Artificial Intelligence and Public Procurement – Deciphering the Interdisciplinary Perspectives of the Literature[*]

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ABSTRACT This article performs a literature review on the topic of public procurement and artificial intelligence. It critically analyses a growing body of literature, examines current theories and research trends, identifies research gaps and highlights potential paths for future exploration. The interdisciplinary corpus of literature consists of fifty-seven articles, book chapters and conference papers that blend technology, law and management perspectives. The analysis highlights that future research into public-procurement digitalisation should organically integrate policy, management and technological aspects, with data management as core point.

1. *Introduction*

The aim of this article is to critically present the current state of the literature concerning the relationship between artificial intelligence and public procurement. It excludes research that focuses exclusively on the private-supply chain and does not refer to one jurisdiction in particular.

One simple search into the literature will reveal a multitude of definitions for the concept of 'artificial intelligence', such as the one offered in the Artificial Intelligence for Europe Communication from the Commission: 'Artificial intelligence (AI) refers to systems that display intelligent behavior by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals'.[1] The OECD defines artificial intelligence as a 'machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments'.[2] According to the AI Act, an 'AI system is a machine-based system designed to operate with varying levels of autonomy and that may exhibit adaptiveness after deployment and that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments'.[3]

The topic of artificial intelligence (and digitalisation, in general) in EU trade is of high interest for many stakeholders, such as governments, policymakers, members of the industries or citizens. This is proved by a growing body of literature, coupled with an abundance of policy and ethics recommendations for the use of AI. The EU alone has published several relevant documents, in the form of strategies,[4] white papers,[5] communications[6] that are frequently

[1] EC, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions on Artificial Intelligence for Europe, COM (2018) 237 final, 2018, 1.

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[2] OECD, *Recommendation of the Council on Artificial Intelligence*, OECD/LEGAL/0449, 2023, 7.
[3] EC, Proposal for a Regulation of the European Parliament and of the Council laying down harmonised rules on artificial intelligence (Artificial Intelligence Act) and amending certain union legislative acts, Final draft 2024, online: https://artificialintelligenceact.eu/the-act, Article 2 (5g)1.
[4] EC, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, *A European strategy for data*, COM/2020/66 final, 2020.
[5] EC, *White Paper On Artificial Intelligence - A Euro-*

precursors of various recommendations,[7] guidelines,[8] model clauses[9] or acts[10] etc. If one looks for AI-policy related documents, the search will return a remarkable number of results, that are difficult to keep up with.

Foreseeably, the literature keeps up with this exponential trend, with many articles published on the topic in the recent years, including a branch of publications that revolve around public procurement and artificial intelligence. With a continuous increase in interest and research towards artificial intelligence and public procurement, there is currently no dedicated comprehensive literature review, that would take in the various interdisciplinary contributions to the topic. This article aims to fill in this gap, identify shared ideas and contradictions within the literature, pinpoint research gaps and suggest further research topics.

The article is structured as follows: Part 2 presents the method used to perform the literature review, Part 3 describes the main findings from the literature, while Part 4 formulates concluding remarks and further research paths.

2. *Method*

This research performed a literature review on the topic of artificial intelligence and public procurement, following the method of the comprehensive-literature review.[11] Two research databases were used to select the corpus, namely *Scopus* and *Web of Science*. The keywords and Boolean operators[12] used to perform the search were <artificial intelligence> (AND) <public procurement>. Only articles in English were researched. Several articles were considered irrelevant and thus excluded: articles that did not regard public procurement (for example, they only regarded the private-supply chain) or articles that only briefly touched the topic of artificial intelligence were excluded. Moreover, the article did not use <government acquisition> or <government contract> as search terms, which could have brought up more literature from the USA. Finally, the corpus is made up of articles, book sections or conference papers and does not analyse blog entries.

The initial search in *Scopus* found 88 documents, while the initial search on *Web of Science* rendered 56 documents. The duplicates and the irrelevant articles were excluded. Other relevant pieces of research that did not come up in the two databases were added to the corpus. The added contributions were selected based on the following criteria: research cited by other articles from the corpus, written by reference authors on the topic, that add to the current debates on artificial intelligence and public procurement. The final number of articles to be examined was 57.

During the review of the literature, the following questions were answered:
- What are the main concepts of the article?
- What are the main ideas and argument of the article?
- What is the main perspective of the article (e.g.: legal, technical, managerial, etc.)?
- What are the research methods employed?

For the text analysis and coding, this research employed the NVivo tool,[13] in correlation with the Zotero reference manager. NVivo performed several text analyses and generated graphs that will be featured in this article. Moreover, while reading the articles, each article was manually coded in NVivo

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pean approach to excellence and trust, COM (2020) 65 final, 2020.

[6] EC, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Building Trust in Human Centric Artificial Intelligence, COM (2019)168 final, 2019.

[7] Independent High-Level Expert Group on Artificial Intelligence (AI HLEG) set up by the EC, *Sectoral Considerations on the Policy and Investment Recommendations for Trustworthy Aim*, 2019, online: https://futurium.ec.europa.eu/en/european-ai-alliance/document/ai-hleg-sectoral-considerations-policy-and-investment-recommendations-trustworthy-ai.

[8] Independent High-Level Expert Group on Artificial Intelligence (AI HLEG) set up by the EC, *Ethics guidelines for trustworthy AI*, 2019, online: https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai.

