Collaborative Design of Warehousing 4.0 Using The Concept of Contradictions

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"Collaborative Networks of Cognitive Systems"

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EM Strasbourg – Be Distinctive

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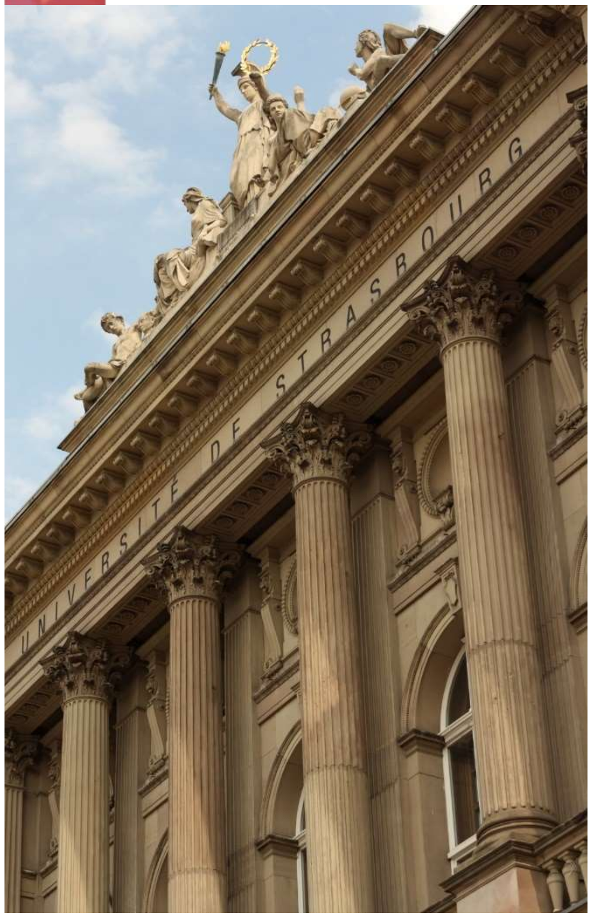
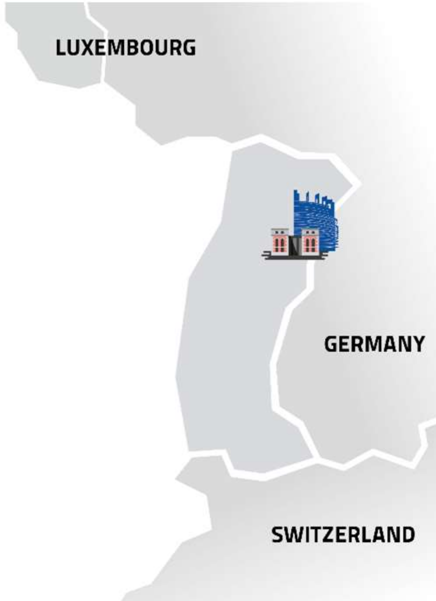




The **University of Strasbourg**

- 4 Nobel Prize Laureates
- 48,000 students
- 20% of international students

Virtual Enterprise

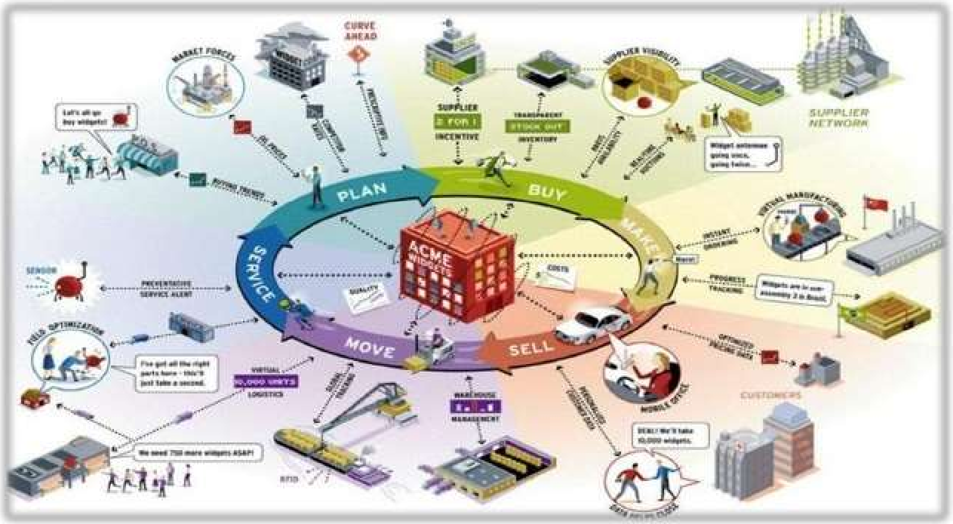
3PL – Third-Party Logistics service provider. To provide logistics services for use by customers: transportation, warehousing, cross-docking, inventory management, packaging, etc.

