Methods of AI and ML in procurement

Review, practical application, and future research

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Overview literature review AI and ML methods in procurement.

Background

AI and ML techniques are recently **starting to emerge** in **procurement theory and practice worldwide**.

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

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 **20 expert interviews** conducted to assess the **business value** and the **ease of implementation**.

Results

286 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, guidance for management to implement innovative applications, and highlight further research opportunities.

Sources: ACM, 2012, Chae et al., 2014, Mayring, 2014, Souza, 2014, Nowosel et al., 2015, Bauer et al., 2017, Gunasekaran et al., 2017, Nguyen et al., 2017, Vollmer et al., 2018, Handfield et al., 2019, Balakrishnan et al., 2020.

Other reviews and gaps of AI / ML in supply chain management.

<table>
<tr><th colspan="2" rowspan="2">Classification</th><th colspan="5">SCOR framework</th><th>Other</th></tr>
<tr><th>Plan</th><th>Source</th><th>Make</th><th>Deliver</th><th>Return</th><th>Enable</th></tr>
<tr><td rowspan="3">CCS framework</td><td rowspan="2">AI / ML methods</td><td></td><td>[Strategic, tactical and operational]
Spreitzenbarth et al., 2021
[Solution provider]
Allal-Chérif et al., 2021
Guida et al., 2021
[Models and case studies]
Berrú et al., 2020
Cui et al., 2021
Cavalcante et al., 2019
Schulze-Horn et al., 2020</td><td>For instance
Li et al., 2017</td><td colspan="2">For instance
Woschank et al., 2020</td><td rowspan="3"></td></tr>
<tr><td colspan="5">For instance Brintrup, 2021</td></tr>
<tr><td>Others, e.g. RPA</td><td colspan="5">For instance Gunasekaran et al., 2017, Choi et al., 2018</td></tr>
<tr><td colspan="7">Other</td></tr>
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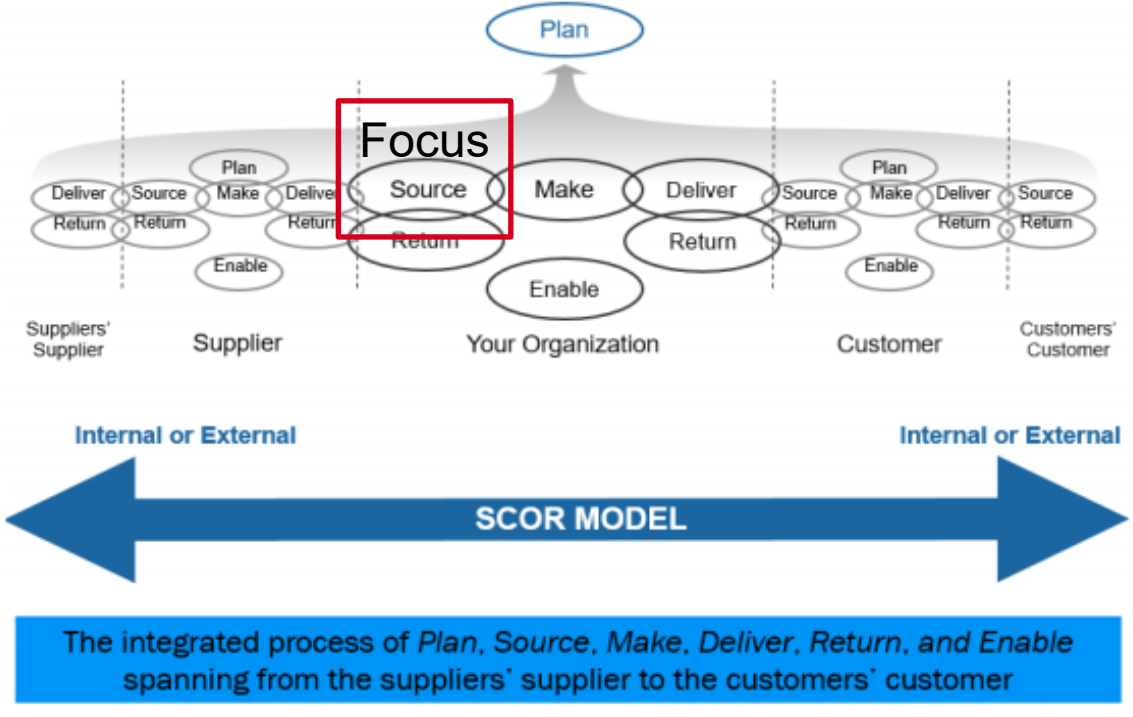
This work contributes to the understanding of AI and ML in operations management from theory and practical insights providing further research directions and provides an overview to supply managers looking for guidance.

Sources: ACM, 2012, APICS Supply Chain Council, 2017. RPA= robotic process automation.

The SCOR framework briefly explained.