[9] EC, Public Buyers Community, *Proposal for standard contractual clauses for the procurement of Artificial Intelligence (AI) by public organisations*, Draft version 2023, online: https://public-buyers-community.ec.europa.eu/communities/procurement-ai/resources/eu-model-contractual-ai-clauses-pilot-procurements-ai.

[10] For example, the EU AI Act.

[11] A. Fink, *Conducting Research Literature Reviews, SAGE Publications Inc*, Los Angeles, 2019.

[12] According to MIT Libraries, *Database Search Tips: Boolean operators*, https://libguides.mit.edu/c.php?g=175963&p=1158594, online: 'Boolean operators form the basis of mathematical sets and database logic. They connect your search words together to either narrow or broaden your set of results. The three basic boolean operators are: AND, OR, and NOT.'

[13] Learn more: NVivo webpage, 'About NVivo', online: https://help-nv.qsrinternational.com/20/win/Content/about-nvivo/about-nvivo.htm.

according to its content. The codes represent common themes and key concepts discussed throughout the articles, such as:
- a prototype for a tool to be used in public procurement
- corruption issues in public procurement
- tech skills of public servants
- sustainability in public procurement
- presentation of a case study or a particular example
- focus on one jurisdiction
- focus on one industry
- the concept of data analysis.

3. *Main findings from the literature*

3.1. *General description of the corpus*

3.1.1. *Chronological distribution and reference type*

Chronologically, the first article in the corpus concerning AI and public procurement was published in 2010 and the most recent one in 2023. The interest for the topic peaked in 2022, with 13 articles selected for the analysis. It is also possible that 2023 will surpass 2022 in terms of number of papers published, but, as this analysis was carried out in the beginning of November 2023, there was still some time left for research to be put out.
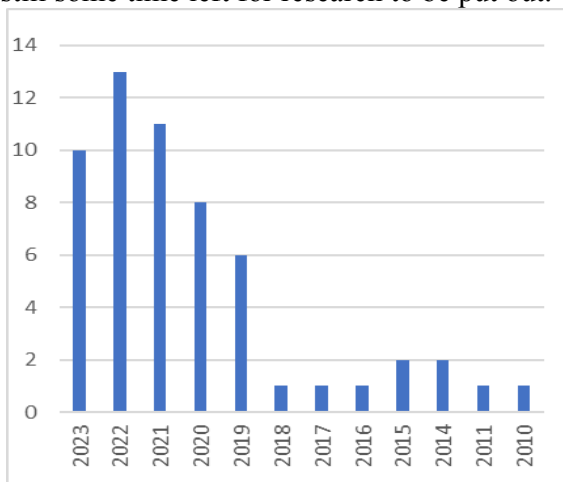
Fig. 1: Chronological description of the corpus

Concerning the distribution per authors, few of them wrote more than one article. This indicates that while there is a growing interest on the subject, there are few specialized researchers on the topic. Sanchez-Graells published the highest number of papers included in this analysis – 6 articles and a monograph on the topic of digital technologies and public procurement. Among the authors that wrote more than one paper on the topic are: Coglianese, García Rodríguez and Mittal.
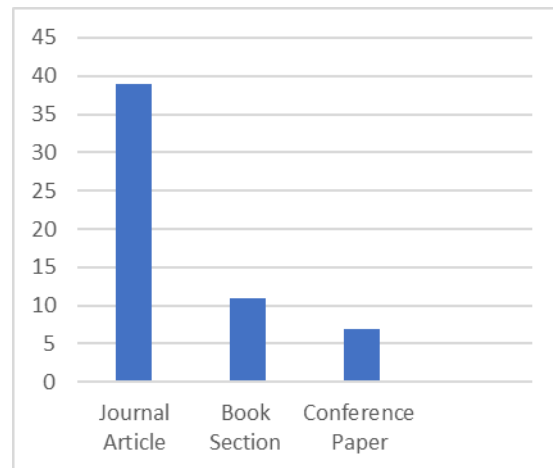
Fig. 2: Reference types from the corpus

When it comes to the type of reference, 39 were articles, 11 were book sections (or, in the case of Sanchez-Graells' monograph,[14] an integral book), while 7 were conference papers.

3.1.2. *Thematic analysis of the corpus*

When it comes to the relationship between artificial intelligence and public procurement, one can identify two perspectives, or branches of research, that are both present in the corpus:
- Buying artificial intelligence through public procurement and
- Using artificial intelligence in the public-procurement process, so as to manage it.

Beyond this classification, the corpus of literature is profoundly interdisciplinary. The main disciplines are: technology, law and policy, and management. While some articles from the corpus focus more on one perspective, some combine two or even three disciplines in their research.

Several other clusters can be observed in the corpus:
- articles that focus on one jurisdiction (Ecuador,[15] Pakistan,[16] Spain,[17] Portugal[18]),

[14] A. Sanchez-Graells, *Digital Technologies and Public Procurement: Gatekeeping and Experimentation in Digital Public Governance*, Oxford University Press, Oxford, 2024.

[15] Y. Torres-Berru, V. F. Lopez-Batista and L. Conde Zhingre, *A Data Mining Approach to Detecting Bias and Favoritism in Public Procurement*, in *Intelligent Automation & Soft Computing*, vol. 36, no. 3, 2023; Vv.Aa., *Application of Explainable Artificial Intelligence to Analyze Basic Features of a Tender*, 3rd International Conference on Electrical, Computer, Communications and Mechatronics Engineering (ICECCME), IEEE, 2023.

