measuring
quality of services
in "ports"

the next frontier

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Port Performance Research Network

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problem statement

- measuring performance beyond traditional efficiency and productivity indicators is an emerging challenge.

- a new potential emerges in transforming attention on integrating all dimensions of sustainability into a competitive advantage of a terminal or port.

- transformation and evolution of such measures also requires a certain level of comparability and benchmark of performance across all sustainability dimensions.

- current and new technology offers new insight and possibilities

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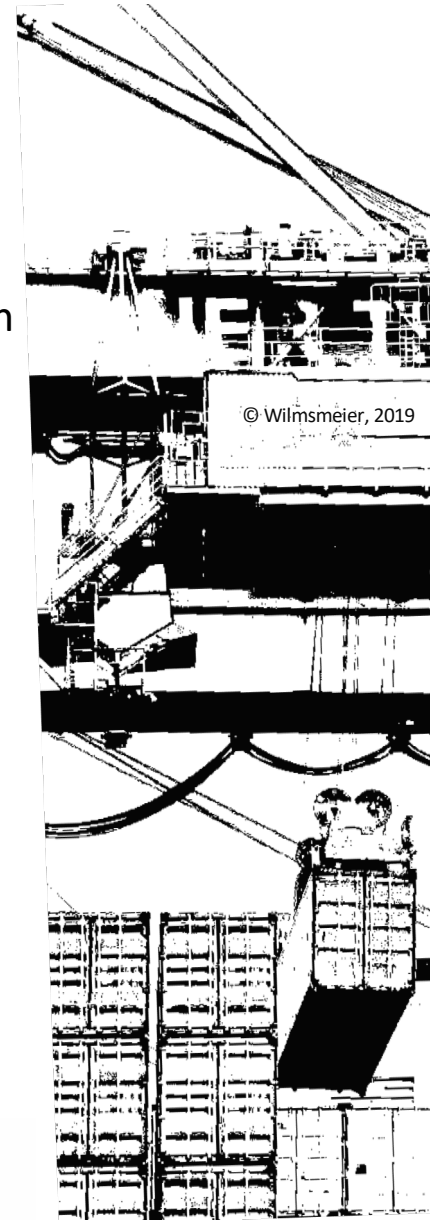
objective of the presentation

to contribute to the discussion on measuring performance and quality of services in "ports" to increase awareness of the current state of the academic discussion and to identify the next frontier of indicators and concepts.

- specific objectives (SO):

    SO1: discuss the multidimensionality of performance and quality of services measurements;

    SO2: discuss the transversal relevance of sustainability for any "modern" measure; and

    SO3: present elements, previously unconsidered, but of significance in the evolution of sustainable performance and quality service measurements.

the multidimensionality of performance and quality of services measurements

defining *performance*

1. *a* : the execution of an action
   b : something accomplished : **deed, feat**

2. the fulfilment of a claim, promise, or request : **implementation**

3. ~~*a* the action of representing a character in a play~~
   ~~*b* : a public presentation or exhibition - *a benefit performance*~~

4. *a* : the ability to **perform: efficiency**
   b : the manner in which a mechanism performs

5. the manner of reacting to stimuli : **behaviour**

6. the linguistic behaviour of an individual, *also* **the ability to speak a certain language — compare competence**

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Source: https://www.merriam-webster.com/dictionary/performance
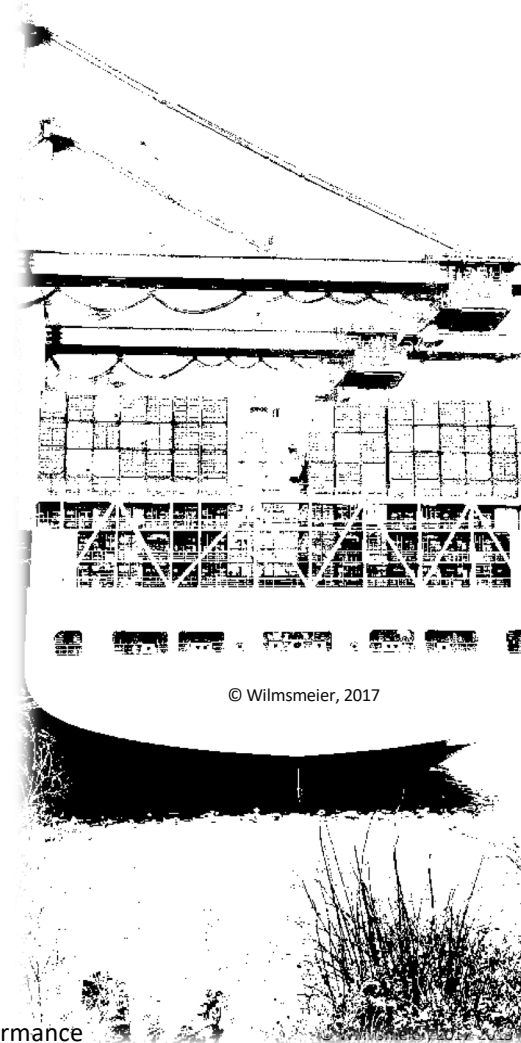
defining *service quality*

Service Quality is a measure of the extent to which the customer is experiencing the level of service that he or she is expecting. Thus, a very simple, yet effective, view of service quality is that it is the match between what the customer expects and what the customer experiences. (Rushton et al., 2010: 35)

- five dimensions: tangible, reliability, responsiveness, assurance, and empathy

- a match between customers' expectations and customers' perceptions
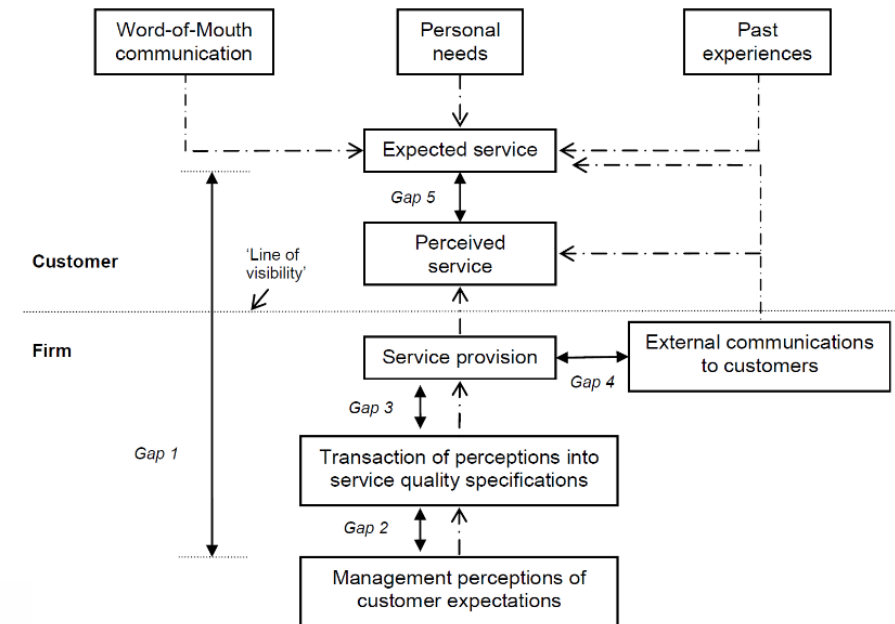
Source: Grant (2012: 30)

about measuring...

Not everything that counts can be counted – not everything that can be counted counts
(A. Einstein)

Measures are only beneficial if they lead to profitable action ... we need to measure things that matter, even when it is difficult to do so. (C. Koch)
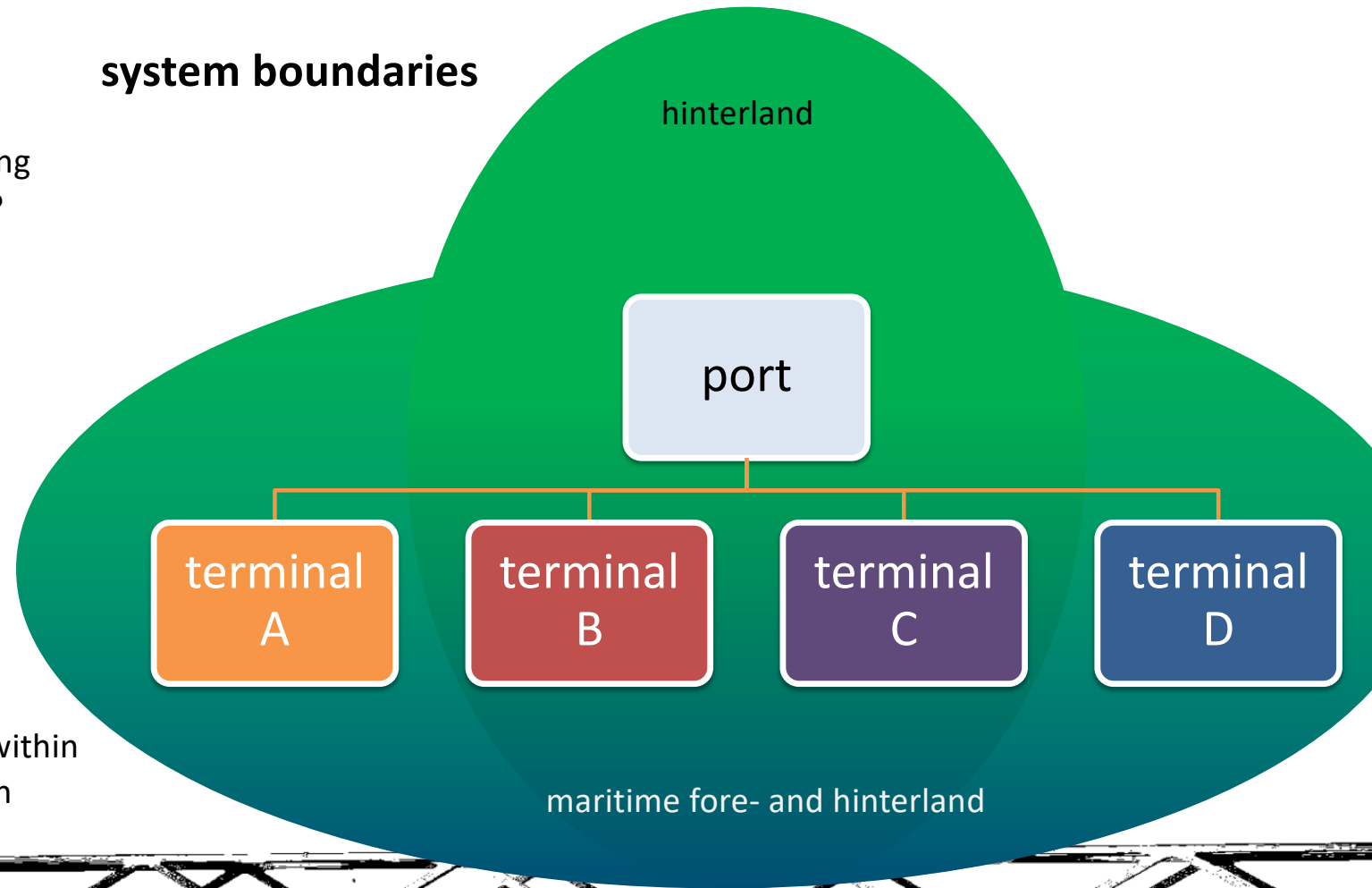
data availability

