A new maturity model for the deployment of advanced analytics in strategic procurement: a case study from the aviation industry

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I. ABSTRACT

Digital transformation is an immensely popular topic, as evidenced in both academic and practitioner publications. Transforming into a digitally mature organisation is viewed as fundamental to successfully advance and prosper in the present business environment in general and in industry-specific contexts such as in the aviation industry. Not adopting state-of-the art technology such as advanced data analytics can pose risks that endanger business continuity. On the other hand, the deployment of technology alone goes against the widely held view that to evolve in a holistic manner and to embrace the multidimensionality of change is necessary to derive the full benefits of digital transformation.

Strategic procurement is one of the corporate functions, for which the status of digital maturity and its progression are under-researched as regards theory, and unclear in practice. Contemporary strategic procurement functions, externally sourcing up to 80% of a company's revenue, make a significant contribution to overall corporate success. As a hub in a network of internal and external stakeholders, the function is ideally positioned to benefit from the deployment of advanced data analytics.

Digital maturity models assist in comprehending the digital constitution of an organisation and in providing guidance on the journey towards an advanced maturity. This research adopts a case study approach, using qualitative data from in-depth interviews with industry practitioners, to develop and apply a digital maturity model for the deployment of strategic procurement analytics. Developing a domain-specific digital maturity model enhances academic comprehension and addresses the lack of such models for strategic procurement. By applying the model, the current deployment of advanced data analytics in the domain of strategic procurement and its effects on processes, people, and structural arrangements can be analysed.

This research presents a snapshot of the digital maturity of the strategic procurement function of an aircraft manufacturer. The application of the model also provides guidance for

practitioners in progressing digital maturity, moving from current to targeted levels of maturity in strategic procurement. As such, the thesis makes a contribution to both theory and practice. However, the research clearly has its limitations. It is based on one in-depth case study in a particular industry sector, and thus cross-industry generalizations concerning data analytics in strategic procurement must be treated with caution.

II. DECLARATION OF ORIGINAL CONTENT

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by specific reference in the text. No part of the thesis has been submitted as part of any other academic award. The thesis has not been presented to any other education institution in the United Kingdom or overseas.

Any views expressed in the thesis are those of the author and in no way represent those of the University.

Signed [redacted]..... Date .[redacted]

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IV. DEDICATION

To *David,* my love and partner, who encouraged, supported, reassured, challenged and pushed me to achieve this part of my “life-bucket-list”.

To *Jannik*, who motivated and always kept telling me: “Mom, you can do it!”

To *Johanna*, whose determination to pursue an aspiration inspires me.

To *Dominic*, my friend, whose tireless entrepreneurship and creativity was a true inspiration. I wish we had more time to realise some of his ideas together.

“The world as we have created it is a process of our thinking.

It cannot be changed without changing our thinking.”

Albert Einstein

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VIII. LIST OF ABBREVIATIONS

3D	three dimensional
3S	Supplier to supplier shipment
4D	four dimensional
777-200 ER	777-200 Extended Range
ADA-CMM	Capability model for advanced analytics
AGV	Automated guided vehicle
AI	Artificial intelligence
AI BW	Airbus Business Warehouse
API	Application Programming Interface
AR	Augmented reality
ARJ21	Advanced Regional Jet Xiangfeng
ATAG	Air Transport Action Group
BA	Business analytics
BDA	Big data analytics
BDMM	Big Data Maturity Model
BME	Bundesverband Materialwirtschaft, Einkauf und Logistik e.V.
BoM	Bill of material
CDAO	Chief Data and Analytics Officer
CDO	Chief Data Officer
CEO	Chief Executive Officer
CO_2	Carbon dioxide
Cobot	Collaborative robot
COMAC	Commercial Aircraft Corporation of China

ConBid	Consolidated material supply process
Covid	Corona virus disease
CPO	Chief Procurement Officer
CRM	Customer Relationship Management
CSO	Chief Sustainability Officer
D&A	Data and analysis
DANN	Deoxyribonucleic acid
DataOps	Data operations
DBMS	Database management system
dbPaaS	Database Platform as a Service
DDD	Data-driven decision making
DDMS	Digital Design, Manufacturing and Services
DMM	Digital maturity model
DOI	Digital object identifier
DTO	Digital Transformation Officer
DVD	Digital video disc
DX-SAMM	Digital Transformation- Self Assessment Maturity Model
e.g.	exempli gratia
E2E	End-to-end
EASA	European Union Aviation Safety Agency
e-commerce	electronic commerce
e-procurement	electronic procurement
ERP	Enterprise resource planning
et al.	et alii, et aliae, et alia
EU	European Union

FinOps	Financial operations
GAAM	Gartner's Analytics Ascendancy Model
GDP	Gross domestic product
GMF	Global Market Forecast
HANA	High performance analytic appliance
HTAP	Hybrid transactional/analytical processing
i.e.	id est
ICAO	International Civil Aviation Organization
ICT	Information and communication technology
IDC	International Data Corporation
IDG	International Data Group
IMD	International Institute for Management Development
incl.	including
IoT	Internet of Things
IP	Intellectual Property
iPaaS	integration Platform as a Service
IT	Information technology
KPI	Key performance indicator
LCC	Low-cost carrier
M&A	Mergers & Acquisition
MFT	Multi-functional team
MM	Material management
MMS	Multimedia messaging service
NASA	National Aeronautics and Space Administration
NatCo	National Company

neo	new engine option
net	Network
Nm	nautical mile
no.	Number
NO_x	Nitrogen oxides
OEM	Original equipment manufacturer
OTD	On time delivery
p.a.	per annum
P2P	Procure-to-pay
para.	Paragraph
PBA	Procurement business analyser
PCF	Provisional conceptual framework
PDA	Personal digital assistant
pdf	portable document format
PhD	Doctor of Philosophy
PMT	Processes methods technology
PSM	Purchasing and supply chain management
POC	Proof of concept
PwC	PricewaterhouseCoopers
PwC	PricewaterhouseCoopers
R&D	Research and development
R.I.P.	Rest in peace
RO	Research objectives
ROI	Return on investment
RPA	Robotic process automation