[16] Vv.Aa., *A Hybrid Multi-Criteria Approach for Evalu-*

and
- articles that focus on one industry (avionics industry,[19] construction,[20] public transport,[21] health system[22]).

3.2. *Main characterisation of the corpus*

The following section will analyse the common ideas and trends in the corpus of literature. It will attempt to highlight scholarship and describe its articulation. The analysis starts with the literature that is mainly technical, followed by managerial approaches, and finally, law and policy perspectives. It is important to note that, as discussed *supra*, most, if not all of these articles, combine more than one perspective, while keeping a main guiding approach.

3.2.1. *Tech perspective*

The tech-centred literature is dominated by a recurring approach – that of a prototype – a model that would automatise one or multiple stages of the public-procurement process. The following paragraphs summarise the main models discussed and their impact on the public-procurement process. This section does not discuss the feasibility of these models, nor performs a costs-benefits analysis.

Several authors suggest that AI could be used in the selection stage of public procurement.[23] For example, García

Rodríguez and others propose an algorithm that would 'recommend potential bidders' to the contracting authority.[24] They present this system using data from Spain and advance both the advantages and the limitations of their prototype. While this could enhance the efficiency of the public procurement process, it also holds its limitations. For example, the system makes recommendations based on previous behaviours – it assumes that economic operators will reiterate their previous actions, yet this could not always be the case.[25]

Other authors propose that AI be used to analyse procurement documents, such as tenders,[26] various documents along the procurement 'pipeline',[27] contract notices[28] or public-procurement case law.[29] When it comes to the technical tools used, they refer to: machine-learning algorithms,[30] natural-language processing,[31] text analysis tools,[32] or 'semantic-based methods'.[33] Moreover, some authors believe artificial intelligence could be used to predict or estimate 'the award (…) price' of the procurement, using machine learning.[34]

Many authors argue that artificial intelligence could be used to identify corruption in public procurement. Machine learning is often mentioned as a suitable tool for detecting corruption in public procurement. One article tests 11 machine-

ation and Selection of Sustainable Suppliers in the Avionics Industry of Pakistan, in *Sustainability*, vol. 12(11), 2020, 4744.

[17] Vv.Aa., *Public Procurement Announcements in Spain: Regulations, Data Analysis, and Award Price Estimator Using Machine Learning*, in *Complexity*, vol. 1, 2019, 2360610.

[18] L.J. De Sousa, J.P. Martins and L. Sanhudo, *Portuguese Public Procurement Data for Construction (2015–2022)*, in *Data in Brief*, vol. 48, 2023, 109063.

[19] Vv.Aa., *A Hybrid Multi-Criteria Approach*.

[20] B. Mohamed and O. Moselhi, *Conceptual Estimation of Construction Duration and Cost of Public Highway Projects*, in *Journal of Information Technology in Construction*, vol. 27, 2022; Vv.Aa., *Optimized Artificial Intelligence Models for Predicting Project Award Price*, in *Automation in Construction*, vol. 54, 2015.

[21] K.D. Solihati and D. Indriyani, *Managing Artificial Intelligence on Public Transportation (Case Study Jakarta City, Indonesia)*, in *IOP Conference Series: Earth and Environmental Science 012021*, 717, 2021.

[22] Vv.Aa., *Health Information Technology and Digital Innovation for National Learning Health and Care Systems*, in *The Lancet Digital Health*, vol. 3, 2021.

[23] Vv.Aa., *A Hybrid Multi-Criteria Approach*; Vv.Aa., *Bidders Recommender for Public Procurement Auctions Using Machine Learning: Data Analysis, Algorithm, and Case Study with Tenders from Spain*, in *Complexity*, vol. 1, 2020, 8858258.

[24] *Ibidem*, 17.

[25] *Ibidem*, 17.

[26] Vv.Aa., *Application of Explainable Artificial Intelligence*.

[27] Vv.Aa., *Chinese Public Procurement Document Harvesting Pipeline*, in *Proceedings of the 22nd ACM Symposium on Document Engineering*, ACM, 2022.

[28] Vv.Aa., *Query Expansion Methods and Performance Evaluation for Reusing Linking Open Data of the European Public Procurement Notices*, in *Advances in Artificial Intelligence*, CAEPIA 2011, LNAI 7023, J.A. Lozano, J.A. Gámez and J. A. Moreno (eds.), Berlin Heidelberg, Springer, 2011.

[29] M. Jungiewicz and M. Łopuszyński, *Unsupervised Keyword Extraction from Polish Legal Texts*, in *Advances in Natural Language Processing*, vol 8686, A. Przepiórkowski and M. Ogrodniczuk (eds), Cham, Springer, 2014, accessed on arXiv:1408.3731v2.

[30] Vv.Aa., *Application of Explainable Artificial Intelligence*.

[31] Vv.aa., *Chinese Public Procurement*.

[32] M. Jungiewicz and M. Łopuszyński, *Unsupervised Keyword Extraction*, 1-2.

[33] Vv.Aa., *Query Expansion Methods and Performance Evaluation*, 495.