Virtual enterprise (VE) – is a temporary alliance of businesses for sharing skills, core competencies and resources in order to respond to business opportunities/demands, while cooperation is supported by computer networks*

* Camarinha-Matos, Luis M., and Hamideh Afsarmanesh. 2007. "A Comprehensive Modeling Framework for Collaborative Networked Organizations." Journal of Intelligent Manufacturing 18 (5): 529–542.

Collaborative networks & Cognitive Systems

collaborative network – is a network consisting of a variety of entities that are autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but that collaborate to better achieve common or compatible goals, and whose interactions are supported by computer networks.



Supply Chain – is a subset of Collaborative Networked Organizations / Goal-Oriented Networks*

Warehousing – is a part of Supply Chain - main functions: (1) to match supply with customer demand, (2) to consolidate product; can be represented as storage tank along the pipeline **

* Camarinha-Matos L.M., Fornasiero R., Afsarmanesh H. (2017) Collaborative Networks as a Core Enabler of Industry 4.0. In: Collaboration in a Data-Rich World. PRO-VE 2017. IFIP Advances in Information and Communication Technology, vol 506, pp 3-17. Springer,

** Bartholdi III, John J., and Steven T. Hackman. (2016) Warehouse & Distribution Science. Atlanta, GA, USA: Georgia Institute of Technology. www.warehouse-science.com

[1] long-term evolution of warehousing?

- trends in **LOGISTICS**
  - E-commerce
  - Anticipatory Logistics
  - Omni-channel logistics
  - Customer centric production
  - Same-Day (or faster) delivery
  - Store products closer to consumers,
  - Collaborative Networks etc.

- trends in **SOCIETY**
  - Demography and aging of the population,
  - Urbanization
  - Increased connectivity, etc.
- trends in **ECONOMIES**
  - Growth of sharing economy (Uber, AirBnb, etc)
  - Towards circular economy
  - Changes in labor market
  - Globalization and deglobalization, etc.
- trends in **LEGISLATIONS**
  - Environmental
  - Labor laws
  - Norms of security, etc.
- trends in **TECHNOLOGIES**
  - Additive manufacturing (3D printing)
  - Autonomous vehicles, drones, collaborative robots
  - Industry 4.0
  - Cyber-Physical Systems & IoT
  - Big Data, etc.

