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Machine Learning in Production Planning and Control: A Literature Review

Juan Pablo Usuga Cadavid: juan_pablo.usuga_cadavid@ensam.eu

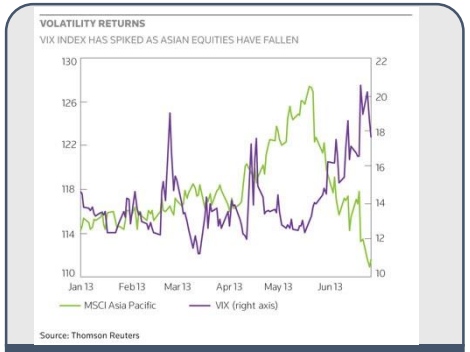
Samir Lamouri: samir.lamouri@ensam.eu

Bernard Grabot: bernard.grabot@enit.fr

Arnaud Fortin: a.fortin@ifakt.com

Production Planning & Control (PPC), context in Industry 4.0

Manufacturing context:



Volatile Markets

Mass Customization

Demanding Delivery Dates

→ Edge over competitors

→ Cost killer

- 67% of the companies from high-wages countries claim that the adherence to the delivery dates is their main logistical target
- They struggle to achieve that due to machine failures, missing raw materials or short-term customer changes
- Prerrequisite to reach logistical targets → Excellent PPC processes

(Reuter *et al.*, 2016)

Production Planning & Control, challenges in Industry 4.0

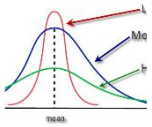
Production Planning & Control (PPC)

Enablers

- High volume of data: 1000 Exabytes per year (Tao et al., 2018)
- More powerful processors
- Internet of Things systems and faster internet connexion

