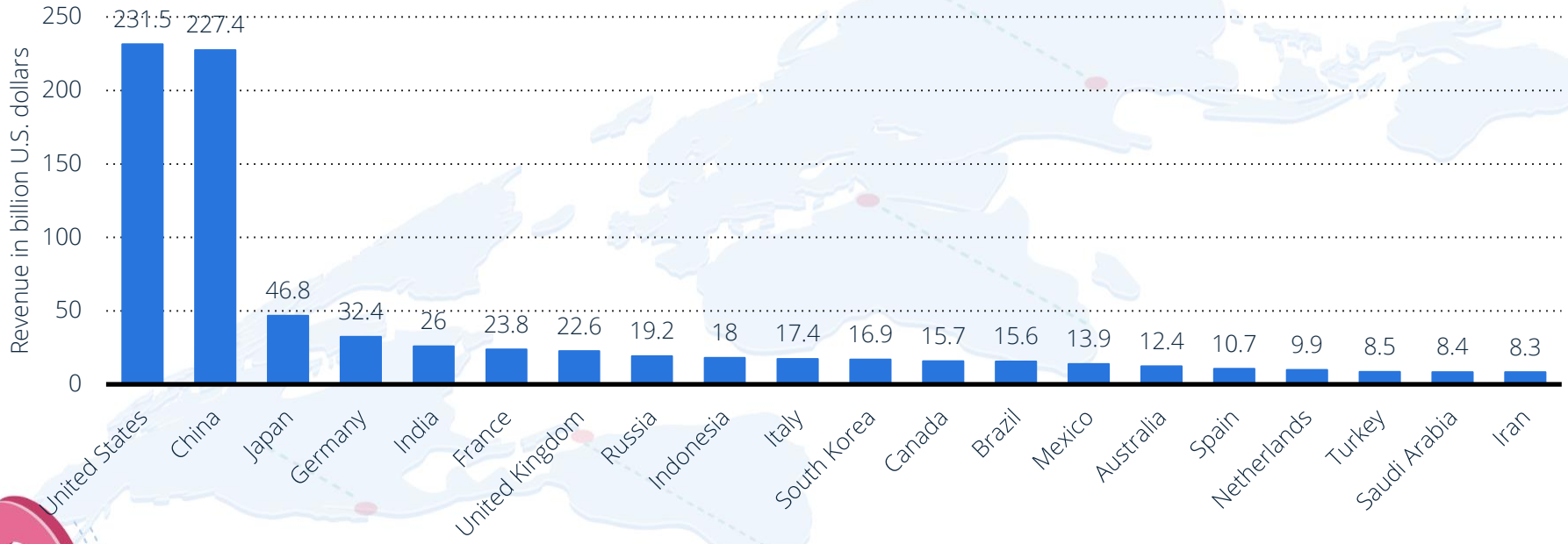
Facts

Third-party logistics (3PL) revenue in 2020, by major country (in billion U.S. dollars)

Third-party logistics (3PL) revenue by country 2020



Note(s): Worldwide; 2020

Further information regarding this statistic can be found on page 8.

Source(s): Armstrong & Associates; IMF; Indonesia Investments; Various sources (Australian Logistics Council, NESDB, Vietnam Business Forum, Logistics Viewpoints); ID 250876

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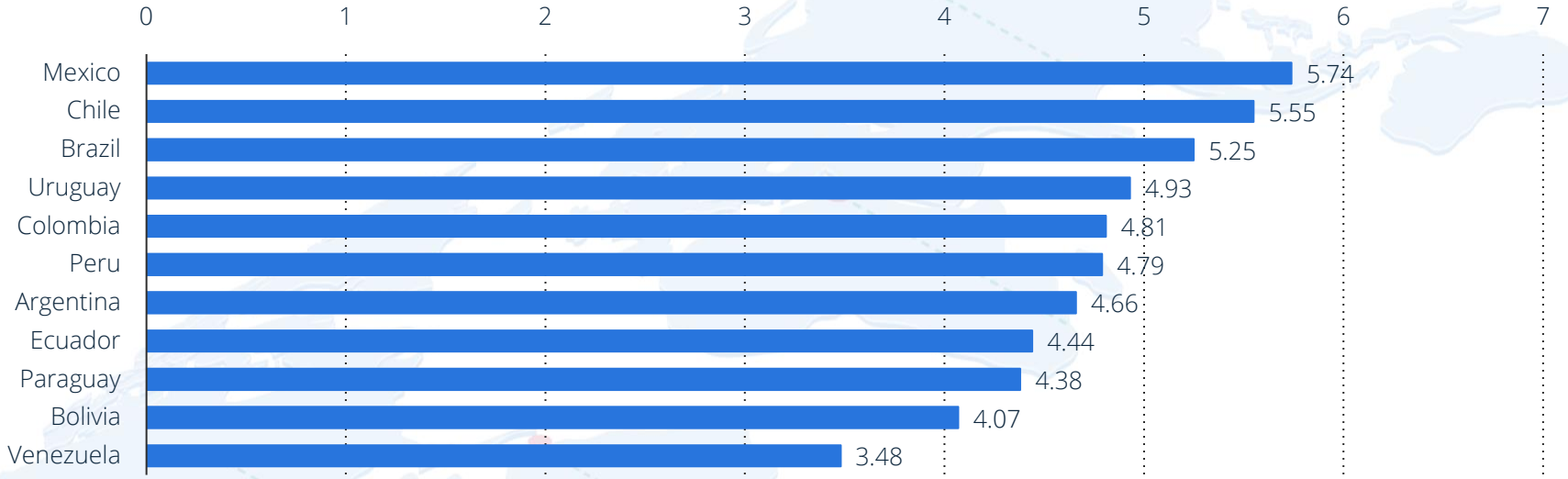
Leading logistics markets in Latin America in 2022, based on the Agility Emerging Markets Logistics Index



Note(s): LAC; 2022

Further information regarding this statistic can be found on page 8.

Source(s): Agility; Transport Intelligence; ID 1238002

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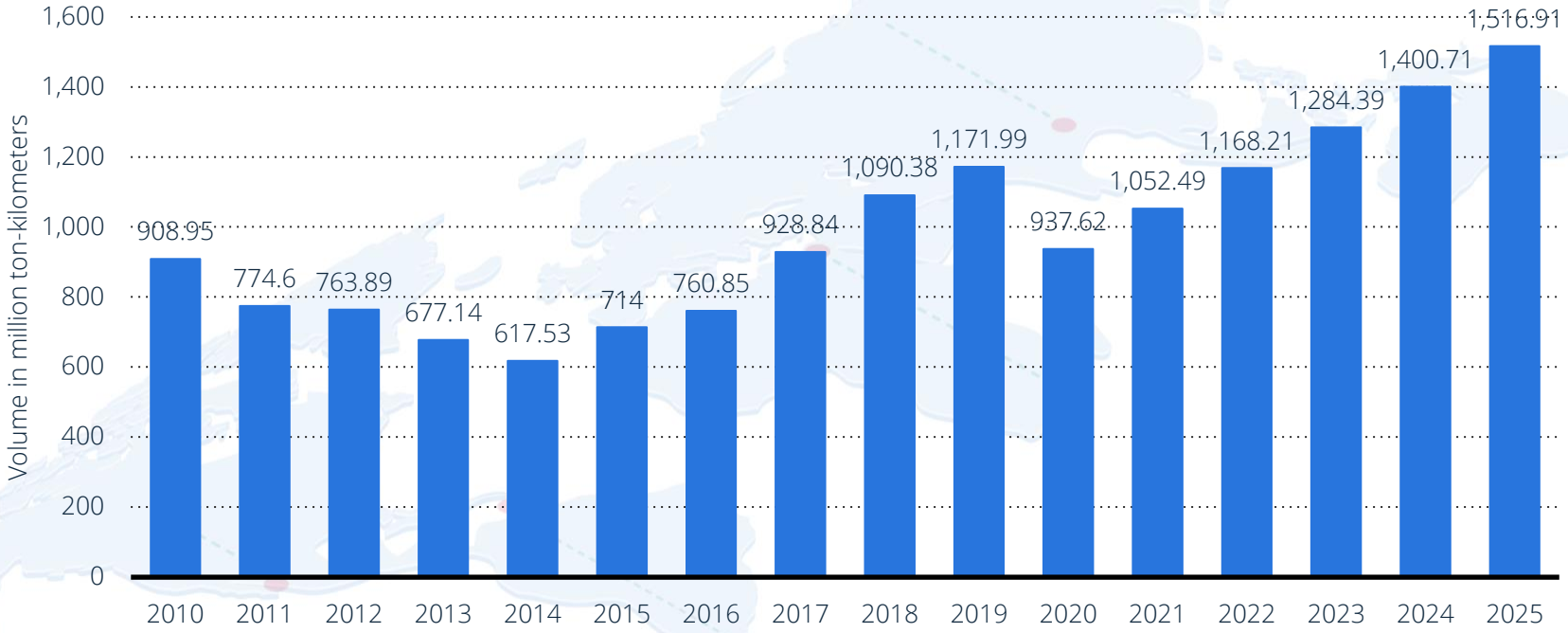
Forecast of the total air-freight transport in Mexico from 2010 to 2025 (in million ton-km)



