EM STRASBOURG HUMANIS
centre de recherche

USING MAP OF CONTRADICTION for decision support within warehouse design process

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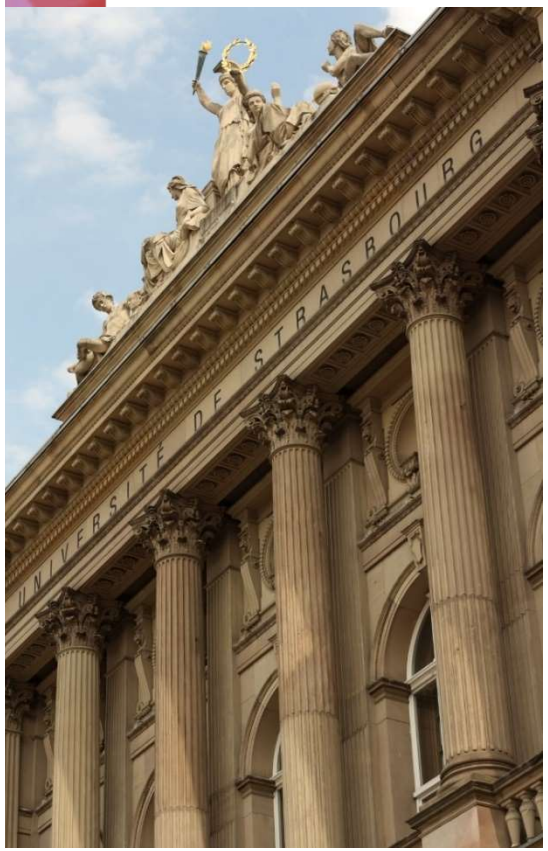

- 4 Nobel Prize Laureates
- 48,000 students
- 20% of international students

EM Strasbourg – *be distinctive*

- 23 degree programs
- 3 600 students
- 22 000 alumnus
- 220 international partners

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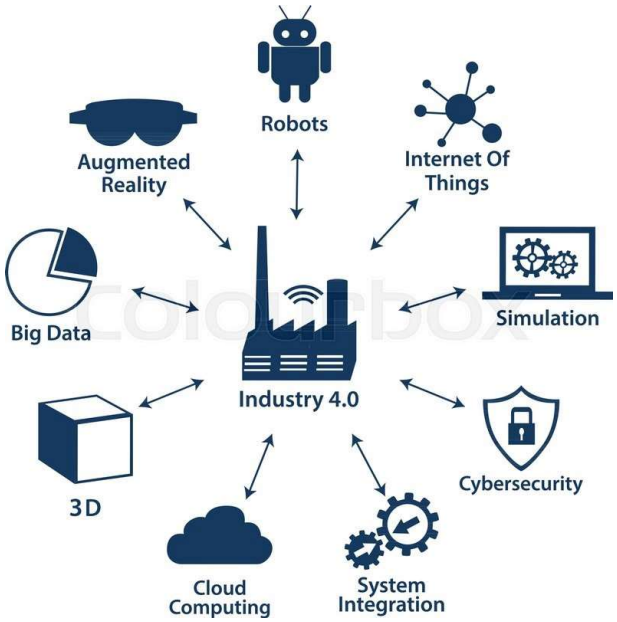
characteristics of Industry 4.0

1. Vertical integration or networking of smart production systems
2. Horizontal integration through global value chain networks
3. Through-engineering across the entire value chain
4. Acceleration of manufacturing
5. *Digitalization of products and services*
6. *New business models and customer access*

technology = Hardware + Software + Orgware



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.

