Beyond Automation: Transforming Strategic Sourcing Decisions Through Industry 4.0 Technologies

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ABSTRACT,
The Fourth Industrial Revolution plays a transformative role in the way procurement decisions are made. In the past, procurement professionals based their decisions on personal judgement, non-integrated systems and data in spreadsheets. Nowadays as digitalisation progresses, purchasing managers are exposed to increasing amounts of data analytics, complex information and global supply networks. Industry 4.0 brings in technologies such as business intelligence, ERP systems and AI that reshape information management as well as decision-making in strategic sourcing processes. In the context of this transformation lies the concept of task augmentation, whereby digital technologies are used to enhance, rather than replace, human task performance. Despite these tools enabling decision makers to reduce cognitive overload, integrate extensive data and consider many variables, their use remains rather limited in strategic decisions. To explore how task augmentation affects the ways procurement managers deal with increased data exposure, a qualitative study using ten semi-structured interviews with purchasing professionals was conducted. The findings show that whilst digital tools facilitate data-driven decision-making, the decision makers' role extends towards tasks such as validating AI output and applying effective AI prompting strategies. This study furthers the understanding of bounded rationality in context of digitalisation, where technologies can be used to enhance human decision-making capacities in strategic sourcing by promoting objectiveness, data visualisation and extensive decision-making criteria.

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Industry 4.0, augmentation, PSM, strategic sourcing, bounded rationality, decision-making, information complexity, task enlargement

"During the preparation of this work, the author used ChatGPT in order to brainstorm ideas and structure at the pre-writing stages. After using this tool/service, the author reviewed and edited the content as needed and takes full responsibility for the content of the work."

1. INTRODUCTION: RESHAPING THE ROLE OF TASK AUGMENTATION

The rise of digital technologies has as immense effect on the way businesses operate nowadays. This digital revolution and its impact on industries is referred to as Industry 4.0 (Glas & Kleemann, 2016, p. 529). This digitalisation extends towards two key processes, namely automation and augmentation. Whilst automation is associated with the replacement of human workforce with technology, augmentation focuses on a combination of human work and technology to enhance task execution (Colombo et al., 2023, p. 1). Within the procurement field, digitalisation is perceived as a strategic driver for transforming procurement. Its expected results include improvements in both efficiency and effectiveness of purchasing in terms of aspects such as cost savings, speed, risk assessment, enhanced product quality and innovation (Herold et al., 2023, p. 425).

Together with digitalisation and technological advancements, business practices need to change in order to keep up with the rapid transformations within the digital environment. Consequently, this leads to changing needs in required skillsets to fulfil new job roles that emerge with technological changes (Delke et al., 2023, p. 1). Human tasks are being enhanced by technologies such as AI, robotics, softwares, sensors and virtual reality (Schiele et al., 2022, p. 163). Industry 4.0 technologies can extend the capacities of purchasing roles by generating reliable data. Additionally, the use of advanced analytics for presenting live information can significantly support analysis and decision-making processes within the procurement function (Althabatah et al., 2023, p. 3).

Traditionally the purchaser's decision would be limited to the extents of their cognitive abilities and the amount of information their brain can process. In behavioural economics, this phenomenon is attributed to the term "bounded rationality", where human's decision-making process is constrained by the limits of their cognitive capacity (Simon, 1990, p. 15). Task augmentation enables achieving greater effectiveness thanks to enhanced decision-making as well as risk and opportunity evaluation. Within the augmentation applications, business intelligence solutions have shown to improve market analysis across various segments, geographical dispersion or supplier categories (Colombo et al., 2023, p. 5). However, research has been limited to market analysis and there is limited implementation of similar approach in strategic sourcing processes such as supplier selection and evaluation. Whilst certain multicriteria decision-making tools have been implemented in supplier selection processes, such methodologies were often limited in assigning weights or incorporating suppliers' strategic capabilities (Talluri & Narasimhan, 2004, p. 238).

Specifically, the term "augmentation" remains ill-defined in the Purchasing and Supply Management (PSM) literature. As supply networks become more complex, supplier selection processes have shifted towards being more strategic tasks (Herold et al., 2023, p. 424; Saputro et al., 2022, p. 1). Analysis and information processing in supplier selection becomes more limited due to increased complexity and intervention of biases (Kaufmann et al., 2017, p. 84). The availability of technology can provide, consider and analyse a larger number of variables compared to what a human brain is able to grasp (Bienhaus & Haddud, 2018, p. 978). This can significantly impact the decision-making throughout the activities within strategic sourcing. The strategic sourcing process itself is outlined by elements such as planning supply, supplier selection and contracting (Zijm et al., 2019, p. 48).

This research aims to take a strategic perspective onto the new roles within PSM and explore how task augmentation influences decision-making processes given the increasing information exposure. The research questions are as follows:

RQ 1: How does task augmentation help overcome bounded rationality in procurement decision-making in strategic sourcing processes?

RQ 2: How does task augmentation affect PSM professionals' ability to process complex information throughout strategic sourcing processes?