willingness to share

system boundaries

what is the boundary for measuring
"performance or service quality"?
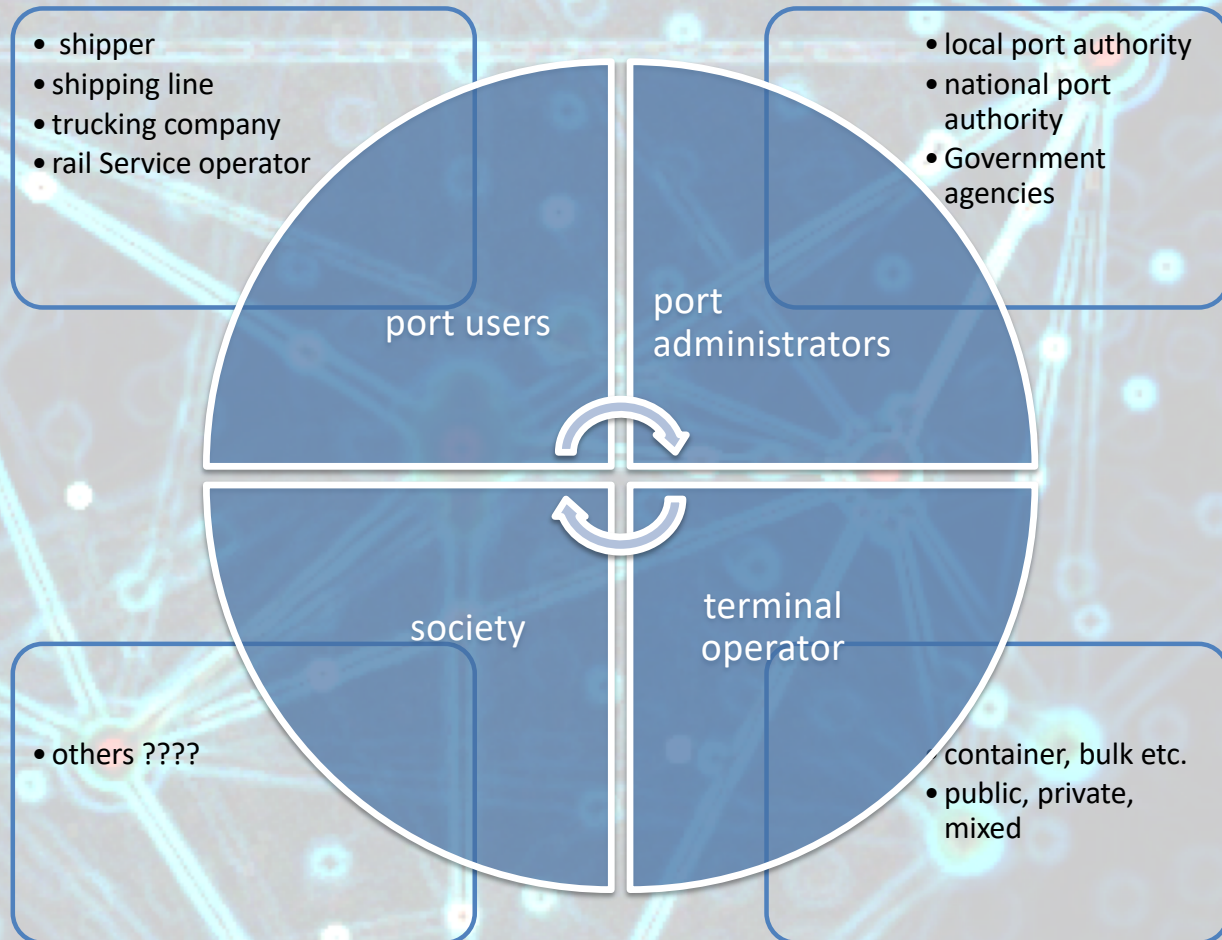 terminal?
  port?
  logistics chain
  supply chain

Different expectations and roles within
  the logistics and supply chain

hinterland

port

terminal A   terminal B   terminal C   terminal D

maritime fore- and hinterland

who is the customer? – whose expectations are to be "fulfilled"?

- shipper
- shipping line
- trucking company
- rail Service operator

- local port authority
- national port authority
- Government agencies

"ports have to attach a high level of internal integration within a firm and effective collaboration with the external operation of inter-firms in the supply chain, which in turn leads to overall performance improvement in the whole chain."
(Ha et. al., 2019)

port users

port administrators

society

terminal operator

- others ????

- container, bulk etc.
- public, private, mixed

port service quality

- service quality is a relative concept.
- service quality classes:
  - tangible components: assets, personnel and availability
  - ways of fulfilment:
    - reliability and responsiveness dimensions,
    - flexibility, service care, supply condition, and lead time
  - informative actions: empathy and assurance dimensions:
    - marketing information and selling conditions; order management; after-sales service; and e-information
- to be compared with some norm or benchmarked against similar data for other units

- surveys of the perceptions of stakeholders

Sources: Grant, 2003; Rafiq and Jaafar, 2007
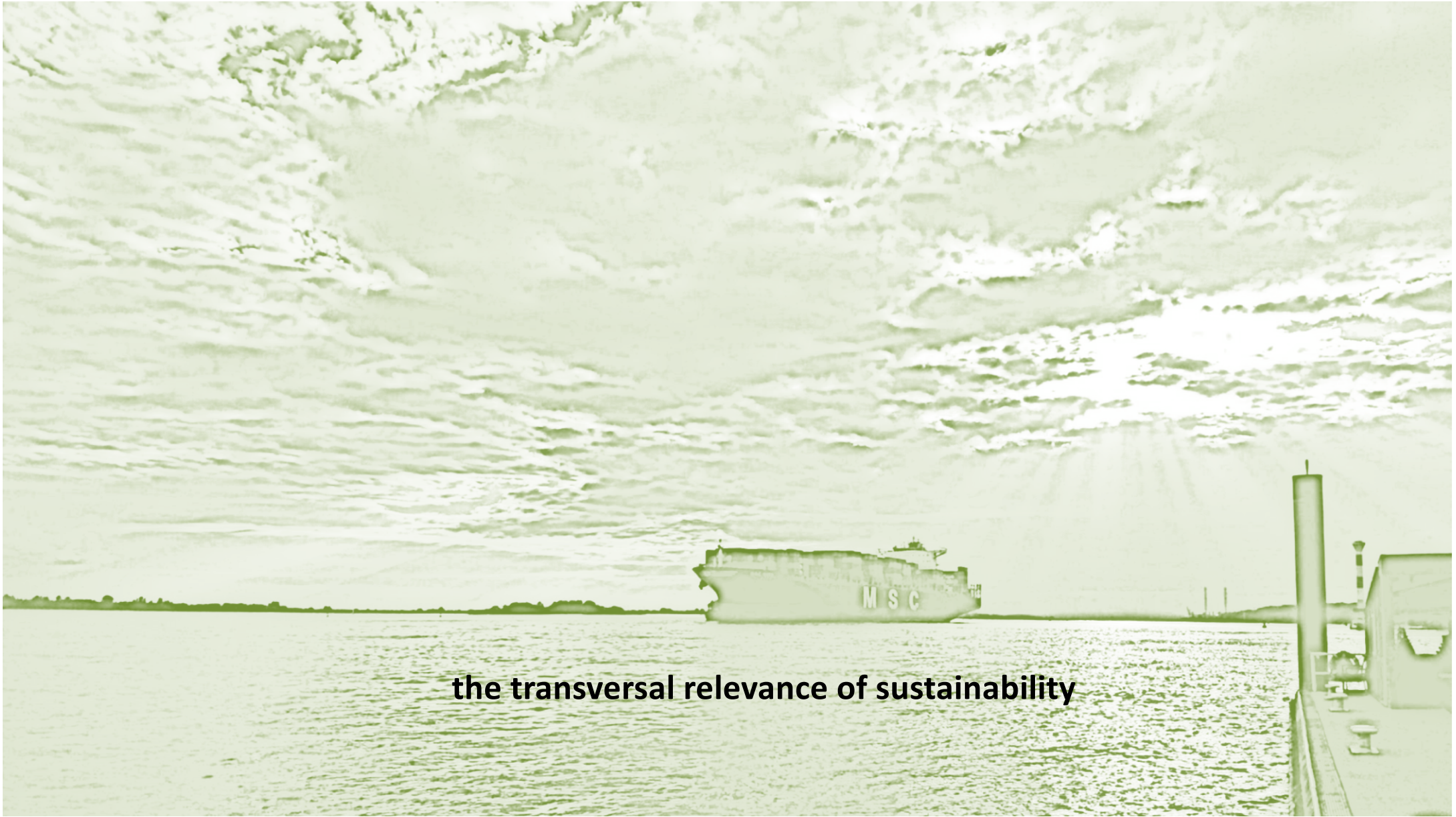
the transversal relevance of sustainability

what is a sustainable port service?

ports and terminals in the sustainability discussion

Sustainable /green service quality: "*corporate desire to do the right thing*"
(Lieb and Lieb, 2010)

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Is this sufficient?

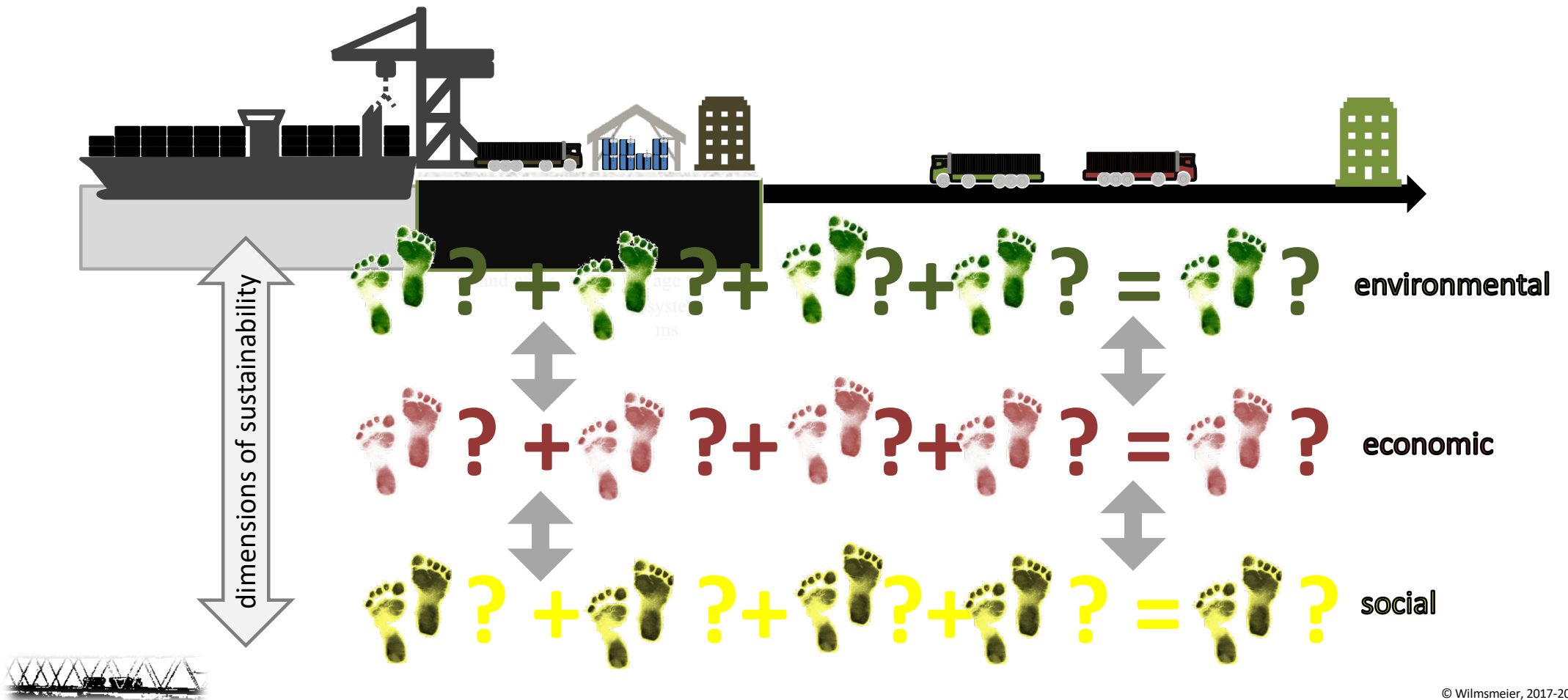move from seeing sustainability as being, at best, a reformist concept and,
being "inherently reactionary"
(Swyngedouw 2010:229),

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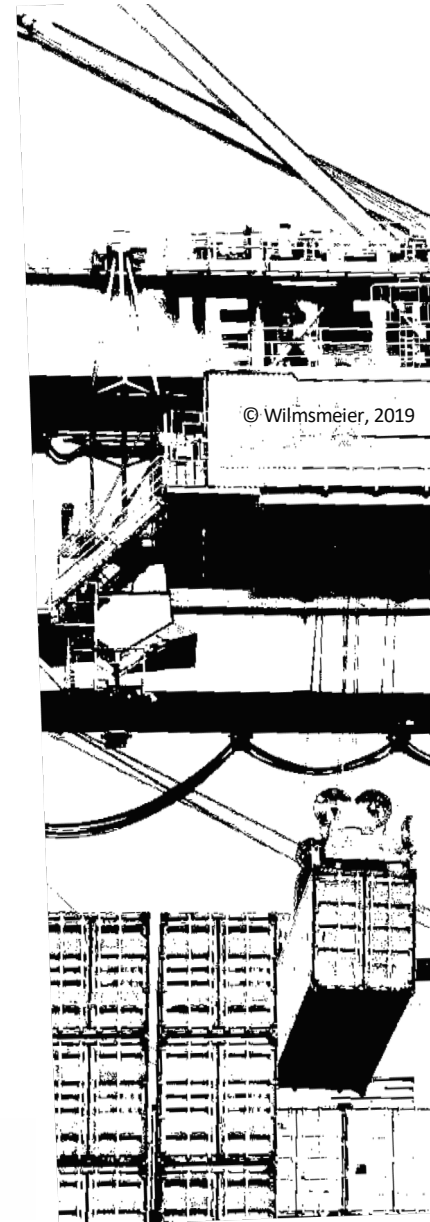
*"Sustainability performance can be defined as the
performance of a company in all dimensions
and for all drivers of corporate sustainability"*
(Schaltegger and Wagner, 2006, p.2)

"It extends beyond the boundaries of a single company

and typically addresses the performance of both upstream suppliers and downstream

customers in the value chain"
(Fiksel et.al, 1999).