warehouse indicators

Dimensions	Indicator name
Time	Order lead time | Receiving time 5 | Order picking time Delivery Lead Time | Queuing time | Putaway time | Shipping time Dock-to-stock time | Equipment downtime
Quality	On-time delivery | Customer satisfaction | Order fill rate Stock-out rate | Physical inventory accuracy | Storage accuracy Picking accuracy | Shipping accuracy | Delivery accuracy | Perfect orders Scrap rate | Orders shipped on time | Cargo damage rate
Cost	Inventory cost | Order processing cost | Cost as a % of sales | Labour cost Distribution cost | Maintenance cost
Productivity	Labour productivity | Throughput Shipping productivity Transport utilisation Warehouse utilization | Picking productivity | Inventory space utilisation Turnover | Outbound space utilisation | Receiving productivity

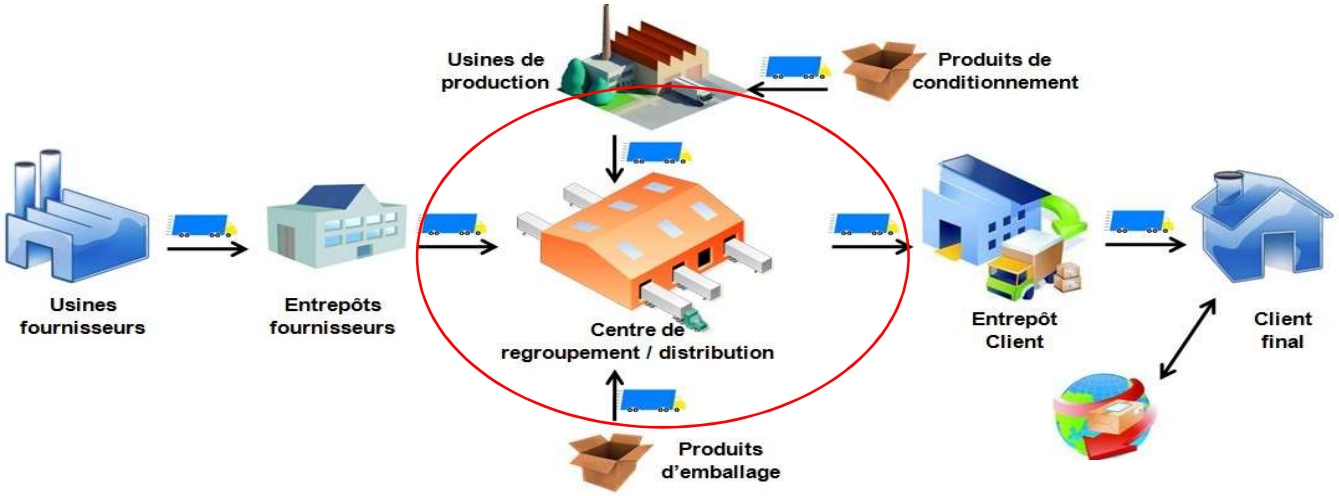
* Staudt, Francielly Hedler, Gülgün Alpan, Maria Di Mascolo, and Carlos M Taboada Rodriguez. 2015. "Warehouse Performance Measurement: A Literature Review." International Journal of Production Research 53 (18). Taylor & Francis: 5524–5544

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

what is the SUBJECT?

- In the context : third-party logistics provider (3PL) : FM LOGISTIC
- The warehousing system :
  < provide customers > < products > with the desired quantity within the desire deadline
- **Research Question :**
  what are the key characteristics for strategic decision-making *in terms of warehousing* design*?*



