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27/07/2022
Nice, France

Recommendation Ranking Based on AHP Approach for Productivity Improvement in SME Context

Authors:

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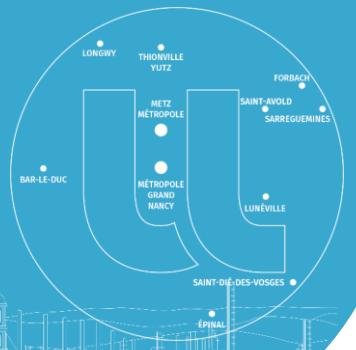

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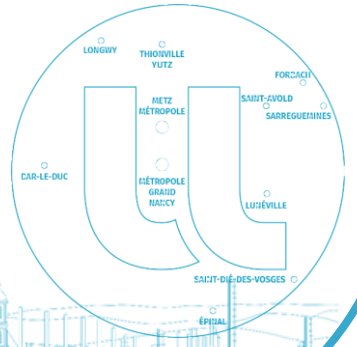
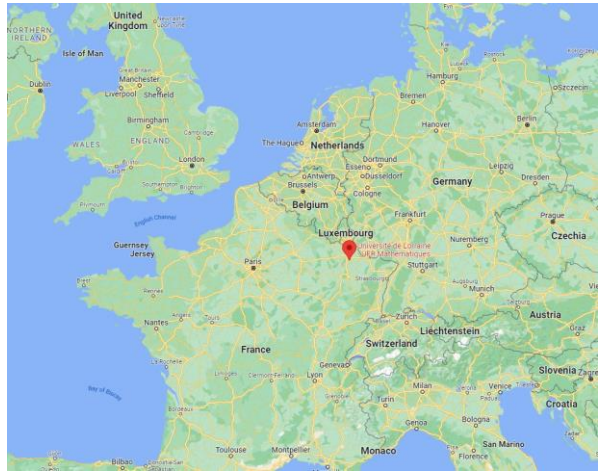


1. Short biography

- He is Doctor in Computer Science since 2016, obtained at Université de Lorraine (France) in collaboration with the Luxembourg Institute of Science and Technology (Luxembourg).
- Youcef Abdelsadek currently holds the position of Research Engineer and working on the European Interreg PRODPILOT project.
- From September 2022, he will be Associate Professor at Laboratoire de Conception, Optimisation et Modélisation des Systèmes (LCOMS) of Université de Lorraine (France)
- His research activity focuses on advanced algorithms to solve NP-hard problems and data analysis combined to visual analytics approach.
- The applications are interdisciplinary, such social networks (Community Detection and Sentiment Analysis), productivity improvement (Logistics and Leveling), information visualization and data management (Big Data).

LCOMS – Université de Lorraine

- Founded in 2011
- Multidisciplinary
  - Computer Science
  - Automatic
  - Electronics
  - Neuroscience



- More than 50 permanent researchers (including 21 HDR)
- About 40 contractual researchers per year
- Scientific production nearly 400 articles in international journals over the last 10 years

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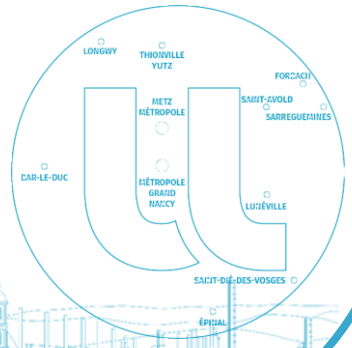
Context introduction

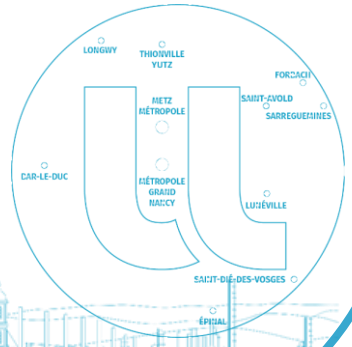


2. Context introduction

- Productivity improvement
  - Measures in Lean Production and Industry 4.0
- A Small and Medium-sized Enterprises (SMEs) context
- Competitiveness