[34] Vv.Aa., *Award Price Estimator for Public Procurement Auctions Using Machine Learning Algorithms: Case Study with Tenders from Spain*, in *Studies in Informatics and Control*, vol. 30, 2021, 69.

learning algorithms on datasets from 5 countries around the world to identify the best one to pinpoint corruption.[35] Others present an artificial-intelligence tool they developed and that is meant to identify corruption.[36] The link between artificial intelligence and corruption in procurement is so prominent in the research field, that there is even a literature review paper dedicated to it (the article refers both to private and public procurement).[37]

Data is another key concept often represented in the selected corpus. Data represent 'an abstraction of a real-world entity (person, object or event)',[38] while data analysis refers to 'any process for extracting useful information from data'.[39] Data are an essential point in the digitalisation of public procurement, as they can bridge the gap between the current e-procurement system and the use of artificial intelligence.[40] The selection of articles captures the most important concepts, research trends and theories when it comes to data in public procurement: open data, data issues and data management.

Several articles from the corpus bring up the concept of open data.[41] Open data are 'data

that anyone can access, use and share'.[42] Two articles from the corpus discuss the once-only principle,[43] relevant in the context of interoperability of systems, while another older article explores the interoperability of the Virtual Company Dossier.[44]

The first article from the corpus to tackle data management in public procurement was published in 2014 and talks about 'Knowledge Management Applied to Electronic Public Procurement'.[45] Following this article, multiple authors explore the idea of data structures and their importance for implementing artificial intelligence, that could serve for predictions[46] or decision-making[47]

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[35] Vv.Aa., *Collusion Detection in Public Procurement Auctions with Machine Learning Algorithms*, in *Automation in Construction*, vol. 133, 104047, 2022.

[36] Vv.Aa., *Robust System for Identifying Procurement Fraud*, in *Proceedings of the AAAI Conference on Artificial Intelligence*, 29(2), 2015; N. Goryunova, A. Baklanov and E. Ianovski, *A Noisy-Labels Approach to Detecting Uncompetitive Auctions*, in *Machine Learning, Optimization, and Data Science LOD 2021*, vol. 13163, Vv.Aa. (eds.), Cham, Springer, 2022; M.E. Kehler Niessen, J. M. Paciello and J.I. Pane Fernandez, *Anomaly Detection in Public Procurements Using the Open Contracting Data Standard*, in *Seventh International Conference on eDemocracy & eGovernment (ICEDEG)*, IEEE, Buenos Aires, Argentina, 2020; Y. Torres-Berru, V.F. Lopez-Batista and L. Conde Zhingre, *A Data Mining Approach*; Vv.Aa., *A Decision Support System for Fraud Detection in Public Procurement*, in *International Transactions in Operational Research*, vol. 28, 2021.

[37] Vv.Aa., *Artificial Intelligence Techniques to Detect and Prevent Corruption in Procurement: A Systematic Literature Review* in *Applied Technologies ICAT 2019*, Vv.Aa. (eds.), Springer, Cham, 2020.

[38] J.D Kelleher and B. Tierney, *Data Science*, Illustrated edition, The MIT Press, Cambridge, 2018, 39.

[39] *Ibidem*, 240.

[40] See: A. Sanchez-Graells, *Digital Technologies and Public Procurement*, 126 et seq., 176 et seq.; N. Sava, *The eForms Regulation and Sustainable Public Procurement Data Collection*, in *European Procurement & Public Private Partnership Law Review*, vol. 18, 2023, 178.

[41] Vv.Aa., *The eLOD Ontology: Modeling Economic Open Data*, presented at 12th IFIP International

Conference on Artificial Intelligence Applications and Innovations (AIAI), Thessaloniki, 2016; Vv.Aa., *A Data-Driven Model for Linking Open Economic Information*, *Internet* Science *INSCI 2017*, *Lecture Notes in Computer Science*, vol. 10673, Vv.Aa. (eds.), Cham, Springer, 2017.

[42] Data Europa EU, *What is open data?*, online: https://data.europa.eu/elearning/en/module1/#/id/co-01.

[43] S. Mamrot and K. Rzyszczak, *Implementation of the 'Once-Only' Principle in Europe – National Approach*, in *The Once-Only Principle. Lecture Notes in Computer Science*, R. Krimmer, A. Prentza and S. Mamrot (eds.), vol. 12621, Springer, Cham, 2021; F. Gorgerino, *Legal Basis and Regulatory Applications of the Once-Only Principle: The Italian Case* in *The Once-Only Principle*, in *The Once-Only Principle. Lecture Notes in Computer Science*, R. Krimmer, A. Prentza and S. Mamrot (eds.), vol. 12621, Springer, Cham, 2021. According to the European Commission, EC, *The Once Only Principle System: A breakthrough for the EU's Digital Single Market*, online: https://commission.europa.eu/news/once-only-principle-system-breakthrough-eus-digital-single-market-2020-11-05_en, the once-only principle refers to the fact that 'citizens and businesses will provide their data only once to public administrations, which will store, secure and reuse them following one of the world's strictest data protection law'.

[44] A. Mondorf and M.A. Wimmer, *The European VCD System: Facilitating Public Procurement through Criteria-to-Evidence Mapping*, in *What Kind of Information Society? Governance, Virtuality, Surveillance, Sustainability, Resilience*, vol. 328, J. Berleur, M.D. Hercheui and L.M. Hilty (eds.), Berlin Heidelberg, Springer 2010.

[45] H. Lindskog and E. Mercier-Laurent, *Knowledge Management Applied to Electronic Public Procurement* in E. Mercier-Laurent and D. Boulanger (eds.), *Artificial Intelligence for Knowledge Management, AI4KM 2012 IFIP Advances in Information and Communication Technology*, vol. 422, Berlin Heidelberg, Springer, 2014, 95.