the treated question

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

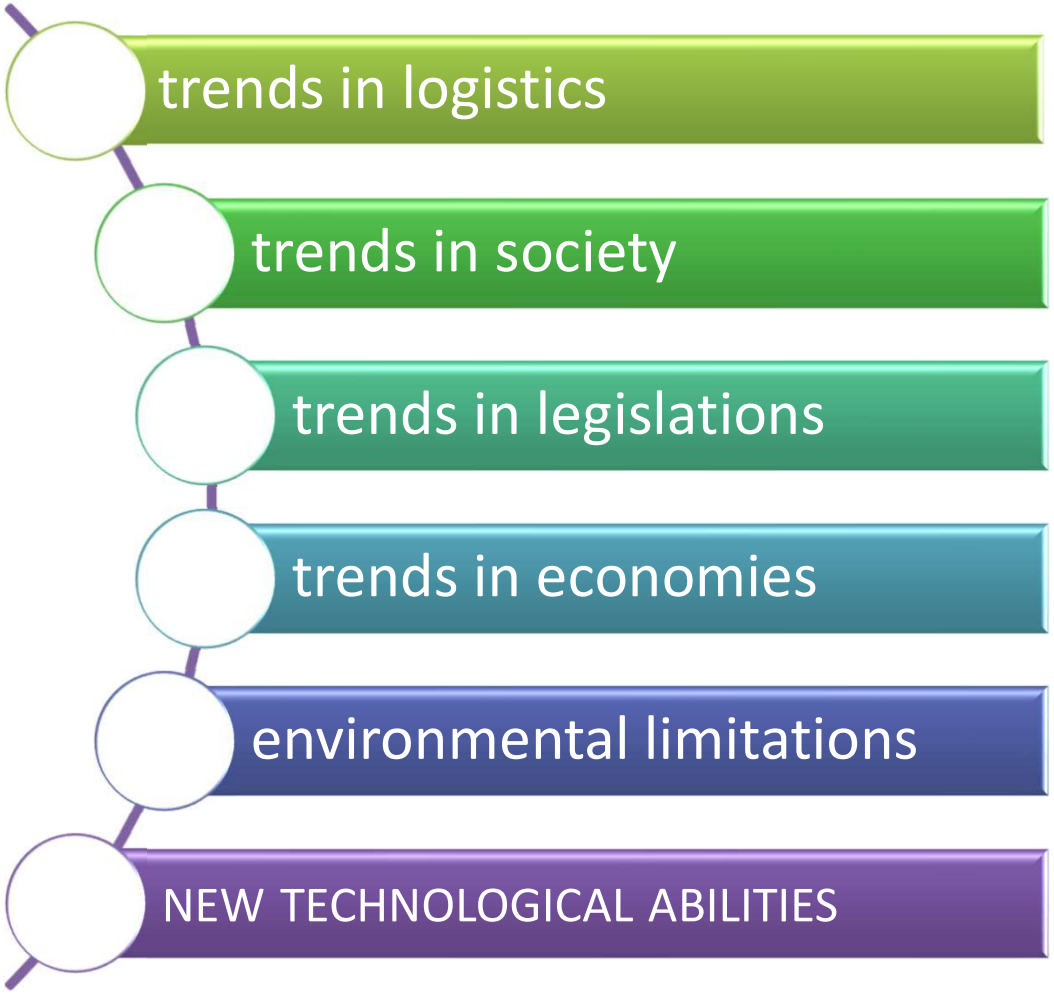
strategic decision – a planning choice between two or more options, for warehousing it is generally characterized by a horizon of 10 to 15 years;

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*)