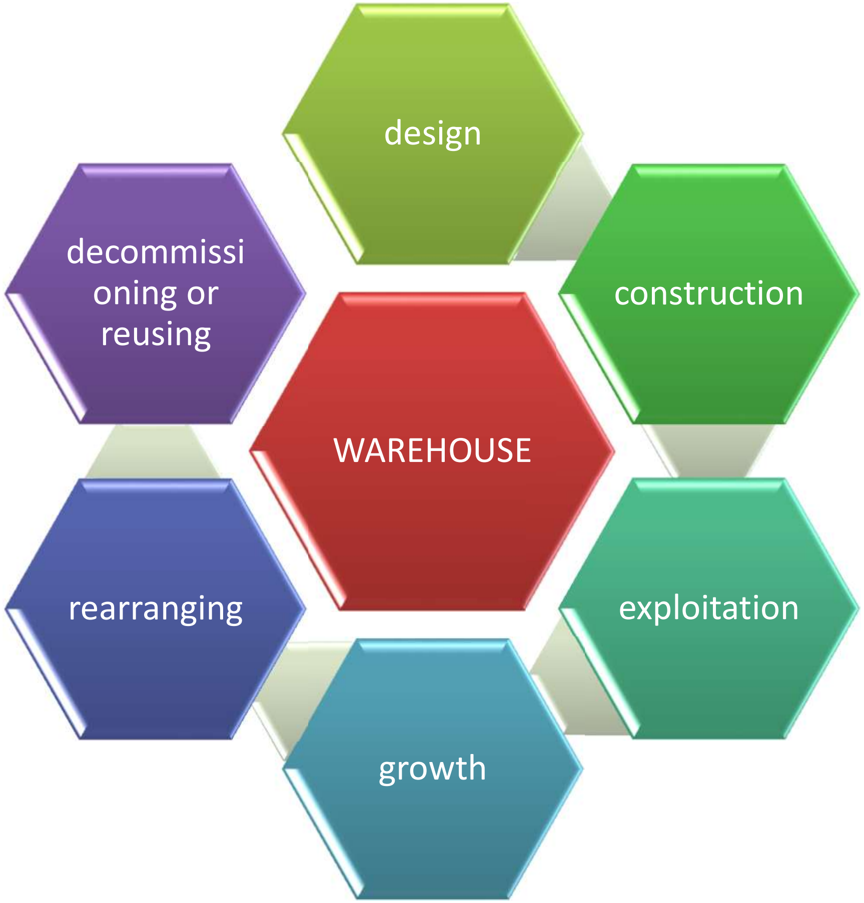
[1] the treated question

what are the key characteristics
for strategic decision-making
in terms of warehousing design?

strategic decision – a planning choice between two or more options, for warehousing it is generally characterized by a horizon of 10 to 15 years;

key characteristic – a solution (usually unknown) that satisfies the most relevant couples of trend-barrier for a successful evolution of the system in a certain time (e.g. *agile supply chain*)

[2] the need for reliable vision



The strategic decision relating to warehouse evolution must take account of the dynamic changes of the activities and functions, as well as the specific characteristics of the system's life cycle

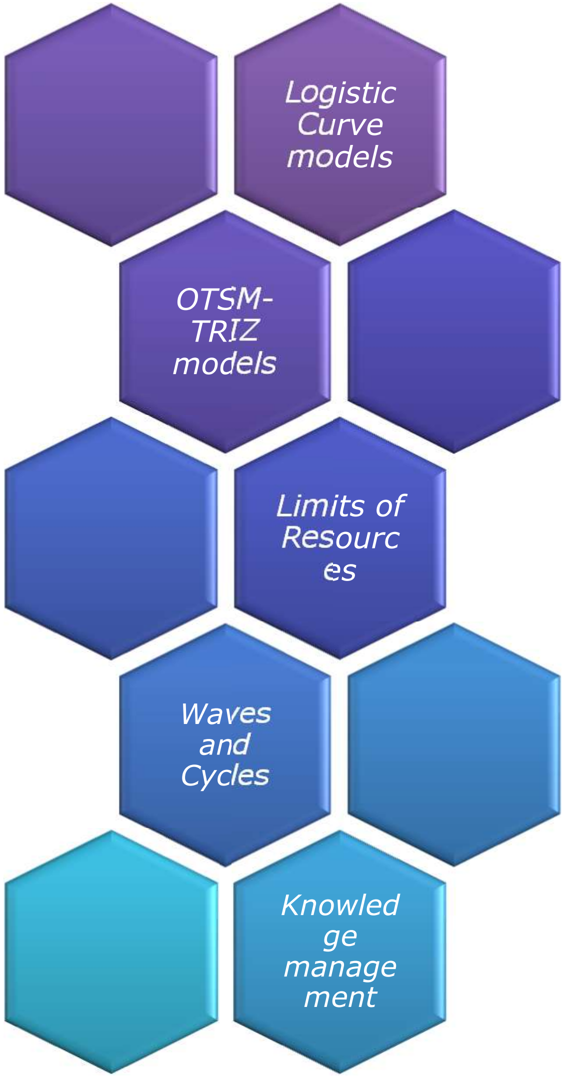
[3] how can we predict trends of warehousing?