  ➔ Implementing the most beneficial measure/action
- Avoiding bad decisions at the top management in strategic plan

Problem statement and objective



3. Problem statement and objective

Several heterogeneous measures for productivity improvement with different added value levels

VS

SMEs do not have enough resources and technological experience to implement several measures

- How to choose the most beneficial measure/action?
- Multi-criteria decision making
- Compare and rank measures using approach that integrates experts priorities

  ➔ Analytic Hierarchy Process (AHP)

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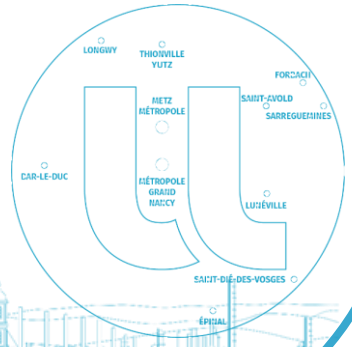
Related work

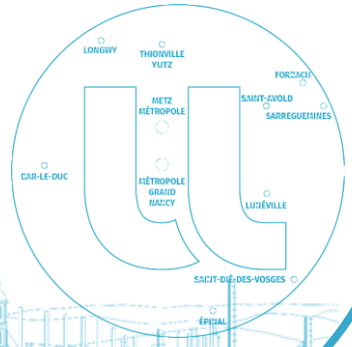


4. Related work

- Belongs to the Multiple Criteria Decision Making (MCDM) family Introduced by T. L. Saaty in 70’s

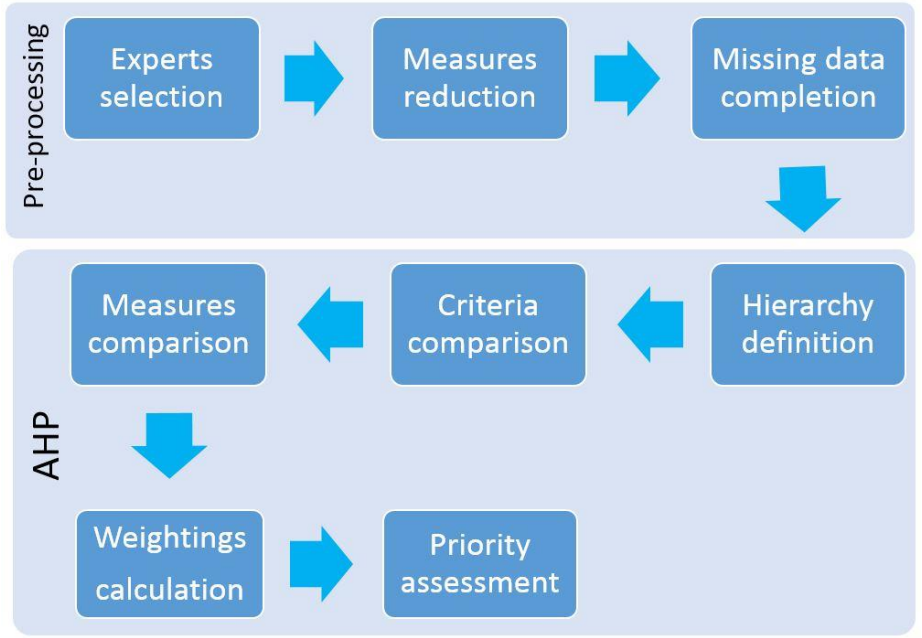
Field	Alternatives	Reseach
Reactive scheduling for healthcare	Algorithmic solution techniques	V. Farrokhi, I. Kacem, and L. Pokordi, in 2014
Construction projects	Factors in use of labour resources	H. Doloi, in 2008
Services and supply	Suppliers selection	A. K. Kar, in 2013
Industrial IT	Choosing Flexible manufacturing systems (FMS)	O. Bayazit, in 2005
	Choosing Enterprise Resource Planning (ERP)	L. He and C. Li, in 2009

