Methods of artificial intelligence in procurement

A conceptual literature review

IPSERA Conference 2021 digitally on March 29th, 2021

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Together with Prof. Dr. Heiner Stuckenschmidt and Prof. Dr. Christoph Bode

Research motivation artificial intelligence methods in procurement.

Monday 10:30 am Dollywood
The impact of Artificial Intelligence on the Procurement process (…)
Ms. Michela Guida, Prof. Antonella Moretto, Prof. Federico Caniato
(Politecnico di Milano)

Monday 01:30 pm Dollywood – stay tuned after this presentation!
Evolutions and disruptions in Procurement Digital Transformation
Prof. Jean Potage (Kedge Business School)

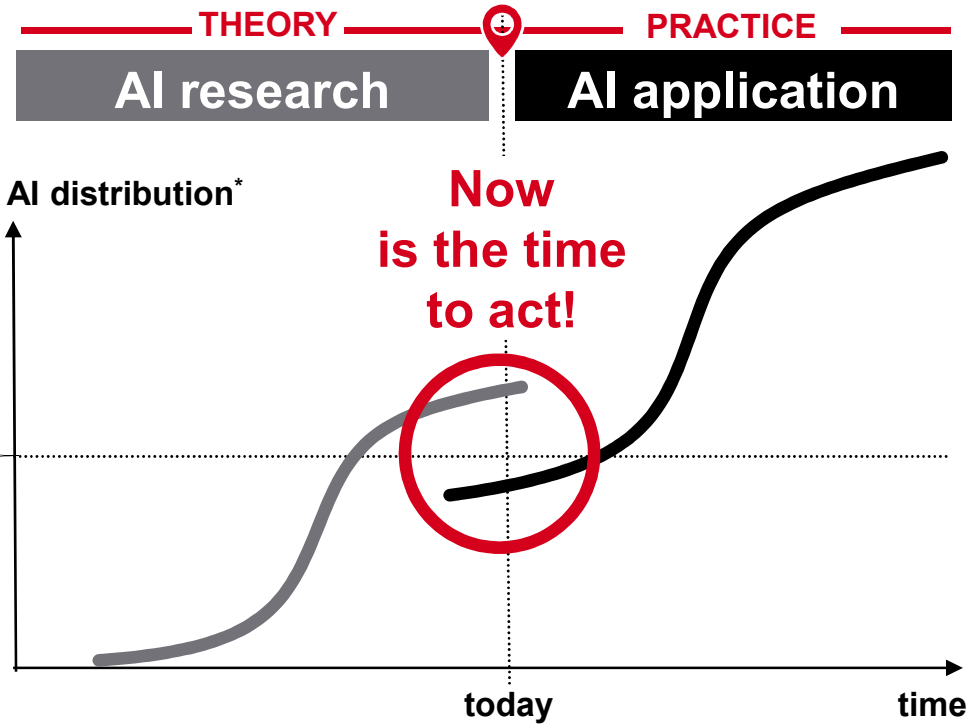
Tuesday 01:30 pm Dollywood
Assistance for the implementation of AI in procurement - An analysis of maturity models
Mr. Dennis Meyer, Mr. Matthias Brüggenolte, Mr. Tan Gürpinar, Prof. Michael Henke
(TU Dortmund University)

Wednesday 09:00 am Volunteer Walk
Impacts of Digitization on Freight Forwarding: A Delphi Study
Mr. Benjamin Müßigmann, Prof. Evi Hartmann, Prof. Heiko von der Gracht
(Friedrich Alexander Universität and Steinbeis University)

Wednesday 10:30 am Dollywood
Big Data Analytics and Machine Learning pathway to Supply Chain Sustainability (…)
Prof. Mihalis Giannakis, Ms. Linjing Huang
(Audencia Business School and University of Warwick)

RPA improves procurement process and support digital transformation
Mr. Fabio Fontes, Prof. Holger Schiele
(University of Twente)

Artificial intelligence (AI) is a research area that attempts to design mechanisms allowing machines to develop intelligent behavior. Few have successfully integrated AI methods into their operations and across their supply chains. This constitutes a research opportunity on how AI can increase the performance of procurement.