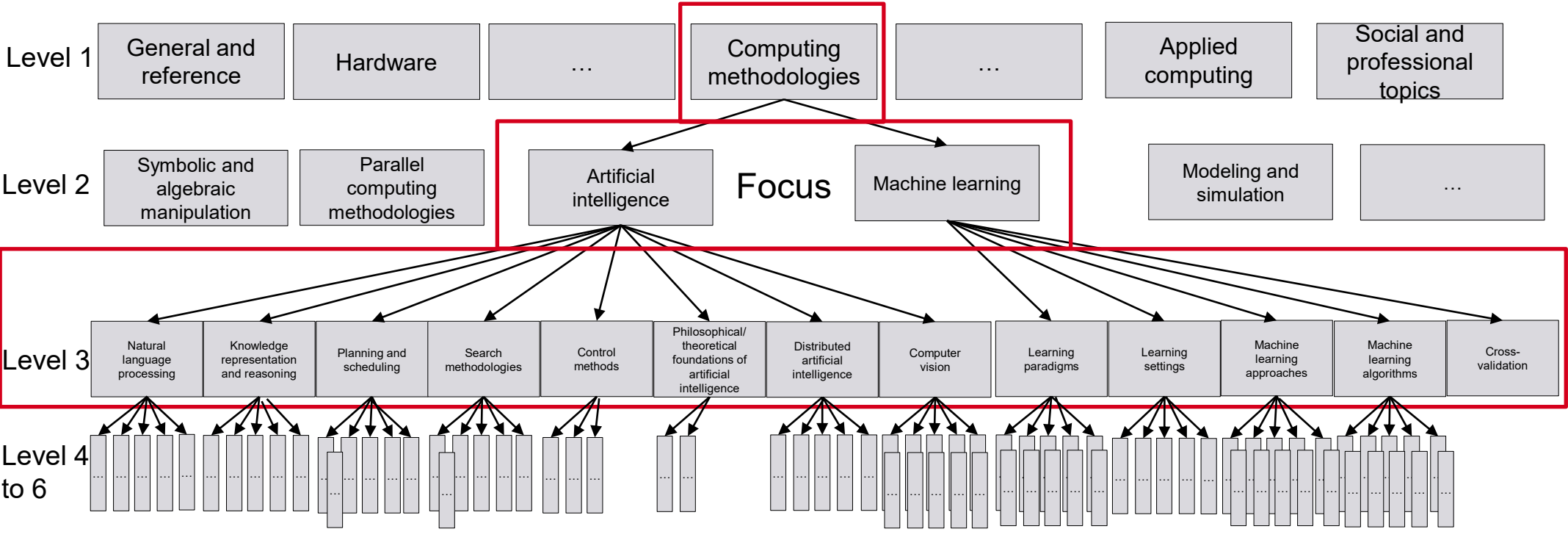
The Supply Chain Operations Reference model (SCOR) provides methodology, diagnostic and benchmarking tools that help organizations make improvements in supply chain processes. This includes downstream and upstream activities in the supply chain network.



Source: APICS Supply Chain Council, 2017 with focus of this review.

The CCS framework briefly explained.

The Computing Classification System (CCS) is a poly-hierarchical ontology that can be utilized in semantic web applications, which is the de facto standard for the computing field.



Source: ACM, 2012.

The ACM framework offer a clear terminology providing clarity.

Findings and interpretation based on 20 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	**3,6**	3,5	3,2	4,1	**2,4**	2,5	2,4	2,5
Strategic supplier management	1,0	**3,5**	3,8	3,2	3,6	**2,8**	2,8	2,8	2,8
Supplier sustainability	1,0	**3,3**	2,7	3,5	3,9	**2,5**	2,5	2,6	2,8
Supplier pre-qualification	1,1	**2,9**	3,1	2,8	3,0	**3,0**	3,0	3,0	3,1
Cost analysis	1,1	**3,7**	4,3	3,4	3,6	**3,6**	3,6	3,5	3,3
Negotiation support	1,1	**3,0**	3,5	2,7	2,9	**3,2**	3,2	3,4	2,8
Automated negotiation	1,1	**3,0**	3,6	2,8	2,6	**3,3**	3,3	2,8	2,9
Supplier selection	1,0	**3,6**	4,0	3,0	3,7	**3,0**	3,0	2,9	2,7
Risk monitoring	1,2	**3,7**	3,9	3,8	3,6	**3,3**	3,3	3,1	3,7
Ordering	1,2	**3,0**	2,9	3,0	3,0	**4,0**	4,0	3,6	3,5
Supplier evaluation	1,1	**3,3**	3,2	3,0	3,7	**3,4**	3,4	3,5	3,7
Average	**1,1**	**3,3**	**3,5**	**3,1**	**3,4**	**3,1**	**3,1**	**3,0**	**3,1**