Problems are more important than solutions. Solutions can become obsolete when problems remain.

– Niels Bohr
(Nobel prize in Physics, 1922)

- trends in logistics
- trends in society
- trends in legislations
- trends in economies
- new technological abilities
- environmental limitations

[3] combination of contradiction maps and S-curves



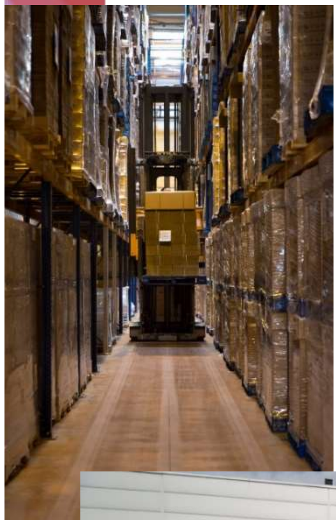
- system description – the model of **System Operator** from TRIZ (Altshuller, 1984),
- modeling problems – map of **Contradictions** for elaborating network of problems within OTSM-TRIZ (Altshuller, 1985, Khomenko, 2010)
- measuring capacity of evolution – **S-curves** logistic fits (Modis, 1992, Meyer, 1999)
- timing evolution – **Technology substitution** models (Marchetti, Nakicenovic, 1979), (Modis, 2013)
- interpretation patterns of the **knowledge** obtained from the DITEK model (Grundstein, 2011)

[4] Warehousing System (WS)

(warehouse has evolved towards Logistics Cluster)

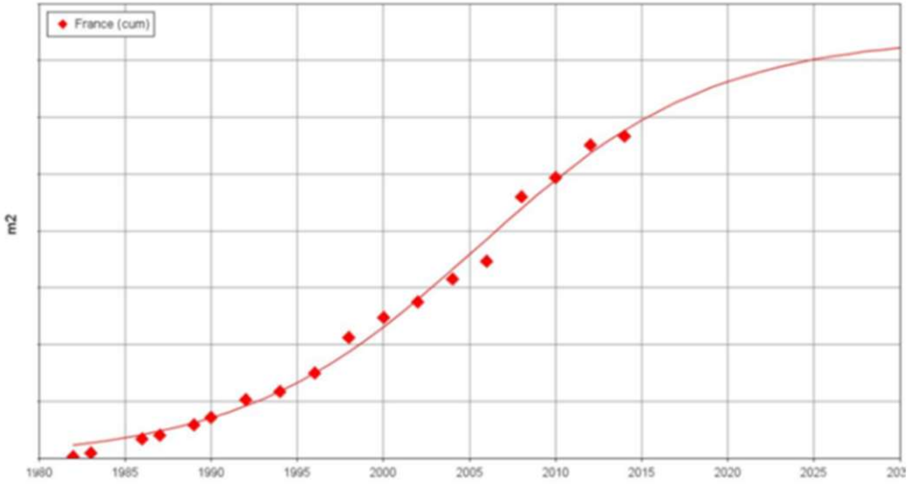
defined the primary function:

Provide customers with the desired quantity of products within the desired deadline