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sustainable performance and Service quality of ports in logistics chains

dimensions of sustainability

? + ? + ? + ? = ? environmental

? + ? + ? + ? = ? economic

? + ? + ? + ? = ? social

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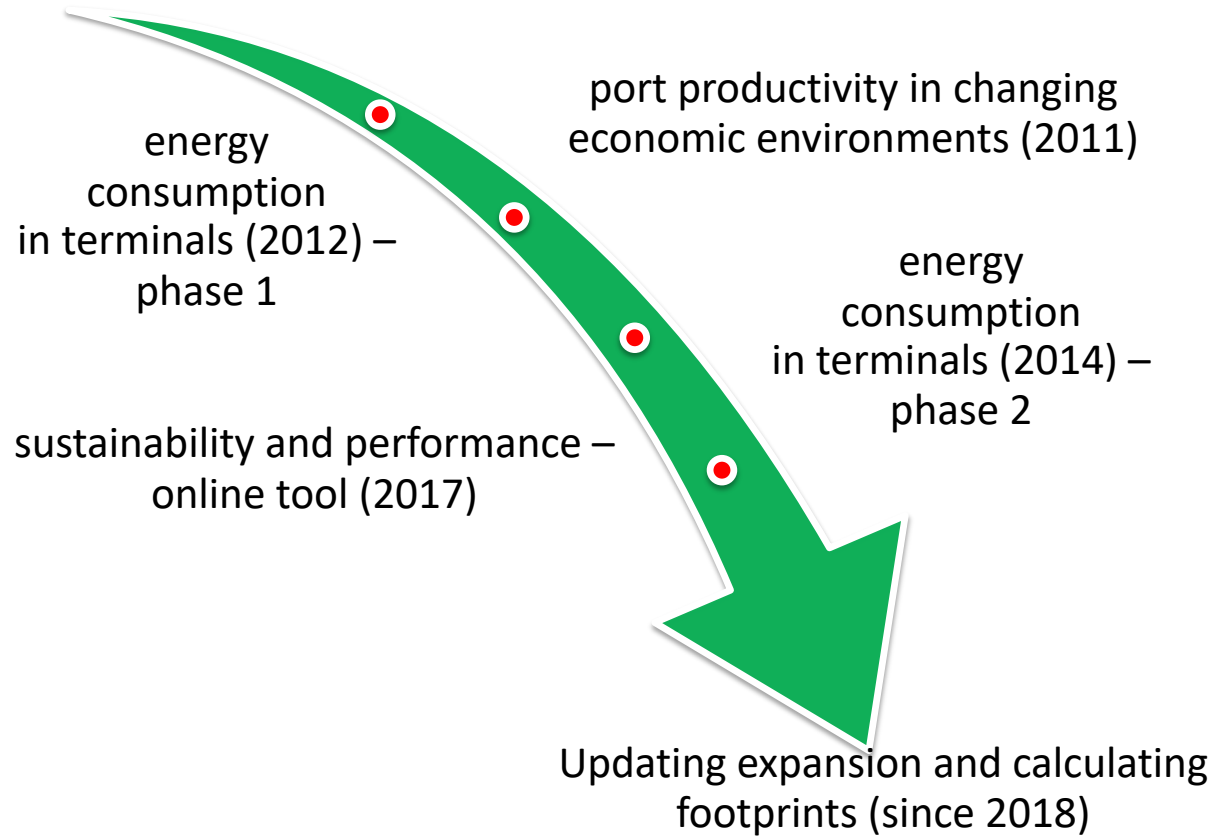
elements,
previously unconsidered,
but of significance in the evolution of sustainable performance
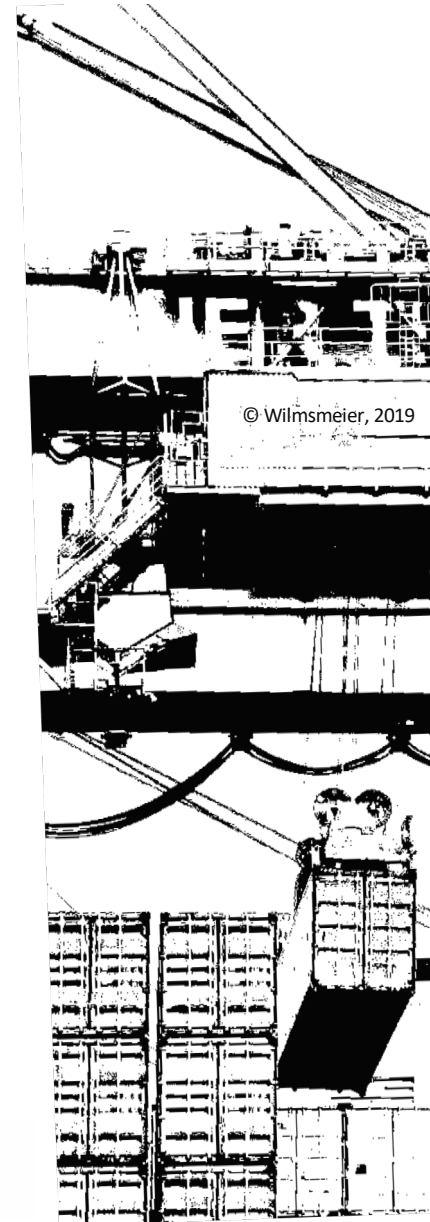and quality service measurements

sustainable performance monitor (SPM)
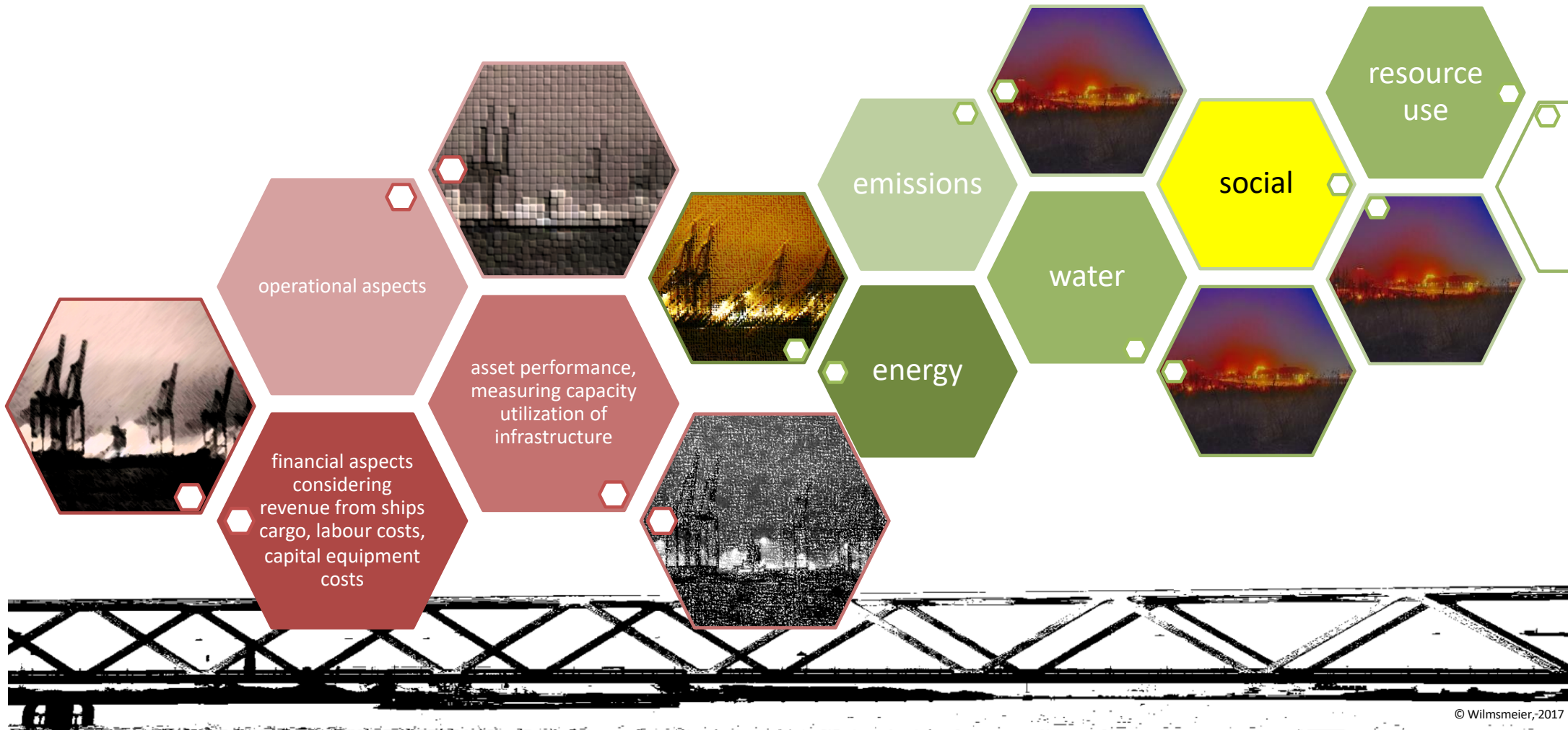
traditional performance measures in ports/terminals

a) financial aspects considering revenue from different activities in the terminal, including ship revenue, cargo revenues, labour costs, capital equipment costs;

b) asset performance, measuring the capacity utilization of infrastructure, and

c) operational aspects indicators.

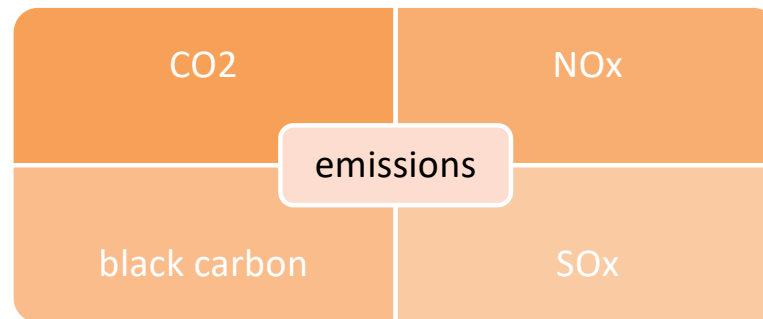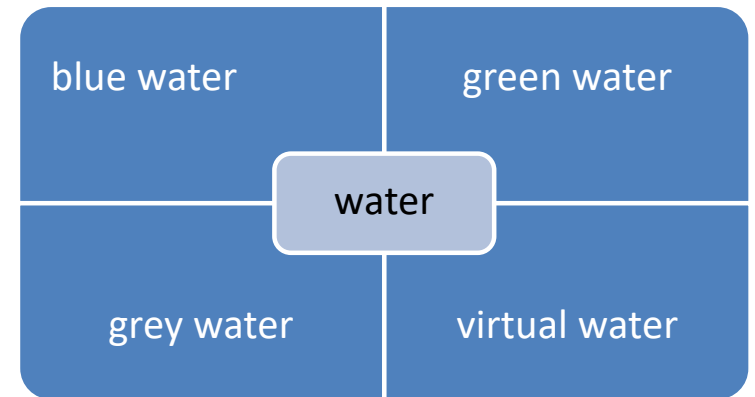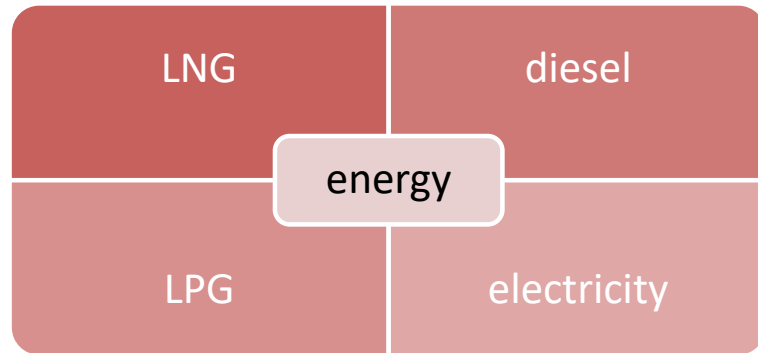The latter two having received more attention in literature.
While energy consumption is intrinsically linked to either of these areas this has not gained significant attention