Inhibitors

- Machine breakdowns



- Variable production times

- Changes in customer orders

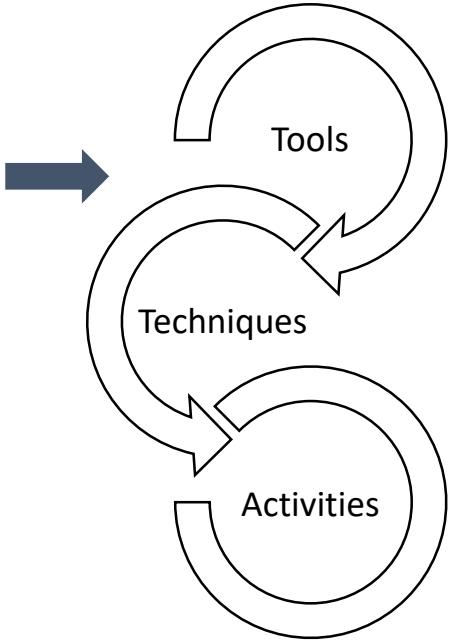
Unfeasible PPC in the execution phase

Need of a more robust PPC

Research objectives (1/2): how to implement ML-aided PPC

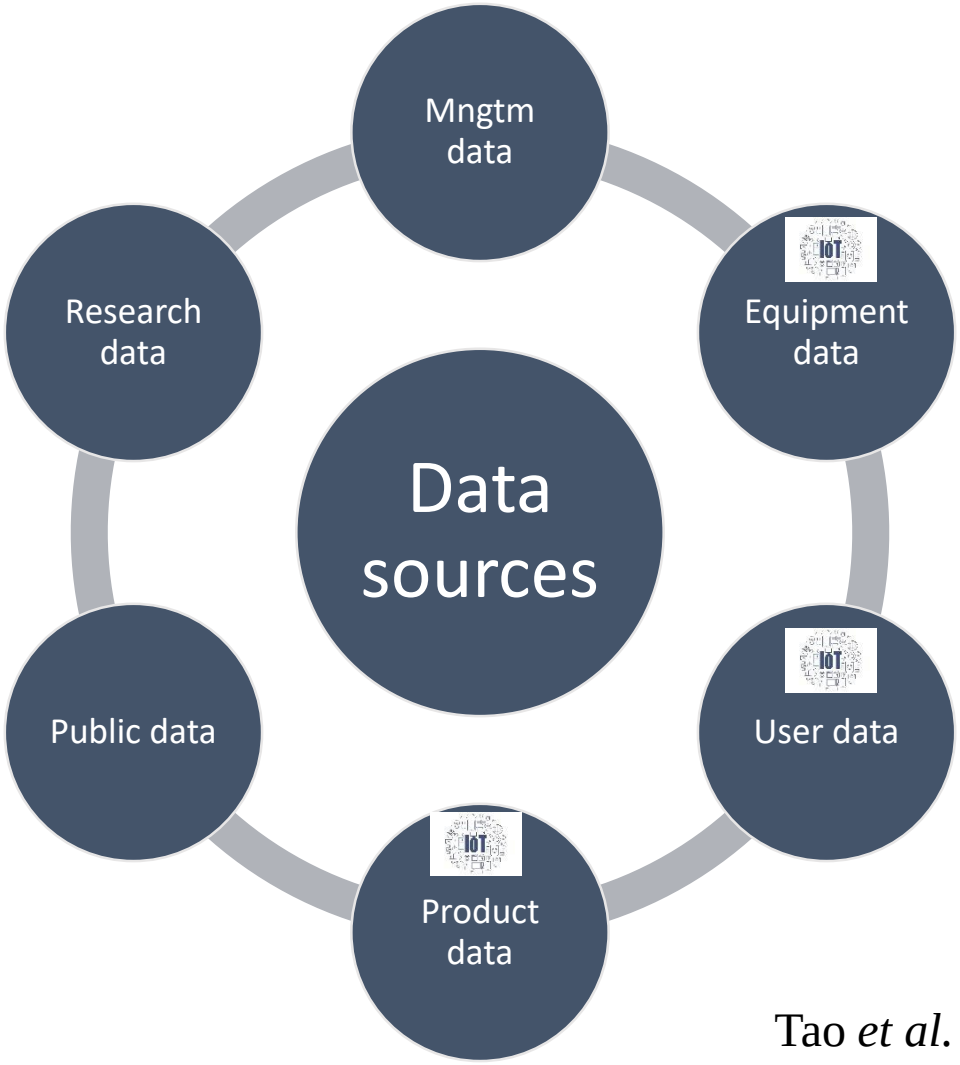
Mandatory Elements of a Method (Zellner, 2011)

- Procedure
- Techniques
- Results
- Roles
- Information Model



Which are the activities, techniques and tools used to deploy ML-aided PPC?

Research objectives (2/2): where to find the data?



Tao *et al.* (2018)

Which are the commonly used data sources when implementing a ML-aided PPC?