Sources: IPSERA Abstract and Online Conference Program, Kok et al., 2009, Min, 2010, Chae et al., 2014, Schoenheer and Speier-Pero, 2015, Sanders, 2016, Handfield et al., 2019, Russell and Norvig, 2020, Schulze-Horn et al., 2020 as well as AI@Porsche project team with * according to a typical trajectory for the introduction and adoption of new technologies.

Overview literature review AI methods in procurement.

Background

AI and machine learning techniques are recently **starting to emerge** in **procurement theory and practice**.

Based on literature reviews of big data analytics in supply chain management, there is a need to review the literature **focusing specifically** on **AI** and **machine learning in procurement**.

The work started off as a systematic literature and become more of a conceptual literature review over time.

Methodology

Content analysis approach by **Mayring**:

1. **Material collection**, which entails a process of search and delimitation of articles
2. **Descriptive analysis**, which provides characteristics of the studied literature
3. **Category selection**, which aims to construct a classification framework

Followed by the **material evaluation**, additionally **13 expert interviews** conducted to assess the **business value** and the **ease of implementation**.

Results

174 publications were identified, described and classified based on the **strategic**, **tactical** and **operational level of procurement** and according to the **ACM computing classification system**.

Summarized the **state-of-the-art** in **theory enriched** with **practical ideas,** made **available** for **further research**.

11 use case clusters were derived, assessed through the interviews, and a research agenda is proposed.

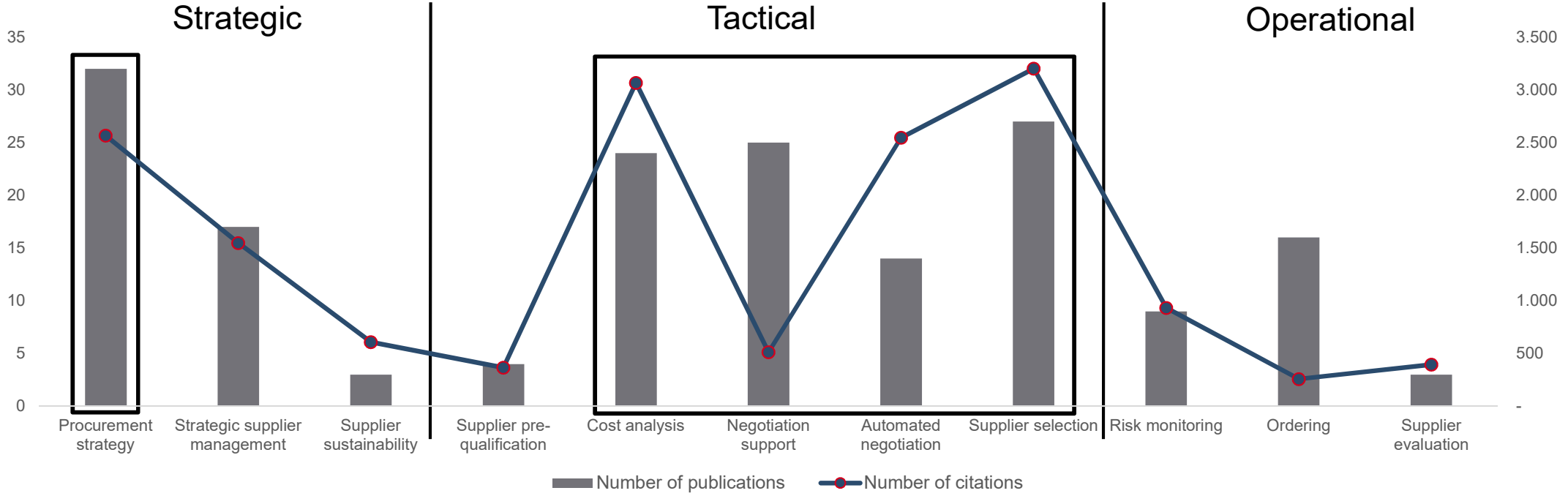
→Goal: Provide an understanding of the state-of-the art and highlight research opportunities.