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a wider set of measures of performance is necessary?

operational aspects

asset performance, measuring capacity utilization of infrastructure

financial aspects considering revenue from ships cargo, labour costs, capital equipment costs

emissions

energy

water

social

resource use

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new data and measures complexity

LNG	diesel
LPG	electricity

energy

blue water	green water
grey water	virtual water

water

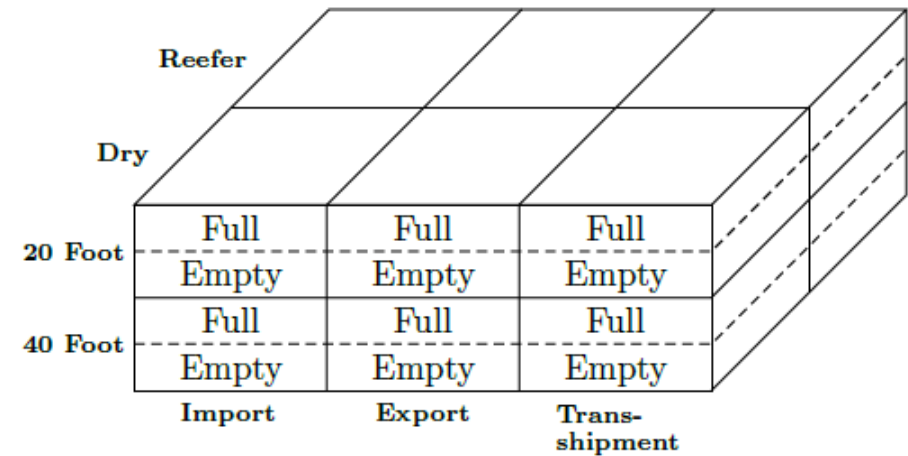|	
CO_2	NOx
black carbon	SOx

emissions

example: container terminal example:
an activity based approach to allocate energy consumption
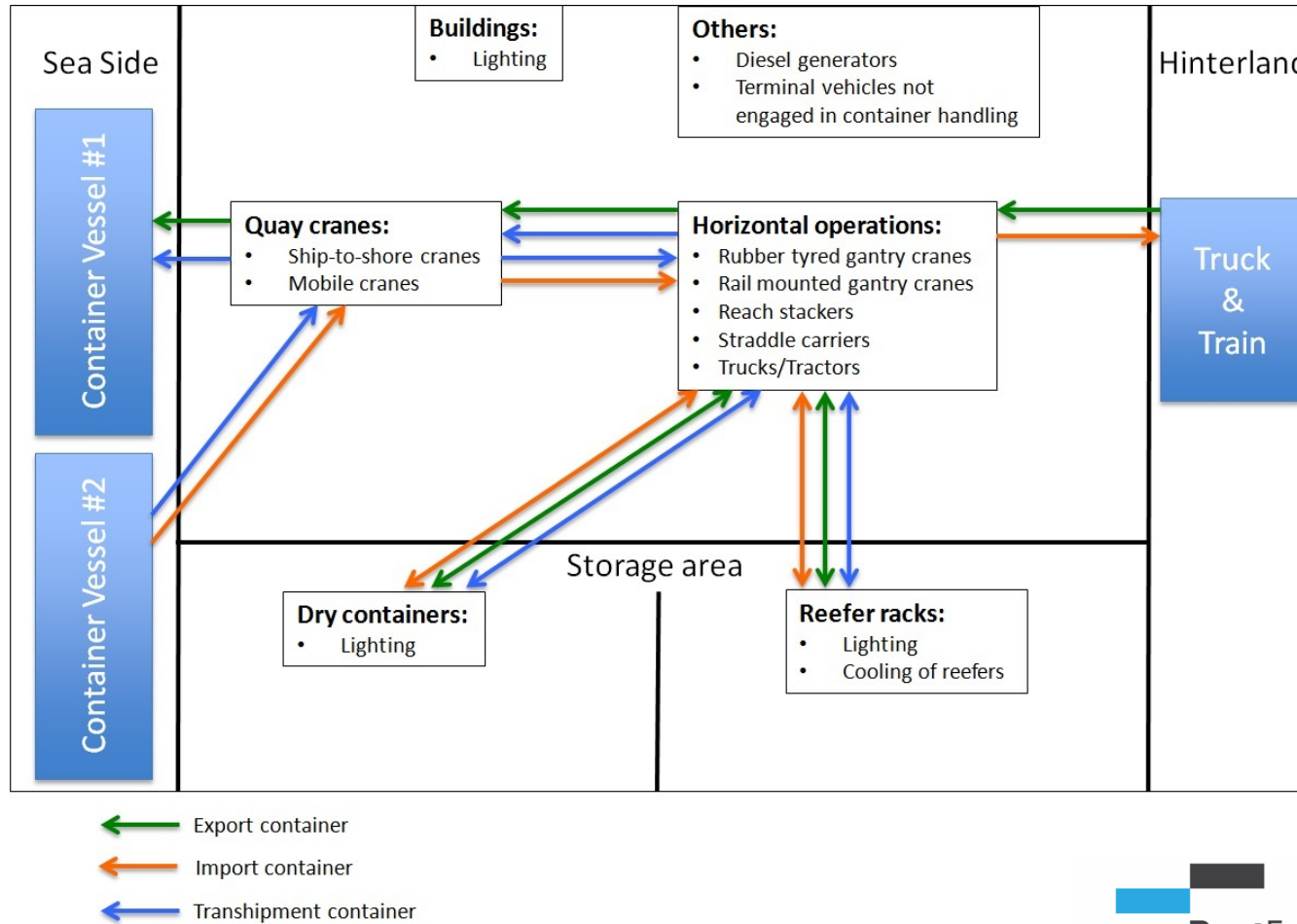
Source: Spengler 2015

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container terminals are multi product operations

- differentiation necessary between:
  - container types (i.e. dry, reefer)
 - transhipment and impo/expo cargo
  - full and empty

different products have different service requirements and performance

data structure of the SPM

Basic data	Storage capacity	Cargo movements per type (tonnes)	vessel calls (number)	Containers dwell time (days)	Terminal characteristics	Equipments (number)
Name of the port, Name of the terminal Contact details (job title, email, phone):	adhoc-TEU e.g. containerized (refrigerated, dry) - number Stacking height of containers - number Other cargo by type (e.g. bulk) - m3, tonnes	e.g. cargo in controlled atmosphere, dry containerized, general cargo not containerized, dry bulk cargo	total in the terminal and by ship type	Differentiated (import/export) and type – annual average	Total berth length (m) Number of berths Total annual berthing time (in hours) Water depth (in meters) -Min & Max Average truck turnaround time (minutes) Average crane productivity (movements/hour)	Ship-to-Shore Cranes (STS) Post Panamax Ship-to-Shore Cranes (STS) Panamax Rail Mounted Gantry Cranes (RMG) Rubber Tyred Gantry Cranes (RTG) Mobile Harbour Cranes Reach Stackers, Top Lifters and Empty Handlers Straddle Carriers (SC) Trucks Generators Forklifts up to 5 tons other equipment

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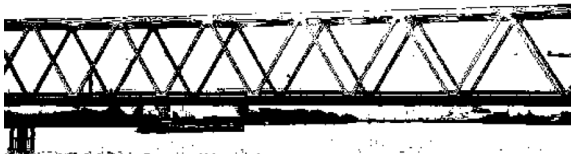
data structure of the SPM (2)

Labour/workforce	Annual movements (number)	Consumption	Energy consumption equiments (areas)	Energy consumption of equipment	Annual expenditures (national currency)	Annual CO2 emissions (tonnes)
port workers - number	containers by type – annual and monthly total) - number	Annual and Monthly data on	Total annual electricity consumption of...	Cranes STS Post Panamax/Panamax	electricity	cargo handling equipment
worked hours (annual total)		electricity from the national power grid (kWh):	terminal lightening (kWh)	RMG, RTG	gasoline	reefer platforms
		electricity produced in the terminal (kWh):	Size of terminal (m2)	Mobile Cranes	diesel	reefer container connection
				Reach Stackers, Top Lifters and Empty Handlers, SC	LPG	fuels (incl. transportation)
		gasoline (liters), type :	buildings (kWh)	Trucks	LNG	offices
		diesel (liters), type:	Size of buildings (m2)	Diesel Generators	water	vessels and tugs
		LPG (liters)		**Annual data per type:**		third party trucks
		LNG (m3)	Number of reefer plugs	Number of type(s):		others, please describe:
		water (m3) :	storage of (kWh) reefer containers/refrigerated bulk cargo	operation (in hours)		
		Volume of water sold to vessels (m3) :		moves		
		Total hours worked		Electricity consumption (kWh)		
				Diesel consumption (liters)		
				the model(s), type(s) and year build of the equipment		

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example: formula energy consumption

$$TC_{ij} = \sum_{z=1}^{n} \left(QCC_{ij} + HOC_{ij} + CRC_{ij} + BC_{ij} * LC_{ij} + OC_{ij} + GEN_{ij} \right) + UC_{ij}$$

where:

z = type of energy

TC_{ij} = Total energy consumption in terminal i in period j

QCC_{ij} = Energy consumption within the process cluster of quay cranes

HOC_{ij} = Energy consumption within the process cluster of horizontal operations

CRC_{ij} = Energy consumption within the process cluster of reefer cooling

BC_{ij} = Energy consumption within the process cluster of buildings

LC_{ij} = Energy consumption within the process cluster of lighting

OC_{ij} = Energy consumption within the process cluster of others

GEN_{ij} = Energy consumption within the process cluster of generators

UC_{ij} = Undefined consumption

example: formula quay crane cluster

$$QCC_{ij} = \sum_{z=1}^{n} \left(EC_{ijk} \right) + UC_{ijk}$$
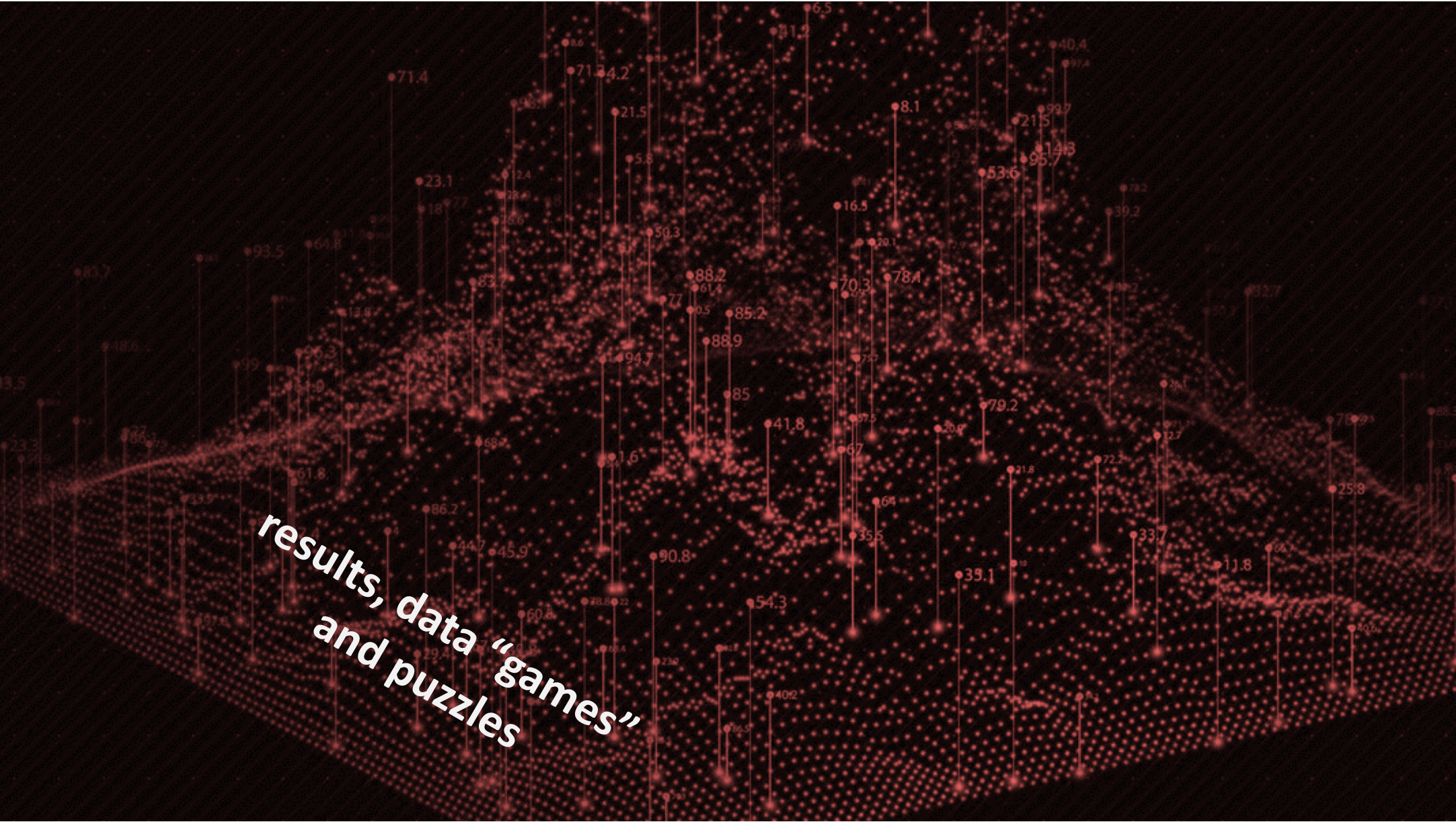
where:

z   = type of energy

K   = type of crane

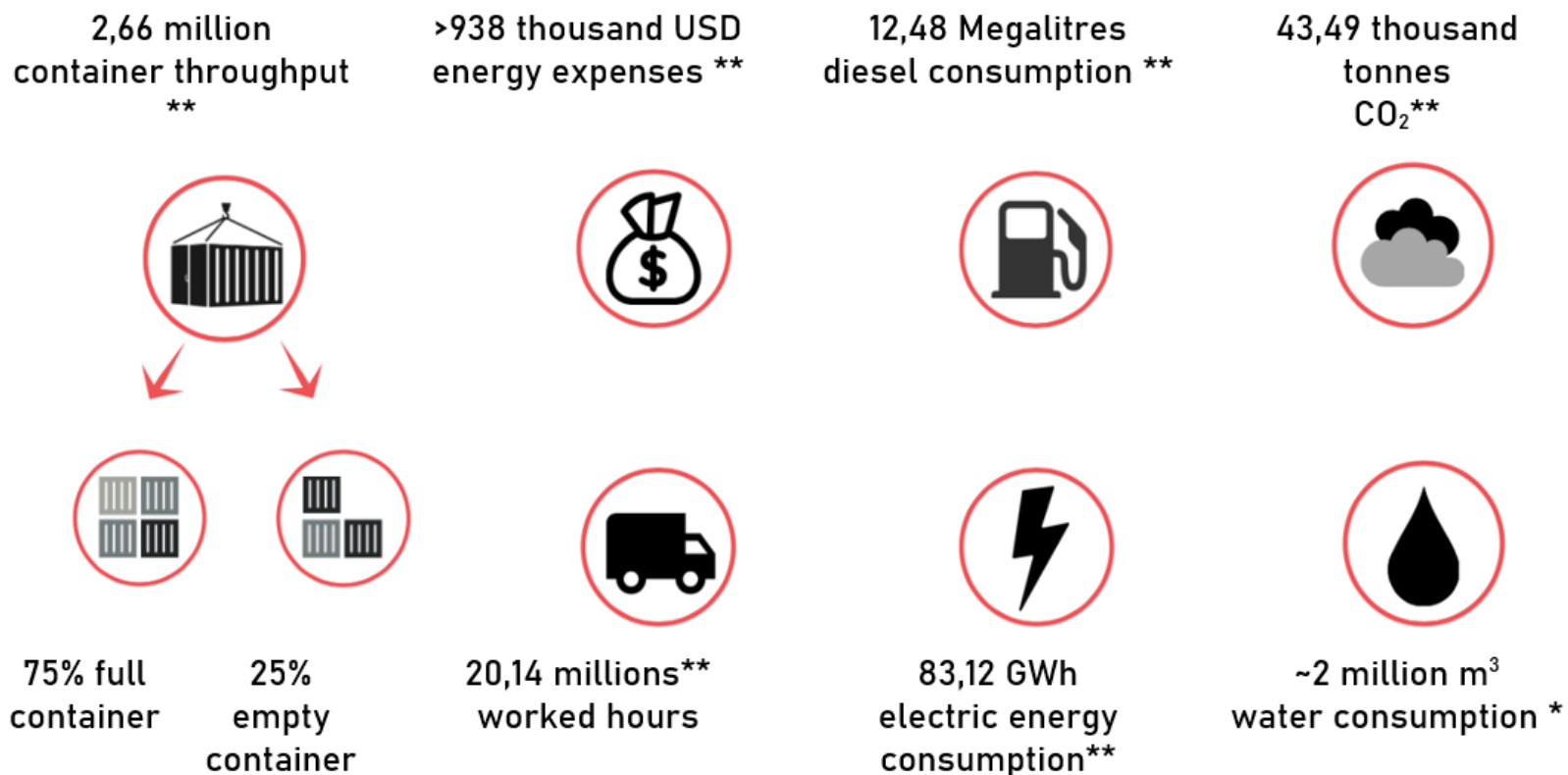EC_{ijk} = Total energy consumption in terminal i in period

j

UC_{ijk} = Undefined consumption

results, data "games" and puzzles

dashboard performance in container terminals in Colombia 2017

2,66 million container throughput **

>938 thousand USD energy expenses **

12,48 Megalitres diesel consumption **

43,49 thousand tonnes CO_2**

75% full container

25% empty container

20,14 millions worked hours**

83,12 GWh electric energy consumption**

~2 million m^3 water consumption *

Notas: * Valor resultante de estimaciones realizadas a partir de datos proporcionados por 5 terminales de contenedores
** Valores obtenidos a partir de costos y consumo asociados a energía eléctrica y diésel para 6 terminales de contenedores
***Valores basados en estimados de 8 terminales de contenedores; consumo de agua a partir de 6 terminales de contenedores
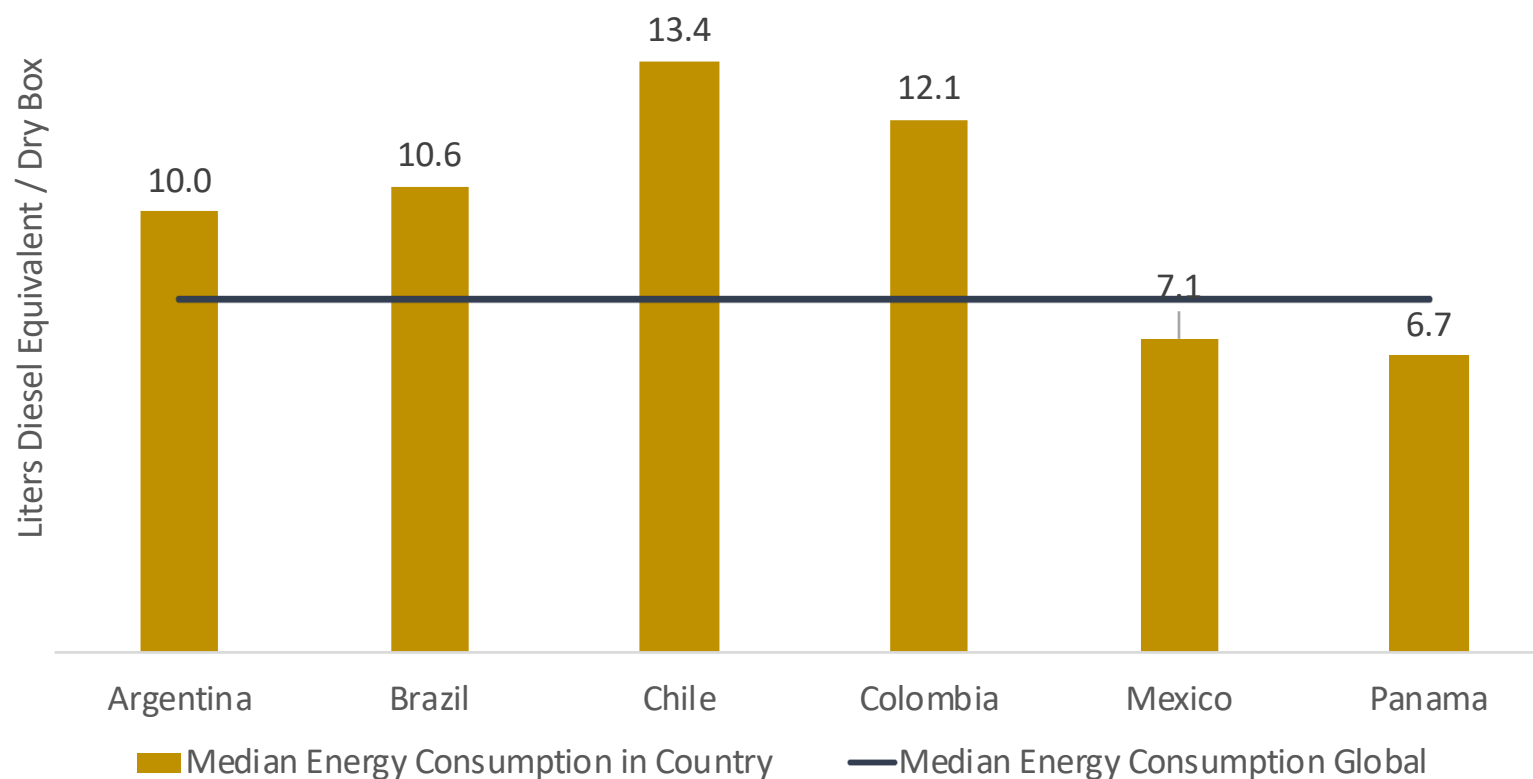
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share of energy consumption by activity cluster in container terminals, Colombia 2014-2017

Legend:
- Ligthing (lt diesel eq)
- Horizontal (lt diesel eq)
- Quay Cranes (lt diesel eq)
- Other & not defined (lt diesel eq)
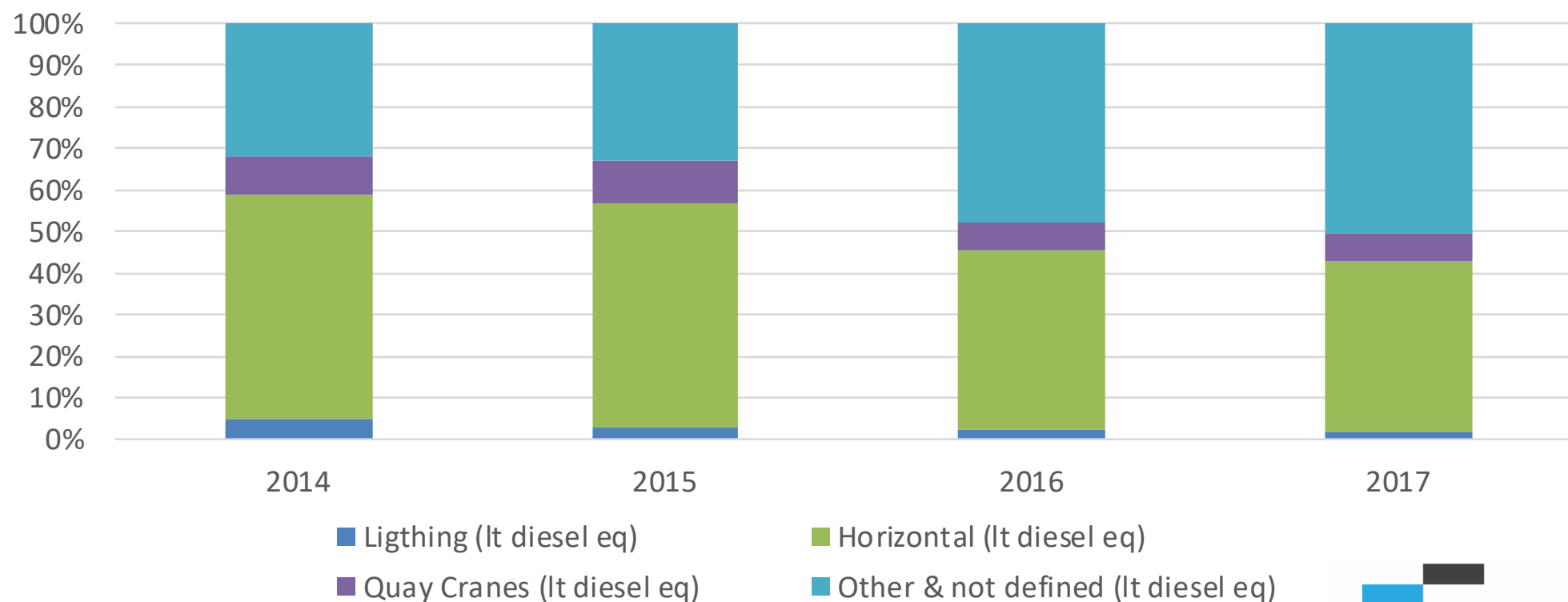
Source: Survey UniAndes Mintransporte 2018