RPK	Revenue passenger kilometres
Saas	Software as a service
SAF	Sustainable aviation fuels
SAP	System applications and products in data processing
SCA	Supply chain analytics
SCM	Supply chain management
SDD	Spare direct delivery
SDG	Sustainable development goals
SDG	Sustainable Development Goals
SMART	specific, measurable, attainable, relevant, and time-bound
SPA	Strategic procurement analytics
SQL	Structured query language
SRM	Supplier relationship management
TCO	Total cost of ownership
U.S.	United States
UN	United Nation
USA	United States of America
VMI	Vendor managed inventory
VR	Virtual reality
vs.	Versus
VUCA	volatile, uncertain, complex, and ambiguous business conditions
web	world electronic base
WTO	World Trade Organization
XLR	eXtra Long Range
ZB	Zettabytes

CHAPTER 1: INTRODUCTION AND OVERVIEW

1.1 Introduction

This chapter provides the background to the research study which addresses the digital maturity of the strategic procurement function in an aircraft manufacturer. The relevance and value of this thesis derives from the focus on the peculiarities of the industry and its specific business environment, including competition and market forecast issues and the impacts from global developments on the way strategic procurement is set-up and operates.

The chapter comprises five sections. Following this introduction, the key characteristics of the aviation industry, with a focus on aircraft manufacturers, are outlined in section 2. In addition, contemporary trends that shape the industry stakeholders are presented. Subsequently, in section 3, the research motivation is articulated. Then, in section 4, the research subject, objectives and the importance of the research are introduced. The chapter is concluded with a summary, and an overview of the content and structure of the thesis as a whole, in section 5.

1.2 Background: The aviation industry

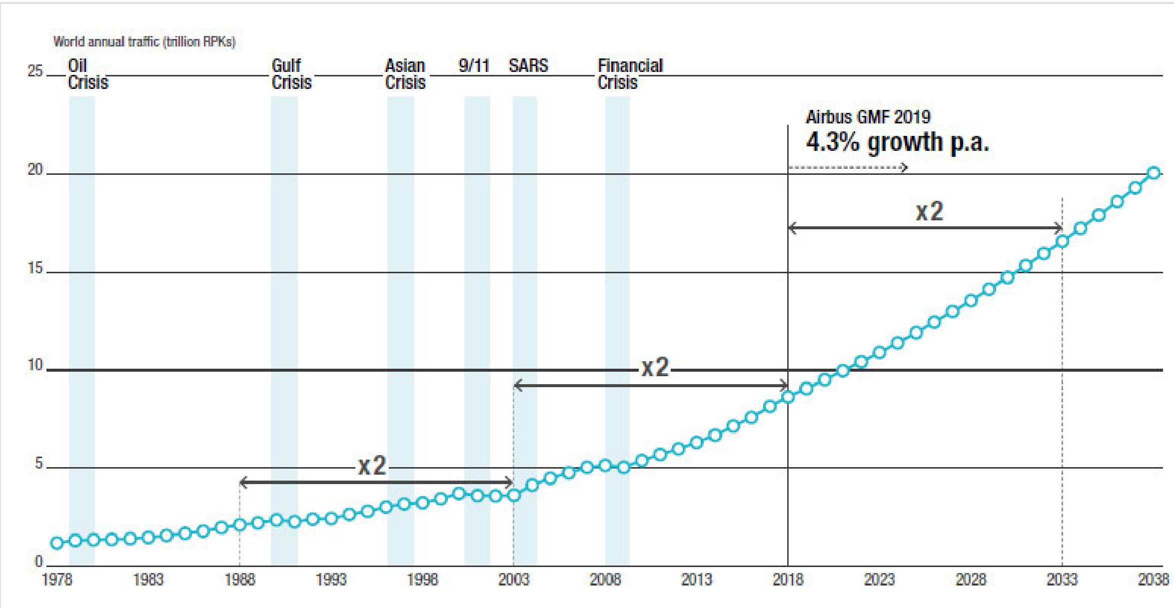
1.2.1 The industry

The aviation industry is comprised of the air transport sector, including airlines and airports, and the aircraft manufacturing sector. Prior to the Covid-19 pandemic, starting in 2019, the air transport industry accounted for $961.3 billion directly and $816.4 billion indirectly of the world's gross domestic product (GDP) and supported 11.3 million jobs directly and 18.1 million jobs indirectly worldwide (ATAG, 2020). As per GDP, the industry is larger than the automobile manufacturing and the pharmaceutical manufacturing sectors.

In addition, by offering global connectivity, aviation contributes further value to the world economy and has made a significant impact on people's perception of distances and the so-called "shrinking of the world". The advancement of aircraft technology and the increasing affordability in the transportation of goods and people has altered mobility patterns. Aviation has made an “incalculable contribution to global trade and economic development” (Asquith, 2020, para.7). In 2018, global air traffic accounted for 4.4 billion passengers carried (Airbus, 2020, p.34). Prior to the Covid-19 pandemic, world annual air traffic was estimated to further increase by 4.3% per year on average for the next two decades from 2019-2038 and to double approximately every 15 years (see Figure 1). According to the Airbus Global Market Forecast (GMF) from 2020, the continuously growing world annual traffic, measured in Revenue Passenger Kilometres (RPK), was viewed to be resilient even in the phases of political and economic crisis such as oil crisis in 1978 and 9/11 in 2001. Hence, aviation was forecast to benefit from a steady gain (Airbus, 2020, p.37).