Sources: ACM, 2012, Waller and Fawcett, 2013, Mayring, 2014, Souza, 2014, Nowosel et al., 2015, Gunasekaran et al., 2017, Nguyen et al., 2017, Vollmer et al., 2018.

Classification of procurement dimensions with clusters.

The procurement function can be subdivided in different ways, i.e. strategic, tactical, and operational level. SAP utilizes this framework under the name of plan to strategic, source to contract, and purchase to pay as well as the German supply chain association, the consultancy BCG, other reviews and academic works.

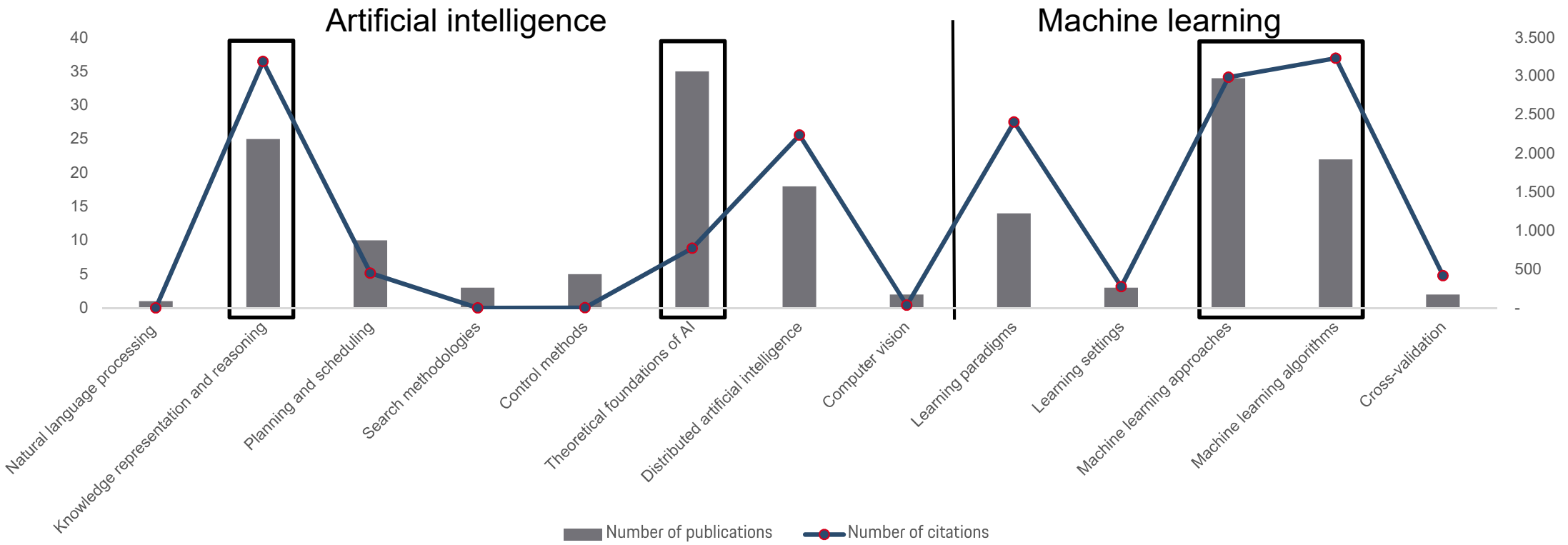
All publications have been clustered in the eleven sub-cluster to further assess them in the interviews.



Sources: Souza, 2014, van Weele, 2014, Batran et al., 2017, BME, 2018, Chopra, 2019, Inverto, 2020.

Classification for AI methods together with machine learning.

AI and machine learning are sub-categories of computing methodologies according to the computing classification system by the Association for Computing Machinery as a three-tiered hierarchical ontology and de facto standard classification for information technology. Accordingly the clustering as on the slide before:



Sources: ACM, 2012, Galbusera et al., 2019.

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Findings and interpretation based on 13 expert interviews.