To answer the research questions, this study takes a qualitative approach where exploratory interviews with procurement professionals were conducted. The theoretical framework delves into existing literature and practices regarding digitalisation, task augmentation and bounded rationality. The methodology section presents the research design, data collection and analysis techniques used to explore the topic. Followed by results chapter which illustrates key findings derived from this research in the context of posed research questions. Next, the discussion section interprets these findings in relation to existing literature and practical contributions. The paper is concluded with the acknowledgement of limitations of this research as well as pointing out the direction for future research in this topic.

This research contributes to existing literature in PSM by providing a strategic insight into how digitalisation, in light of task augmentation within the strategic sourcing activities, transforms the decision-making process. The role of digitalisation in procurement is crucial to understand, given that procurement is perceived as the main cost driver in an organisation (Klünder et al., 2019, p. 1). However, Herold et al. (2023, p. 425) emphasises the limited adoption of digital technologies within procurement. With the support of theory in bounded rationality, this study provides an insight into how sourcing processes can become more strategic thanks to task augmentation that expands the decision-making capacities within procurement processes. These findings allow companies to enhance their effectiveness in strategic decision-making related to PSM, reduce supplier-related risks and improve their sourcing strategies.

2. THEORETICAL FRAMEWORK: TASK AUGMENTATION AND BOUNDED MIND

2.1 The Rise of Digitalisation in Purchasing and Supply Management

The increasing impact of digitalisation on industrial production has given the rise to the fourth industrial revolution known as the Industry 4.0 (Glas & Kleemann, 2016, p. 55). "Big Data" is proposed to be one of the key drivers for the digital revolution allowing organisations to leverage their competitive advantage. Organisations implement AI in combination with human interaction within the PSM in order to enhance innovation, collaboration and create new knowledge (Bienhaus & Haddud, 2018, p. 966). The implementation of cyber-physical systems allows the support of physical processes with digital ones, both by reproducing and augmenting them. This can be applied across supply networks enabling real-time interconnectedness (Müller et al., 2018, p. 4).

As there is increasing amount of advanced digital technologies available over the time, the role of PSM has shifted from being purely transactional to rather strategic function. This involves new functions such as strategic sourcing, supplier networks and supplier relationship management (Herold et al., 2023, pp. 424-425). Within the purchasing department, digitalisation extends across technological applications in communication, data

analysis, human interaction with machines as well as advanced procurement systems (Colombo et al., 2023, p. 2). Purchasing decision-makers implement digital technologies to enter global markets and leverage buyer-supplier relationships (Althabatah et al., 2023, pp. 2-3). In particular, technologies such as AI and big data are used to enhance supplier analysis and selection, strategic sourcing and supply risk assessment (Colombo et al., 2023, p. 2). At a strategic level, digitalisation in procurement mainly entails technological implementations in relation to augmentation (Colombo et al., 2023, p. 5)

2.2 Task Augmentation in Decision-Making

Kaufmann et al. suggest that decision-makers should combine rational, emotional and experience-based processing of information with regards to purchasing decisions (2016, p.90-91). However, business processes change due to rapid digitalisation that occurs with the emergence of Industry 4.0 (Delke et al., 2023, p. 1). Such changes appear in the field of purchasing and supply management and are referred to as task automation and augmentation. Raisch and Krakowski (2021, p. 194) identify these processes as a trade-off where firms that use AI choose between automating or augmenting the task depending on its nature. Whilst routine tasks are likely to be automated, more complex and strategic ones still require a human input such as their intuition or common-sense reasoning. Particularly, task augmentation would focus on the complementary approach towards decision-making that is associated with collaborative and complex tasks. The authors propose that task augmentation enhances the effectiveness of decision-making thanks to the possibility to evaluate risks and opportunities (Colombo et al., 2023, p. 5). Whilst task augmentation has already been implemented in domains such as meta-learning (Yao et al., 2021), its benefits can be further extended to the PSM processes including strategic sourcing.

Industry 4.0 technologies such as AI and the utilisation of Big Data can be used to support complex decision-making thanks to their ability to process vast amounts of data in real-time and proposing most suitable outcomes (Bienhaus & Haddud, 2018, p. 978). For example, thanks to their calculation power AI systems can provide enhanced decision-making support (Schiele et al., 2022, pp. 163-164). Data availability increases with digitalisation, where procurement professionals must consider new extensive information pieces such as supply risk analysis and market data (Delke et al., 2023, p. 8). Talluri and Narasimhan (2004, p. 237) emphasise the increase in decision-making complexity as the number of alternatives and evaluation factors increases together with the difficulty of attributing weights consistently. They designed a Data Envelopment Analysis (DEA) model that enables a consideration of supplier capabilities, performance metrics and alternative supplier efficiency that can be used for strategic sourcing decisions. However, the output measures are still limited in understanding (Talluri & Narasimhan, 2004, p. 248). Similar applications of task augmentation by enhancing existing DEA models will enable a more comprehensive and consistent approach towards the decisions associated with supplier selection and evaluation processes. This will enable the decision-makers to address the issue of being limited by the amount of variables their cognitive capacity is able to consider, which is further discussed in the following section in relation to the Transaction Cost Economics theory.