Figure 1

World annual traffic (trillion RPKs), 1978-2038



Note. Revenue Passenger Kilometers (RPK) is the measurement of number of kilometers travelled by paying passengers. The definition is from “*Total domestic aviation passenger kilometers”* (para.1), by Our World in Data, 2018 (https://ourworldindata.org/grapher/total-domestic-aviation-km?tab=chart);

From “*Global Market Forecast Cities, Airports & Aircraft 2019-2038”* (p.11), by Airbus, 2020 (https://www.airbus.com/sites/g/files/jlcbta136/files/2021-07/GMF-2019-2038-Airbus-Commercial-Aircraft-book.pdf).

Despite global events such as 9/11 or successive financial crises, world annual air traffic has continuously doubled in a 15-year period, and has thus been considered resilient to external shocks.

An important role in the air transport industry is played by the Aviation Mega-Cities (AMCs) where approximately 25% of the urban population lives worldwide and nearly 80% of the world's airlines operate at present (Airbus, 2020, p.3). AMCs are defined as "cities with more than 10,000 daily international long-haul passengers" and are understood as "centres of urbanisation and wealth creation" (Addepalli et al., 2018, p.6). The Airbus Global Market Forecast (GMF) underlines the significant role of air transport in connecting cities and estimates an increase in AMCs from 66 in 2018 to 95 in 2038, adding Lagos, Muscat, Rio de Janeiro and Philadelphia, amongst others, to the list. 40% of all passenger travel through AMCs on almost three quarters of long-haul flights and more than one third of short-haul flights (Airbus, 2020, p.3). In total, the global air transport network spans over approximately 55,000 individual routes and is understood to further expand (Airbus, 2020, p.34). In aviation, economic development is a strong indication of market demand (Addepalli et al., 2018).

North American and European airlines transport about 48% of the traveling population (Boeing, 2016, p.23). By 2035, according to forecasts, Asia-Pacific routes will dominate air traffic with 10 of the biggest flows. China will outperform North America as the world's largest air traffic market over the next two decades, followed by the demand for domestic India routes. Generally speaking; the largest share of global air traffic originates from countries in Asia (Airbus, 2020).

The rise and success of low-cost carriers (LCCs) in the past results from an evolution of airline business models, and the expansion of a present market share of 25% (Airbus, 2020, p.24) is expected to continue to reach 32% by 2035 (Boeing, 2016, p.25). Business models of airlines will continue to evolve in the future, such as the expansion of LCC in the long-haul flight business (Addepalli et al., 2018).

Despite the strong correlation between economic development and market demand, the aviation industry experienced a steady annual growth of 4.3% over the three past decades and was able to overcome perturbations such as economic recessions, oil-crisis, near pandemics, wars and security threats within a short period of time. Passenger numbers rebounded quickly after economic or geopolitical shocks, which lead to the profiling of the aviation industry as an anti-cyclical and shock-resilient industry. Since 2010, the industry saw an overall annual growth of more than 6% (Rutkowsky et al., 2020, p.1).

In February 2020, the Covid-19 pandemic severely hit the industry. Within a few weeks air traffic collapsed (see Figure 2). Big carriers worldwide stopped their services to China by the end of January 2020 and the beginning of February 2020 which meant a scenario impossible to imagine before (Pogkas et al., 2020, para. 2). By April 2020, European airlines had suspended over 90% of their flights (Rutkowsky et al., 2020). Around two thirds of the world's commercial aircraft were parked up or in storage (Kingsley-Jones, 2020).

Figure 2

Reduction in the number of scheduled flights during Covid-19 between February and April, 2020

Note. Adapted from "*The future of aviation: could COVID-19 be the first and final crisis for airlines"* (p.3) by Rutkowsky et al., 2020 (https://www.de.kearney.com/documents/291362523/291368847/The+future+of+aviation--could+COVID-19+be+the+first+and+final+crisis+for+airlines.pdf/b0b1aa65-5544-f278-6b05-b66fd41081a5?t=1608449911000).

The aircraft manufacturers and supply chain ecosystem suffered from an unprecedented decline. Manufactured aircraft were not delivered to customers. Airlines negotiated to postpone deliveries. In April 2020, Airbus announced that production rates were cut by a third compared to the pre-Covid-19 level. Immediate "cash-out containment" actions to secure financial liquidity and long-term cost structure adaptations were put into force to anticipate a longer downturn or recovery (Airbus, 2020a, para.1). Immediate business adaptations in procurement included the cancellation of purchase orders to suppliers or delay of delivery dates while assessing and managing supplier-related contractual claim risk. Airbus Chief Executive Officer (CEO) Guillaume Faury summarised the situation: “We are now in the midst of the gravest crisis the aerospace industry has ever known. (…) We’re focused on the resilience of our company to ensure business continuity” (Airbus, 2020a, para.1). Revenues for the commercial aircraft division decreased by 37% to €34 million (2019: €55 million), predominately caused by 297 aircraft less delivered compared to the previous year (Airbus, 2021, p.16).

In 2022, the aviation industry recovered from the Covid-19 pandemic reaching approximately 70% of 2019 air traffic volumes. The International Civil Aviation Organization (ICAO) projects pre-Covid-19 volumes in terms of passenger figures to be reached in 2024 (ICAO, 2023).