Note(s): Mexico; 2010-2019; All values are estimates.
Further information regarding this statistic can be found on page 8.
Source(s): Statista; ID 1153159

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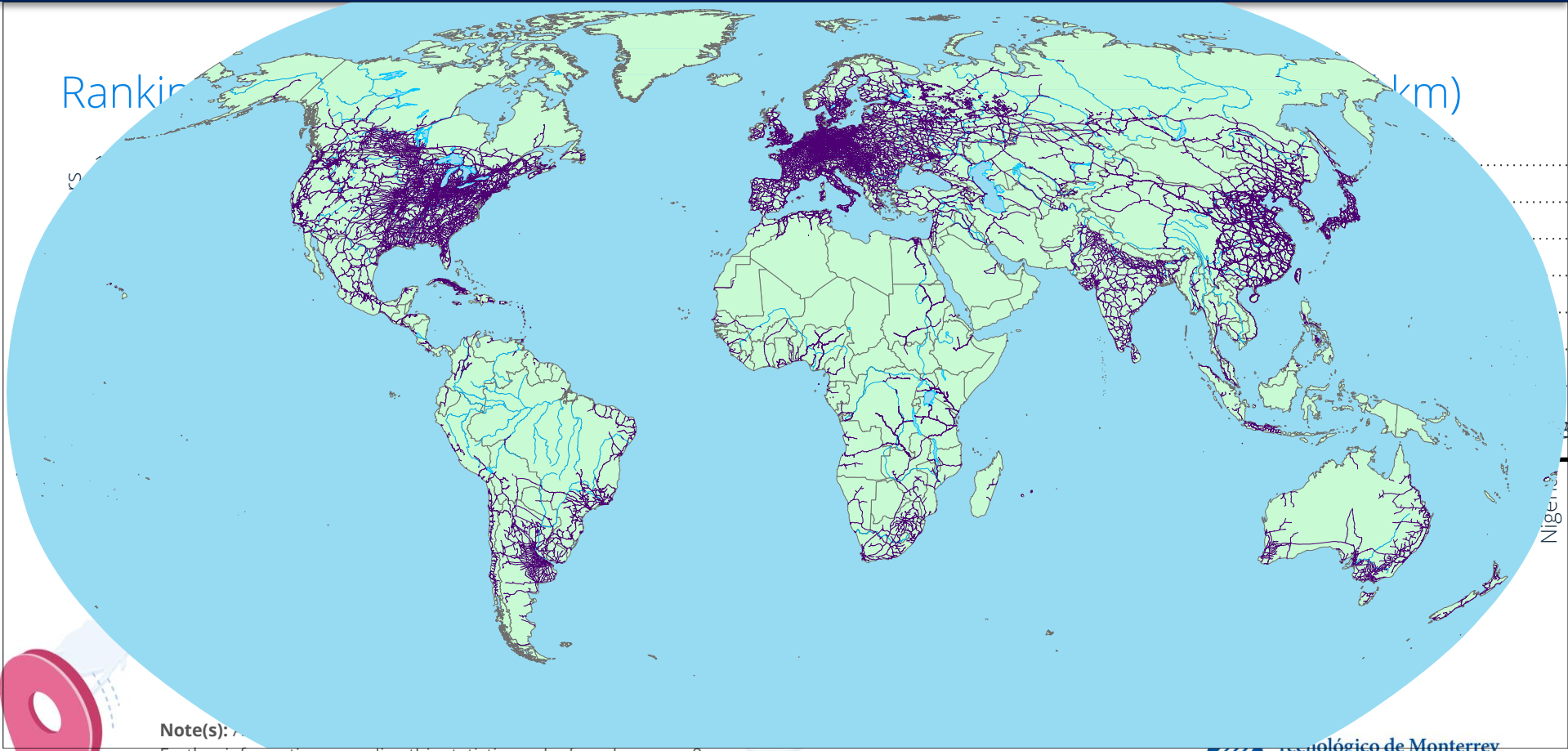

Note(s): A
Further information regarding this statistic can be found on page 8.
Source(s): Statista; ID 1150798

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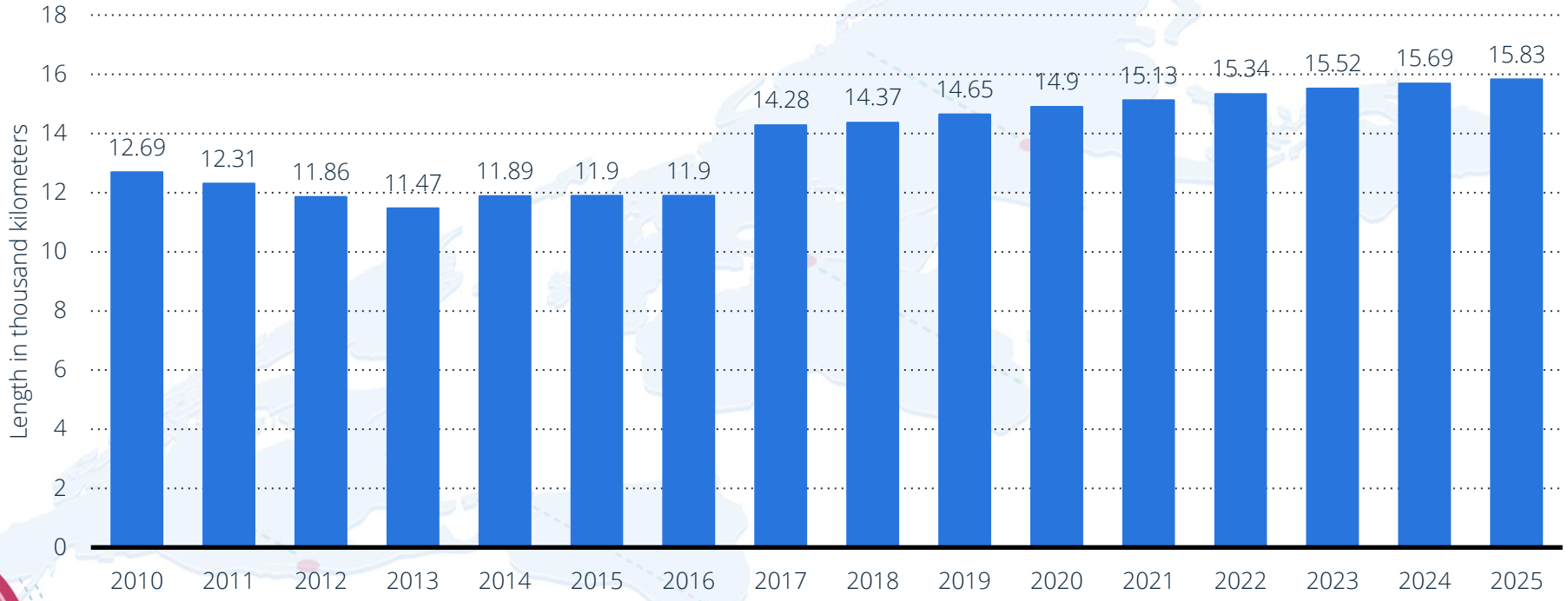
Forecast of the total length of rail lines in Mexico from 2010 to 2025 (in thousand km)



Note(s): Mexico; 2010-2019; All values are estimates.
Further information regarding this statistic can be found on page 8.
Source(s): Statista; ID 1151456

statista

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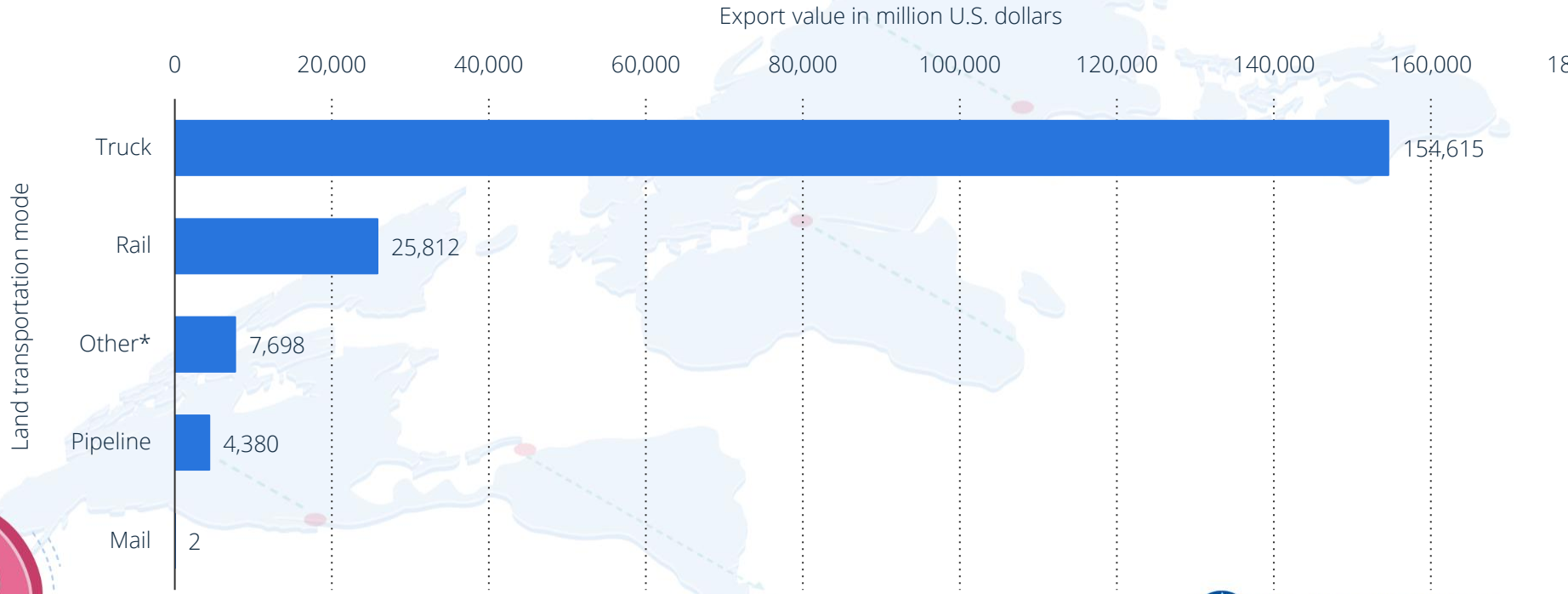
Value of U.S. exports to Mexico by land transportation mode in 2019, by mode (in million U.S. dollars)



Note(s): Mexico, United States; 2019

Further information regarding this statistic can be found on page 8.