2.3 Transaction Cost Economics and Bounded Rationality in Purchasing Decisions

In the field of purchasing and supply management, the Transaction Cost Economics (TCE) theory is associated with the make-or-buy decision that supply chain managers face. Bounded rationality is a closely related term to TCE, where the capacity of human brain to solve complex issues is much smaller compared to the issue as a whole (Ketokivi & Mahoney, 2020, p. 1017). Generally, in behavioural economics, the term "bounded rationality" refers to a phenomenon where human's decision-making process is constrained by the limits of their cognitive capacity (Simon, 1990, p. 15). In order to avoid cognitive overload, decision makers can simplify their tasks by disregarding certain information this way reducing the number of alternatives to consider (Krabuanrat & Phelps, 1998, p. 84). In the context of strategic decision-making, actors must think both rationally and intuitively whilst considering all information available. Nevertheless, decisions are influenced by cognitive biases and heuristics in processing information (Acciarini et al., 2021, p. 641). With the rise of Industry 4.0, the amount of information availability grows (Delke et al., 2023, p. 7). Namely in PSM, purchasers are exposed to a wide supplier network spread across the globe which makes it challenging for them to consider many possible weighted variables throughout the sourcing process. Thus, with the help of AI supplier selection process considers not only the purchaser's internal needs but also supplier compatibility, reciprocity and the relationship (Allal-Chérif et al., 2021, p. 70).

Whilst the TCE theory is interdisciplinary and has been applied in a variety of fields (Ketokivi & Mahoney, 2020, p. 1011), there is limited research in the effects of task augmentation, through digital technologies such as AI and decision-support systems that would reduce the transaction costs in PSM. Particularly in the context of strategic sourcing, the TCE theory is applicable beyond individual sourcing transactions, but rather can take a comprehensive perspective on managing a network of the organisation's sourcing transactions. Its strategic focus extends towards increasing the value of sourcing relationships whilst minimising the costs associated with managing a network of procurement transactions. Additionally, strategic sourcing applications within the TCE may be associated with plural sourcing thanks to which firms are able to reduce their transactions costs by maintaining flexibility between make or buy and ally relations (Shook et al., 2009, pp. 6-7). The purchaser's strategic decision lies upon choosing to outsource those items the transaction costs of which are lower compared to production costs (Shook et al., 2009, p. 8). The implementation of Industry 4.0 tools will enable reduced transaction costs thanks to reduced information search, negotiation and monitoring costs as well as minimised uncertainty (Gottge et al., 2020, p. 730).

2.4 Theory-Based Propositions

Grounded in the literature above, task augmentation can be used to contribute to enhancing the effectiveness of procurement decision-making on a strategic level. The following propositions are made to guide this study:

1. *Task augmentation allows purchasers to make more informed decisions based on live data available.*

Purchasers have a visual overview of a variety of procurement variables that are crucial for making effective decisions. This enables purchasing specialists to base their decision in supplier selection on a completer and more detailed picture, thus resulting in better-informed and strategic decision-making.

2. *Task augmentation enhances decision making throughout the strategic sourcing process, particularly supplier selection.*

Strategic sourcing decisions require evaluation of multiple complex criteria beyond simple operational ones such as cost and quality. They also include strategic aspects such as quality management or cost reduction capabilities of suppliers which must be considered during strategic sourcing process (Talluri &

Narasimhan, 2004, p. 236). Task augmentation supports multi-criteria evaluation, therefore enabling procurement professionals to analyse the criteria in a more objective and consistent manner this way enhancing their strategic choices.

3. *Task augmentation allows procurement professionals to effectively evaluate greater amount and complexity of supplier-related data.*

Purchasing professionals can work with larger number of variables and data without being overwhelmed by them.

4. *Task augmentation reduces the effects of bounded rationality in supplier evaluation processes through greater information processing capabilities*

As human cognitive resources are limited, humans are likely to settle for the "good enough" option rather than seeking the best one (Conlisk, 1996, p. 671). Task augmentation addresses this issue and expands the purchaser's decision-making capacity thanks to its ability to consider a larger number of variables, weighting them and evaluating risks.

The propositions above guide this research and enhance the understanding of the qualitative approach taken in this study that is explained in the section below.

3. METHODOLOGY: A QUALITATIVE APPROACH USING INTERVIEWS

3.1 Research Design

This research follows a qualitative research methodology approach. Given the growing digital environment in which business decisions are made, the complexity of decision-making also increases. More holistic research methodologies are required for an in-depth understanding, thus making qualitative approach most suitable for research (Guercini, 2014, p. 663). This design enables the development of a more holistic and complex perspective in a natural context (Castleberry & Nolen, 2018, p. 808). Taking a qualitative approach allows to derive meanings and relationships between them from participants' words (Saunders et al., 2019, p. 179). It produces rich and contextualised data that enables in-depth analysis where emerging themes can be used to develop explanations grounded in theory (Saunders et al., 2019, p. 639). Given the qualitative nature, this study follows an exploratory purpose in order to obtain insights and deepen the understanding of the given topic (Saunders et al., 2019, pp. 186-187).