[46] R. Delina and M. Macik, *Quality of Artificial Intelligence Driven Procurement Decision Making and Transactional Data Structure*, in *Quality Innovation Prosperity*, vol. 27, 2023, 107.

[47] Vv.Aa., *AI-Based Decision Support System for Public Procurement*, in *Information Systems*, vol. 119, 2023, 102284.

Digital Tools and Public Procurement

and identifying potential problems.[48]

Public-procurement data can also be used to monitor Key Performance Indicators (KPIs). While data can be very useful for tracking indicators, there are also multiple risks attributed to a KPI-approach, such as the choice of KPI, its definition, the methods to verify if the goal was achieved, or its implementation. One article tackles precisely the issue of 'KPI overload' and the difficulties of corruption monitoring in public procurement: they explain that tracking corruption can lead to an overload of indicators and offer a solution to counteract this problem.[49] They test their solution in the Italian medical sector[50] and obtain positive results.[51] This article highlights that data use in public procurement is fundamentally also a managerial problem, closely connected to risk management.

While data are a key element in the digitalisation of public procurement, the lack of data or the lack of quality data represents an important barrier in the development of all of these instruments. Soylu and others explain the data-quality issues that most national systems face, evaluate all the stages in obtaining relevant data and propose policy solutions for solving these problems.[52]

Aside from being a founding pillar for a digital public procurement, data can also be viewed as a frontrunning example of interdisciplinarity in digitalisation. The topic of data in public procurement merges elements of technology, management and regulation. From a legal standpoint, the law defines if and what data should be collected and who is/are the responsible bodies for doing so. From a managerial perspective, data should be collected and managed and a dedicated infrastructure should be developed. In the context of public-procurement data management, one article presents a data dashboard tested in Italy in order to track corruption and other indicators.[53] Data dashboards are user-friendly tools that allow

public servants to have access to real-time data on procurement processes.[54]

The importance of dialogue and collaboration is pointed out by another article in the corpus.[55] It presents the use of AI in the management of subsidized food in schools.[56] It notices a divergence between the plan and the practice, between the tech and the management people that led to 'missed opportunities'.[57] Collaboration becomes a key concept in digitalising public procurement – be it between the actors that develop a data infrastructure and the beneficiaries, the tech and management persons, the management of a contracting authority and the procurers, etc.

3.2.2. *The management perspective*

While the previous section presented the so-called 'tech perspective', one cannot overlook the fundamental interdisciplinarity of the articles, that merge elements from IT, law and management. Therefore, this section complements the previous one and presents contributions that have a *predominantly* managerial approach. The main concepts tackled by this branch of literature are: digitalising the public sector, sustainable public procurement and data capabilities of the public bodies.

Several articles from this section link public procurement, digitalisation and sustainability. For example, one literature review, focused on the supply chain in general, rather than on public procurement in particular, uncovers the link between circularity, as a form of sustainability, and technology.[58] Another paper links blockchain and the internet of things to a positive impact on public procurement.[59] It argues that these

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[48] K. Niessen, J.M. Paciello and J.I. Pane Fernandez, *Anomaly Detection*.

[49] Vv.Aa., *Artificial Intelligence to Counteract "KPI Overload" in Business Process Monitoring: The Case of Anti-Corruption in Public Organizations*, in *Business Process Management*, vol. 29, 2023, 1228-1229.

[50] *Idem*, 1229.

[51] *Idem*, 1241-1243.

[52] Vv.Aa., *Data Quality Barriers for Transparency in Public Procurement*, in *Information*, vol. 13, 2022, 99.

[53] Vv.Aa., *AI-Based Decision Support System*, 9 *et seq*.

[54] Vv.Aa., *Strengthening public procurement through data analytics*, World Bank Blogs, online: https://blogs.worldbank.org/governance/strengthening-public-procurement-through-data-analytics-0.

[55] S. Camaréna, *Artificial Intelligence (AI) for Sustainable Institutional Food Systems: Implementation of AI Tools for School Nutrition Program Management in the United States of America*, in *Frontiers in Sustainable Food Systems*, vol. 6, 2022, 743810, 11-12.

[56] *Idem*, 2.

[57] *Idem*, 11.

[58] A. Rejeb and A. Appolloni, *The Nexus of Industry 4.0 and Circular Procurement: A Systematic Literature Review and Research Agenda*, in *Sustainability*, vol. 14, 2022, 15633.

[59] M. Mircea, M. Stoica and B. Ghilic-Micu, *Analysis of the Impact of Blockchain and Internet of Things (BIoT) on Public Procurement*, in *IEEE Access*, vol. 10, 63370-63371.

technologies could bring benefits for: sustainability, transparency and reduction of corruption, 'smart public procurement' whilst meeting difficulties that can be either tech or management oriented.[60]

Other approaches focus on local authorities and local case studies in proving different paths towards successful digitalisation in the public sector. Peretz-Andersson and others explore the AI organizational transformation of the public sector, through a case study of public authorities from Sweden, New Zeeland and Norway.[61] They note that this topic is under-researched and conclude that more interdisciplinary inquiry should be dedicated to it. Soe and Drechsler theorise the idea that ICT could add 'public value via agile methods', through the case study of Intelligence Transport systems from Helsinki and Tallinn.[62] They believe these pilot-projects could be successfully replicated by other local governments.[63] This can be linked to the Indonesian case study performed by one article that explored artificial intelligence in local public transport.[64]