Source(s): US Department of Transportation; ID 194963

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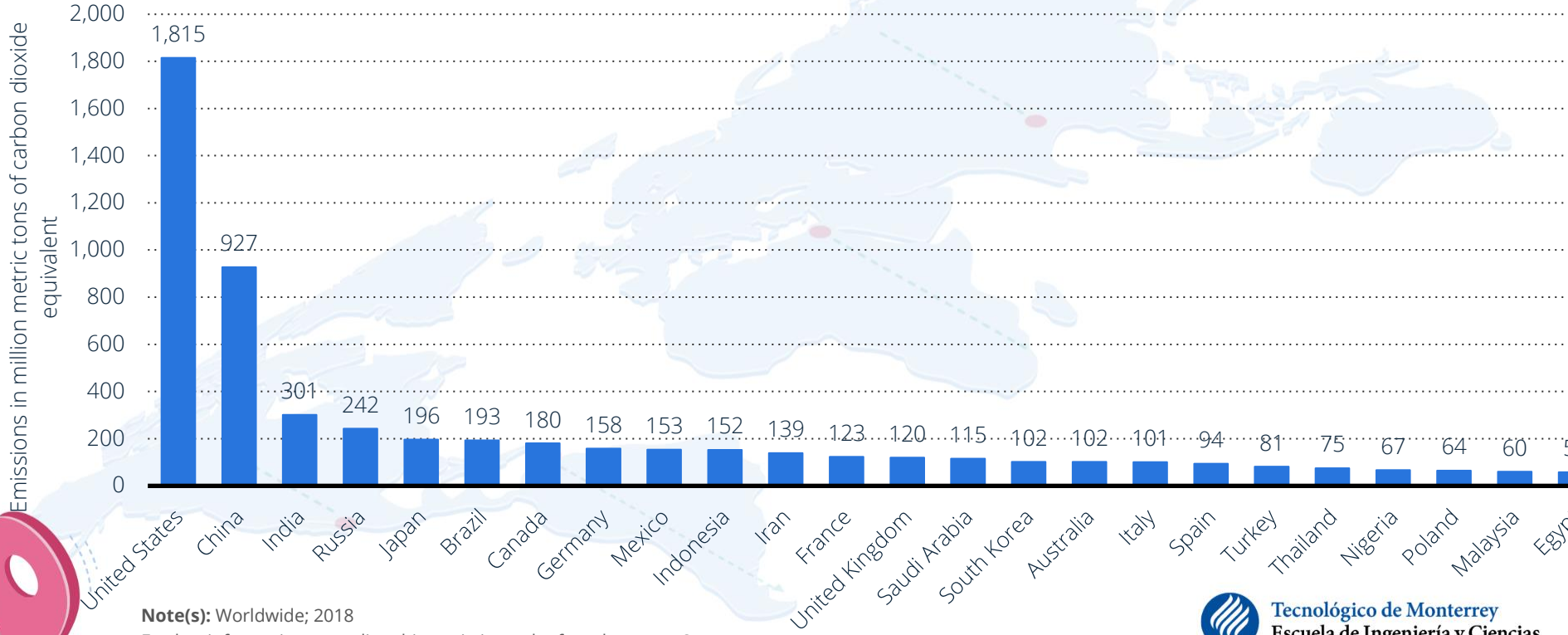
Greenhouse gas emissions from transportation worldwide in 2018, by select country (in million metric tons of carbon dioxide equivalent)



Note(s): Worldwide; 2018

Further information regarding this statistic can be found on page 8.

Source(s): European Commission; EDGAR/JRC; Expert(s) (Crippa et al.); ID 1084166

statista

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Facts

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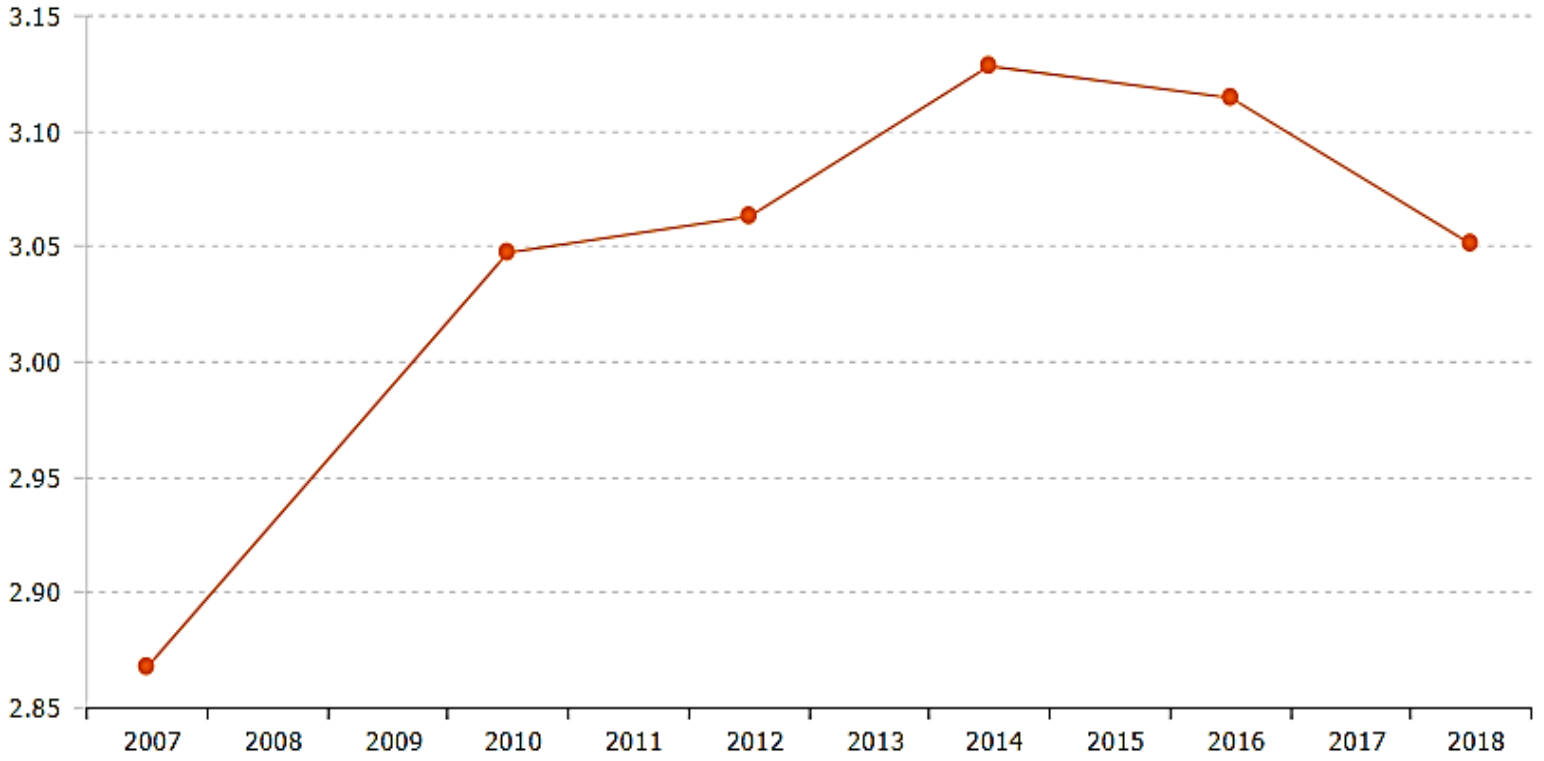

Mexico's Logistic Performance Index (World Bank: Logistic Performance Index (Link))