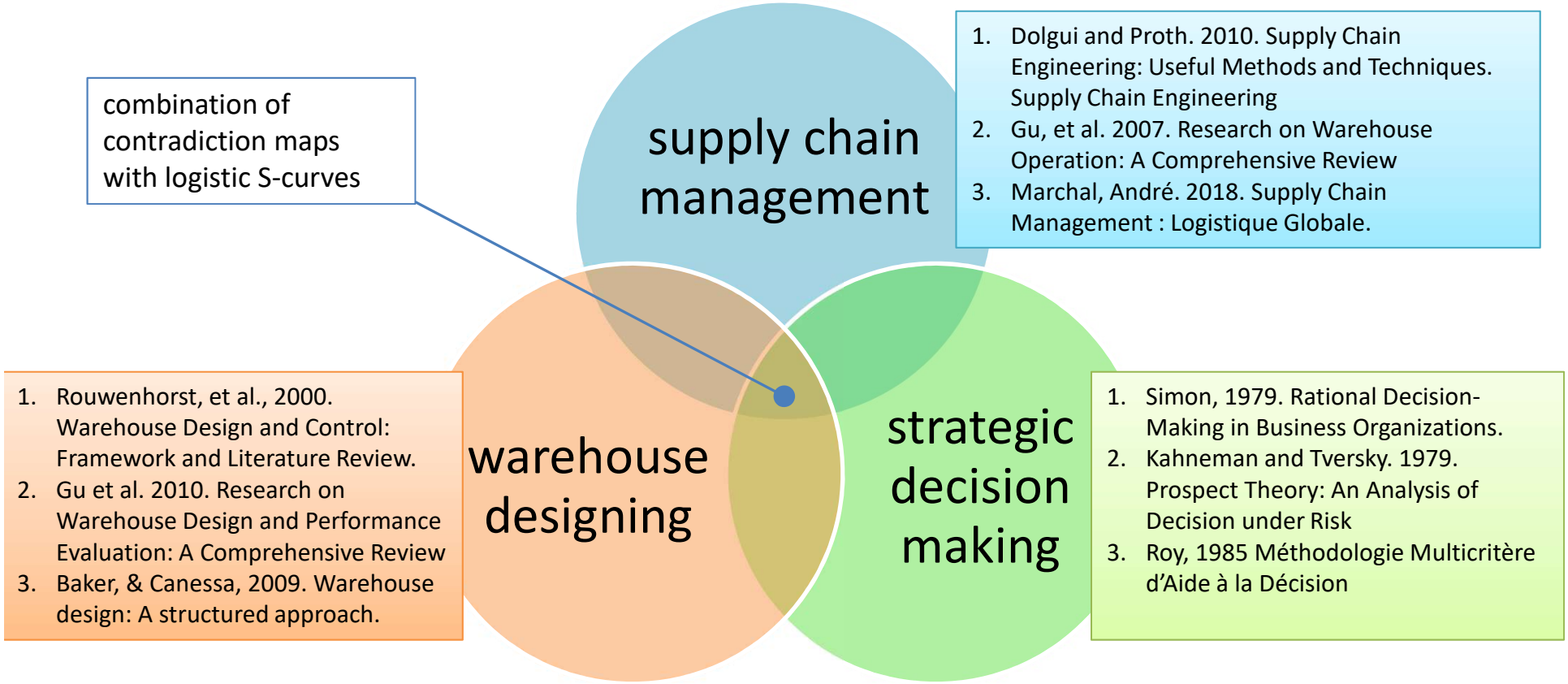
how can we predict future of warehousing?