1.2.2 Aircraft market forecast

The business environment prior the Covid-19 pandemic was characterised by favourable market conditions and rapidly growing order books which had direct impact on the prosperity of aircraft manufacturers. Both market-dominating aircraft manufacturers, Airbus and Boeing with their respective, offering a directly competing product portfolio (see Table 1), predicted a demand of more than 40,000 passenger and freight aircraft over the next two decades (Airbus, 2020, p.3; Boeing, 2020, p.3).

Table 1

Portfolio passenger aircraft of industry-dominating players- Airbus vs. Boeing

Category I: Narrowbodies

Company	***Type***	***Seat-Capacity***	***Rang in nautical miles (NM)***
Airbus	A220-100	100-120	3,450
Airbus	A220-300	120-150	3,400
Airbus	A319 neo	120-150	3,650
Boeing	737-7	138-153	3,850
Airbus	A320neo	150-180	3,450
Boeing	737-8	162-178	3,500
Boeing	737-9	178-193	3,300
Boeing	737-10	188-204	3,100
Airbus	A321neo	180-220	4,000
Airbus	A321XLR	180-220	4,700

Category II: Widebodies

Company	***Type***	***Seat-Capacity***	***Rang in nautical miles (NM)***
Boeing	787-8	248	7,305
Airbus	A330-800	220-260	8,150
Airbus	A330-900	260-300	7,200
Boeing	787-9	296	7,565
Airbus	A350-900	300-350	8,300
Boeing	787-10	336	6,330
Boeing	777-8	395	8,745
Airbus	A350-1000	350-410	8,700
Boeing	777-9	426	7,285
Boeing (produced until 01/2023)	747-8	467	up to 8,960
Airbus	A380	400-550	8,000

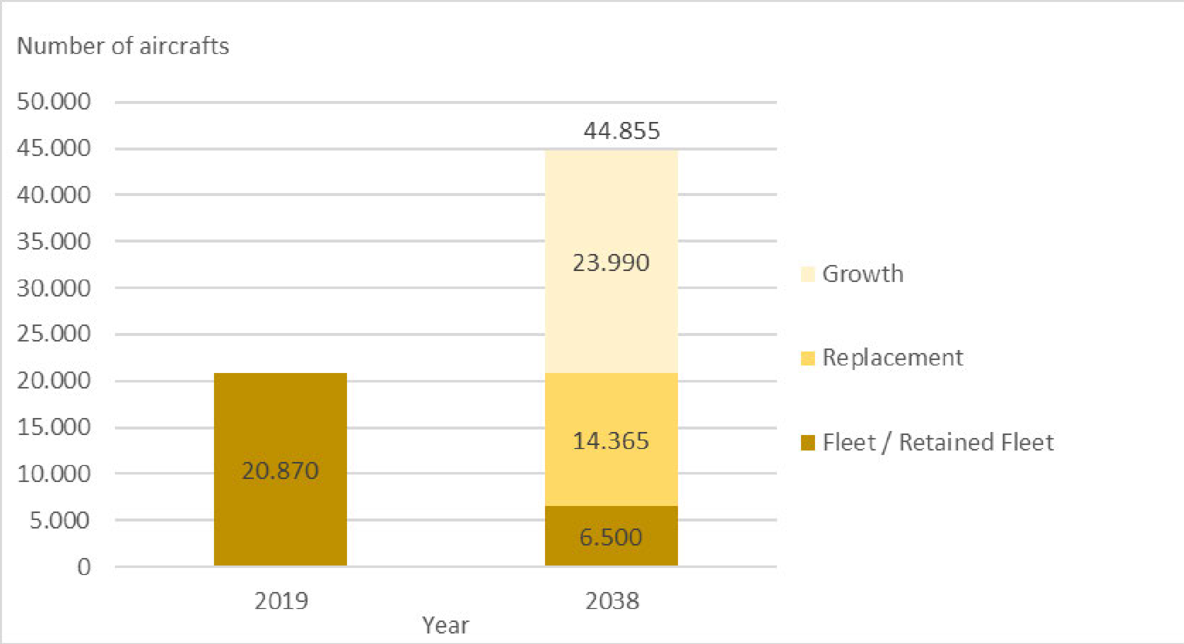
Note. New engine option (neo) means the implementation of advanced engines with 20% fuel saving and CO^2 reduction, eXtra Long Range performance (XLR) means the increase of range allowing a narrowbody aircraft operating large distance flights.
Adapted from "*Family Figures July 2022 Edition"* (p.3), by Airbus, 2022 (https://www.airbus.com/sites/g/files/jlcbta136/files/2022-07/AI-Family-Figures.pdf);

Adapted from "*Current Products & Services"* (para.1), by Boeing, 2023 (https://www.boeing.com/commercial/).

Prior to Covid-19, aircraft manufacturing experienced a “supercycle” resulting in an approximately five-year production backlog (Hader, 2020). Even though there are slight differences in figures, industry-dominating players agreed on the fact that there was an enormous demand in aircraft, whether that be growth or replacement of existing fleets (see Figure 3 and Figure 4). There were no availabilities for short time deliveries. In October 2020, the Airbus backlog stood at 7,441 aircraft which translated in to work of almost a decade (Airbus, 2020b, para.4.). Boeing reported a backlog of more than 5,146 aircraft as of August 2020 (Oestergaard, 2020, para.8). In order to satisfy the immense appetite for new airplanes, Original Equipment Manufacturers (OEMs) were determined to ramp-up the production rate for single aisle aircraft, the so-called “bread-and-butter” product of the industry to 70 or even 80 aircraft per month. These challenging ambitions are also reflected in the articulation of manufacturing as the highest ranked priority expressed by aerospace and defence industry stakeholders in an annual survey published by Roland Berger consultancy (Hader, 2020). The iterative formulation of operations as the number one objective over 6 years is an expression of the industry’s high pressure to deliver the committed number of aircraft to customers and an efficient manufacturing set-up as an indispensable prerequisite. Most respondents of a survey published in February 2020 expressed certainty about the prosperous development of the industry during the next 5 years (Hader, 2020).