3.2 Data Collection Through Exploratory Interviews with Procurement Professionals

Semi-structured exploratory interviews with procurement professionals in different companies were conducted. This method is most suitable as engaging in interviews with professionals provides a variety of opinions and interpretations given the participants' experience, which can be considered crucial for gaining an in-depth understanding of complex business networks (Dubois & Araujo, 2007, p. 175). A detailed semi-structured interview guide was developed enabling a systematic way of interviewing people on predetermined topics whilst maintaining flexibility in exploring themes as they unravel throughout the conversation (Patton, 2002, p. 343). The interview guide was designed based on literature established in the section above (see Appendix A). The interviews consisted of a set of open questions where participants were encouraged to provide extensive answers (Saunders et al., 2019, pp. 458-459). The interviews took place online via Microsoft Teams and lasted 45-60 minutes. Microsoft Teams transcription function was used to transcribe interviews word for word to ensure the meaning is preserved (McMullin, 2023, p. 145). The interviews were conducted together with a fellow International Business Administration (IBA) researcher due to similarities in research focus and for purposes of obtaining a larger sample size.

3.3 Sampling Strategy

Target population included medium to large sized Europe-based companies that have a designated procurement department. Interview partners were selected through purposive sampling technique where participants are chosen deliberately based on how likely they can provide relevant information for the exploration (Kelly, 2010, p. 317). This strategy is most appropriate given the small sample size as well as the need to select cases able to provide in-depth information. The selection of such cases is based on research questions (Saunders et al., 2019, p. 321). The participants should feel open about sharing insights into the decision-making process within purchasing in the company. The sample size consists of ten interview partners that hold a position which is involved in procurement decision-making. Table 1 presents the sample characteristics in terms of industry, role and interview duration.

Table 1 – Sample Characteristics

	Industry	Role	Duration
P1	Nuclear	Procurement manager	45 min.
P2	Liquid logistics	Global procurement manager	55 min.
P3	Metal processing	Sourcing manager	50 min.
P4	Healthcare	Change manager in procurement	48 min.
P5	Oil and gas	Project coordinator	61 min.
P6	Writing supplies	Strategic procurement manager	45 min.
P7	Insurance	Procurement manager	66 min.
P8	Procurement consultancy	Procurement advisor	45 min.
P9	AI procurement software	CEO	30 min.
P10	Industrial supplies distribution	Procurement manager	50 min.

3.4 Thematic Approach to Data Analysis

After the initial familiarisation with data by reading the transcripts and noting preliminary ideas, the data was analysed following the proposed phases of thematic analysis by Braun and Clarke (2006, p. 87). Thematic approach to data analysis is frequently used in qualitative research and is associated with determining, interpreting and presenting recurring themes within the data (Castleberry & Nolen, 2018, p. 808). Firstly, the dataset was systematically coded based on similarities in data chunks (Braun & Clarke, 2006, p. 87; Miles et al., 2013, p. 79). Patterns within the data was identified from the deductive coding approach as data was coded with the focus on research questions (Braun & Clarke, 2006, pp. 83-84). Qualitative analysis software ATLAS.ti was used for consistent and traceable coding. Secondly, the codes were organised into themes, thus examining how different recurring codes associate together to form a theme (Braun & Clarke, 2006, p. 89). Themes were then refined to ensure there was enough data to support each theme (Braun & Clarke, 2006, p. 91). The development of themes was related to the elements of research questions and literature (Eisenhardt,

1989, p. 536). Examples of themes established include "expanding decision-making criteria" or "positive effects on complex information processing". Appendix B presents a process diagram illustrating a step-by-step process from data collection to conclusions.

After systematically coding the first two interviews, codes were compared with the second IBA researcher. The remaining interviews were coded afterwards. For example, to build a cross-case comparison table (Table 2), the codes were structured based on the strategic sourcing process and type of digital technology used, altogether forming a group for "Task augmentation in strategic sourcing". In order to understand the extent of implementation of digital tools within the organisation, participants' general description of technologies utilised was used in combination with the degree to which they relied on Excel spreadsheets in strategic sourcing. The extent to which each tool was used within the company was divided into being used "extensively" and "superficially". Tools used extensively are attributed to those that integrate the tool (such as AI or BI) in a software and are used in advanced decision-making, whereas those used superficially are attributed to tools that are used merely as an information source or lose support to the decision. In line with the deductive approach, quotations were selected based on the research questions to develop Table 3.

4. RESULTS: DEALING WITH INCREASED INFORMATION EXPOSURE

4.1 Current Implementation of Industry 4.0 Technologies in Strategic Sourcing

The interviews revealed that the adoption of task augmentation in strategic sourcing is yet at early stages. Several participants admitted attempts in implementing digital tools to aid decision-making at a strategic level, this however has not yet shown desired outcomes. Table 2 below presents an overview of types of task augmentation used across different strategic sourcing processes amongst interview partners. To better illustrate the extent of task augmentation adoption in companies, the cases are represented based on stages of Maturity Profile Industry 4.0 in Purchasing model. They were ranked in the "Adoption of Technologies" dimension based on their answers to technology use rather than a systematic categorisation. Stage 1 represents favouring manual data analysis and minimal use of Industry 4.0 technologies in procurement, whereas Stage 4 is associated with real time data analysis, its purposeful collection, machine-to-machine communication as well as the use of AI in decisions (Schiele & Torn, 2020, p. 529).

A case represented by Participant 9 introduced the use of agentic AI in strategic activities such as when conducting extensive data analysis in preparation for negotiations, or even in supplier selection. Nevertheless, the current use of task augmentation within strategic sourcing amongst other cases is shown to be rather limited, where some participants admitted their preference for more traditional approach to data analysis using Excel which is also represented in Table 2 as a special case with specific activities participants mentioned using Excel for. A common reason for favouring Excel determined was the problem of no single system available on the market which would integrate all processes and data across the strategic sourcing activities whilst meeting the exact strategic objectives of the company.