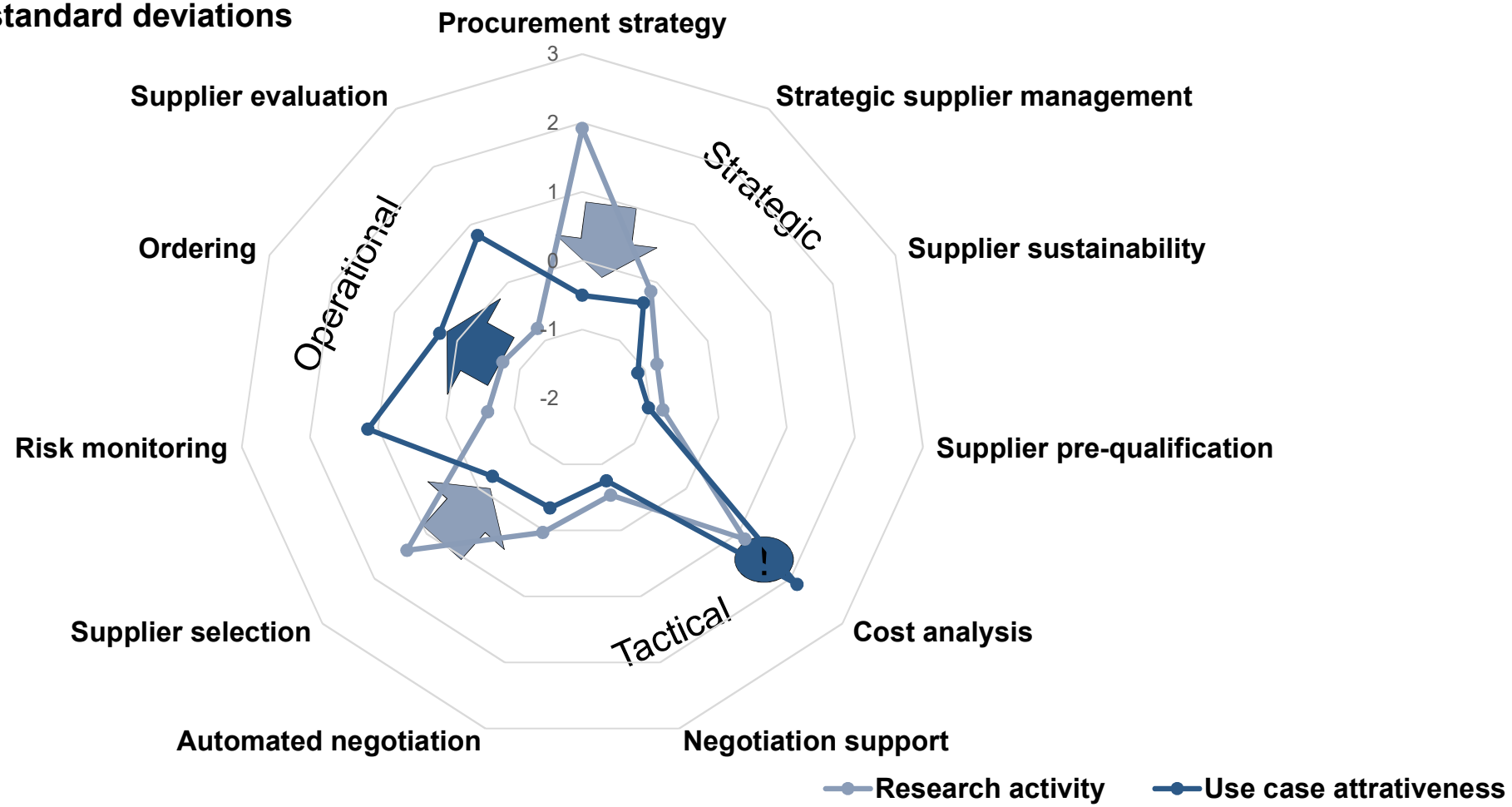
Use Case Cluster	Standard Deviation	Business Value	Financial	Customer	Strategic	Ease of implementation	Input data	Know-how	Change effort
Procurement strategy	1,2	**3,7**	3,6	3,3	4,4	**2,5**	2,6	2,4	2,6
Strategic supplier management	1,0	**3,4**	3,7	3,2	3,4	**2,8**	2,9	2,7	2,9
Supplier sustainability	1,1	**3,3**	2,5	3,4	4,0	**2,6**	2,4	2,6	2,8
Supplier pre-qualification	1,1	**2,8**	2,9	2,7	2,9	**3,1**	3,1	2,9	3,2
Cost analysis	1,1	**3,8**	4,2	3,4	3,7	**3,5**	3,6	3,6	3,3
Negotiation support	1,0	**2,9**	3,3	2,7	2,8	**3,1**	3,1	3,3	2,8
Automated negotiation	1,1	**3,0**	3,6	2,8	2,8	**3,2**	3,5	3,1	3,0
Supplier selection	1,0	**3,6**	4,1	3,0	3,6	**2,7**	2,9	2,7	2,6
Risk monitoring	1,2	**3,7**	3,9	3,7	3,4	**3,2**	3,1	2,9	3,5
Ordering	1,2	**2,9**	2,8	2,9	2,9	**3,6**	3,8	3,4	3,8
Supplier evaluation	1,1	**3,2**	3,1	2,9	3,6	**3,5**	3,4	3,4	3,8
Average	**1,1**	**3,3**	**3,1**	**3,4**	**3,4**	**3,1**	**3,1**	**3,0**	**3,1**