Figure 3

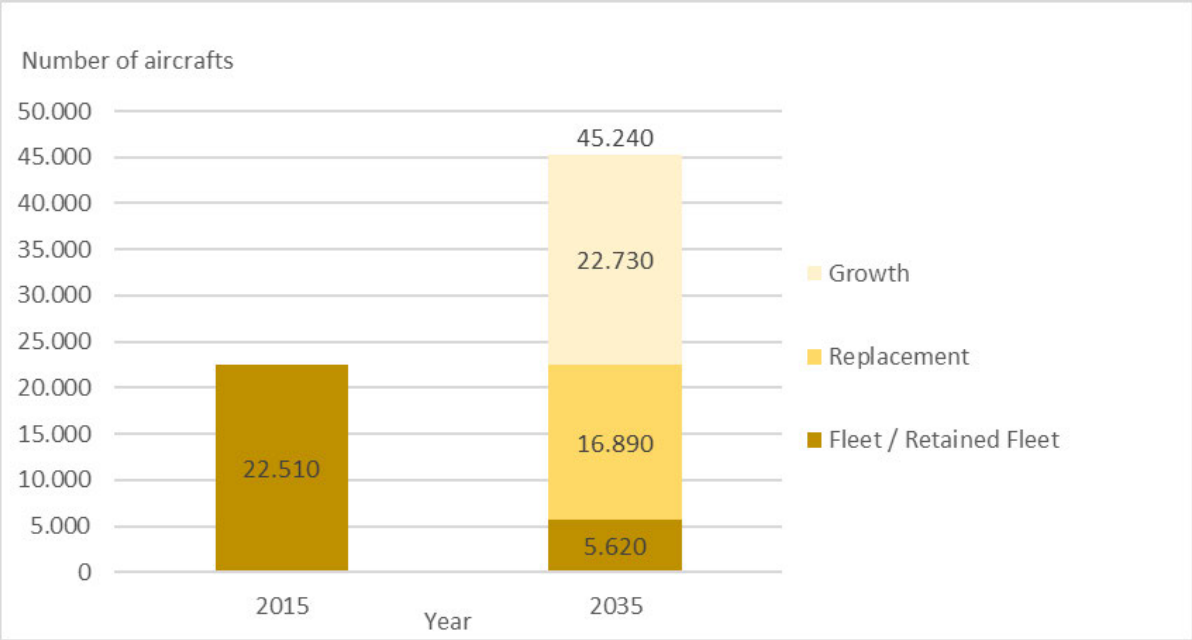
Airbus global market forecast, 2019-2038, pre-pandemic



Note. Adapted from "*Global Market Forecast Cities, Airports & Aircraft 2019-2038"* (p.53), by Airbus, 2020 (https://www.airbus.com/sites/g/files/jlcbta136/files/2021-07/GMF-2019-2038-Airbus-Commercial-Aircraft-book.pdf).

Figure 4

Boeing global market forecast, 2015-2035, pre-pandemic

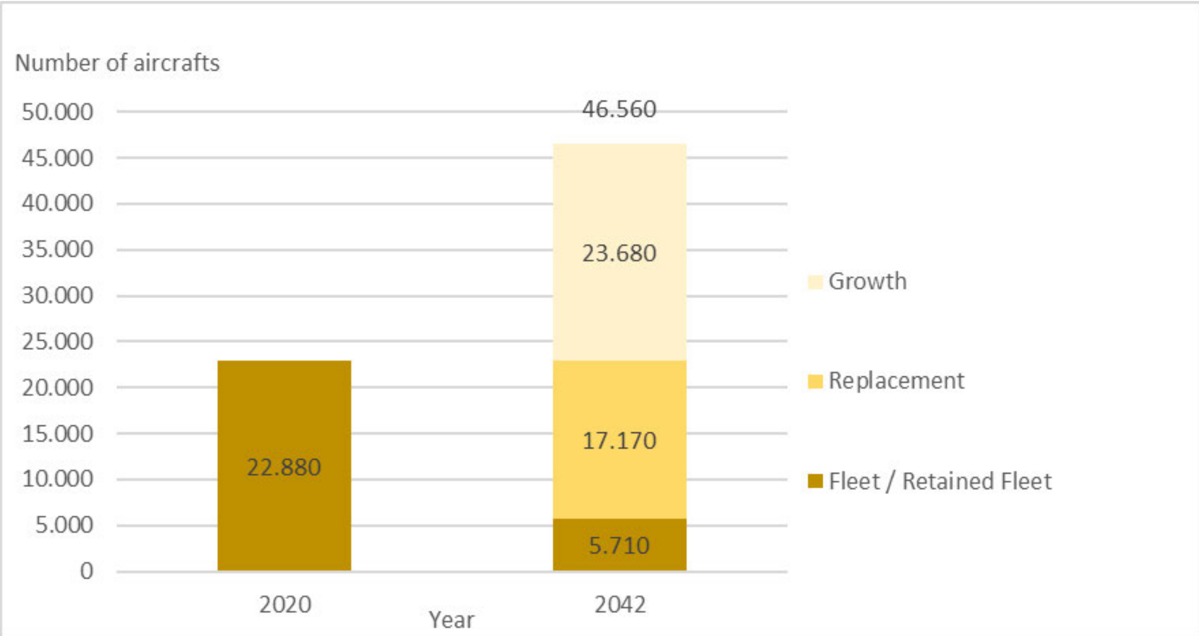


Note. Adapted from "*Current Market Outlook 2016-2035"* (p.14), by Boeing, 2016 (https://787updates.newairplane.com/Boeing787Updates/media/Boeing787Updates/cmo_print_2016.pdf).