Methodology



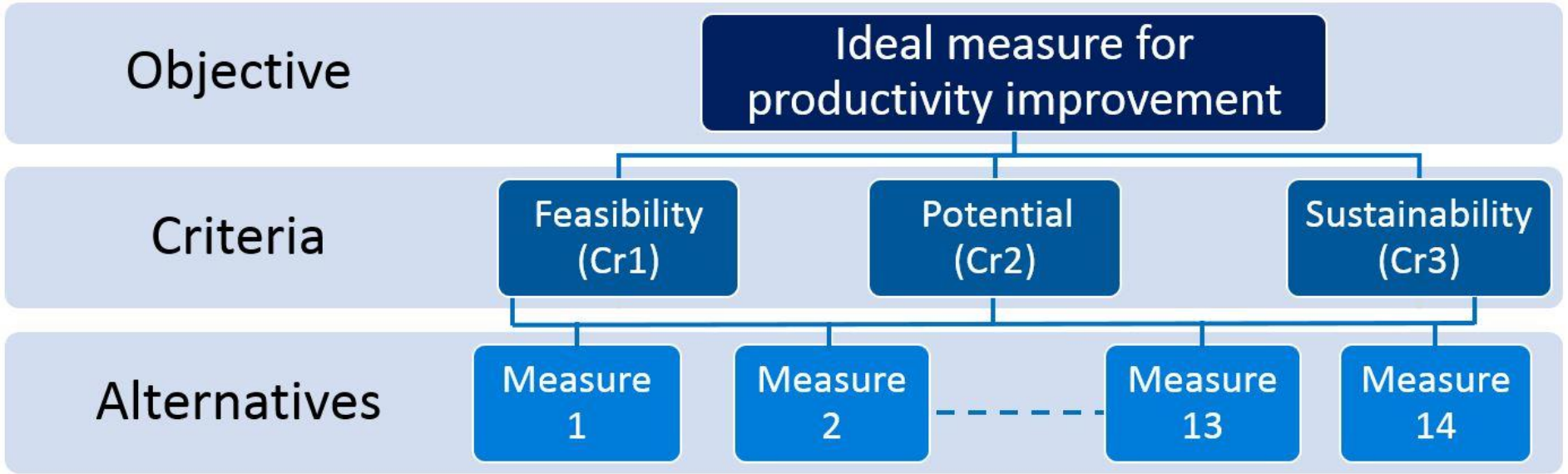
5. Methodology: Framework

- Questionnaire to gather prioritization of a panel of experts
- Use of Prodpilot self-assessment tool (36 measures divided into 5 categories)
  - ➔ Reduced to 14 measures
  - ➔ Data completion relying on the Shannon's entropy principle of the Information Theory



5. Methodology: Hierarchy definition

- ***Feasibility* (Cr1):** How easily a measure can be implemented by a company. How much does the company need additional resources or experience?
- ***Potential* (Cr2):** Degree of improvement in productivity that the company reaches after implementing a measure. To what extent the implementation of a measure allows for a noticeable progress in productivity?
- ***Sustainability* (Cr3):** Durability of an action over time before it becomes obsolete. The longer the company benefits from the measure implementation, the better the measure.



5. Methodology: Priority assessment

- Criteria and measures comparison
  - **Ordinal scale:** 1 denotes equal importance, 2 low importance and 9 extreme importance

- Weightings computation
  - Solve the induced Eigen value problem by comparisons matrix
  - The first normalized right Eigen vector of the matrix represent the priorities (weights)
    - Apply geometric mean when multiple experts opinions = $(v_{1ij} \cdot v_{2ij} \cdots v_{kij})^{\frac{1}{k}}$
  - The Eigen value represent the Consistency Ratio (CR)
    - Consistency = $v_{ij} \cdot v_{jg} = v_{ig} \ \forall i, j, g$
    - Consistency Ratio = (Consistency / n) – (Consistency of a large random matrix / m)
    - CR < 0.1