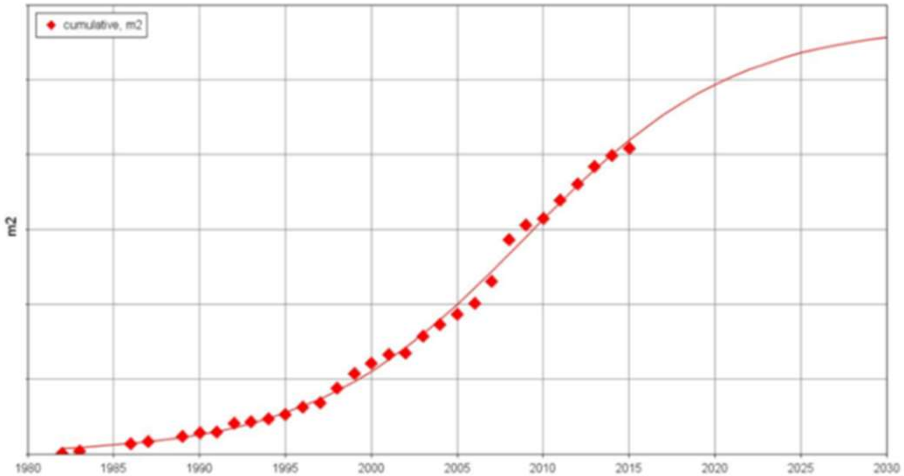


- harmonize supply with customer demand,
- consolidate the product,
- buffer the flow of material along the supply chain
- consolidate products from different suppliers
- value-added processing
- product customization

[4] the surface of warehouses



Example of evolution for surface area of WS constructed in France, m^2 (Tm=2005.5 ; Δt=30.1 ; Rsq=0.993)



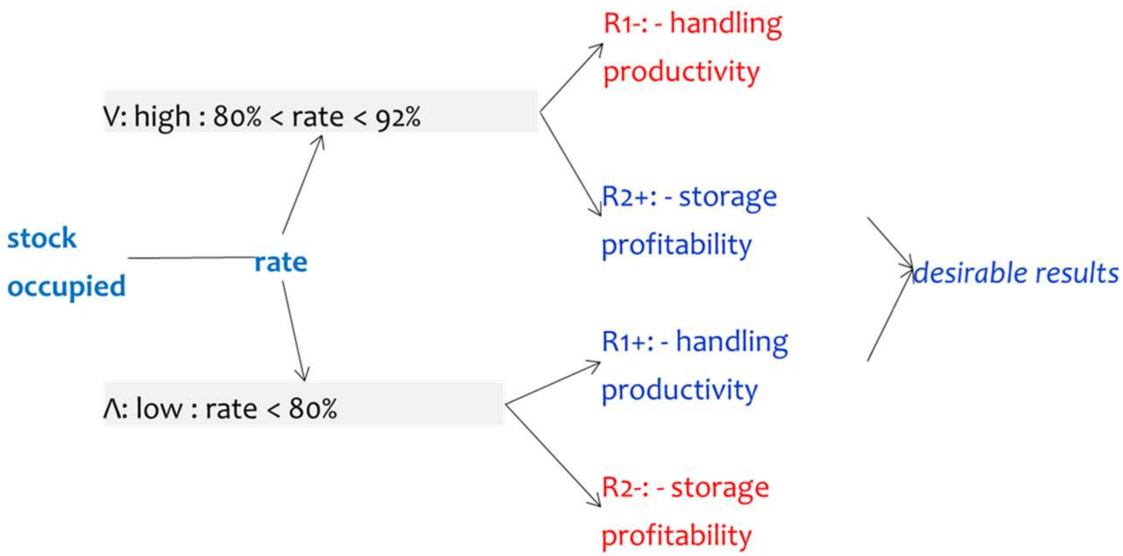
Example of evolution for surface area of WS constructed worldwide, m^2 (Tm=2008.9 ; Δt=27.2 ; Rsq=0.996)

New warehousing systems must enable revenue growth - without increasing the surface area of the WS