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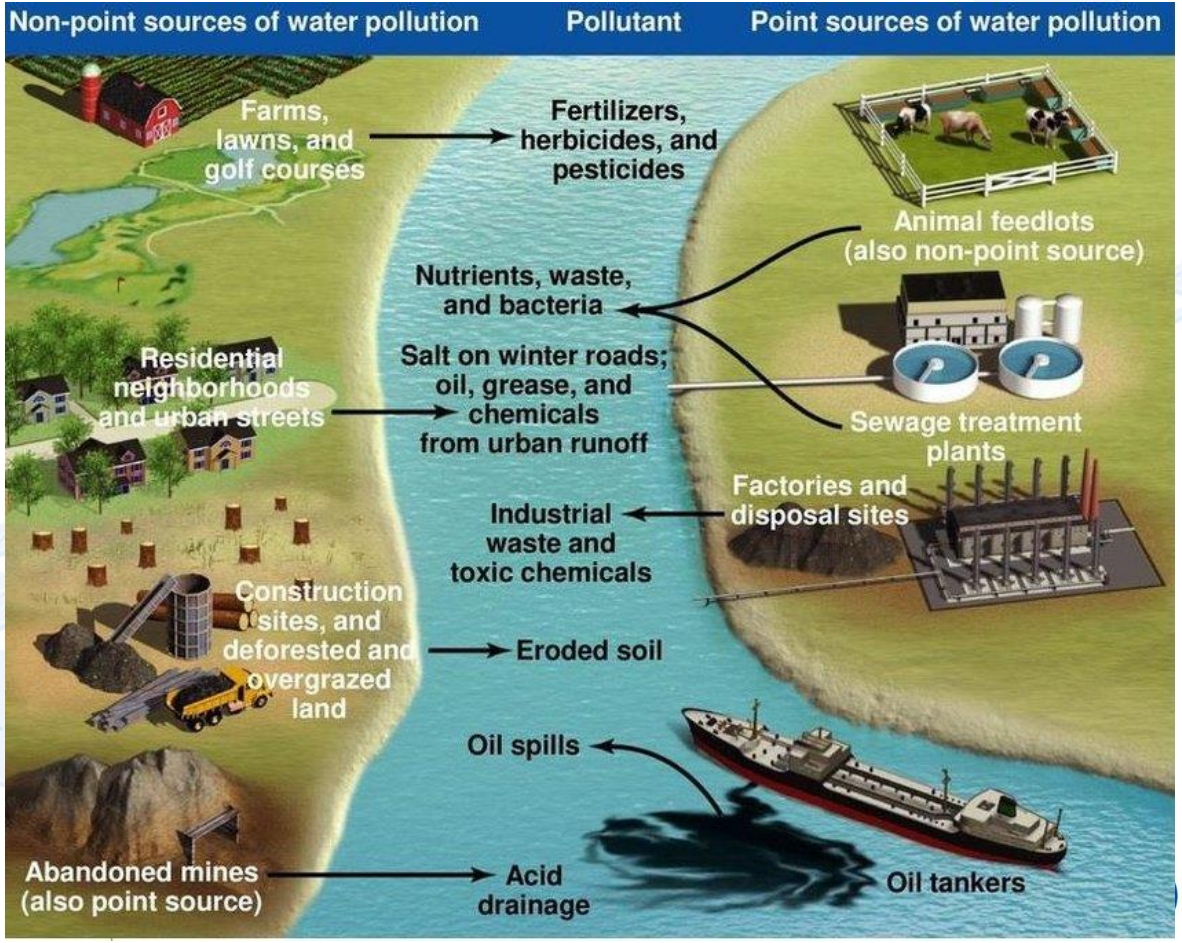
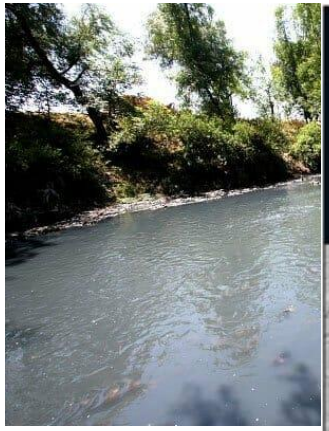
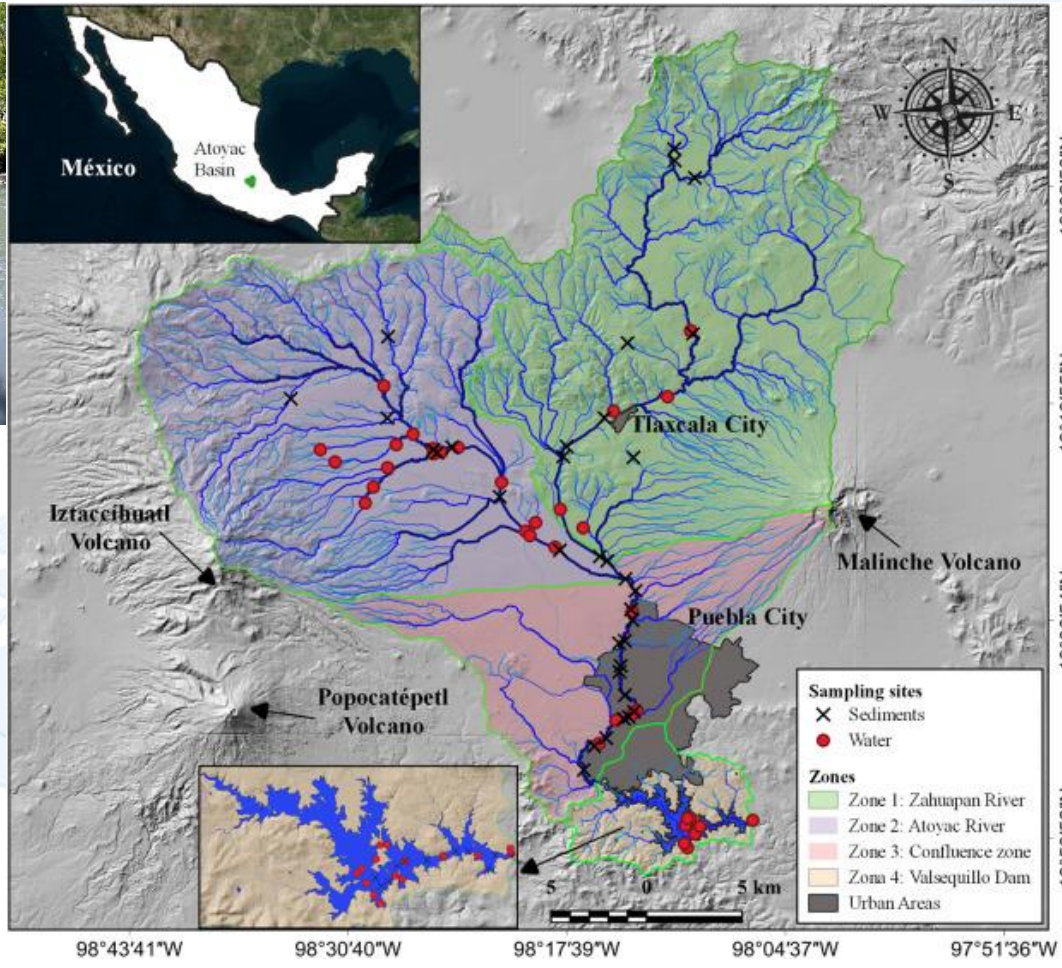
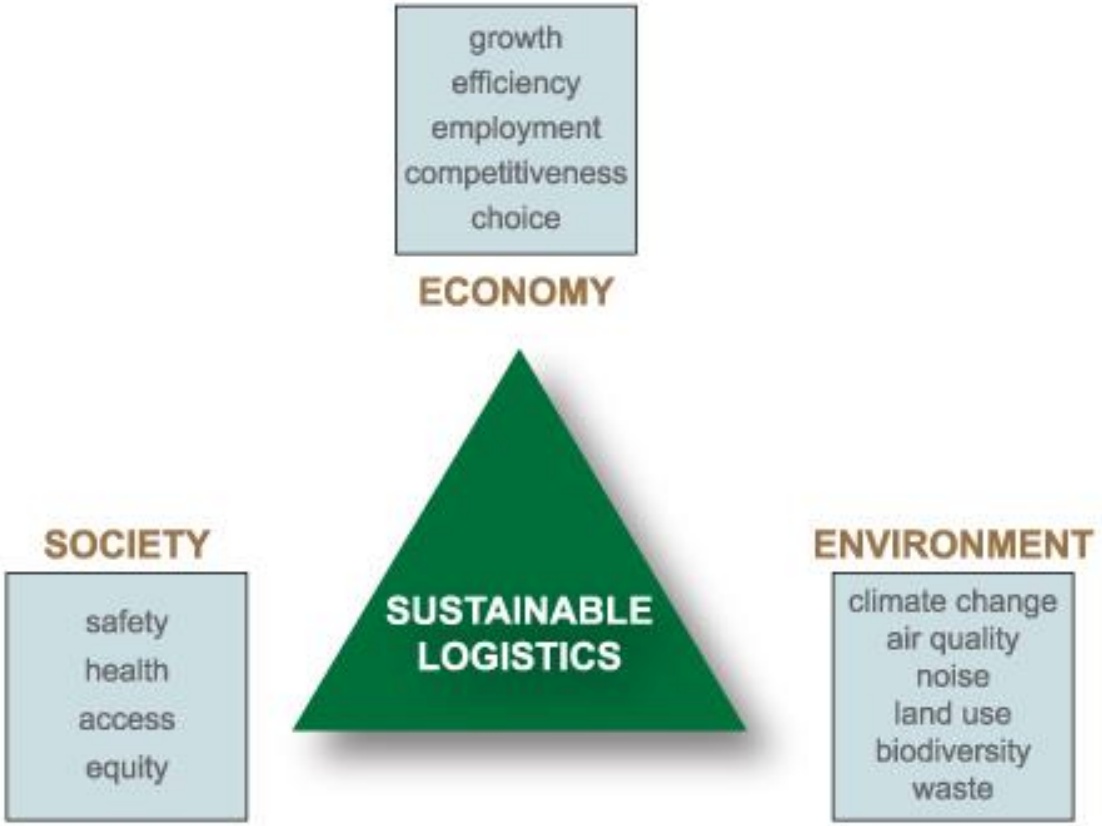