Recent, post-pandemic assessments confirm the previously developed prognosis by OEMs such as Airbus and Boeing (see Figure 5 and 6). It assumes that the pandemic has not altered passenger behaviour in the long-term and air traffic volume will continue to recover and increase. This increase is expected to be bolstered by leisure trips and respective demand for civil aircraft. Business travel is expected to recover more slowly (Bouwe et al., 2021).

Figure 5

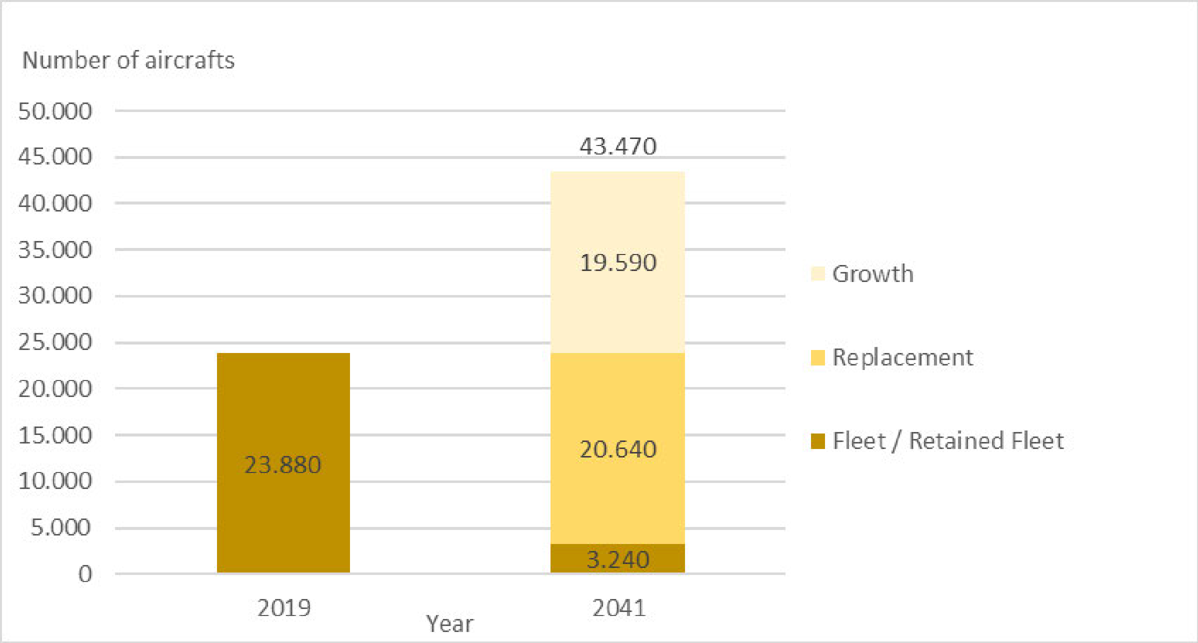
Airbus global market forecast, 2020-2042, post-pandemic



Note. Adapted from "*Global Market Forecast 2022",* (p.16), by Airbus, 2022a (https://www.airbus.com/sites/g/files/jlcbta136/files/2022-07/GMF-Presentation-2022-2041.pdf).

Figure 6

Boeing global market forecast, 2019-2041, post-pandemic



Note. Adapted from "*Commercial Market Outlook 2022-2041"* (p.13), by Hulst, 2022 (https://site-1747986.mozfiles.com/files/1747986/Boeing_CMO-2022-Hulst_Presentation_v01.pdf).

The forecast assumes the recurrence of the pre-pandemic challenge to satisfy the immense demand for passenger aircraft, and the limitations of the industry and its supporting systems in trying to cope with ever accelerating operations and increasing production rates. However, this concerns not only operations, but also supporting functions such as procurement and supply chain management as key contributors to a functioning value chain, in which new ways to enhance performance to secure a robust supply chain, reduce costs and time-to-market cycles will be required.

At present, OEM Airbus suffers from disruptions in the supply chain and consequently has had to the reduce the production rates of its best-selling aircraft, the A320 aircraft family, and failed to achieve delivery targets in 2022. Beyond loss of revenues, this has led to a loss of trust in the company by customers and shareholders (Pfeifer, 2023). The production target of 75 aircraft a month will slip to the end of 2026. The company struggles to attain pre-pandemic productivity levels for a variety of reasons.