Notes: For the years 2014-2015 values based on data provided from 6 container terminals. For the years 2016-2017, values based on data provided from 3 container terminals and estimations based on partial energy data for 3 terminals
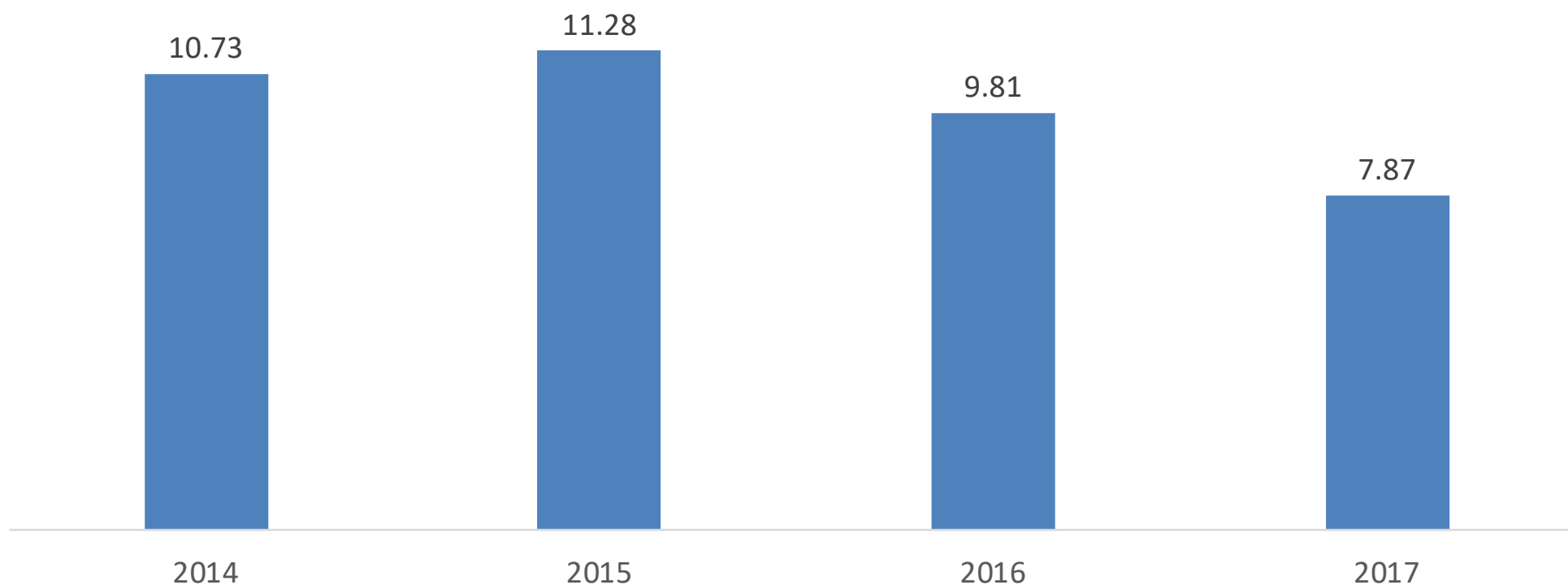
median litres of diesel equivalent consumed for handling one dry box (excluding reefer consumption), by country, 2012-2015

Liters Diesel Equivalent / Dry Box

10.0	10.6	13.4	12.1	7.1	6.7
Argentina	Brazil	Chile	Colombia	Mexico	Panama

■ Median Energy Consumption in Country　━ Median Energy Consumption Global

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Source: Authors based on Wilmsmeier and Spengler (2016) and ECLAC Infrastructure Services Unit

average litres of diesel equivalent consumed for handling one dry box (excluding reefer consumption) in Colombia, 2014-2017.
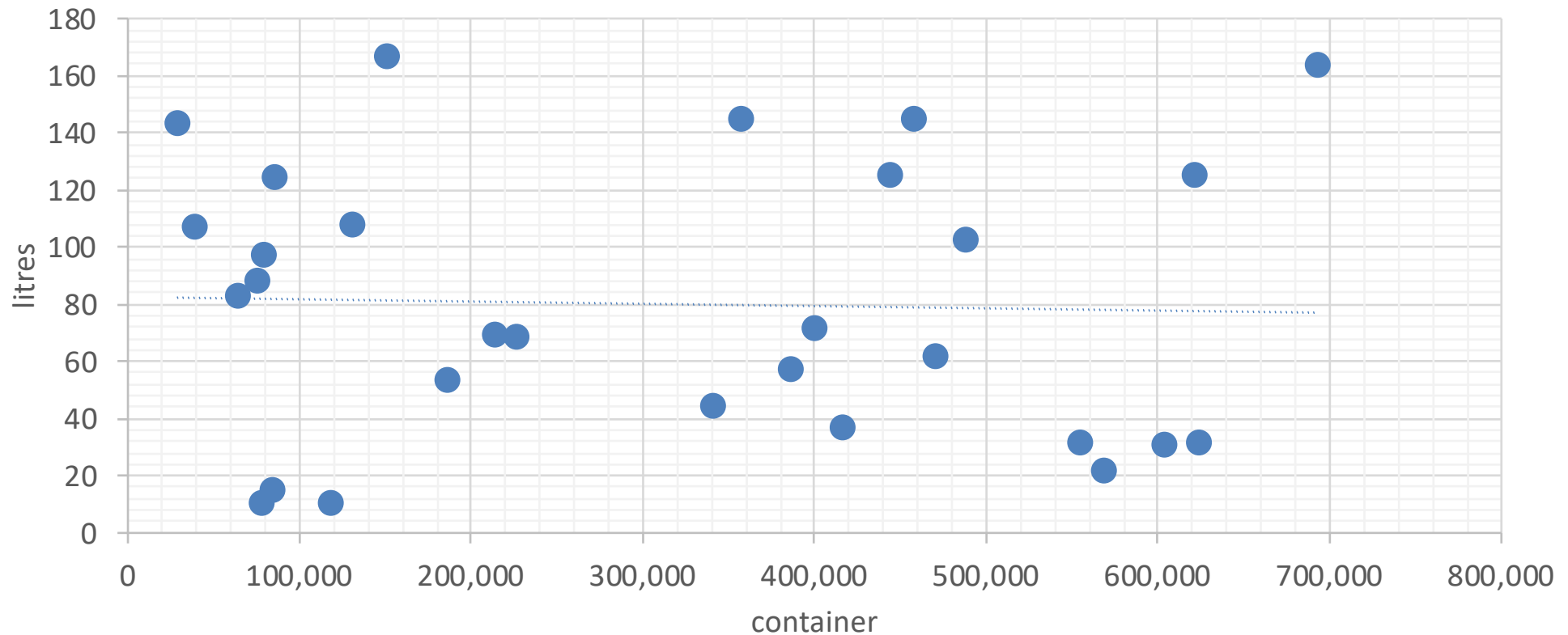
reachstacker (diesel) operating hours and consumption
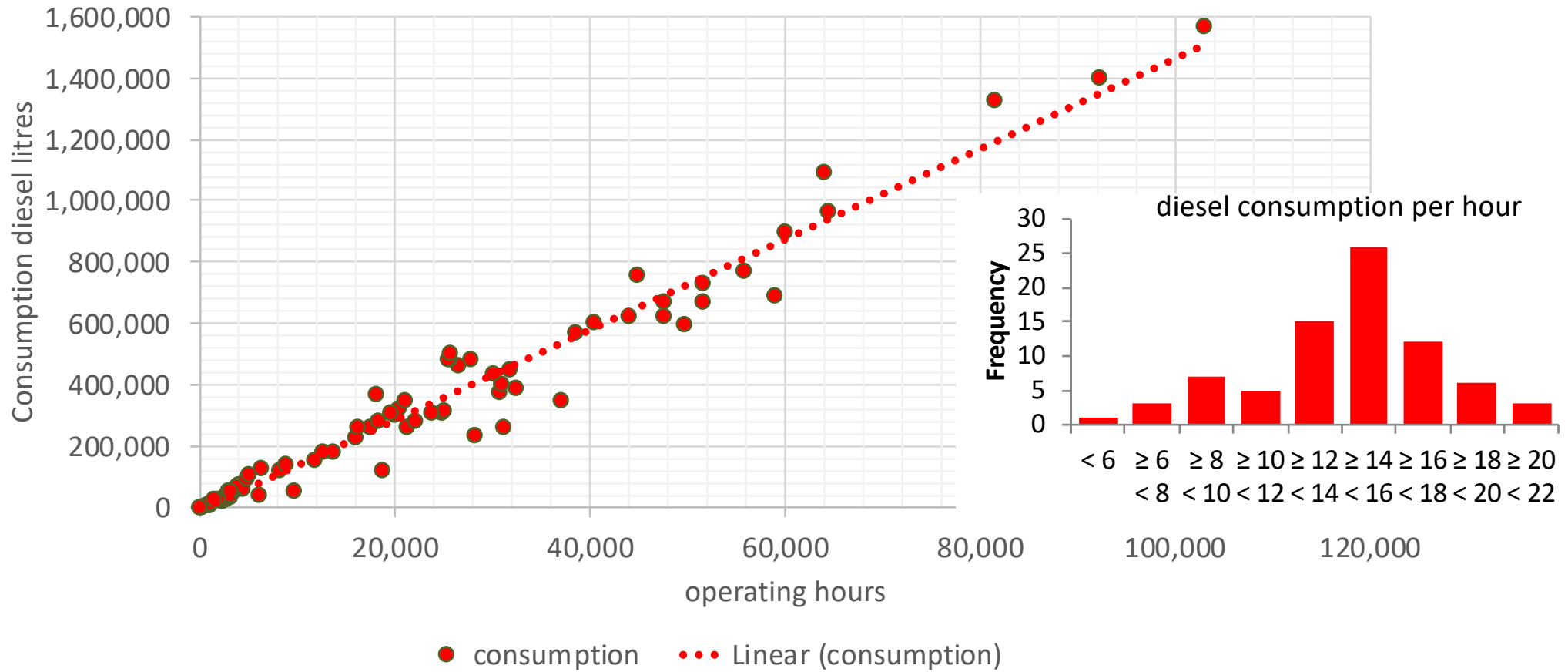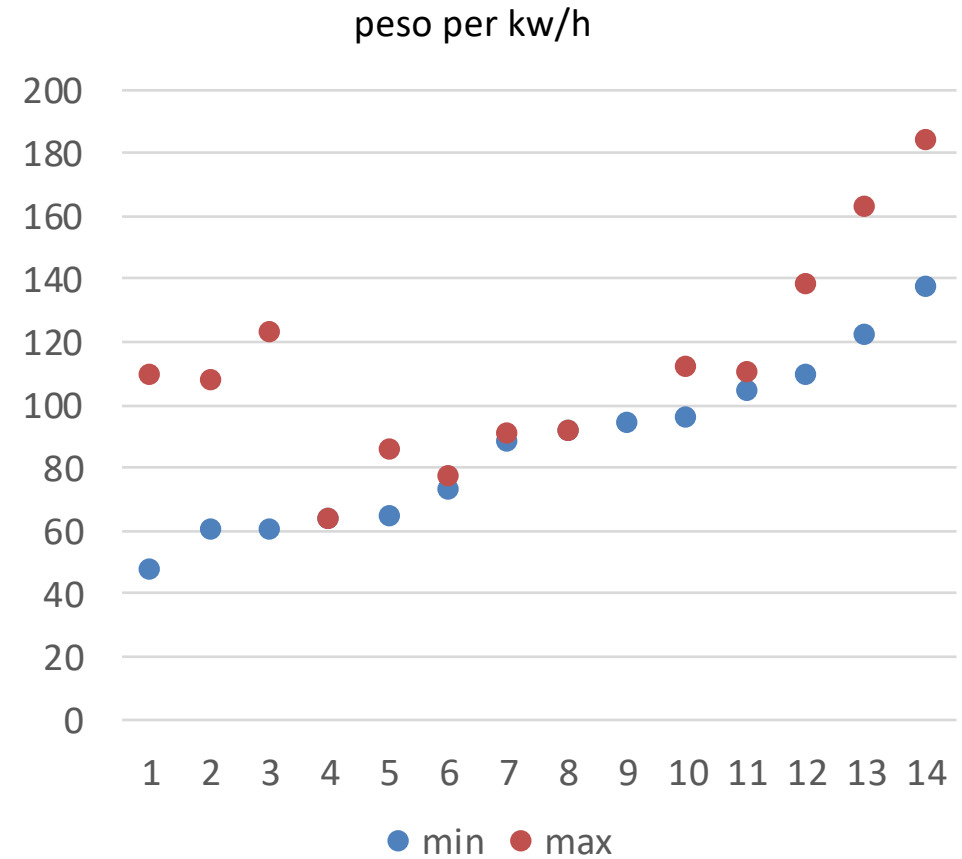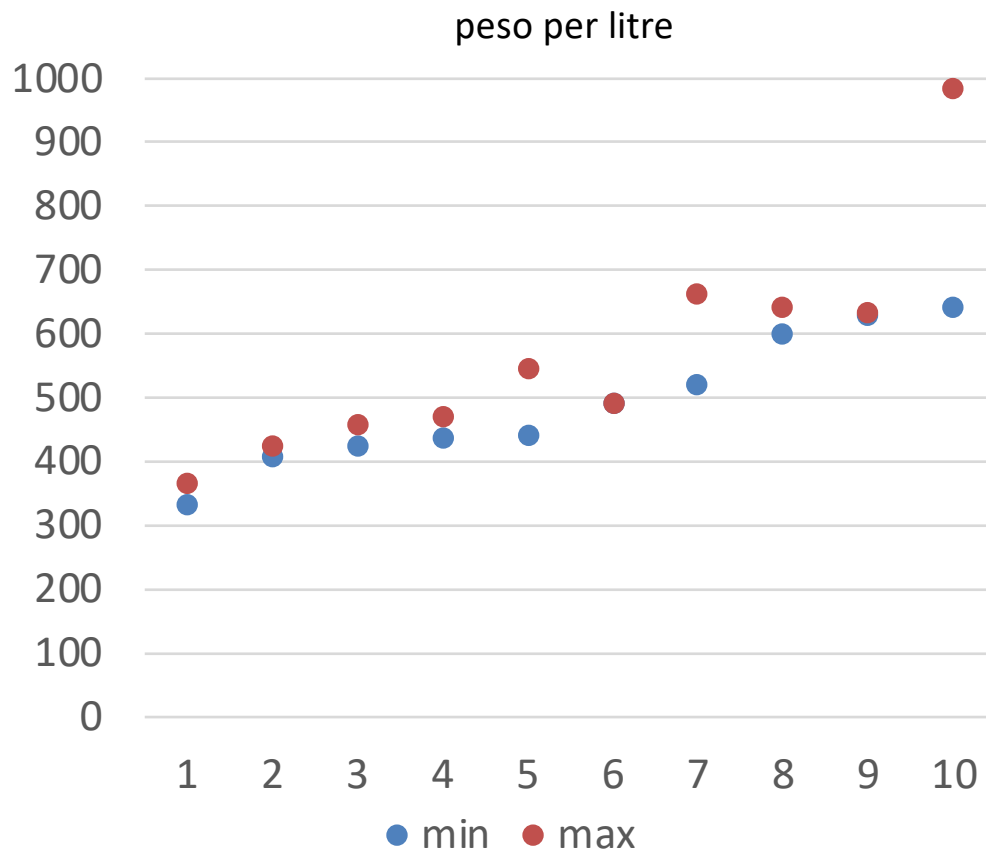
Note: 78 observations, 8 countries