* S-curves are elaborated using data about 25 WS spread over 13 countries

[4] contradiction model for problem descriptions

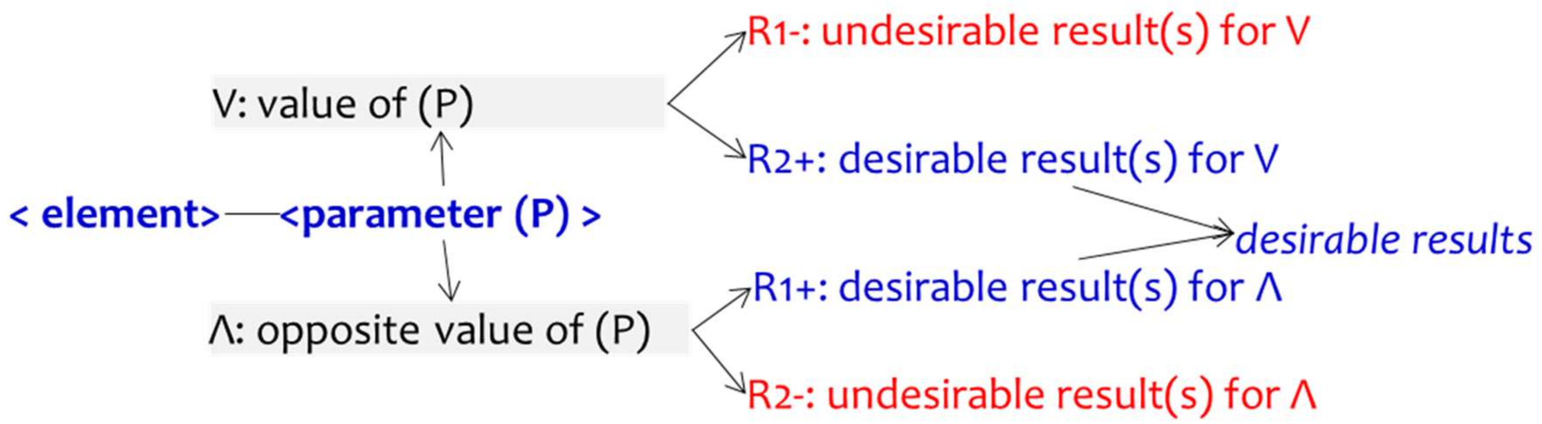
Example of contradiction:
In the <distribution centre> *system, the trend* < significant flow heterogeneity> *encounters a barrier* <*storage profitability*>



handling productivity = *number of (parcels or pallets)/hour;*
storage profitability = *(storage turnover / m²) / cost per m² of the storage surface area*

Contradiction

Contradiction – model to describe a problem through the description of a conflict of interest (of stakeholders).
The contradiction model includes an element, a parameter, a parameter value and an opposing parameter value, desired results (R1+, R2+) and unwanted results (R1-, R2-).

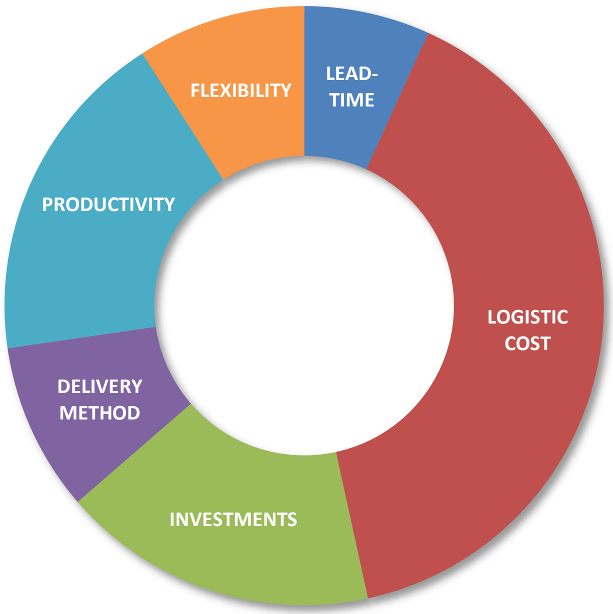


Contradiction appears in the following case: *when the evolution in the value of a parameter towards the R2+ desired leads to an unwanted R1-, and when the change in the opposing value of a parameter towards the R1+ desired leads to an unwanted R2-.*