Non-point sources of water pollution
Pollutant
Point sources of water pollution
Farms, lawns, and golf courses
Fertilizers, herbicides, and pesticides
Animal feedlots (also non-point source)
Nutrients, waste, and bacteria
Residential neighborhoods and urban streets
Salt on winter roads; oil, grease, and chemicals from urban runoff
Sewage treatment plants
Factories and disposal sites
Industrial waste and toxic chemicals
Construction sites, and deforested and overgrazed land
Eroded soil
Oil spills
Abandoned mines (also point source)
Acid drainage
Oil tankers

Facts




México
Atoyac Basin
N
W
E
S
Tlaxcala City
Iztaccíhuatl Volcano
Malinche Volcano
Puebla City
Popocatépetl Volcano
Sampling sites
Sediments
Water
Zones
Zone 1: Zahuapan River
Zone 2: Atoyac River
Zone 3: Confluence zone
Zona 4: Valsequillo Dam
Urban Areas
5 0 5 km
98°43'41"W
98°30'40"W
98°17'39"W
98°04'37"W
97°51'36"W
19°32'56"N
19°19'55"N
19°06'54"N
18°53'52"N

Ssutainable Logistics



Source: http://www.greenlogistics.org

A Question:

Do you believe that we can improve the logistics indices in Mexico?
Yes or No.

- **When?**
- **How?**

- **Who is the most contributed to this problem?**
- **Who have important roles to improve these indices?**

Government, Universities, Private sectors, United Nation, Mafia?????

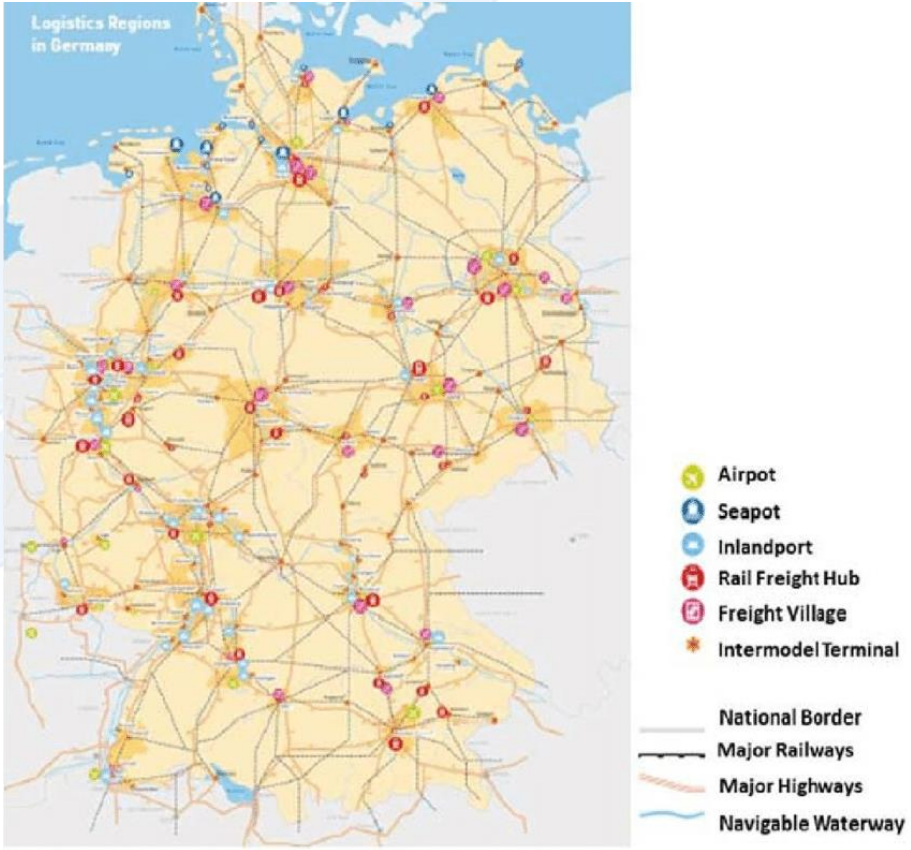
Facts (Germany)

- In **Germany** the logistics sector employs more than **2.8 million people**, and generates an annual turnover of more than **EUR 220 billion**[1]!

- However! these benefits come with an environmental cost: the German transport sector has an environmental cost:

  - **28.9% share of primary energy consumption!**

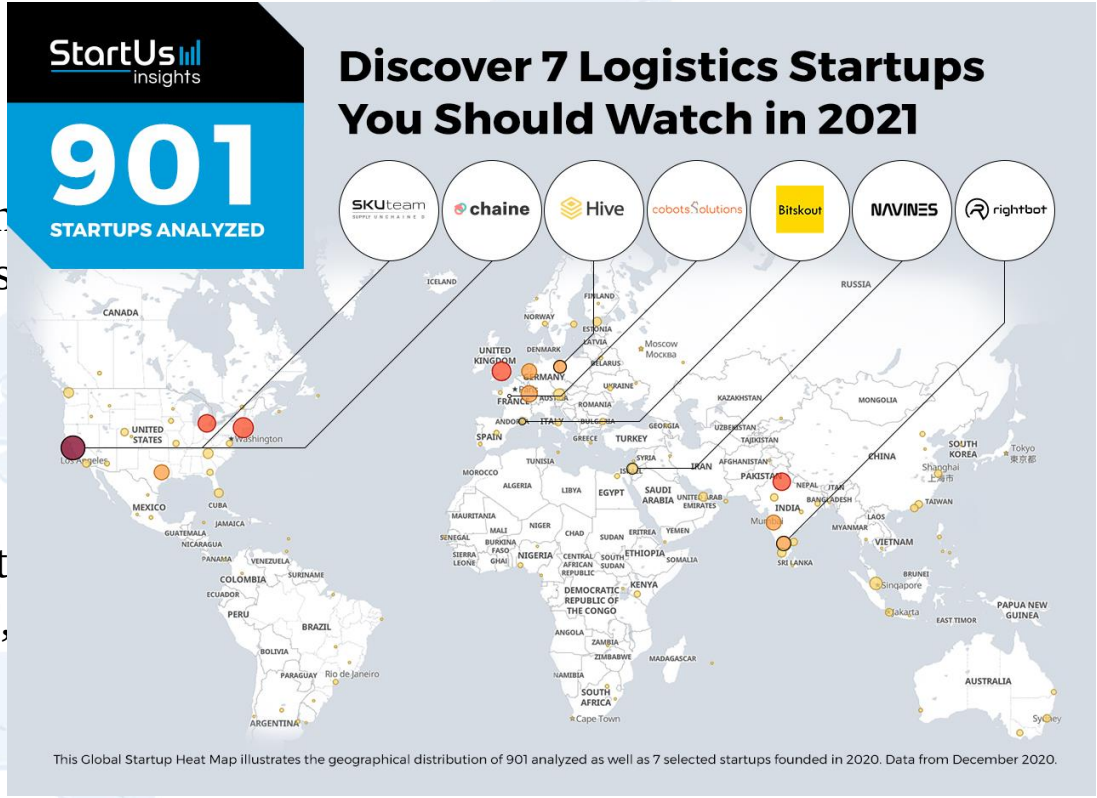
  - **the sector is one of the largest emitters of GHGs**[2].