another piece of the puzzle
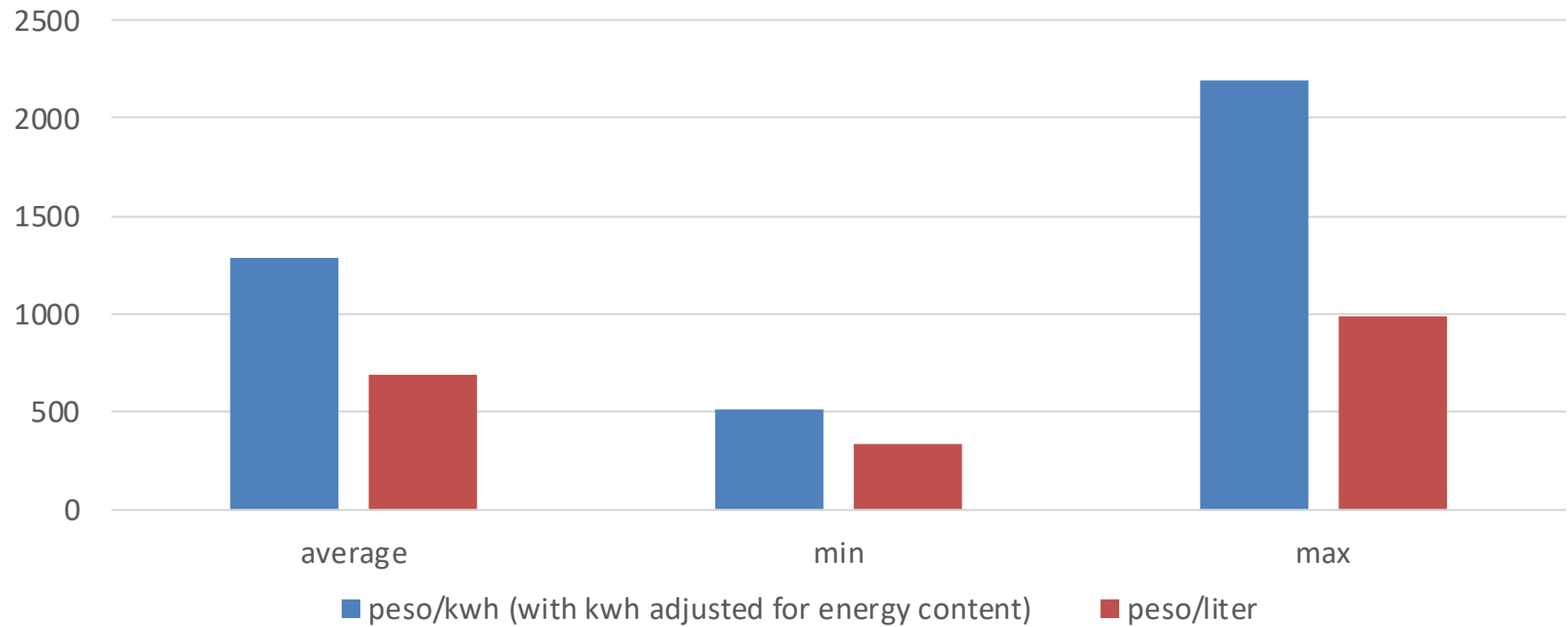example: net water consumption (litre) per box in relation to terminal throughput

Note: 30 observations, 4 countries

energy expenses: distribution in country X, by terminal

peso per litre

peso per kw/h
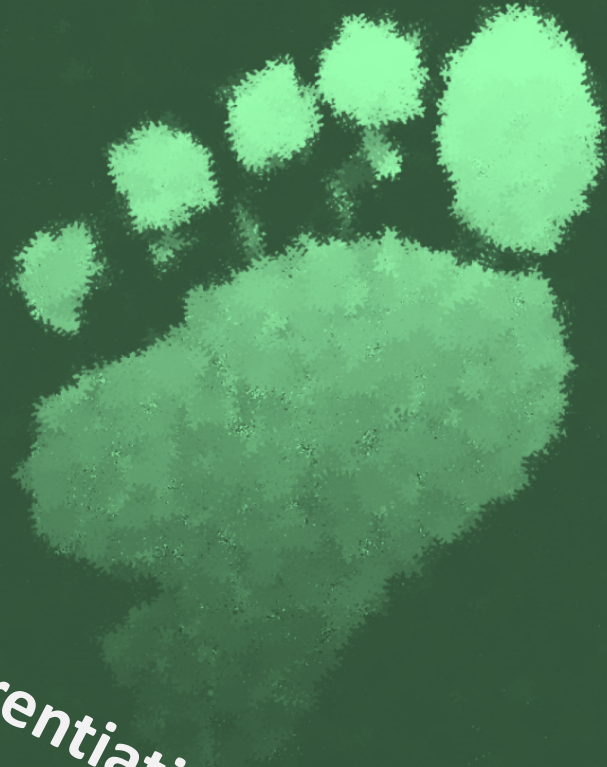
● min   ● max

Note: information on 4 years

energy expenses differences by type in country X

Legend: ■ peso/kwh (with kwh adjusted for energy content) ■ peso/liter

Categories: average, min, max

Y-axis: 0, 500, 1000, 1500, 2000, 2500

the need for differentiation in footprint calculation

emissions

company vehicles

fuel combustion

on-site energy generation

scope 1

purchased energy

scope 2

Business travel, communiting

suppliers

water/ waste

procurement
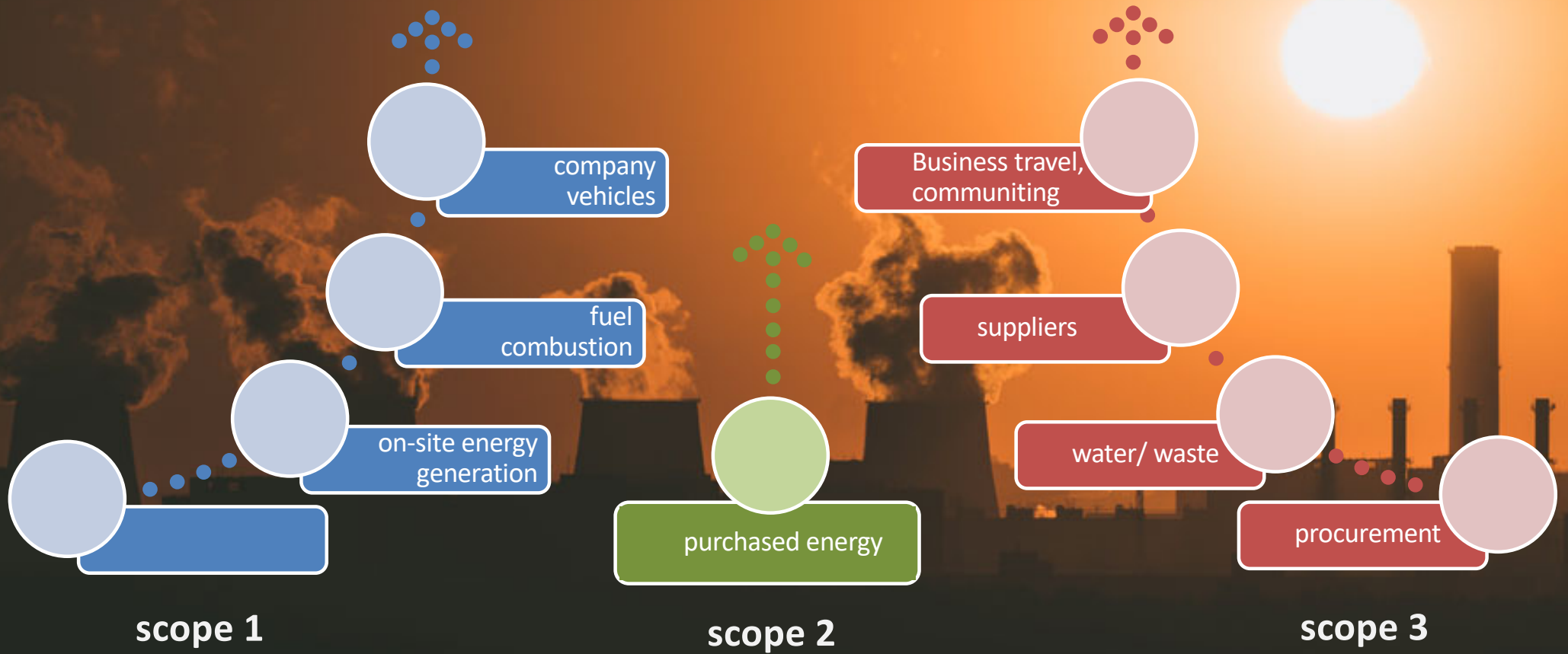
scope 3

Emissions
Kg CO2 per container Terminal X

Dry container

Reefer container

Electricity w/o reefer cooling (scope 2)
diesel for generators (scope 1)
diesel w/o generators (scope 1)
LPG (scope 1)
LNG (scope 1)
petrol (scope 1)