5. Methodology: Priority assessment

O	C1	C2	C3	C4	C5
C1	1	1/3	1/5	3	9
C2	3	1	1/9	1/5	1
C3	5	9	1	1	5
C4	1/3	5	1	1	1/3
C5	1/9	1	1/5	3	1

C1	A1	A2	A3
A1	1	1/3	1/5
A2	3	1	1/9
A3	5	9	1

C2	A1	A2	A3
A1	1	1/5	1/9
A2	5	1	1/3
A3	9	3	1

C3	A1	A2	A3
A1	1	1/5	1
A2	5	1	5
A3	1	1/5	1

C4	A1	A2	A3
A1	1	1/3	1/5
A2	3	1	1/9
A3	5	9	1

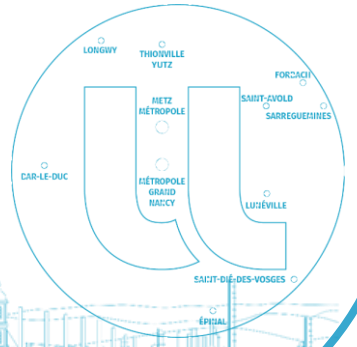
C5	A1	A2	A3
A1	1	1/9	1/9
A2	9	1	1/3
A3	9	3	1

5. Methodology: Priority assessment

$$\begin{pmatrix} a_1^{c_1} & a_1^{c_2} & a_1^{c_3} & a_1^{c_4} & a_1^{c_5} \\ a_2^{c_1} & a_2^{c_2} & a_2^{c_3} & a_2^{c_4} & a_2^{c_5} \\ a_3^{c_1} & a_3^{c_2} & a_3^{c_3} & a_2^{c_4} & a_3^{c_5} \end{pmatrix} * \begin{pmatrix} c_1^o \\ c_2^o \\ c_3^o \\ c_4^o \\ c_5^o \end{pmatrix} = \begin{pmatrix} w_1^a \\ w_2^a \\ w_3^a \end{pmatrix} \longrightarrow \begin{pmatrix} 0.255 \\ 0.338 \\ 0.407 \end{pmatrix}$$

$$\left(\bar{a}^{c_1} \quad \bar{a}^{c_2} \quad \bar{a}^{c_3} \quad \bar{a}^{c_4} \quad \bar{a}^{c_5}\right) * \left(\bar{c}^o\right) = \left(\bar{w}^a\right)$$

Results


LONGWY
THIONVILLE
YUTZ
FORBACH
METZ
MÉTROPOLE
SAINT-AVOLD
SARREGUEMINES
BAR-LE-DUC
MÉTROPOLE
GRAND
NANCY
LUNÉVILLE
SAINT-DIÉ-DES-VOSGES
ÉPINAL