Literature review methodology

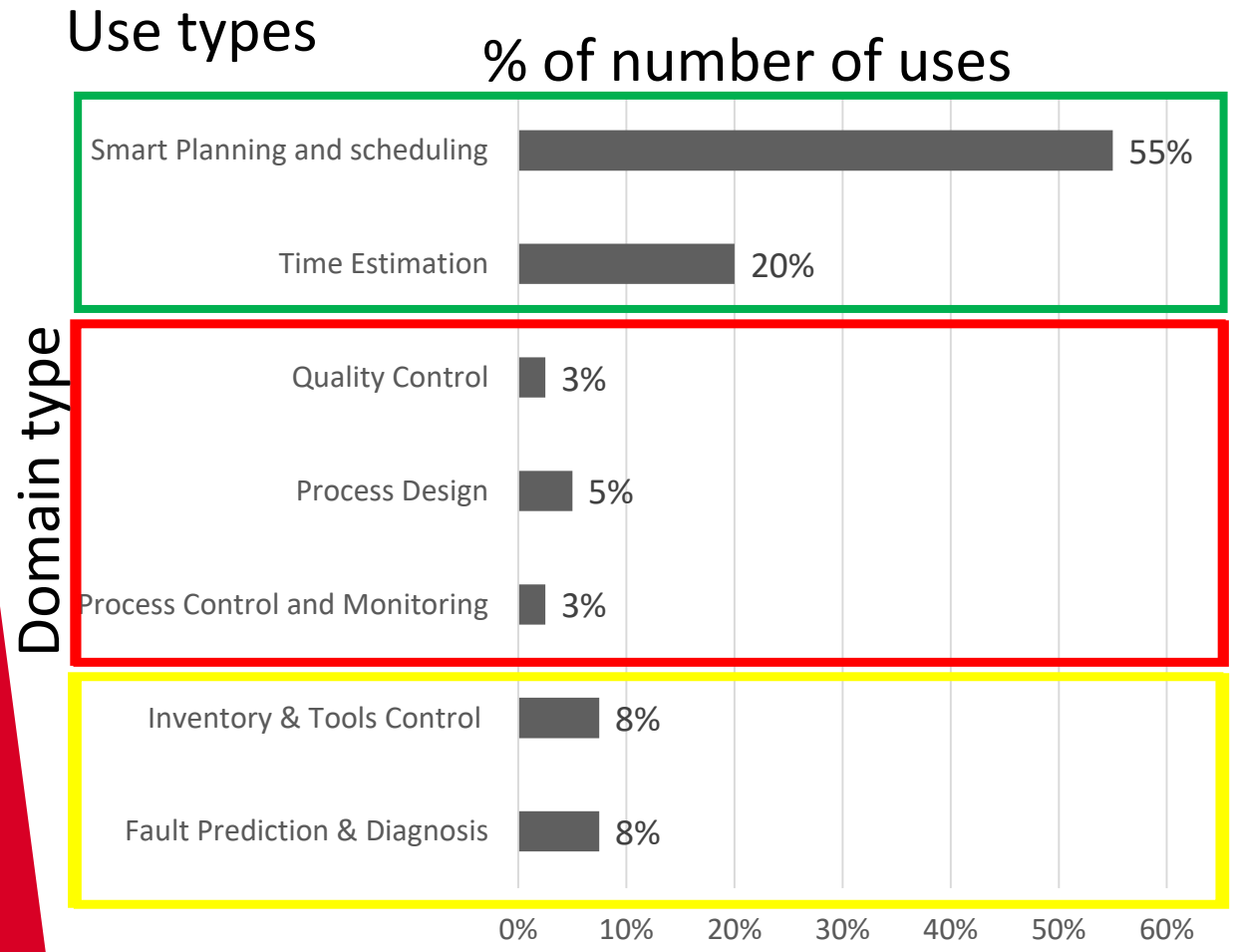
Used keywords

("Deep Learning" OR "Machine Learning") AND
- ("Production scheduling")
- ("Production control")
- (“Line Balancing”)
- (“Production Planning”)

Results

Step	Science Direct	SCOPUS	Kept Articles	Excluded
First results	1538	611	2149	0
Year >= 2011	761	356	1117	1032
Only "Research Articles" (Science Direct) "Conference Paper OR Article" (SCOPUS)	606	299	905	212
Title and Abstract Review	46	24	70	835
Duplicates removal	32	15	47	23
Full text analysis: short list	27	13	40	7