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

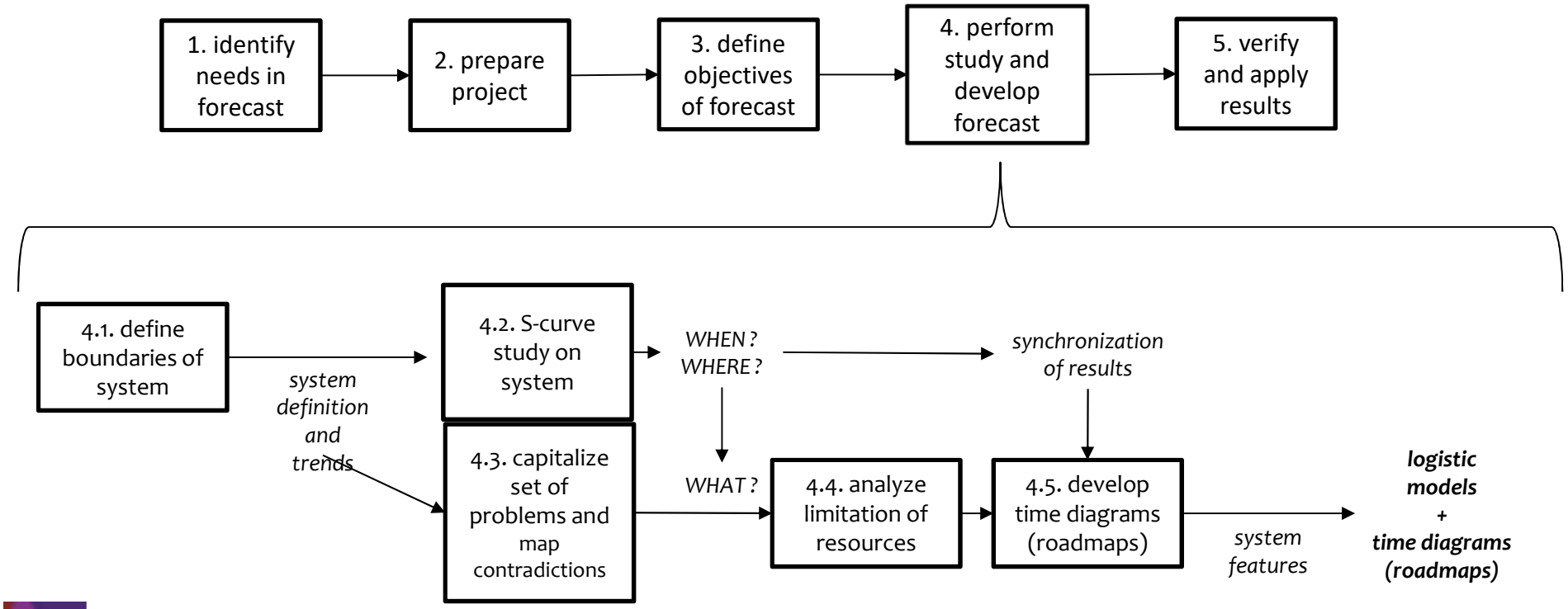
– Niels Bohr
(Nobel prize in Physics, 1922)



research framework

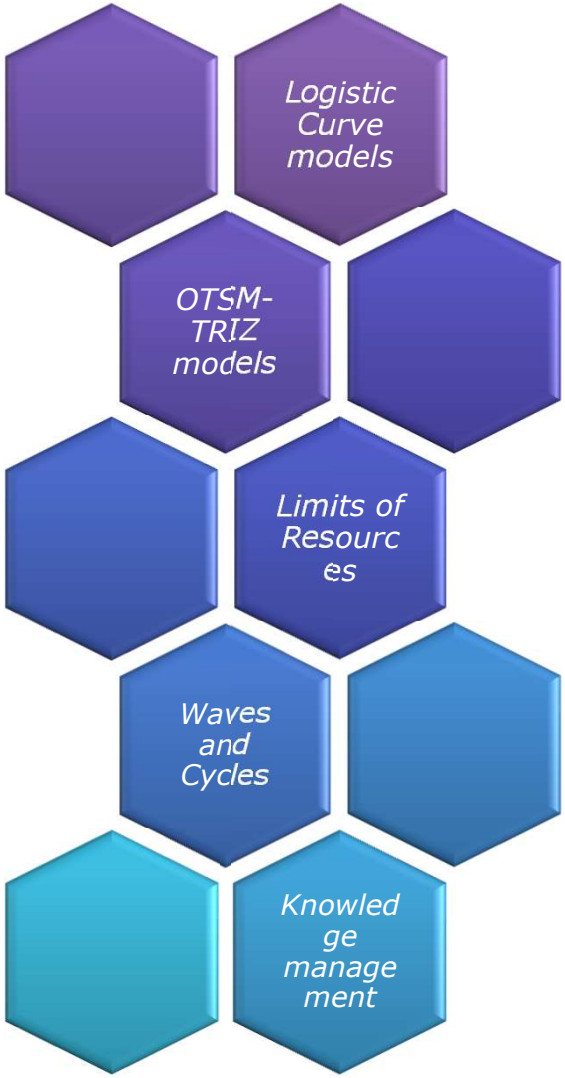


Researching Future* methodology



* Kucharavy, Dmitry, and Roland De Guio. 2008. “Technological Forecasting and Assessment of Barriers for Emerging Technologies.” IAMOT 2008. Dubai, UAE