Electricity reefer cooling (scope 2)

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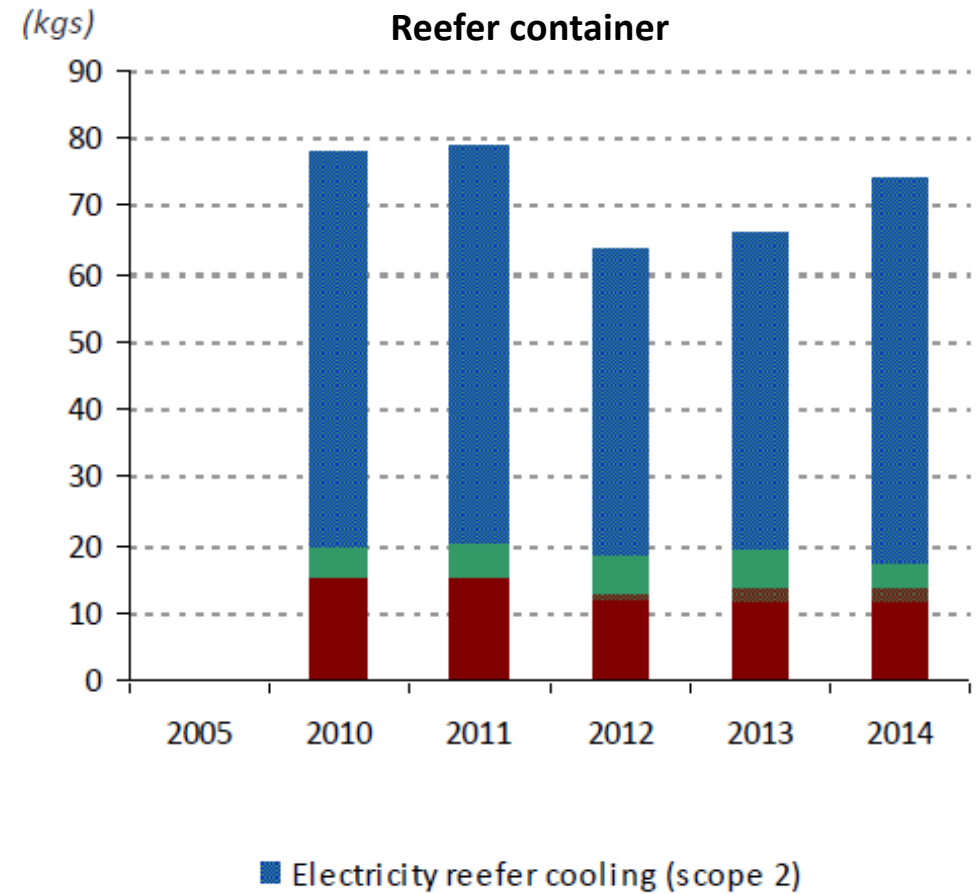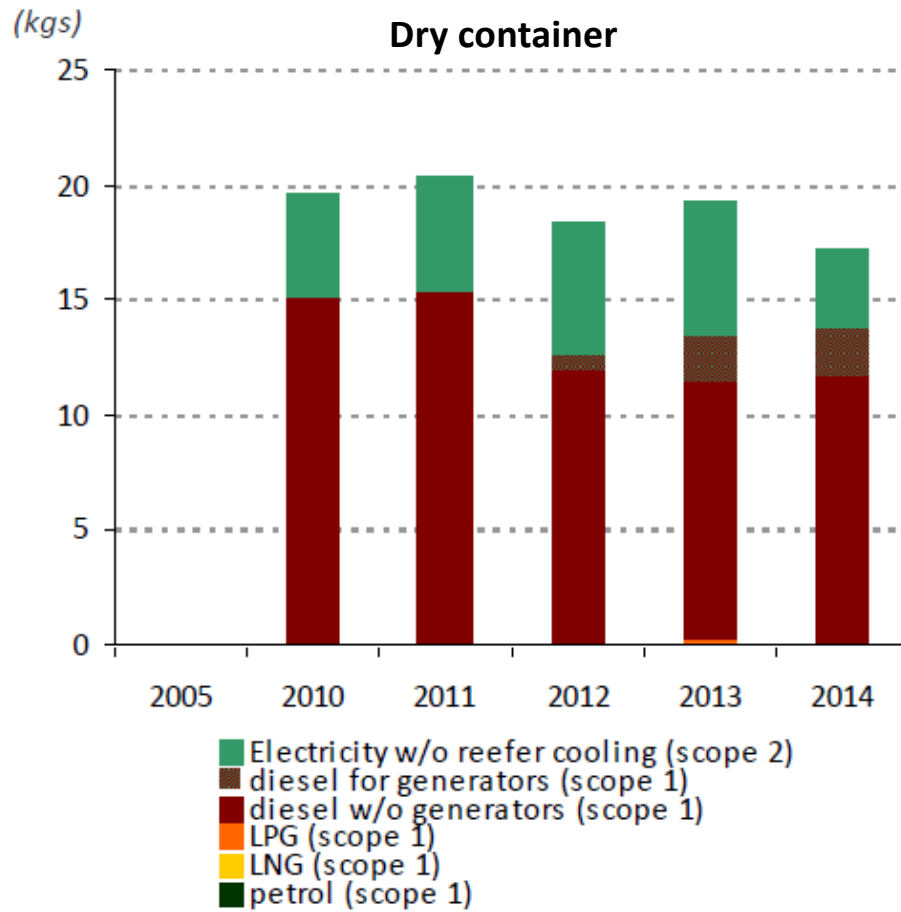
Estimated CO2 emissions (Scope 1 and Scope 2) per container and terminal in Colombia, 2014-2017
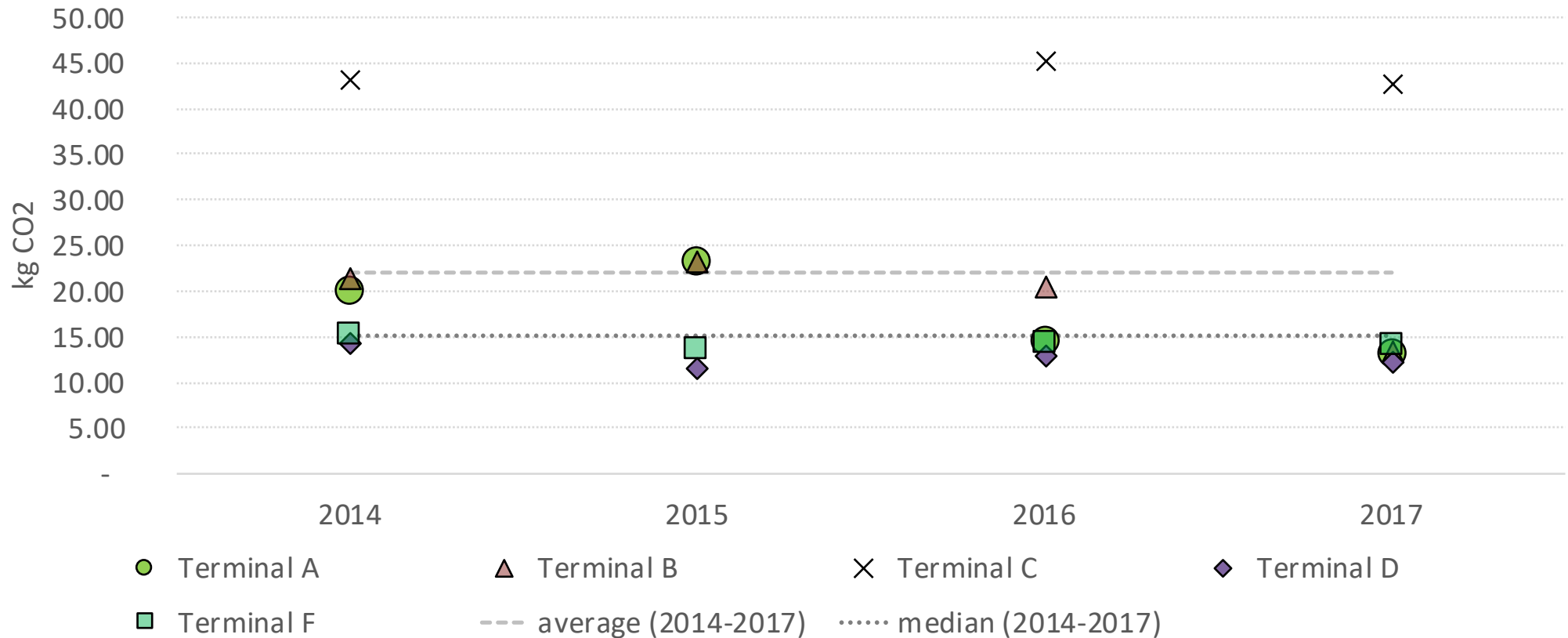
developments

- understanding and establishing interrelationship between the sustainability dimensions related to service quality
- emissions as a negative output of terminals
- the role of terminal performance in the supply chain perspective
- Indicator
  - energy consumption per unit moved (depending on type of terminal tonnes/boxes et.)
  - emissions footprint (CO_2, PM, NOx etc. per unit moved (depending on type of terminal tonnes/boxes et.)
  - water footprint unit moved (depending on type of terminal tonnes/boxes et.)

- Qualitative measurements
  - environmental accidents: e.g. oil spills
  - wasted disposal system (e.g. black water, solid waste)
  - implementation of standards: e.g. ISO 14001, 50001, 11204, 14064 etc.
  - public environmental reporting

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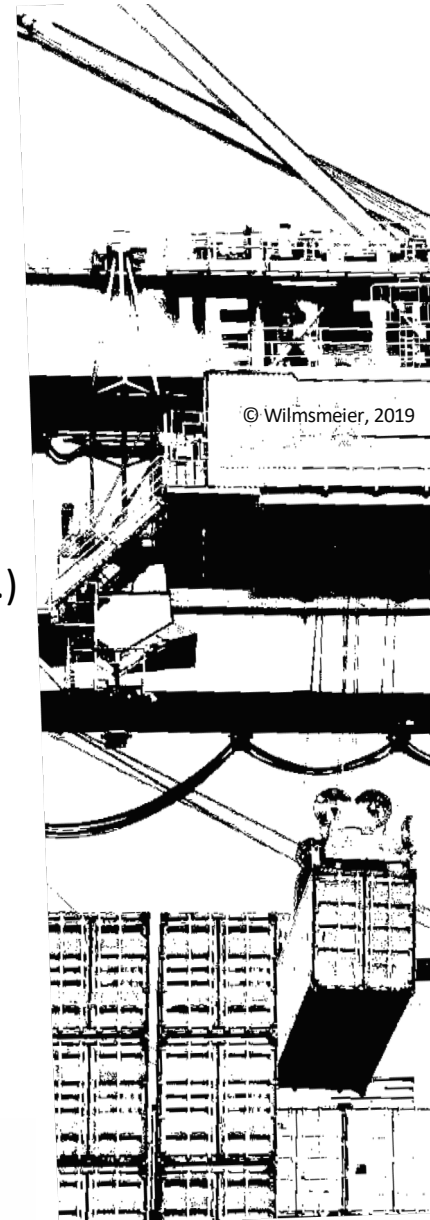
SPM - next steps for moving ahead

- further develop and use tools to expand data sets
  - Water
  - Energy
  - Emissions,
  - Waste, and
  - Social indicators
- further evaluation of the effects of:
  - Technological change
  - Operational differences
  - Energy generation and security issues
  - Simulation and projection of performance indicators
- tool development for
  - Bulk,
  - Roro
  - Passenger terminals

- collaborate towards a new standard of information

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questions?

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Seoul, Korea, October, 2019

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