Table 2 – Cross-case comparison of types of technologies used in strategic sourcing decisions

		P4	**P7**	**P1**	**P5**	**P6**	**P8**	**P10**	**P2**	**P3**	**P9**
Industry 4.0 maturity		Stage 1		Stage 2					Stage 3		Stage 4
Planning Supply	AI					X			X		
	BI				X						
Supplier Scouting	AI		(X)						X	X	X
	BI							X			
	Software						X	X			
Supplier Selection	Software			X		X					X
Negotiation (preparation stage)	AI		(X)`				(X)		X		X
	ERP					X				X	
Contracting	AI								X		
	Software								X		
	ERP										
Spend Management	ERP	X									
	Software						X	X			
Supplier Performance Tracking	Software			X			X	X	X	X	
Supplier landscape evaluation *Decision matrix* *Supplier selection* *Data analysis*	Excel*	X	X	X	X	X				(X)	
X=used extensively, (X)=used superficially											

*Special case, not directly part of Industry 4.0 technologies

Table 3 – Cross-Case Comparison Table of Positive and Negative Effects on Processing Complex Information

		Quote example	Traceability across cases
Positive effects	ERPs as centralised information storage	*"That's why it's a game changer that like the whole ERP integration…because now you are kind of forced to look at things as well. Now everything is on the same place, so you have to like, tick every box"* – Participant 8	P2, P7, P8
	Increased control	*"More data means more tasks but on the other hand you are more in control"* – Participant 1	P1, P4, P5
	BI for enhanced data analytics	*"Best way to process that is to by business intelligence tools. And for that to use the information coming out of the different systems and process that into a readable graph, that is in one overview creating, combining multiple information and as such, giving you the understanding what your risk is, what the next move should be, when that should be…"* – Participant 5	P2, P5
	Data visualisation	*"So having the accurate numbers and being able to not spend as much time on it, like just having a dashboard here you see it's getting updated in real time. You see it's accurate. You see it eliminates the whole guesswork thing"* – Participant 8	P1, P4, P5, P6, P7, P8
	AI for understanding price ranges	*"As for negotiation. I would say tools like ChatGPT are probably gonna become your best friend because a ChatGPT will be able to tell you the range of prices you should be looking for certain screws because it's just an aggregator of information, right?"* – Participant 8	P7, P8
Negative effects	Validation of data	*"I still believe that you need to validate that, and you have to have the skills to be able to validate that information. Just to get the Halo effect out"* – Participant 2	P2, P3, P5
	Need for correct AI prompting	*"You have to get more knowledge, let's say on artificial intelligence. So, the output of the artificial intelligence, just as an example really depends on the prompts you put in"* – Participant 3	P2, P3, P6, P9
	Data analysis skills	*"When you have a new list of suppliers you need the skill to analyse or quickly analyse which suppliers are relevant. So when you see the results, there are certain keywords, there are certain descriptions, and I don't want to click on every name on every result. I want to analyse it rather quickly. And there's sometimes a huge pool of information which you have to, yeah, identify or sort, relatively quickly and in terms of data management, I would fully agree that the purchases nowadays should be able to efficiently or effectively analyse a huge amounts of data to really get results quickly (…) So you really have to be fit with data"* – Participant 3	P2, P3, P6, P8
	Increased KPI tracking	*"Increase the number of tasks so we have more KPI's which are also floating around in the organisation which we need to fulfil. On the other hand, working more with data also makes your job easier because you can just share: ok we made a data-driven decision."* – Participant 6	P2, P6, P8

4.2 Overcoming Bounded Rationality in Procurement Decisions in Strategic Sourcing

The interview partners acknowledged the humans' cognitive limitations in procurement decision-making, such as information overload, cognitive biases and reliance on subjective human opinion of their colleagues. They particularly noted how digital tools enable data-driven decision-making leading to more informed, rational and objective decisions to be made. Almost all interview partners stated that having access to maximum amount of information is crucial for making educated strategic decisions in procurement. The relation between maximised information access and data-driven decision-making has been traceable across seven participants. An example of such is illustrated by the quote *"if we think about both supplier selection and negotiations, it's most of the time a big question of having all information that you need in order to make a decision"* from Participant 9. The use of digital tools enables increased access to information promoting informed decision-making whilst allowing the decision-maker to avoid falling into the trap of their cognitive shortcuts.

Interview partners particularly highlighted the use of KPIs for benchmarking and access to data which contributes to the reduction of heuristics in making decisions. This is also reflected by Participant 8, *"We'll go for this supplier because the prices are decent (…) That's genuinely how it used to go (…) Then you make that decision like it was a lot of guesswork and it was easy. But now, because there's so much data. You'll get questioned more as well"*. The use of digital tools in decision-making contributes to the shift from subjective human-based judgement towards data-driven decisions that allow procurement professionals to enhance their position in negotiation. However, there was no mention of current use of emotion AI or other augmented negotiation analytics that would allow to reduce the cognitive overload throughout the negotiation itself.