[4] distribution of performance indicators and desired results by category

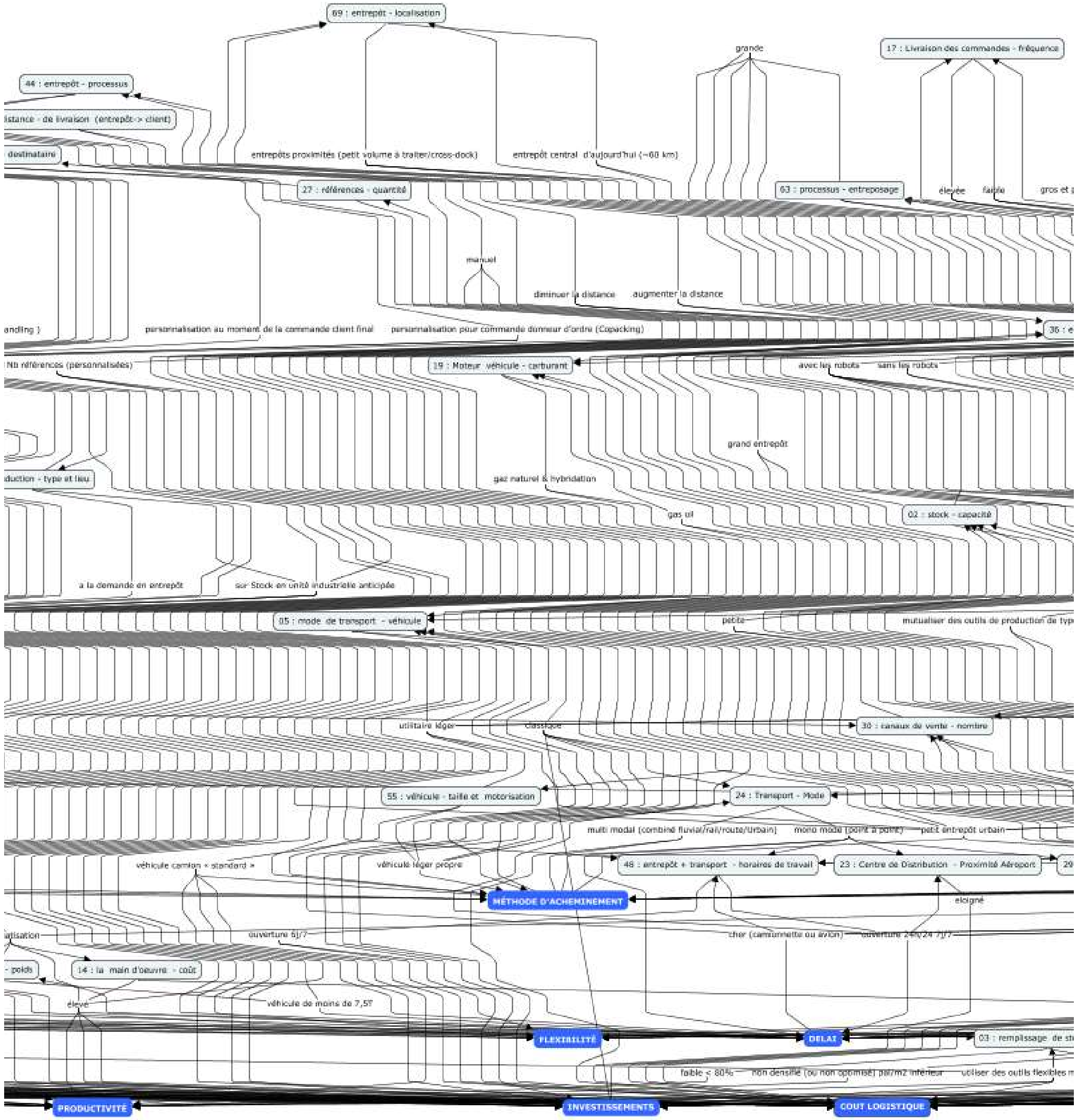
As a result of the work carried out by the working group:

- 21 trends;
- 48 drivers, 49 barriers;
- 281 desired results



	Category	number of performance indicators / category	number of desired results / category
1	Lead-time	6	37
2	Logistic cost	35	115
3	Investments	15	43
4	Delivery method	8	33
5	Productivity	16	34
6	Flexibility	8	19
	TOTAL :	**88**	**281**