[1] **Bode, W.; Ziegler, A. (2011)**: Praxisleitfaden "Grüne Logistik
[2] **Bretzke, W.; Barkawi, K. (2010)**: Nachhaltige Logistik, Berlin

Current Challenges and Possible Futures in Logistics

- Start-up, shake up
- Complex competition
- Customer expectations
- Globalization & Individualization
- Shortening the product life cycles
- Reduction of lot sizes
- Price decline and cost pressure
- Limitations and regulations from
- Sustainability
- Shortening of the return-to-invest
- Using the internet, networks, IoT,
- COVID-19



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Current Limitations

- Emission Limit
- Energy Taxes
- Road Pricing
- Working Hours and Driving Times
- International Agreements
- Carbon Foot printing (GHG, Tokyo Protocol, ISO 14064-1;2006); Direct and Indirect Emissions

Some solutions:

- Rout Optimization
- Freight Villages
- Energy Saving
- Combined Transport
- Modernization of Vehicle Fleet
- Optimizing Tires and Oils
- Eco-driving
- Changing Product Design and Optimizing Packaging

Table 6: Key indicators of European regulations on working hours and driving times in road transport

Indicator	Restriction
Maximum daily driving time	9 hours (two 10 hour days per week permitted)
Maximum weekly driving time	56 hours (max 90 hours in two successive weeks)
Compulsory break	45 minutes after 4 ½ hours of driving
Daily rest period (1 driver per truck)	11 hours every 24 hours (9 hours permitted three times per week)
Daily rest period (2 drivers per truck)	9 hours every 30 hours
Weekly rest period	45 hours after 6 days of driving

Table 4: The European framework for toll and user charges for heavy goods vehicles *)

Charging for use of infrastructure	■ Voluntary, not mandatory ■ May be a distance-based toll or a time-based user charge ■ Charges must reflect European standards (see EC directive below for more information and details)
Tolls	■ A specified amount payable for a vehicle based on the distance travelled on a given infrastructure ■ Rate per kilometre related to the construction, maintenance and operating costs of the infrastructure network concerned, which may also include a return on capital and/or a profit margin ■ No maximum yearly rate
User charges	■ A specified payment amount that permits driving for a given period ■ Yearly maximum rate: EUR 1 329 for modern vehicles and EUR 2 233 for vehicles meeting EURO 0 standard ■ Monthly maximum: no more than 10 % of the annual rate ■ Weekly maximum: no more than 5 % of the annual rate ■ Daily maximum: no more than 2 % of the annual rate
Limitation of toll variation	■ Prevents infrastructure charges from being more than 100 % above the same charge for equivalent vehicles meeting the strictest EURO emission standards
External-cost charge	■ Voluntary, not mandatory ■ Traffic-based air pollution can be charged up to EUR 0.16 per km (depending on the EURO class — not applicable to vehicles which comply with the most stringent EURO emission standards) ■ Traffic-based noise pollution can be charged up to EUR 0.02 per km (depending on time of day)

*) Information taken from Directive 1999/362/EC of the European Parliament and of the Council amended by Directive 2011/76/EU of the European Parliament and of the Council of 27 September 2011, http://ec.europa.eu/transport/modes/road/road_charging/charging_hgv_en.htm

Current Trends

1. CONSUMER EXPERIENCE
Nespresso Coffee Experience

2. MASS CUSTOMIZATION
From one car for all.....to a unique car for each of us

3. GLOCALIZATION
Think Global Act local

4. INTERNET OF THINGS

5. REMOTE CONTROL
relaunch factory with his iPad from home

6. 3D PRINTING
CHANGE YOUR BUSINESS MODEL

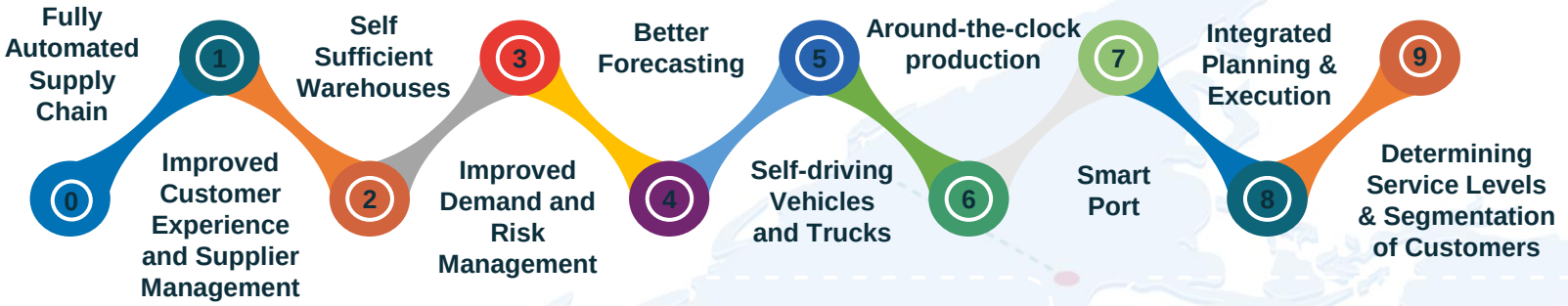
7. SMART OBJECTS

8. RESHORING MANUFACTURING

9. REGULATION COMPLIANCE

10. SUSTAINABILITY EVERYWHERE

What Kind Of Transformation Are We Looking At?



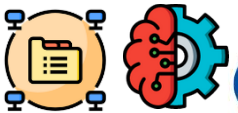
Logistics 4.0

The application of the technologies of the **Fourth Industrial Revolution** in the processes of the Supply Chain is called Supply Chain 4.0.

Internet of Things uses sensors to collect and transmit information in real time throughout the entire supply chain.

The implementation of these decisions is carried out by **automated and robotic systems**, without human intervention.

The analysis of this information through **Big Data, Artificial Intelligence, and Cloud Computing** allows simultaneous decisions to be made for different processes.



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Industry 4.0 and Supply Chains

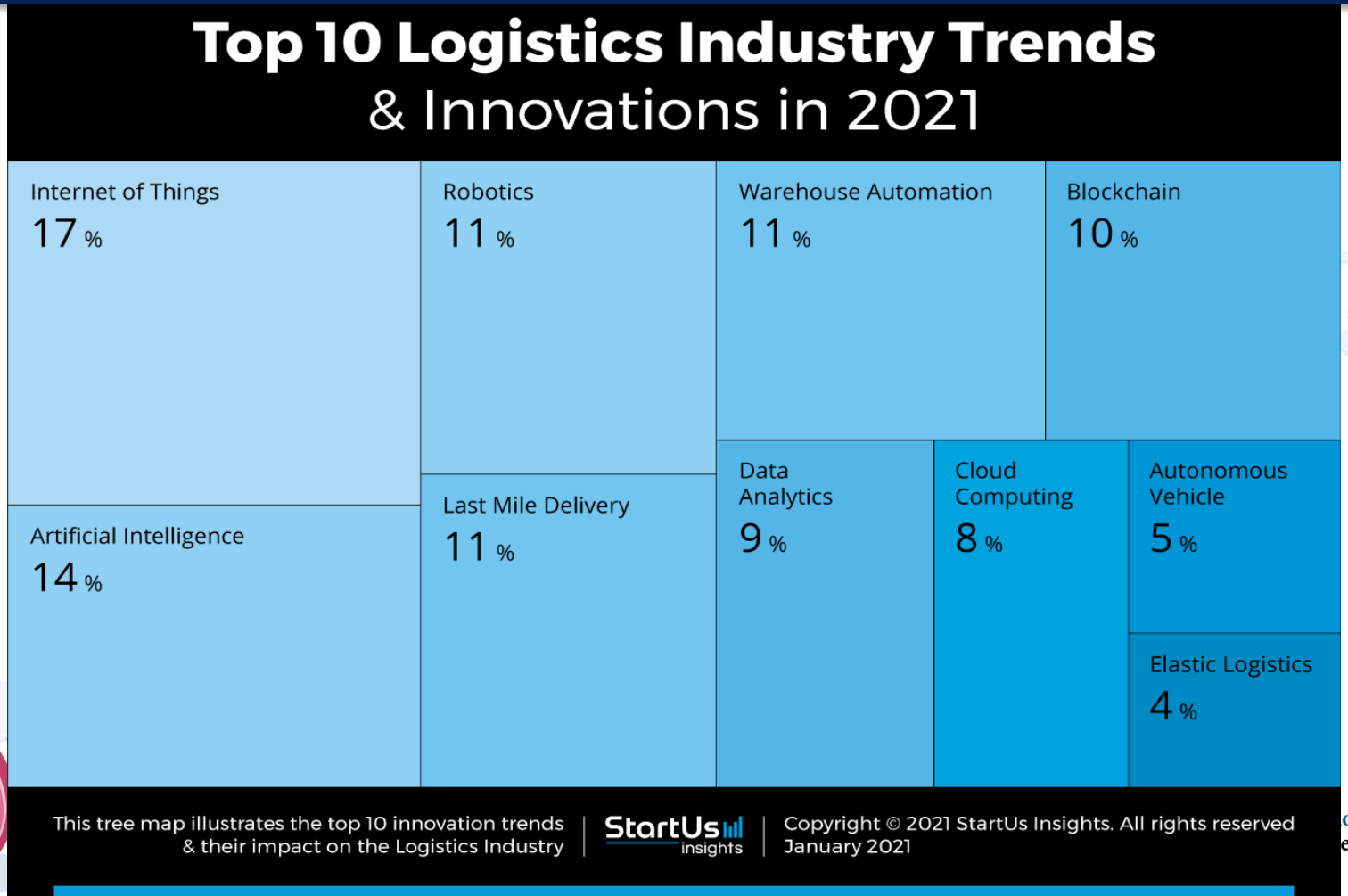
Exhibit 1: **Adoption of Industry 4.0, by Sector**

Respondents were asked: "How would you classify the current level of digitization and integration [in operations, supply chain, and related activities] in your company? What levels are you expecting in the next five years?"