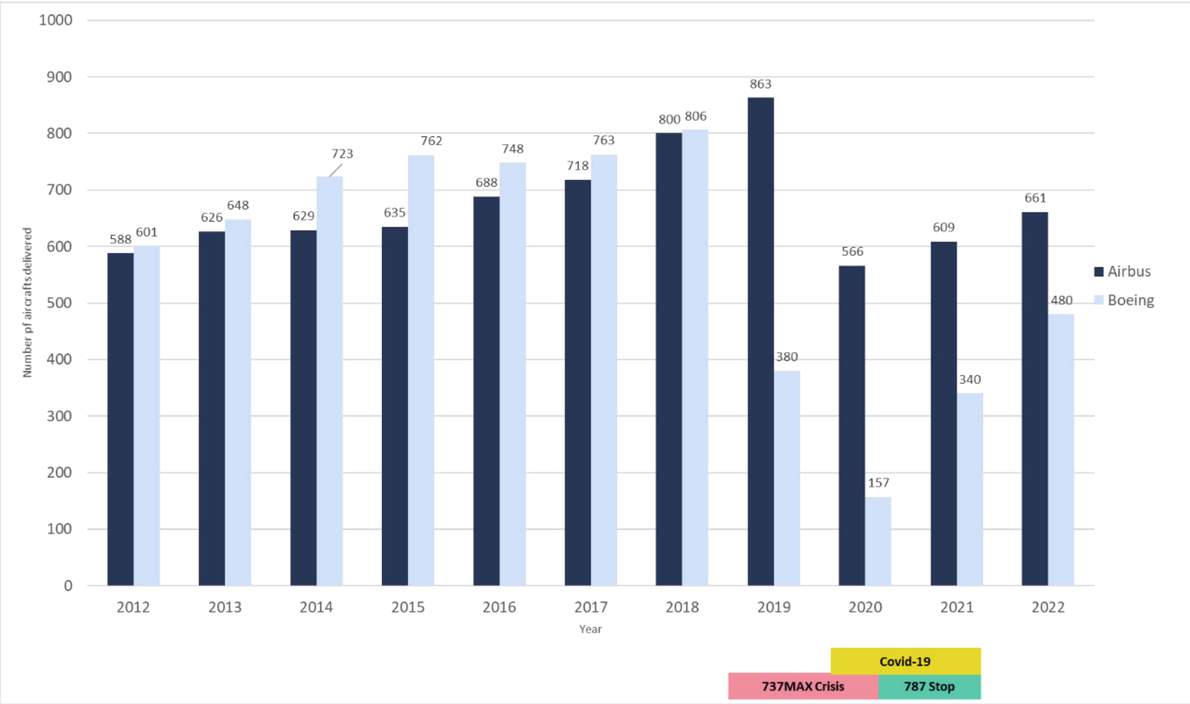
1.2.3 Competitors

The global aircraft market is ruled by a duopoly between Airbus, headquartered in Toulouse, France, and Boeing, home-based in Seattle, Unites States of America (USA), together accounting for 99% market share. In an industry with high barriers to entry due to cost-intensive technology, manufacturing and customer support, financial power and history are found to be the root for success of both companies (Shelmon, 2019). Both companies maintain a close relationship with their respective governments.

The competition between the two rivals is fierce, long-lasting and fuel to a serious trade dispute between Europe and USA. Every year, there is an intense and publicly followed battle for the highest number of sold and delivered aircraft. Airbus passed Boeing in 2019 to become the biggest plane maker (see Figure 7).

Figure 7

Yearly aircraft deliveries 2012-2022, Airbus and Boeing comparison



Note. Adapted from "*Year-end surge boosts Boeing, but Airbus still No. 1 in 2022"* (para.4), by Gates, 2023 (https://www.seattletimes.com/business/boeing-aerospace/year-end-surge-boosts-boeing-2022-jet-orders-and-deliveries/).

Boeing dominated the aircraft market for over a century after its foundation in 1916, and with its introduction of 707 model became the first choice for civil aircraft operators in 1958 (Shelmon, 2019). Airbus was formed as a conglomerate by the French, British and German governments after launching the development of the A300 programme as counterweight to the American prevailing competition in 1969, heavily subsidized by European governmental funds. A300 performed its maiden flight in 1972 (Airbus, 2023). Tapping into the American market, Boeing claimed that Airbus has benefited from unfair subsidies and U.S. governmental response to it. Therefore, the U.S. and European Community signed a bilateral trade agreement that defined limits for subsidies on large civil aircraft in 1992 (Airbus, 2023a). With the introduction of the Airbus A380 as a directly competing product to the Boeing 747, the conflict between the two parties intensified (Irwin & Pavcnik, 2004).

Following a decade-lasting claim made by the U.S. and counter-claim made by the European Union (EU), the World Trade Organization (WTO) found that both companies had benefitted from illegal subsidies, allowing both to impose tariffs on up to $7.5 billion worth of EU goods in 2018 and $4 billion worth of USA goods in 2019 (Pandey, 2020, para.7). With tariffs imposed on EU goods, Airbus amended the French and Spanish loan agreement in July 2020, complying with WTO regulations and thus removing any legal ground for further countermeasures by the U.S. (Airbus, 2023a). Most recent developments seem to indicate a willingness by both Airbus and Boeing to re-open negotiation.

At present, emerging competitors from China, Russia and Japan account only for a small market share. However, especially domestic products from Commercial Aircraft Corporation of China (COMAC) such as ARJ21 and C919 could emerge as serious rivals on the global biggest home market, where a demand of more than 8,600 airplanes over the next 20 years is forecast (Boeing, 2020, p.8).

1.2.4 Megatrends and dynamics in the business environment

The aviation industry benefited from prosperous development and proved resilient against political, financial and economic shocks in recent years. However, as in many other industries, the aviation industry has been shaped by market, industry and societal dynamics and what are often termed “megatrends”: sustainability, innovation and digitalisation. Recovering from the enormous pandemic impacts and an evolving business circumstance, the aviation industry and its stakeholders such as OEMs are asked to proactively manage existing and upcoming trends and transitions.