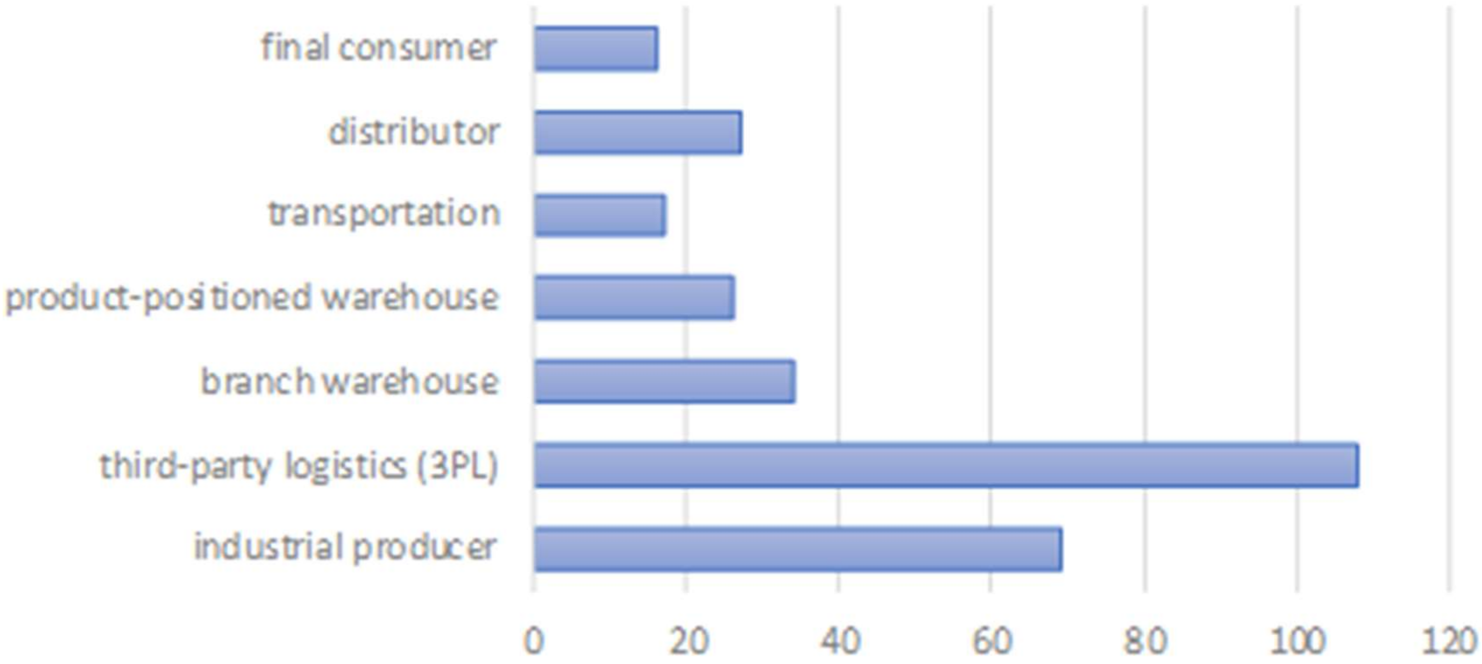
[4] map of contradictions



The map of contradictions represents

- the conflicts of interest between seven major players
- evokes 88 performance indicators
- for 21 defined trends and
- 281 desired results

[4] Actors/relationships



The number of most significant contradictions concerns the logistics provider and the industrial producer, who are therefore the key players (stakeholders) in the change process.

[5] discussions and prospects

The result is the definition of a map of warehousing system contradictions *(cognitive map)*

The concept of contradiction is pertinent for initiating issues pertaining to the strategic evolution of WSs.

The results obtained only allow for partial generalization *(25 warehouses from three industries)*.

The prospects of this study are:

- the prioritisation of contradictions and
- the development of a systematic method designed to identify contradictions

All models are wrong,
but some are useful

- George E. P. Box

THANK YOU

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