Whilst participants admitted the increasing use of digital tools in procurement activities, they were hesitant to implement them in some strategic sourcing activities, particularly due to the nature

of their product where either strategic sourcing are highly customised activities or simply the lack of trust in systems producing credible information in highly complex environments. On the other hand, other participants stated the opposite – reflecting on how the use of task augmentation drives data-driven decision-making thanks to the elimination of human errors when working with data manually, which is illustrated by the quote, *"I've worked in environments where we didn't have those tools as well, where everything was being done in Excel (…)It was a lot of work to update it, and you never really know. Like you, we didn't really know if the data was accurate like there was a lot of guesswork and eliminating that guesswork will lead to better decisions because you have certainty now you have. OK. These are the real numbers (…), when you have accurate data, you can also predict",* from Participant 8.

An important aspect mentioned, was the notion of cognitive overload that occurs from exposure to large amounts of data. Digital tools such as AI or data visualisation software are able to reduce the cognitive overload, as mentioned by Participant 9, *"All these 1000 lines of code are right in the in the cache of that agent, and they can really access every line and have all that information at hand, whereas I am as a human, I could only memorise maybe five of these lines of information. Not the best in case of decision-making (…). But if I think about now being in a negotiation and having to understand, oh, what are all my market alternatives, or what are the different suppliers or what are the trends that I'm not seeing? (…) It's just an immense amount of data that you need to have at hand to be very reactive in the situation".* However, while the cognitive overload can be reduced through task augmentation, the increased data exposure is also associated with the need to deal with increasingly complex information.

4.3 Effects on Processing Complex Information in Strategic Sourcing Activities

The respondents recognised both positive and negative effects of the implementation of digital technologies in strategic sourcing. As processes increase in complexity, especially as there are large amounts of data available, this can both simplify as well as impede information complexity management in strategic procurement activities.

As a positive effect, increased control thanks to the availability of data was acknowledged. Additionally, the complexity of information management is substantially reduced thanks to the use of integrated ERP systems as they provide a centralised data storage environment where all information is available. Participants acknowledged that in supplier scouting and negotiation processes, the use of AI is particularly helpful to understand market pricing ranges and should-cost models for raw materials or products where they are lacking expertise in. This allows them to achieve leverage in negotiation. Interview partners reported the use of data visualisation tools, such as dashboards as well as business intelligence (BI) that improve overviews of large amounts of data in a quick manner. Some kind of use of data visualisation tools is determined across seven interview cases, however, visual data still requires to be interpreted which leads to the growing complexity of information management.

As a negative effect, where complexity within procurement increases due to rising amount of data availability, interview partners acknowledged the need to perform data analysis to understand and act upon the data available. Additionally, participants particularly noted activities that impact the way they engage with complex information such as validation of digital data, especially the ones produced by AI, data analysis and the need to prompt AI correctly to receive meaningful output. Types of tools and their role in increasing or decreasing complexity are summarised in the Table 3 on the page above.

Furthermore, as information complexity is higher an important aspect that was mentioned across multiple interviews was the integration of additional criteria that need to be considered beyond price in supplier screening and selection processes. Interview partners consistently highlighted the increasing importance of three criteria, namely sustainability, risk assessment and compliance criteria. The integration of tools that enhance the evaluation of suppliers based on these criteria assures risk reduction throughout the sourcing process whilst also increasing the complexity in information processing due to greater amount of KPIs that suppliers needed to be evaluated against.

5. DISCUSSION: DIGITAL TOOLS FOR DRIVING STRATEGIC VALUE

5.1 The Early Stages of Integrating Task Augmentation in Strategic Sourcing

The results suggest that whilst there is a growing interest in the implementation of Industry 4.0 technologies to augment human activities within strategic sourcing processes, companies are still in the experimental stages of implementing such technologies that go beyond automating routine tasks and would rather focus on enhancing strategic decisions in purchasing. This aligns with Herold et al. (2023, p. 425) who presented scepticism regarding implementing digital technologies in procurement, where only 28% participating companies showed advanced use of digital tools within the procurement function.

To understand the outcomes of this research in the light of research questions *"How does task augmentation help overcome bounded rationality in procurement decision-making in strategic sourcing processes?"* and *"How does task augmentation affect PSM professionals' ability to process complex information throughout strategic sourcing processes?"*, this study presents the following diagram (Figure 1) as an extension to Colombo et al. (2023, p. 9).

In line with the research, Figure 1 presents additional elements and suggests what kinds of task enlargement in strategic level activities is carried out by procurement professionals (Colombo et al., 2023, p. 10). In particular, the results suggest that processing complex information with the implementation of digital technologies leads to additional activities such as conducting effective data analysis, validating AI output and using AI prompting in correct way to obtain desired outcome. Additionally, given the increased information exposure, procurement professionals must also consider additional criteria which include sustainability, risk assessment and compliance with regulations in strategic sourcing processes such as supplier selection and evaluation.