NOW		IN FIVE YEARS
45%	Electronics	77%
32%	Aerospace and Defense	76%
35%	Industrial Manufacturing	76%
32%	Chemicals	75%
38%	Forest Products, Paper, Pkg.	72%
28%	Transportation and Logistics	71%
30%	Engineering and Construction	69%
41%	Automotive	65%
31%	Metals	62%

Source: "Industry 4.0: Building the Digital Enterprise," PwC

Tree Map reveals the Impact of the Top 10 Logistics Industry Trends



New technologies, their impacts, and their uncertainties

The technology[10]	The impact	The uncertainties
Physical Internet (based on the IoT)	• Improved supply chain transparency, safety and efficiency • Improved environmental sustainability (more efficient resource planning)	• Social expectations around data privacy and security may change • Regulation around data security and privacy may increase or be enforced more stringently • The sector's willingness and ability to invest in collaboration • Whether international bodies will drive standardisation
IT standards	• Enabling collaboration horizontally • More efficiency and transparency	• Companies' willingness to adopt is uncertain due to data security concerns
Data analytics	• Improvements in customer experience and operational efficiency in operations • Greater inventory visibility and management • Improved 'predictive maintenance'	• Rate of development of data processing capacity is unclear • Question marks around data security • Social expectations around data privacy and security may change • Regulation of data security and privacy may increase or be enforced more stringently
Cloud	• Enabling new platform-based business models and increasing efficiency	• Development of costs unclear (once a certain scale is reached physical data centres still tend to be cheaper) • Uncertainties around data security
Blockchain	• Enhanced supply chain security (reduction of fraud) • Reduction in bottlenecks (certification by 3rd parties) • Reduction of errors (no more paper-based documentation) • Increased efficiency	• Rate of adoption uncertain • Unclear whether one or two dominant solutions will emerge or multiple competing solutions
Robotics & automation	• Reduction in human workforce and increased efficiency in delivery and warehousing (including sorting and distribution centres) • Lower costs	• Speed of technology development unclear

Some Facts about future (Good news and opportunities)

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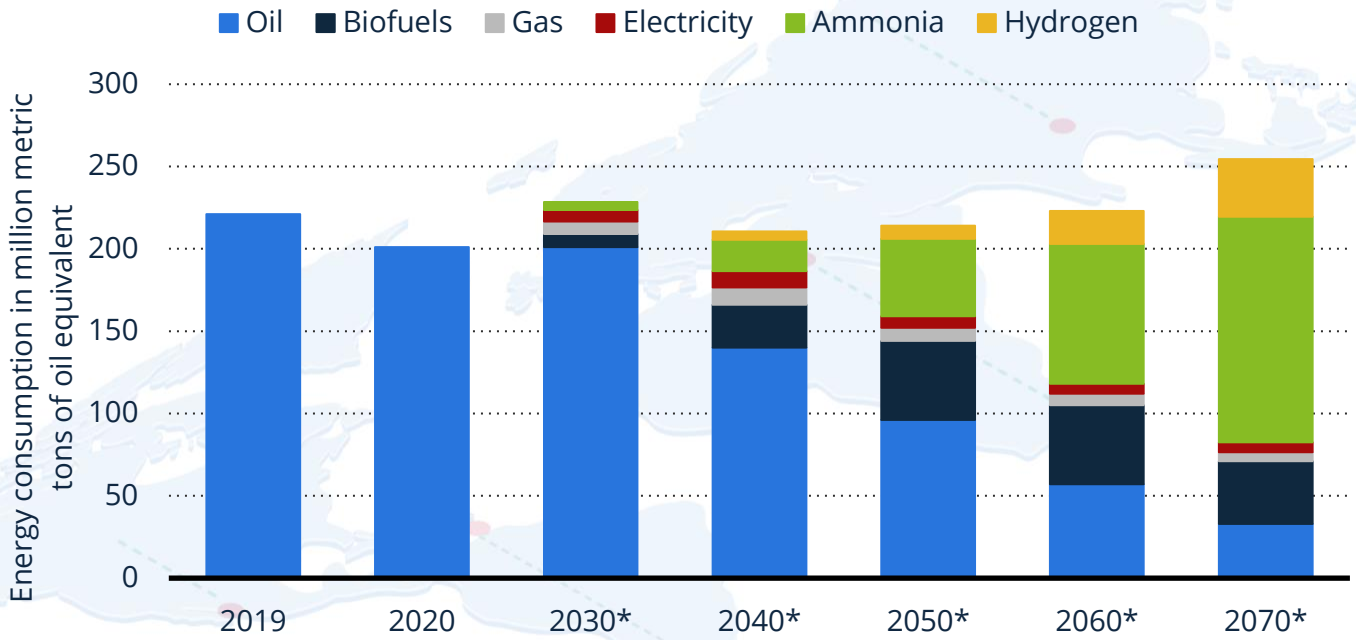
Consumption of energy by the shipping industry worldwide in 2019 and 2020, with a forecast through 2070, by fuel type (in million metric tons of oil equivalent)

Global energy consumption by shipping 2019-2070, by fuel type



Description: It is projected that until 2050, oil will continue to be the prevalent fuel used by the shipping industry. In 2050, however, the energy mix should become more varied, with alternative fuels accounting for around half of total energy consumption by the industry. By 2070, ammonia is expected to become the dominant source of energy for powering ships. Read more
Note(s): Worldwide; 2019 and 2020; * Forecast. Read more
Source(s): IEA; Statista estimates

statista

Some Facts about future (Good news and opportunities)

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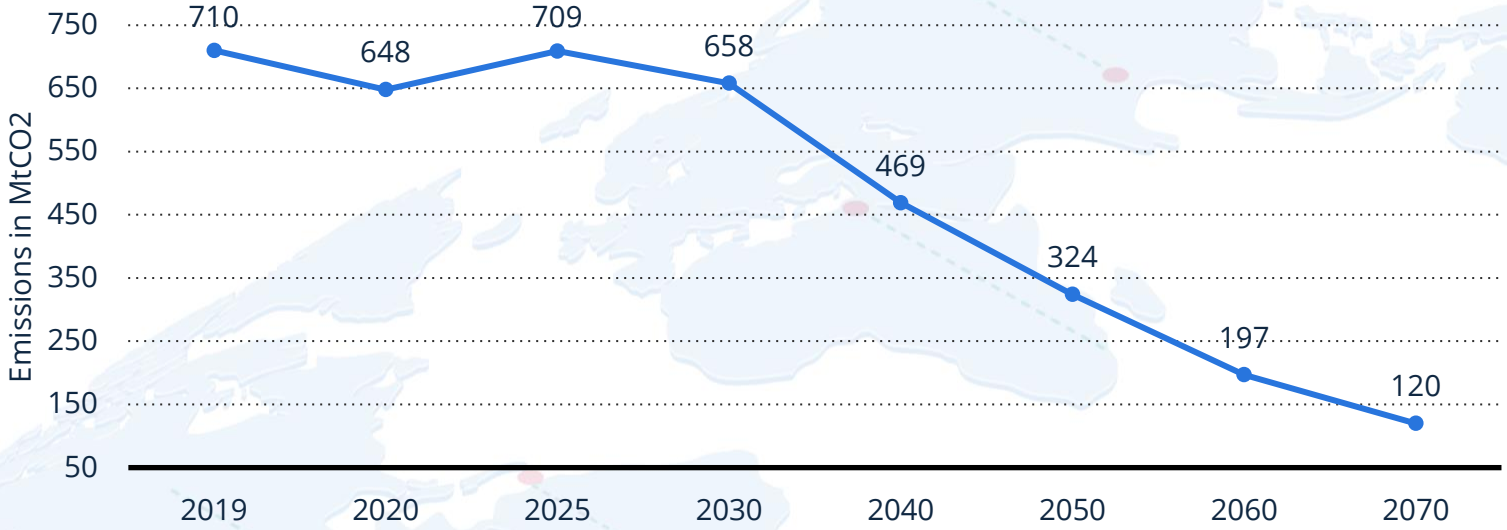
Global international shipping CO2 emissions outlook from 2019 to 2070 in the Sustainable Development Scenario* (in million metric tons of CO2)

International shipping CO2 emissions outlook worldwide 2019-2070



Description: Global emissions from international shipping are expected to reach 709 million metric tons of CO2 in 2025. However, under the IEA's "Sustainable Development Scenario", in which the use of alternative fuels such as hydrogen, ammonia, and biofuels have increased, CO2 emissions from shipping could fall considerably in the coming decades. Under this scenario, emissions from the international shipping sector are projected to drop to 120 million metric tons of CO2 by 2070. Read more
Note(s): Worldwide; 2019; *Further information about the IEA's Sustainable Development Scenario can be found here Read more
Source(s): IEA

statista

Repeating the Question:

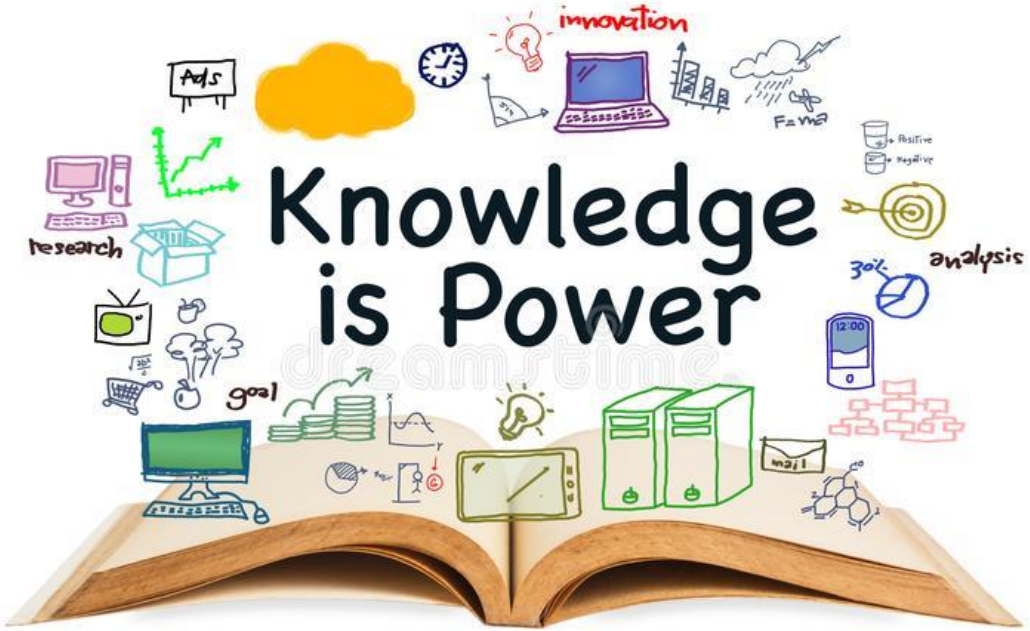
Do you believe that we can improve the logistics indices in Mexico?
Yes or No.

- When?
- How?

- Who is the most contributed to this problem?
- Who have important roles to improve these indices?

Government, Universities, Private sectors, United Nation, Mafia?????

The answer


innovation
Ads
Knowledge
is Power
research
analysis
goal
mail

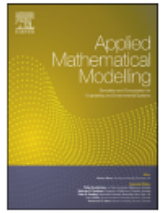
Our focus at Tec (An example at CLIS)
(Why should companies consult with universities first?!)

Applied Mathematical Modelling 101 (2022) 600–631

Contents lists available at ScienceDirect

Applied Mathematical Modelling

journal homepage: www.elsevier.com/locate/apm



Designing a Closed-loop Supply Chain Network Considering Social Factors; A Case Study on Avocado Industry

Amirhossein Salehi-Amiri[a], Ali Zahedi[a], Fatemeh Gholian-Jouybari[b], Ericka Zulema Rodríguez Calvo[b], Mostafa Hajiaghaei-Keshteli[b,*]

[a] *Department of Systems Engineering, École de Technologie Supérieure (ÉTS), University of Quebec, Montreal, Canada*
[b] *Tecnologico de Monterrey, Escuela de Ingeniería y Ciencias, Puebla, Mexico*

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Our focus at Tec (An example at CLIS)
(Why should companies consult with universities first?!)

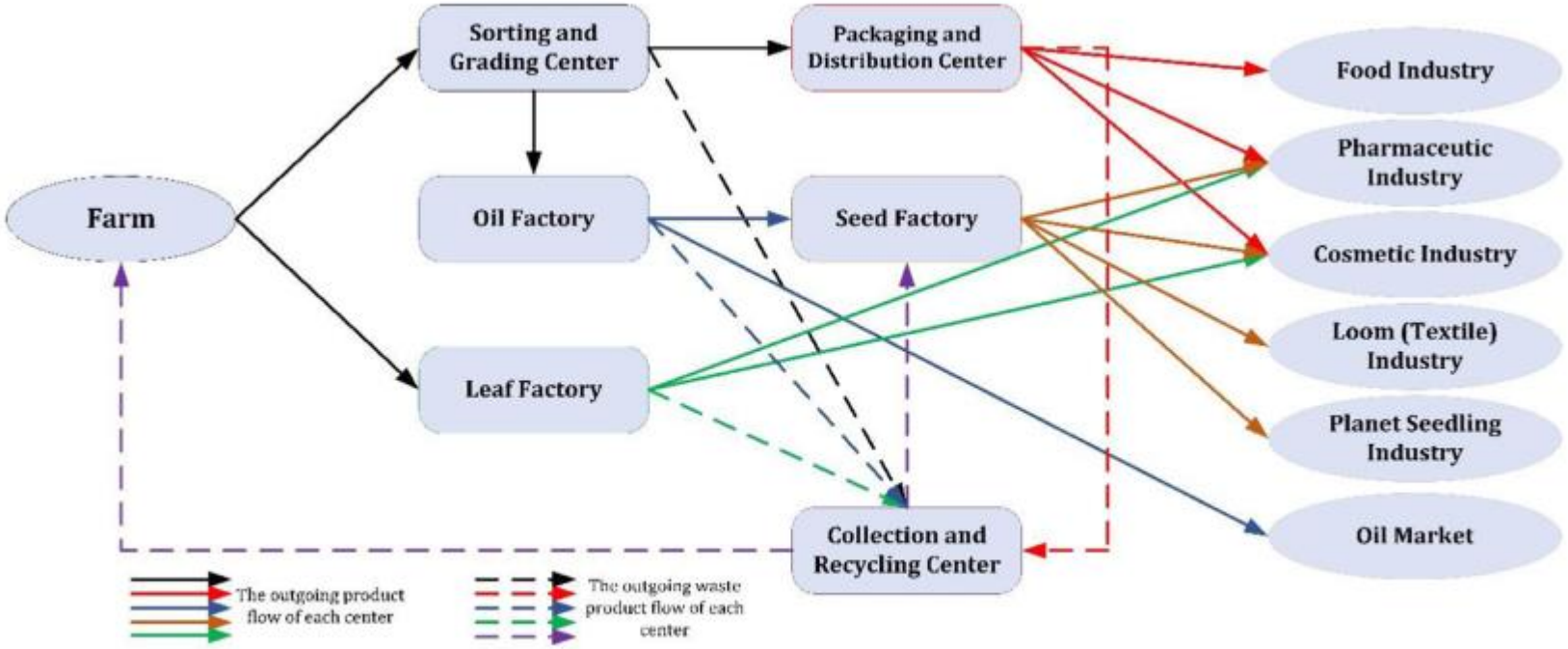

Fig. 7. The structure of the proposed avocado supply chain.

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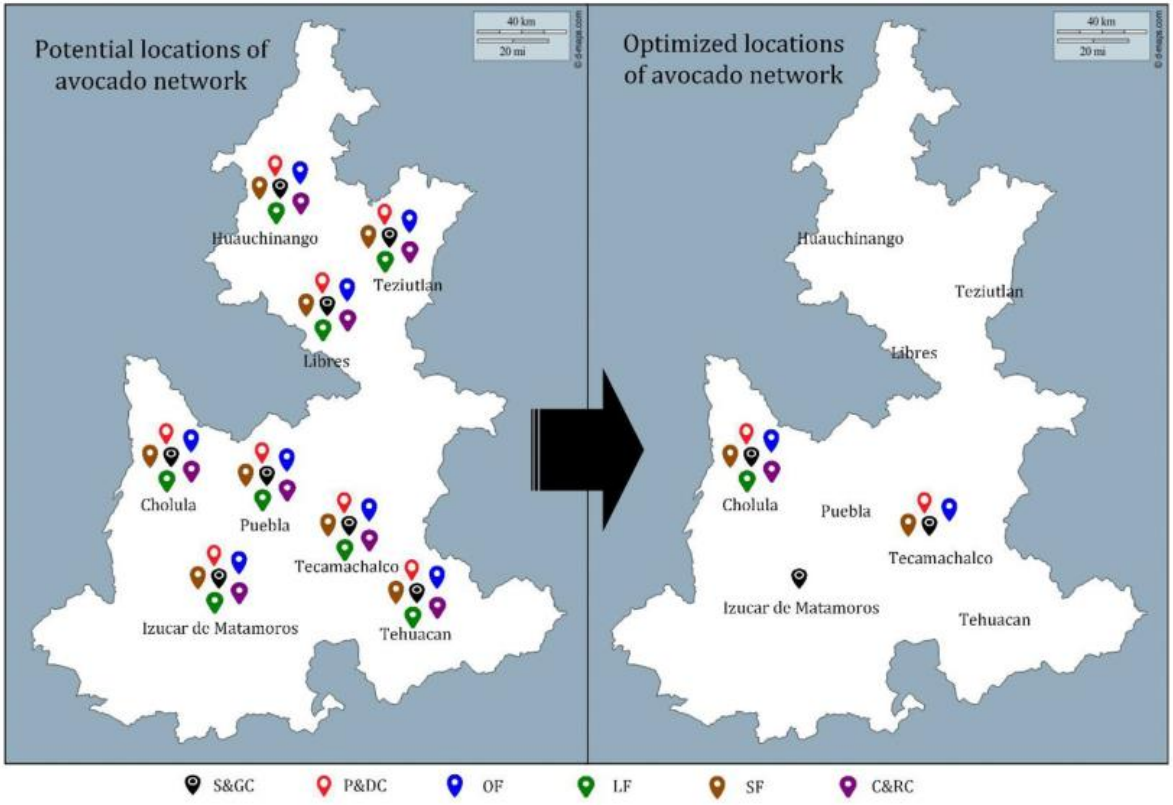
Our focus at Tec (An example at CLIS)
(Why should companies consult with universities first?!)



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Thank you

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