Two papers highlight the importance of data capabilities of each country, linking them to the previous section, dedicated to data in public procurement. Mittal uses the AI readiness index[65] to analyse the role of different elements, such as 'alternative technology, data capabilities, innovation, AI start-ups'.[66] Their conclusions highlight the importance of 'data capabilities'.[67] Another paper by the same author notes that each country should have a data strategy for government digitalisation, should improve its infrastructure, human resources and policies dedicated to data.[68]

3.2.3. *The legal and policy perspective*

Compared to the tech and managerial sections, that are fragmented and produced by a multitude of authors, the legal section seems more knit together and thus atypical in the context of this research. Two main authors dominate the topic, namely Coglianese (with a more general approach on machine learning in the public administration) and Sanchez-Gralles (with a more specific analysis on digitalisation and public procurement). A careful analysis will uncover the articulation of arguments between the two authors, and also their dialogue with others, such as: Mulligan and Bamberger, Nagitta and others and Naudé and Dimitri.

3.2.3.1. *Machine learning in the public administration*

Our analysis will start with Coglianese's and co-authors' work on machine learning in the public administration,[69] that covers both the use of AI in managing public procurement and procurement of AI. They explore AI in public management, more particularly the topic of algorithmic decision-making in the government. Coglianese starts the research by presenting the limits of the *status quo* and points out that the decision to use 'digital algorithms' should always be compared with the current 'human algorithms'.[70] According to the author, one should not compare machine learning with an imaginary and ideal decision-making system, but rather should be put up against the human decision-making process.[71] Indeed, humans do not make perfect decisions, not individually, nor collectively, because they have limits and biases.[72] In this context, machine learning could, sometimes,

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[60] *Idem*, 63370-63371.
[61] Vv.Aa., *AI Transformation in the Public Sector: On-going Research*, in *2021 Swedish Artificial Intelligence Society Workshop (SAIS)*, IEEE, 2021.
[62] R.-M. Soe and W. Drechsler, *Agile Local Governments: Experimentation before Implementation*, in *Government Information Quarterly*, vol. 35, 2018, 323.
[63] *Idem*, 330.
[64] K.D. Solihati and D. Indriyani, *Managing Artificial Intelligence*.
[65] Oxford Insights, *Government AI Readiness Index*, online: https://oxfordinsights.com/ai-readiness/ai-readiness-index.
[66] P. Mittal, *A Multi-Criterion Decision Analysis Based on PCA for Analyzing the Digital Technology Skills in the Effectiveness of Government Services*, in *2020 International Conference on Decision Aid Sciences and Application (DASA)*, Sakheer, Bahrain, 2020, 493.
[67] *Idem*, 493.
[68] P. Mittal, *Impact of Digital Capabilities and*

Technology Skills on Effectiveness of Government in Public Services, in *2020 International Conference on Data Analytics for Business and Industry: Way Towards a Sustainable Economy (ICDABI)*, Sakheer, Bahrain, 2020.
[69] C. Coglianese and A. Lai, *Algorithm vs. Algorithm*, in *Duke Law Journal*, vol. 72, 2022; C. Coglianese, *A Framework For Governmental Use of Machine Learning*, Report to the Admin. Conf. of the U.S., 2020; C. Coglianese and A. Lai, *Assessing Automated Administration*, All Faculty Scholarship, 2826, 2022; C. Coglianese, *Procurement and Artificial Intelligence*, forthcoming in *Handbook on Public Policy and AI*, R. Paul, J. Cobbe and E. Carmel (eds.), Cheltenham, Edward Elgar, 2024.
[70] C. Coglianese, *A Framework For Governmental Use*, 7.
[71] *Idem*, 7.
[72] *Ibid.*, also 8 *et seq.*

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offer a better decision-making process – however, it also comes with various legal limitations concerning 'delegation and accountability, (…) due process and reason-giving, transparency, privacy, and equal protection'.[73] Given this conundrum, the author offers a framework to support public servants to choose between the two.[74]

When and how should the public administration make use of machine learning?[75] As explored in the paper referred to above, there are several legal issues that could intervene, however the authors argue that these problems do not forbid a 'responsible' use of artificial intelligence in the administration.[76] The decision to use machine learning in the public sector should be a case-by-case analysis, in the situations in which it 'will prove more beneficial than human decision-making'.[77] They list the conditions that are 'necessary but not sufficient' for using AI in the public sector: 'adequate resources, (…) goal clarity and precision, (…) data availability, (…) external validity'.[78] Coglianese also tackles the topic of empathy in the digital state: can an automated state be empathetic?[79]

3.2.3.2. *Procurement of AI vs. AI in public procurement management*

As priorly explained, there is a distinction between the use of AI in the management of public procurement and procuring AI. While some articles focus on one of the two options, others tackle both.