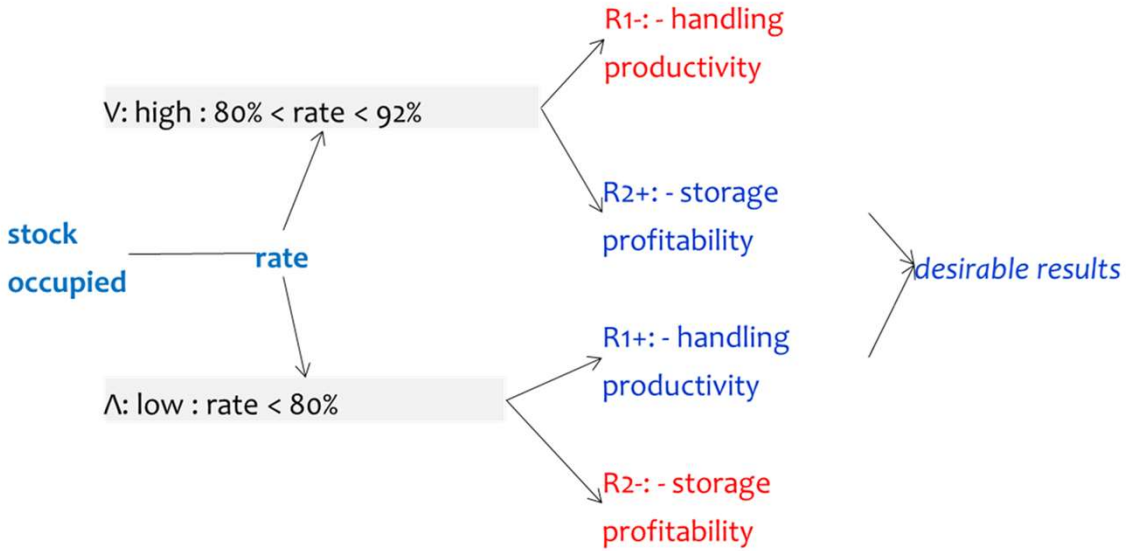
combination of qualitative and quantitative methods



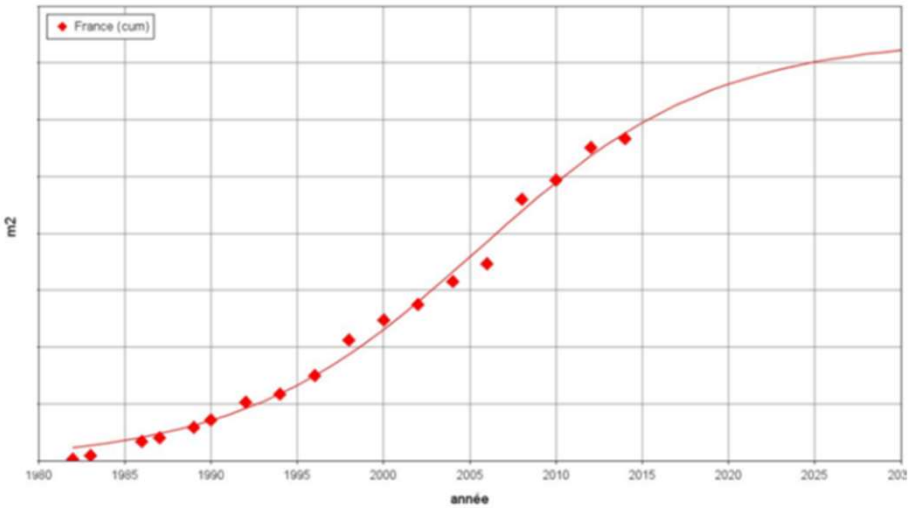
- system description – the model of **System Operator** from TRIZ (Altshuller, 1984),
- modeling problems – map of **Contradictions** for elaborating network of problems within OTSM-TRIZ (Altshuller, 1985, Khomenko, 2010)
- measuring capacity of evolution – **S-curves** logistic fits (Modis, 1992, Meyer,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