As presented in Figure 1, two drivers for the implementation of Industry 4.0 technologies within the purchasing function at a strategic level includes data aggregation and effectiveness. Firstly, digital tools can be used to collect data from different sources and store it altogether in an integrated system. Secondly, increased effectiveness is associated with augmentation which supports procurement activities by promoting informed decision-making (Colombo et al., 2023, p. 10). The results of the interviews support the findings of Colombo et al. (2023, p. 10) where the use of digital technologies enhances human decision-making processes by transforming large amounts of data into meaningful and visual information. Particularly, as presented in Table 3, positive effects of implementing digital tools to support complex information processing include data visualisation and

centralised information storage. However, data visuals yet still require analysis and interpretation, thus the increased emphasis on data analysis abilities as one of the task enlargement elements presented in Figure 1. In order to overcome the limits of bounded rationality and cognitive biases, increased emphasis should be put on data analysis capabilities.

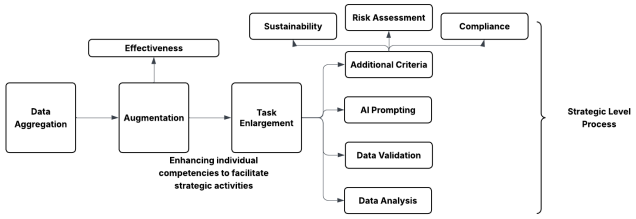

Figure 1. Adapted Diagram from Colombo et al. (2023)

5.2 Theoretical Contributions

This research contributes to existing literature by proposing an extension to the framework from Colombo et al. (2023, p. 10) at strategic process level and represents additional key activities that are becoming increasingly important as exposure to data increases (Figure 1). In line with the findings of Bienhaus and Haddud (2018, p. 978) who suggest that the procurement role extends to the collection, analysis and processing of data thanks to digitalisation, this research determined additional elements for task enlargement, namely AI prompting, data validation and analysis, additionally with extended evaluation criteria during supplier selection and evaluation. Research by Delke et al. (2023, p. 7) presents the role of a data analyst as key in era of Industry 4.0, where it has the highest agreement levels amongst experts, given its high impact on PSM. This study identifies human interaction with AI in terms of the ability to prompt it effectively and validate its output as elements within new skillsets required amongst procurement professionals separately from data analysis, whilst research by Delke et al. (2023, p. 8) incorporates this as part of the data analyst role. Schiele et al. (2022, pp. 163-164) acknowledges the need for professionals to organise AI tasks and interpret outputs, whilst the growing data availability further empowers employees to make data-driven decisions.

Literature suggests that increasing external complexity further complicates the purchasers' ability to extensively analyse data. Purchasers are recommended to put greatest emphasis on the rational evaluation of data in combination with experience and emotion (Kaufmann et al., 2017, p. 83). This notion can be leveraged through task augmentation as respondents in this research consistently referred to the positive effects of digital tools enabling data-driven decision-making. This ensures a more rational and analytical perspective on the data presented, thus allowing purchasers to avoid the limits bounded rationality. Besides that, augmentation can further extend these findings by providing maximised information access that shows further contributions to informed, data-driven decision-making across most participants in this research. Additionally, Srai and Lorentz (2019, p. 90) identifies knowledge and information as an important enabling element which underlies decisions with regards to sourcing strategies and other supplier-related decisions such as selection and relationship management. The participants in this study emphasised the increasing importance of maximising access to information to make decisions, where current implementations are mostly associated with accessing big data through BI tools and use of AI for better estimating price ranges in preparation for negotiations. In the research regarding augmentation, Herold et al. (2023, p. 438) pointed out a direction for investigating the extent to which procurement professionals trust digital tools over their personal judgement. Whilst this study aligns with the assumptions of limited trust in advanced integration of digital tools, the findings present a link to the extent to which AI systems are currently trusted by professionals. It is represented by purchasing professionals using AI but acknowledging the need to validate its output as well as to ensure to prompt it correctly to achieve desired outcomes.

Allal-Chérif et al. (2021, p. 74) present the use of AI-integrated softwares in effective decision-making regarding CSR policies, supplier selection and risk reduction. The results of this study present these as key additional criteria procurement professionals must consider in supplier scouting, selection, evaluation and subsequent benchmarking (Figure 1). AI-based procurement enables purchasing professionals to assess risk criteria, such as geopolitics, finance and environment, thus leading to more effective mitigation strategies (Allal-Chérif et al., 2021, p. 74).

5.3 Managerial Contributions

This study emphasises the use of digital tools for enhancing human judgement rather than replacing the human role in strategic procurement decisions. The elements of task enlargement (Figure 1) within the procurement role provide recommendations for managers on what kinds of skillsets employees need to develop in order to maximise the usage capacity of digital tools available, rather than using them superficially or in a limited number of contexts. By taking greater advantage of technological advancements, companies will be able to strengthen their competitive position and streamline their strategic sourcing competencies. This is particularly important as the procurement function has shifted from being purely transactional towards strategic (Herold et al., 2023, pp. 424-425). Decision makers in procurement should explore opportunities for shifting from the use of Excel in processes related to supplier scouting, selection and evaluation in favour of softwares that are able to extensively analyse larger number of variables, particularly associated with criteria such as sustainability, risk assessment and compliance as regulations tighten.