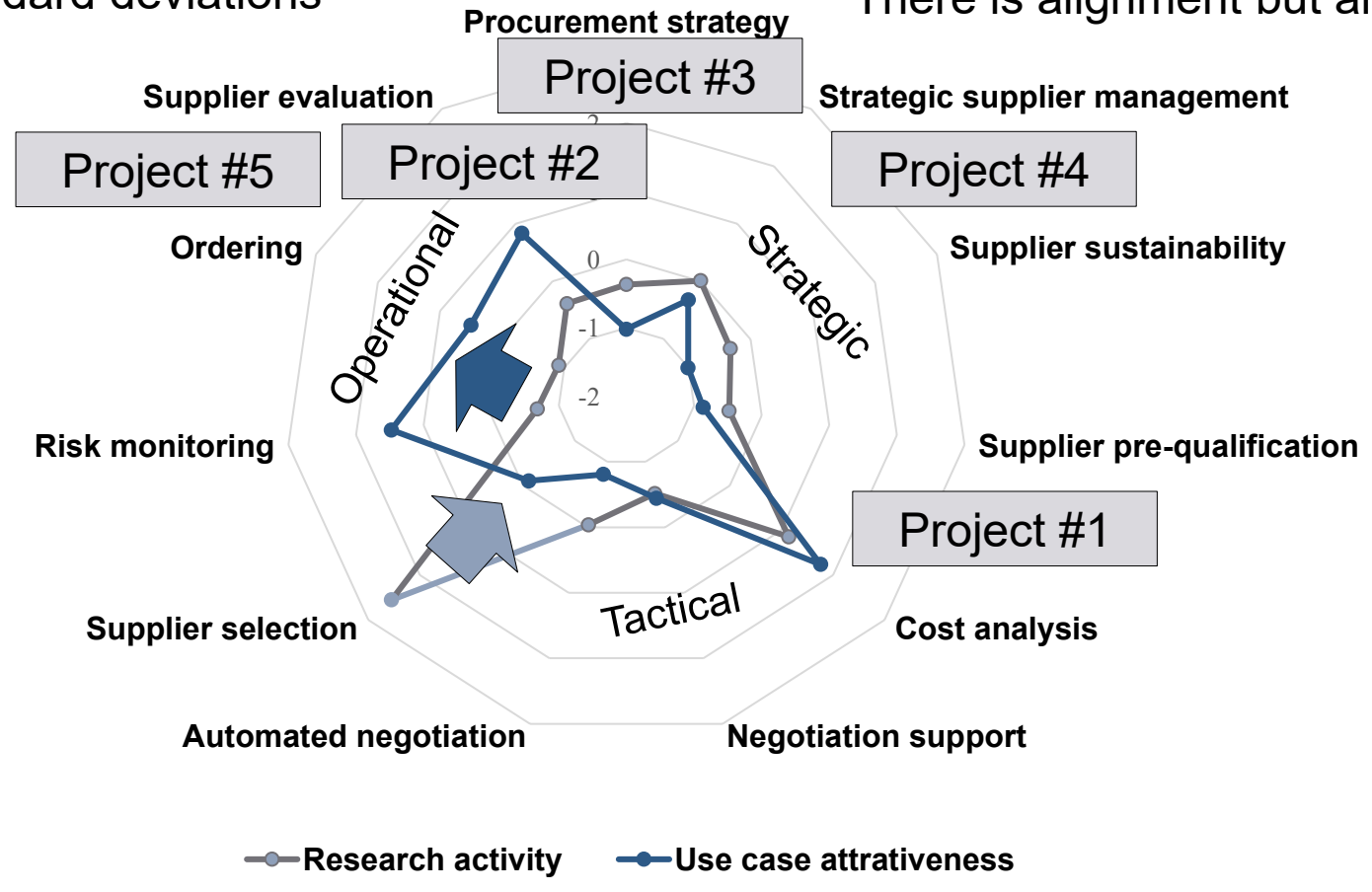
- **Now it the time to act**! However, **in practice**, there any **often proof of concepts only**.
- Strongest **business value** are cost analysis, procurement strategy, and risk monitoring.
- Greatest **ease of implementation** are ordering, cost analysis, and supplier evaluation.
- **Most attractive** 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.

Source: Gartner (2018).

Comparison of research activity with use case attractiveness.

Normalized in standard deviations

There is alignment but also mismatch



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	Total cost of ownership
		Risk monitoring	Start ups such as riskmethods and Prewave
		Ordering	Connecting order and capacity management
		Supplier evaluation	Quality inspection

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

- How does procurement compare with other functional areas, i.e., the negotiation partners in sales and marketing functions, and why?
- How can supply chain integration be supported by AI and ML technologies?
- Which ethical aspects should be considered for AI and ML methods in procurement?
- Which regulations should be introduced regarding procuring AI and ML technologies and in terms of applications in procurement organizations?
- What is the impact of AI and ML usage on business performance in supply management?

…and many more research opportunities→Are you interested in taking up the challenge?!

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**.
- **286 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 combines the SCOR model 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,** which a strong difference in options.
- Successful practical implementation requires **high analytical maturity** not necessarily present today.

Thanks for your time! The references are summarized below.

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