contradiction model for problem descriptions

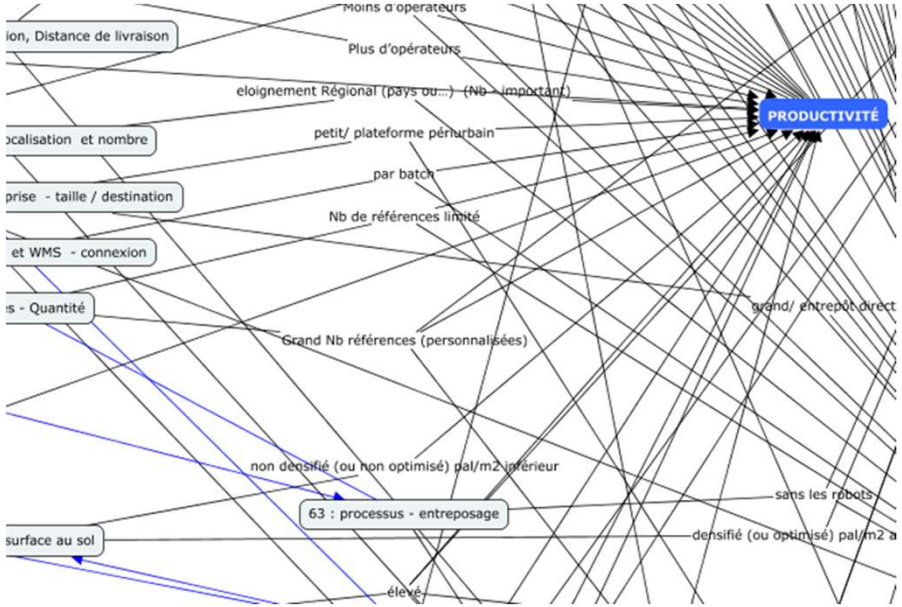
Example of contradiction:
In the <distribution center> *system, the trend* < significant flow heterogeneity> *encounters a barrier* <*storage profitability*>



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



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



some results

3 experts 3PL and 3 researches:
26 x 4 h working sessions in 12 months

identified :
- 21 trends;
- 48 drivers et 49 barriers;
- 281 desired results ;
- 88 indicators classified into 6 dimensions

logistic S-curves were developed using data from 25 WS from 13 countries : France ; Europe ; East Europe, Central Europe, West Europe; Asia

map of 58 contradictions :
- 64 concepts,
- 107 connections,
- 332 propositions for
- 7 stakeholders

* Kucharavy D, Damand D, Barth M, Derrouiche R (2018) Entrepôt du futur : formalisation des caractéristiques clefs. In: MOSIM'18. Toulouse, France.

discussions and prospects

- the concept of contradiction is relevant to the strategic evolution issues of warehousing systems (WS)
- the results obtained only allow a partial generalization.

- **Perspectives**:
  - the development of a systematic method of identifying contradictions and mapping
  - the development of mapping and S-curves logistic user guides for strategic decision-making related to technologies.

practical	theoretical
- identify the direction of evolution for the warehouses (What? When? Where?) - conflicts of interest between key actors during WS life cycle	- the definition of a mapping of contradictions of WS; - strategic decision support related to technologies (e.g. emerging)

All models are wrong,
but some are useful

- George E. P. Box

THANK YOU

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