When it comes to procurement of AI by contracting authorities, Ben Dor and Coglianese explore the idea of standards for procurement of AI.[80] Through standards and contractual clauses, procurement can become a tool for AI governance, with several advantages such as 'transparency' or avoiding a 'one-size-fits-all approach that could hamper

technological innovation'.[81]

Mulligan and Bamberger continue this debate on procurement of AI. They argue that the integration of machine learning system into the public sector is done through procurement.[82] This process implicitly creates policy, because it embeds substantive decisions about the functioning and effects of AI in society. However, this policy-making function is not compliant with the legal safeguards of law adoption: 'Government responsibility for policymaking is abdicated'.[83] While procurement of AI indirectly creates policy, the use of AI in managing the procurement process could be less problematic: 'This raises a threshold challenge in distinguishing systems that are inward-facing from those that create public-facing policy of the type that agencies should deliberate about and ventilate in a public manner'.[84]

Sanchez-Graells is a reference author in the area of digitalisation and public procurement that adds to the debates concerning managing public procurement using AI and procuring AI. This is the most prolific author of the selected corpus, with a vast literature both in terms of articles and a dedicated monograph. The author is the first from the corpus to explore the articulation between digital public procurement and sustainability, from a legal perspective.[85]

The author's monograph evaluates the articulation between public procurement and digitalisation: public procurement both as a governance tool and as a place for experimenting with technology.[86] In other words, as previously mentioned, the relation between public procurement and digitalisation is twofold: on one hand, public administrations buy digital technologies via public procurement and, on the other, they digitalise their own management.

In its first dimension, public procurement could become a regulatory actor, using the contract as a governance tool. However,

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[73] *Ibid.*, also 23 *et seq.*

[74] *Ibid.*, also 62 *et seq.*

[75] C. Coglianese and A. Lai, *Assessing Automated Administration*, 1.

[76] *Ibidem*, 5.

[77] *Ibid.*, 9.

[78] *Ibid.*, 10.

[79] C. Coglianese, *Administrative Law in the Automated State*, All Faculty Scholarship, 2273, 2021. This topic is also covered by Sofia Ranchordás: S. Ranchordás, *Empathy in the Digital Administrative State*, in *Duke Law Journal*, vol. 71, 2022.

[80] L.M. Ben Dor and C. Coglianese, *Procurement as AI Governance*, in *IEEE Transactions on Technology and Society*, vol. 2, no. 4, 2021, 194-196.

[81] *Idem*, 196-197.

[82] D.K. Mulligan and K.A. Bamberger, *Procurement As Policy: Administrative Process for Machine Learning*, in *Berkeley Technology Law Journal*, vol. 34, 2019.

[83] *Idem*, 788.

[84] *Idem*, 812.

[85] A. Sanchez-Graells, *Digital Technologies, Public Procurement and Sustainability: Some Exploratory Thoughts*, in *SSRN Electronic Journal*, 2019.

[86] A. Sanchez-Graells, *Digital Technologies and Public Procurement*.

public procurement and the resulting contract are inadequate to play this part. The use of AI by the public sector should not be indirectly regulated through contractual clauses, but managed by a dedicated authority, named AIPSA - AI Public Sector Authority.[87]

In its second dimension, the public-procurement process itself would be digitalised. In the context of 'hype' around the benefits and uses of digital technologies, public bodies could be 'vulnerable' to 'policy irresistibility' that would persuade policy makers into a premature use of AI and other tools.[88] This brings plenty of issues, and thus the potential should be reassessed and balanced in the light of the existing risks - in order to mitigate the risks, Sanchez-Graells defines the theory of a feasibility boundary.[89] The author explores the potential governance risks and applicable legal obligations impending on the contracting authority that wishes to use digital technologies in its procurement process and explains why the current digital risk-oriented governance systems are unsuitable.[90] For Sanchez-Graells, the main risks in implementing digital technologies in public procurement are legal and operational. Among the operational are listed: 'technical debt', 'cybersecurity' and 'digital skills shortages'.[91] Here, an essential topic in digitalising public procurement is tackled, also analysed by the managerial literature of this corpus – the lack of digital skills and qualified human resources. From a EU policy perspective, another issue would be the disconnect between the innovation-oriented EU and the difficulties of Member States in implementation.[92]

Other authors tackle the issue of risks in the procurement of AI, such as the potential 'dependency on private vendors', for which they propose the development of 'AI-specific procurement guidelines'.[93] They warn against 'techno-solutionism' and propose a focus on the 'structural causes of an issue'.[94]

The essential place of data in digitalising public procurement is reiterated by the legal literature. Sanchez-Graells focuses on the importance of a data infrastructure,[95] and restates this idea in his monograph.[96] He makes an interesting correlation between data access and centralization and states that central purchasing bodies, due to their privileged position as data holders, could take on the responsibility of developing and managing several digital tools.[97] Nevertheless, he explains the risks and argues that control over public procurement should be instead given to national competition authorities.[98]

One common notion used by multiple authors is that of 'gatekeeper'. Nagitta and others believe that, without adequate legislation, the public-procurement professional could play the role of gatekeeper for human-centered AI.[99] On the other hand, Mulligan and Bamberger believe this would lead to indirect policy making through procurement.[100] Sanchez-Graells argues for a similar position as Mulligan and Bamberger and explains why procurement is unfit to play a 'gatekeeping role' when it comes to digitalisation.[101]

Finally, a group of three articles from the corpus focus on the question of AI ethics and public procurement. Von Behr and Abrahamsson explore the link between ethics,

[87] *Idem*, 106 *et seq.*
[88] *Idem*, 123.
[89] *Idem*, 185 *et seq.*
[90] *Idem*, 191 *et seq.*
[91] *Idem*, 191.
[92] A. Sanchez-Graells, *EU Public Procurement Policy and the Fourth Industrial Revolution: Pushing and Pulling as One?*, in *SSRN Electronic Journal*, 2019, 3.
[93] M. Hickok, *Public Procurement of Artificial Intelligence Systems: New Risks and Future Proofing*, in *AI & Society*, vol. 39, 2022, 1222.
[94] *Ibidem*, 1222.