Results (1/5): use types overview

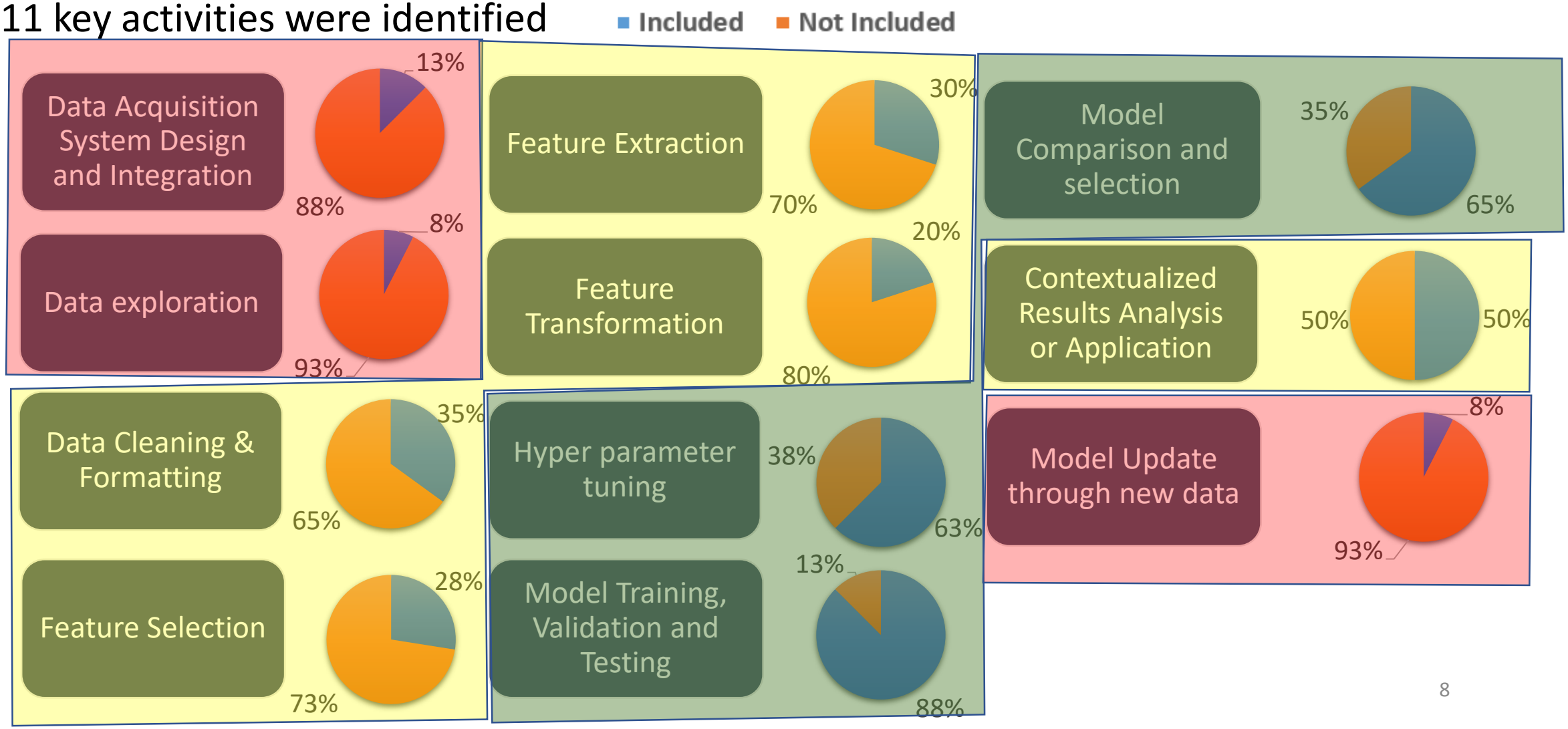


Most recurrent domains to perform PPC with ML

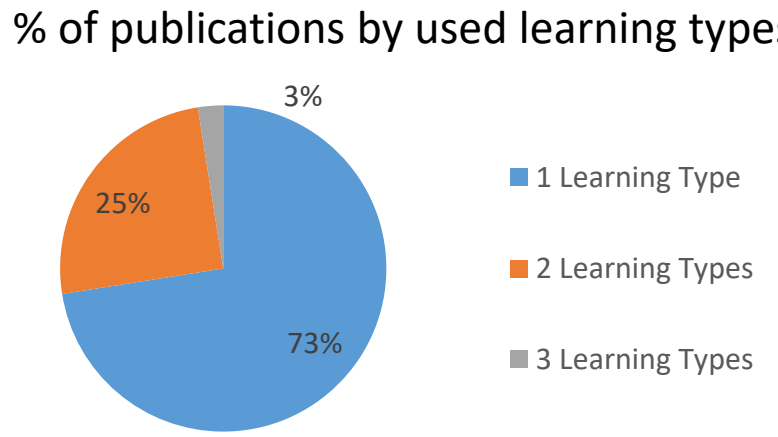
Scarce results coupling these domains with ML-aided PPC