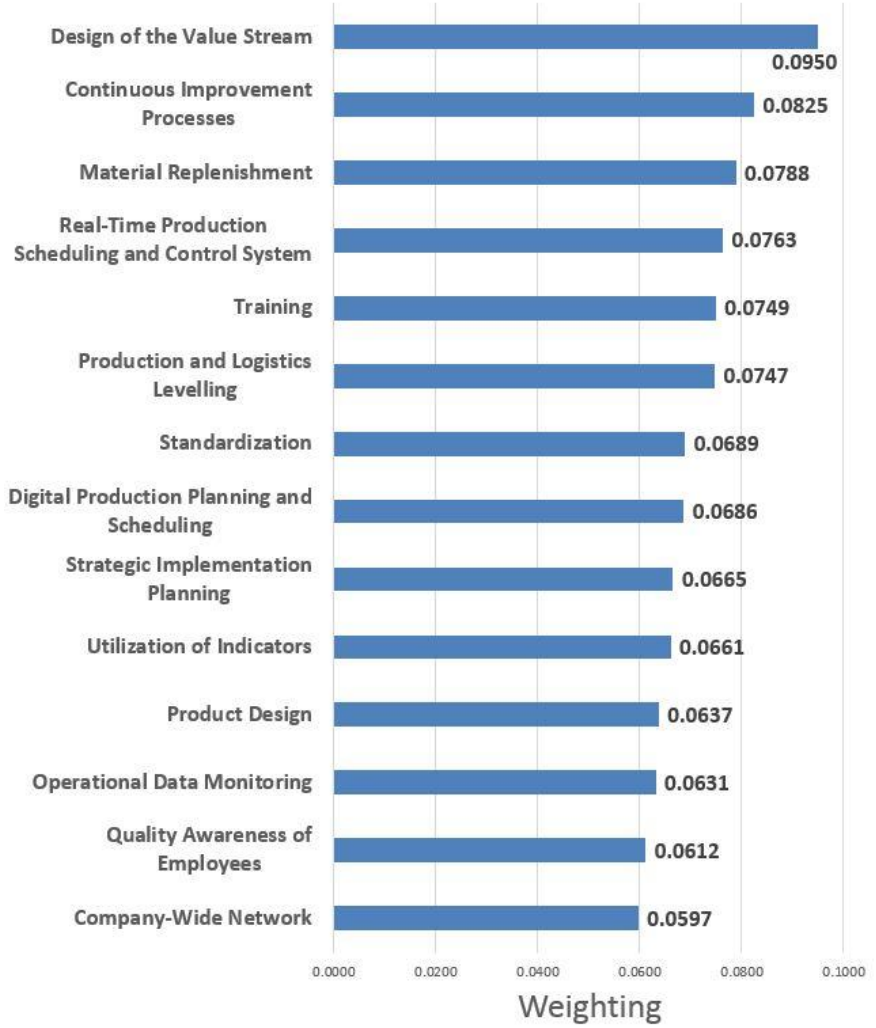
6. Results: Criteria ranking

- Compared to larger companies having an Research and Development (R&D) department where processes are continuously optimized and where new technologies are supported at all hierarchical levels, the feasibility is not as important as in a SME context

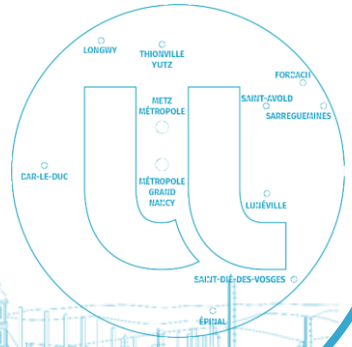
TABLE I
PAIRWISE COMPARISON OF CRITERIA WITH RESPECT TO THE IDEAL MEASURE FOR PRODUCTIVITY IMPROVEMENT

Criterion	Importance	
	Level	*Weighting*
Feasibility (Cr1)	Hight importance	0.505
Potential (Cr2)	Moderate importance	0.301
Sustainability (Cr3)	Low importance	0.192
CR		**0.094**

6. Results: Measures ranking



Conclusion and perspectives



7. Conclusion and perspectives

- We propose a recommendation ranking for productivity improvement in the SME context

- The prioritization is based upon experts judgements to rank the important measures in Lean Production and Industry 4.0 with respect to three criteria

- Applying AHP method

Future work:

- Considering other criteria to rank measures for productivity improvement, such as the reticence of SMEs regarding some measures

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Question?

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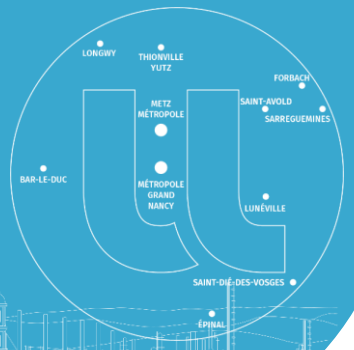
Acknowledgment:
This work is supported by the Interreg PRODPILOT V A project (040-4-09-104)



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