[95] A. Sanchez-Graells, *Data-Driven and Digital Procurement Governance: Revisiting Two Well-Known Elephant Tales*, in *SSRN Electronic Journal*, 2019, 18; A. Sanchez-Graells, *Procurement Corruption and Artificial Intelligence: Between the Potential of Enabling Data Architectures and the Constraints of Due Process Requirements*, to be published in *Routledge Handbook of Public Procurement Corruption*, S. Williams and J. Tillipman (eds.), Routledge, 2024, available at SSRN: https://ssrn.com/abstract=3952665, 6 *et seq.*; A. Sanchez-Graells, *Competition Implications of Procurement Digitalisation and the Procurement of Digital Technologies by Central Purchasing Bodies*, in *SSRN Electronic Journal*, 2023, 4.
[96] A. Sanchez-Graells, *Digital Technologies and Public Procurement*, specifically 176 *et seq.*, 192 *et seq.*
[97] A. Sanchez-Graells, *Competition Implications of Procurement Digitalisation and the Procurement of Digital Technologies by Central Purchasing Bodies*, in *SSRN Electronic Journal*, 2023, 16 *et seq.*
[98] *Idem*, 20.
[99] Vv.Aa., *Human-Centered Artificial Intelligence for the Public Sector: The Gate Keeping Role of the Public Procurement Professional*, in *Procedia Computer Science* 200, 3rd International Conference on Industry 4.0 and Smart Manufacturing, 2022, 1090.
[100] D.K. Mulligan and K.A. Bamberger, *Procurement As Policy*, 788.
[101] A. Sanchez-Graells, *Digital Technologies and Public Procurement*, 25 *et seq.*

Digital Tools and Public Procurement

AI systems and public procurement and notice that it is currently not very researched and should be further explored.[102] Another article linked to ethics discusses the link between AI governance, corporations and public interest.[103] Naudé and Dimitri discuss the role of policy in the management of a potential Artificial General Intelligence (AGI).[104] They argue that 'the danger of an unfriendly AGI can (...) be reduced by taxing AI and using public procurement'.[105]

4. *Conclusions*

This article analysed the current theories and research trends on the topic of artificial intelligence and public procurement. The following common threads stand out:

Firstly, the corpus is fundamentally interdisciplinary, blending technology, law and management perspectives. While law and technology seem to be the most intertwined, one should not leave out a third element – the managerial approach. Beyond the legal procedures and regulatory compliance, public procurement has strong managerial dimensions, be it the organisational infrastructure, the human resources, and the decision-making process. When digitalising public procurement or procuring AI, all three elements should come together: 'there is a need for strong supportive regulatory, technological and organisational foundations. Failing to adopt a more holistic or systemic view of AI will lead to suboptimal outcomes.'[106]

Data are a fundamental pre-requisite for the adoption of AI in public procurement.[107] Data

are the fundamental element for implementing any emerging technology, and the success of digitalising public procurement is dependent on the existence of a qualitative data infrastructure as key layer.[108] Beyond these legal and technical dimensions, data in public procurement represent an issue of management. They imply a dedicated infrastructure, both in terms of data storage and management, and in terms of human resources (for example, a data-analysis team).

The legal literature discusses two main articulations of AI in PP: procurement of AI and AI in public-procurement digitalisation. While AI in public-procurement management might be seen as less problematic,[109] it currently encompasses more challenges than potential benefits. Procuring AI, on the other hand, in certain circumstances, can transform the public buyer into a regulator, which transcends its designated legal powers.[110] In order to conform with the constitutional separation of powers, it should firstly fall into the responsibility of policy makers and of a dedicated authority.[111]

When it comes to future research paths, both researchers and practitioners should focus on developing a realistic plan for tackling the transition towards digital public procurement in a sequential manner, as opposed to a completely reformative approach, with data management as core point.

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[102] T. Von Behr and P. Abrahamsson, *AI Governance and Ethics in Public Procurement: Bridging the Gap Between Theory and Practice*, in *IEEE 28th International Conference on Engineering, Technology and Innovation (ICE/ITMC) & 31st International Association For Management of Technology (IAMOT) Joint Conference*, Nancy, 2022, 6.

[103] P. Cihon, J. Schuett and S. D. Baum, *Corporate Governance of Artificial Intelligence in the Public Interest*, in *Information*, vol. 12, 275, 2021, 2.

[104] W. Naudé and N. Dimitri, *The Race for an Artificial General Intelligence: Implications for Public Policy*, in *AI & Society*, vol. 35, 2020, 369.

[105] *Ibidem*, 369.

[106] K. McBride, *Digital bureaucracies: How data and artificial intelligence are transforming our governments*, in *Apolitical*, 2024, online: https://apolitical.co/solution-articles/en/how-data-and-artificial-intelligence-are-transforming-our-governments.

[107] A. Sanchez-Graells, *Digital Technologies and Public Procurement*, 176 *et seq.*; N. Sava, *The eForms Regulation*, 178.

[108] A. Sanchez-Graells, *Digital Technologies and Public Procurement*, 176 *et seq.*

[109] D.K. Mulligan and K.A. Bamberger, *Procurement As Policy*, 812.

[110] *Ibidem*, 788; A. Sanchez-Graells, *Digital Technologies and Public Procurement*, 25 *et seq.*

[111] A. Sanchez-Graells, *Digital Technologies and Public Procurement*, 106 *et seq.*