- **Now it the time to act**! However, **in practice**, there any **often proof of concepts only**.
- Strongest **business value** are cost analysis, procurement strategy, and risk monitoring.
- Greatest **ease of implementation** are ordering, cost analysis, and supplier evaluation.
- **Most attractive** use case cluster is **cost analysis** strong business case and ease of implementation
- Current research focus on the tactical level, the **operational level** seems to be a **gap**!
- **Most discussed sustainability** and **automated negotiation,** yet no much different standard deviation.
- Success generally requires **high analytical maturity** not necessarily present in organizations today.

Sources: Gartner (2018).

Comparison of research activity with use case attractiveness.

Normalized in standard deviations



Proposal of research focus areas for AI methods in procurement.

Deemphasize	Extend	Highlight	Some ideas – more to be found in the paper ☺
Procurement strategy Supplier pre-qualification Negotiation support	Strategic supplier management Supplier sustainability Automated negotiation Supplier selection	Cost analysis Risk monitoring Ordering Supplier evaluation	Total cost of ownership Start ups such as riskmethods and Prewave Connecting order and capacity management Quality inspection

Next to meta studies and concrete applications, these research questions may follow:

How does procurement compare with other functional areas, i.e. sales?
How is the adaption different in between different organizational types, sizes, and cultures?
Should procurement organizations primarily build their own applications (make) or use solutions buy?
Which ethical aspects should be considered for AI methods in procurement?
Which regulations should be introduced for AI application in procurement?
Which skill sets are important in management and operations in the future?
What do AI champions differently than others in the application in procurement?
What is the main motivation behind AI application in procurement? And the main results?
What are success factors for AI application in procurement? And potential hurdles?
Which AI and machine learning techniques work the best and why?
…and many more research opportunities→Are you interested in taking up the challenge?!

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Summary of the main findings of the study.

- **Now it the time to act!** However, **in practice**, there any **often proof of concepts only.**
- Few have successfully integrated AI methods into their operations and across their supply chains. This constitutes a **research opportunity** on how **AI can increase the performance of procurement**.
- **174 publications** were identified, described and classified based on the strategic, tactical and operational level of procurement in **11 clusters** and enriched with practical ideas
- Framework combined with the **ACM computing classification system as de-facto standard in information technology**, which seems more clear than the board term big data analytics
- Strongest business value are cost analysis, procurement strategy, and risk monitoring.
- Greatest **ease of implementation** are ordering, cost analysis, and supplier evaluation.
- **Most attractive** use case cluster is **cost analysis** strong business case and ease of implementation where already relatively much interesting research is conducted.
- Current research focus on the tactical level, the **operational level** seems to be a **gap**!
- **Most discussed sustainability** and **automated negotiation,** yet no much different standard deviation.
- Success generally requires **high analytical maturity** not necessarily present in organizations today.

Thanks for your time! The references are summarized below.

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