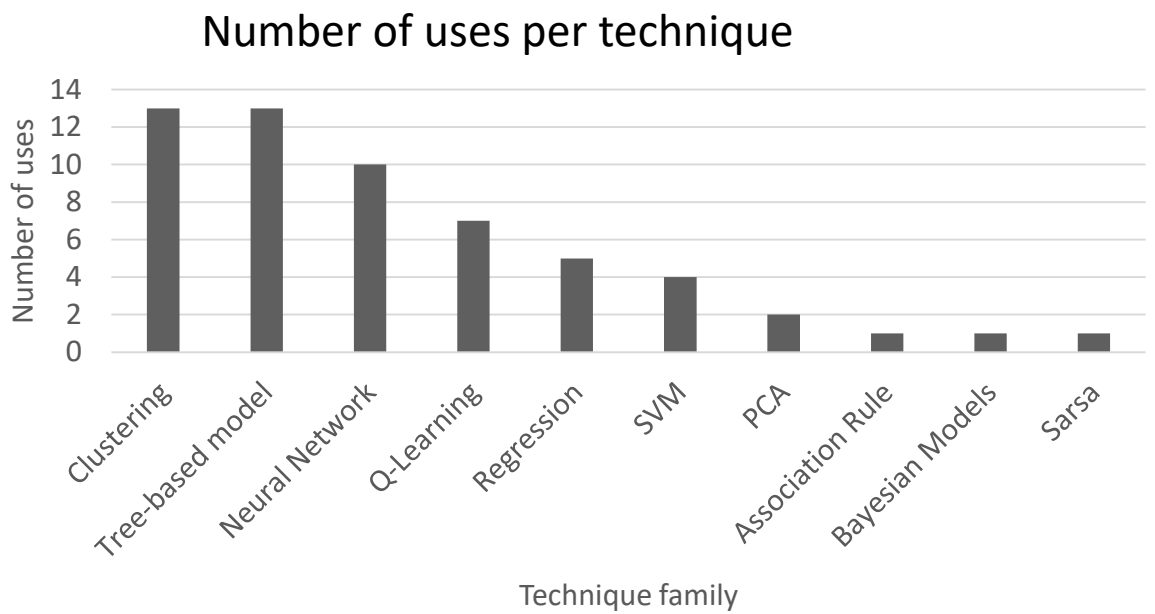
Results (2/5): activities

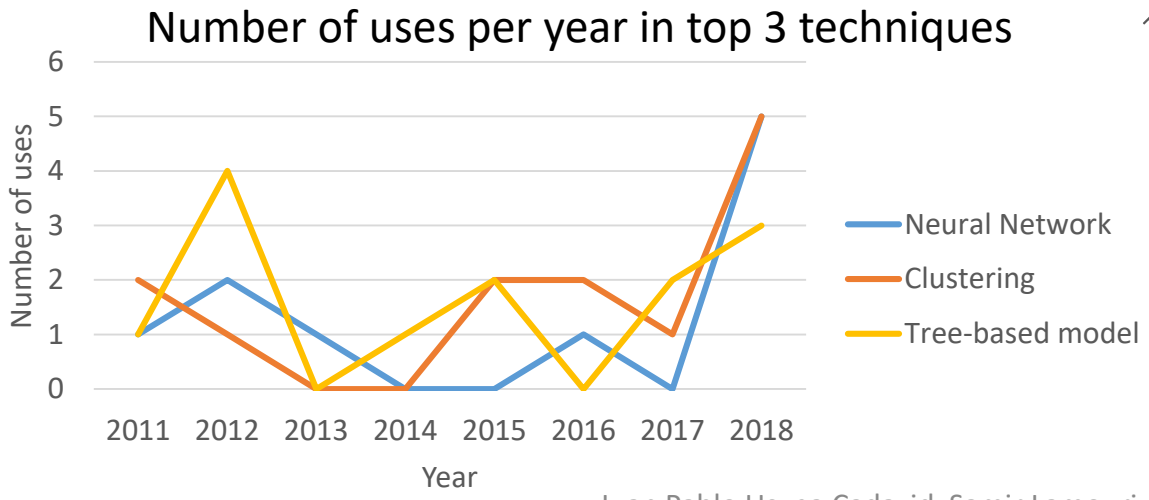
11 key activities were identified



Results (3/5): techniques

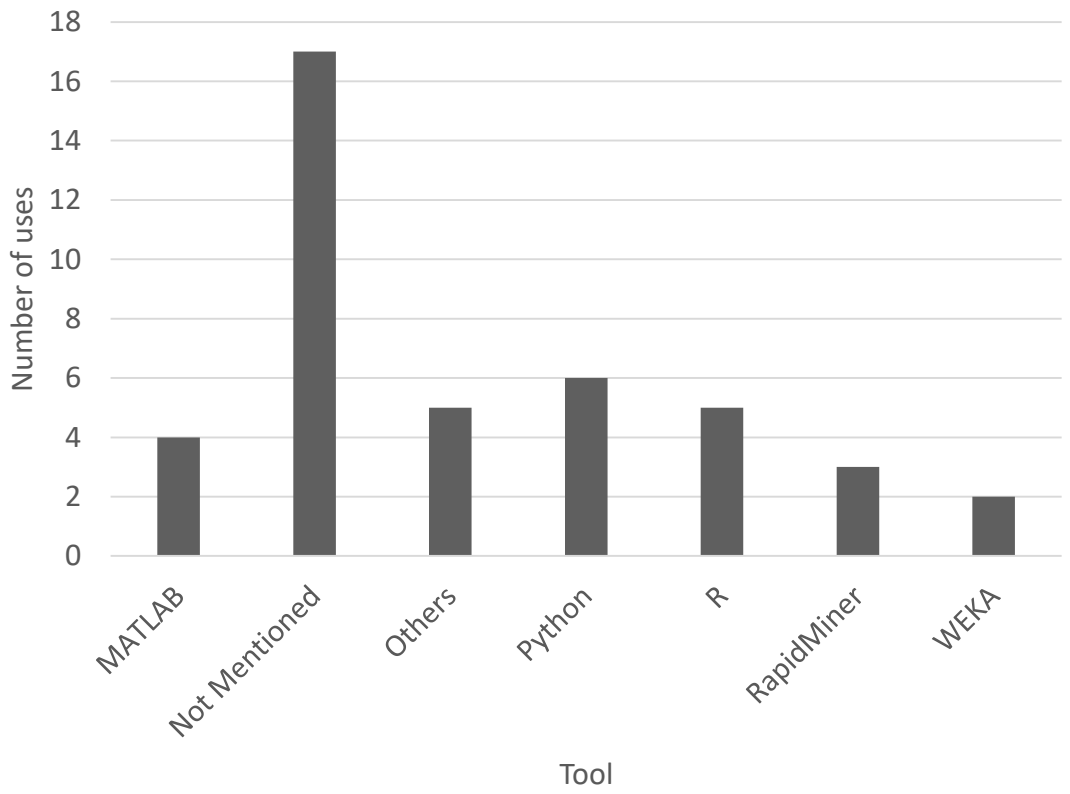




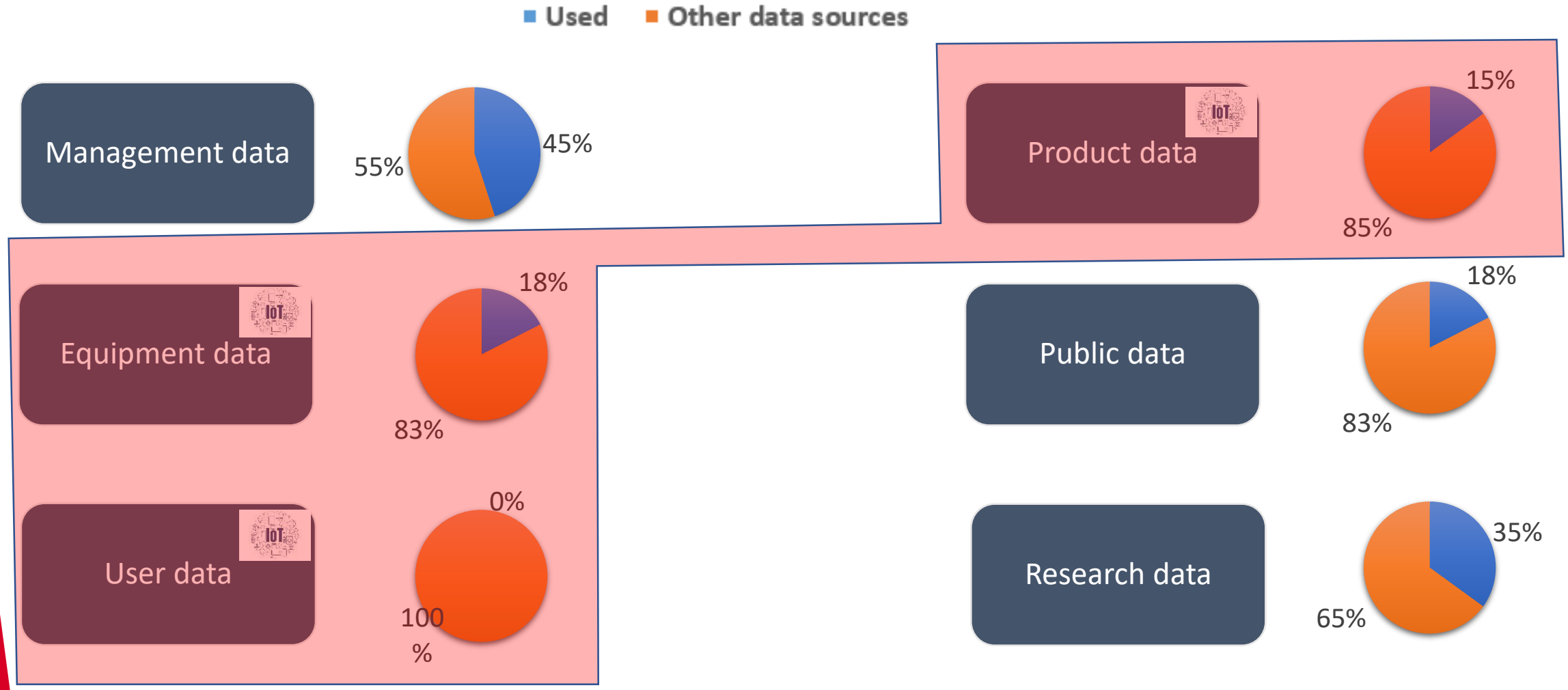


Results (4/5): tools

Tools	Number of uses
Not Mentioned	17
R	5
MATLAB	4
Python	3
RapidMiner	3
Tensorflow (Python based)	2
WEKA	2
ACE Datamining System	1
Clementine	1
Keras (Python based)	1
Neural-SIM	1
Visual C++	1
Xelopes Library	1



Results (5/5): Data source utilization



Further research

- Develop a Robust Procedure to implement ML-aided PPC → Give an order to different activities
- Link techniques and tools to activities (set the basis to an Information Model)
- Test both previous points with an application

Questions?

References

- Tao, F. *et al.* (2018) 'Data-driven smart manufacturing', *Journal of Manufacturing Systems*. The Society of Manufacturing Engineers, 48, pp. 157–169. doi: 10.1016/j.jmsy.2018.01.006.
- Reuter, C. *et al.* (2016) 'Improving Data Consistency in Production Control by Adaptation of Data Mining Algorithms', *Procedia CIRP*. The Author(s), 56, pp. 545–550. doi: 10.1016/j.procir.2016.10.107.