Whilst participants commonly reported using Excel to support strategic procurement decisions, purchasing managers can investigate integrating digital tools for processes such as spend management, supplier scouting and evaluation. Given the increasing importance of criteria such as sustainability, compliance and risk assessment established in this study, managers can invest in platforms such as EcoVadis which enables evaluation of supplier risk across benchmarks such as compliance and sustainability. By providing a data-driven frameworks for supplier assessment, EcoVadis allows informed decision-making regarding supplier selection, evaluation and relationship management (EcoVadis, 2025). Companies can not only mitigate sustainability and compliance related risks in supplier selection but also base decisions on extensive third-party data. Moreover, some companies use a spend management tool which in comparison to Excel does not require manual data entry, thus ensuring data accuracy as well as eliminating reliance on assumptions associated with cognitive biases. AI-powered platforms such as Coupa provide real-time data and visuals that enhance strategic decision-making. Besides that, the tool allows streamlining of contracting processes and risk assessment by considering criteria such as sustainability and compliance (Coupa, 2025). In line with Gottge et al. (2020, p. 730), by integrating such spend management tools, will reduce transaction costs such as information search and monitoring as well as providing a single integrated system for procurement processes.

6. LIMITATIONS AND FUTURE RESEARCH

One of the limitations of this research includes a small sample size consisting of ten interview partners each operating in a different industry, thus impeding the opportunity to determine similarities of task augmentation adoption across industries. Future study should consist of a larger sample size and include interviewees from similar industries to explore in detail the opportunities for implementation of task augmentation in highly customised or regulated environments at further strategic processes such as negotiation execution phase. Whilst cases were categorised by stages of adoption of Industry 4.0 technologies through the lense of technology maturity model by Schiele and Torn (2020), this was done based on researcher's personal judgement from how technology use in the company was characterised by the participants. In the future, research should systematically divide the cases across the four stages to enhance the understanding of the role of task augmentation in strategic sourcing. Future studies should extend towards more companies that are attributed to the third or fourth stages of technology adoption within the procurement department as it will develop insights into the integration of AI and augmented tools in high-level strategic decisions within the procurement department, namely in supplier selection, negotiation and supplier performance tracking. However, given the beginning stages of AI integration in strategic procurement decisions, future research should explore the role of designing powerful AI prompts in maximising the effectiveness of task augmentation in strategic-level decisions in PSM. This will allow to develop models that present effective strategies for human interaction with AI in strategic purchasing processes as well as aid the development of employee training, thus contributing to better definition of the concept of task augmentation in PSM.

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9. APPENDIX

Appendix A: The Interview Guide

(Greeting), introduce us as researchers

Is it possible to record the interview?

Purpose of research: This study explores how digital tools enhance procurement professionals' decision-making in strategic sourcing

Purpose of interview: to gain a real-world insight from your expertise into the challenges and opportunities of procurement decision-making that we can further apply in our research

Explain the interview procedure: we will ask you a set of open-ended questions and you can answer them freely, however, in case it seems like it is getting off topic, we will provide additional guidance.

Question: **Do you have any questions before starting the interview?**

----------INTERVIEW START----------

BLOCK 1*: General industry background, position, how does work look like in organisation*

1. Could you please introduce yourself and describe your current role and general experience
2. What does the process of supplier selection and negotiation typically look like in your company?

BLOCK 2: Technology use at the company, how they help, how they are used (introduce task augmentation), decision-making

Introduce and explain I4.0 technologies if needed, add context for SCM/Procurement (Schiele et al., 2022)

3. What kinds of technology are you already using (if any) to support your decision-making in supplier selection and negotiation?
4. How do these tools assist you in managing information? Could you give some examples? How do they look like?
5. How do these tools assist you in making choices/decision-making in supplier selection and negotiation?

BLOCK 3: Bounded Rationality and strategic decision-making

With technology, we are exposed to more information (more variables in supplier selection/negotiation)

Humans can only process a limited amount of information due cognitive limitations, emotions and information overload. We oftentimes settle for good-enough solutions, such as we settle for the same supplier who's already in use, although it might not be the best option. For example, our brain takes into consideration 2 variables (price & distance of the supplier), whereas a software would consider many more variables (sustainability, political risk etc.)

6. How do these digital tools help you make better/more-informed decisions as you have access to more information?
7. Can this software generate insights that are outside the typical elements any purchaser would consider? Does it take into consideration human blind-spots?
    a. Have you ever experienced a situation where the system supported you in considering variables you might have otherwise overlooked (information blind spots)?
8. How do the digital tools/software promote consistency, objectiveness, enhanced analytical reasoning (based on factual data) and better understanding of the outcome of the decisions of purchasing professionals?

BLOCK 4: Task enlargement

(Colombo et al., 2023, p. 9)

9. How does exposure to an increased number of information/variables add to the complexity of your decision-making process? For example, does it take more time for you to make a decision, given the availability of additional data
10. How does the use of technology change your tasks/work activities as a procurement professional?
11. What tasks does it remove and what new tasks does it create?

BLOCK 5: 2nd Researcher's questions – Prerequisites for I4.0 integration

12. When you were implementing these tools in your organization, what were the most common barriers you encountered? (Consider Technical, Competencies/Skills, Environmental/Organisational barriers/requirements)
13. What had to change in your organization's processes, people and/or business structure to cope/incorporate with the increased level of digitalization?

BLOCK 6: Future of using technology in procurement decision-making

14. How do you see the future development of technology used in decision-making related to supplier selection and negotiation?

Appendix B: Process Diagram from Data Collection to Conclusions