1.2.4.1 Sustainability

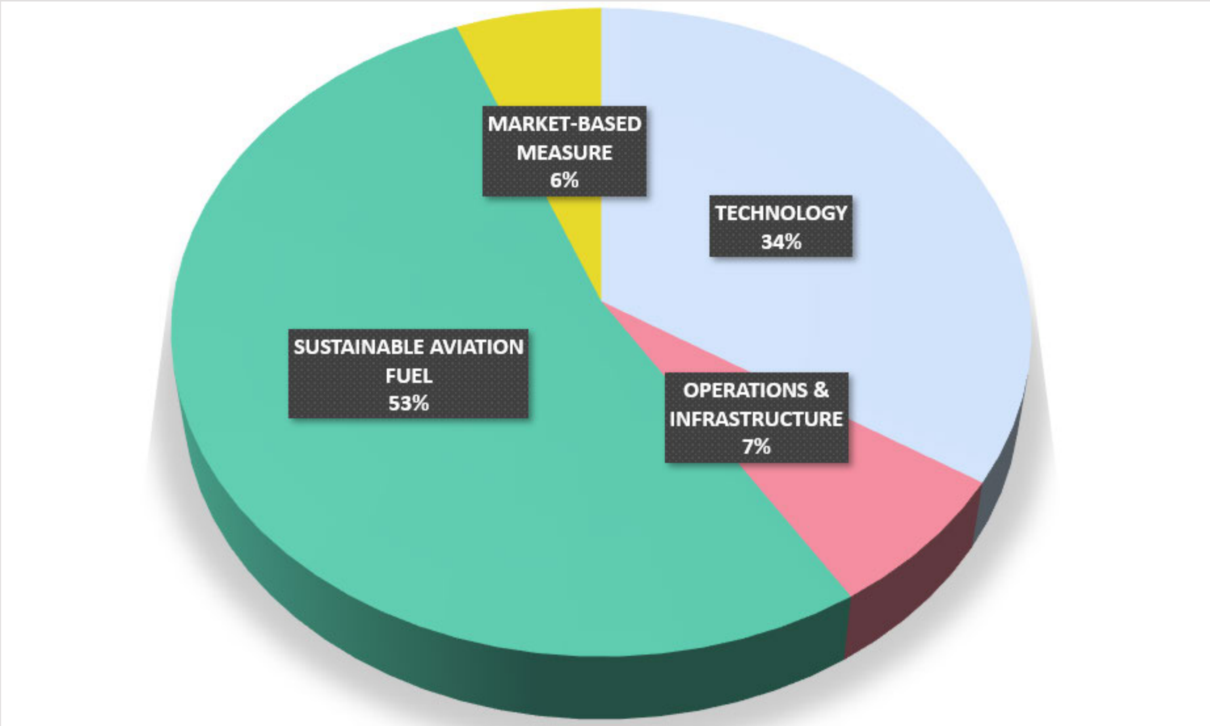
The success of the aviation industry, be it economically or socially, came at a cost; the aviation industry is responsible for 2.5% of the world’s manmade emissions of carbon dioxide (CO_2) (Airbus, 2020c, p.55). Flights over a length of 1,500 kilometres account for approximately 80% of air transport emissions. For those long-range flights there is no alternative mode of transportation (ATAG, 2021).

Boeing’s understanding of sustainability encompasses “environmental stewardship, social progress and inclusion as well as values-based, transparent governance” and is organised around four pillars “People, Products & Services, Operations and Communities” (Boeing, 2022, p.5). However, competitor Airbus incorporates parts of the United Nations’ (UN) Sustainable Development Goals (SDG) framework into its sustainability strategy committing to “1. Lead the journey towards clean aerospace, 2. Build our business on the foundation of safety and quality 3. Respect human rights and foster inclusion, and 4. Exemplify business integrity” (Airbus, 2022b, pp. 13-14.). Despite these wide-ranging and equally important goals, only the environmental ambitions are referred to in this section, because it is of utmost relevance for competitiveness retention and business continuity. The goal to provide safe and highly qualitative products and services is embedded in the entire industry in general.

Environmental consciousness amongst society at large poses severe challenges to the industry. Both, general public and politicians are demanding a substantial reduction of emissions and put pressure on the aviation industry. Global regulations and tougher emission reduction targets are challenges for the industry and will further heighten the demand for more fuel-efficient planes and environmentally friendly engines (Pfeifer, 2023). Furthermore, technology that can improve the environmental performance is closely linked to a competitive advantage in the future. Even though appreciating the aviation industry as a valuable asset for the prosperous development of Europe, the report “Flightpath 2050 Europe’s Vision for Aviation”, issued by the European Commission in 2011 strongly demands that aviation has “an important role to play in reducing noise as well as greenhouse gas emissions, regardless of traffic growth” (European Union, 2011, p.3). Regarding environmental goals, the report formulates, amongst other things, a 75% reduction in CO_2 emissions per passenger kilometre, a 90% reduction in NO_x by 2050 and a 65% reduction of noise emissions of a flying aircraft. Furthermore, aircraft movements are of zero emission during taxi and air vehicles are designed and manufactured to be recyclable (European Union, 2011). In 2021, the aviation industry committed on global civil aviation operations achieving net-zero carbon emissions by 2050, “supported by accelerated efficiency measures, energy transition and innovation” (ATAG, 2021a, para.3). Measures (see Figure 8) proposed to achieve this objective are the introduction and scaled-up application of sustainable aviation fuels (SAF) and abandonment of traditional fossil fuels in the context of a cardinal energy/fuel transition encompassing low-carbon electricity and hydrogen, and “research, development and deployment of evolutionary and revolutionary airframe and propulsion systems, including the introduction of electric and / or hydrogen powered aircraft” (ATAG, 2021a, para.5). Further means include enhanced efficiency of operations and infrastructure in the entire sector. Investments in none-industry related offset opportunities might be needed to close the gap on remaining emissions that are part of committed objectives and not achieved by market-based and industry-specific measures (ATAG, 2021, ATAG, 2021a). The development and use of SAF is considered the biggest opportunity to meet the 2050 industry target; however, in order to industrialise the technologies $1.45 trillion investment will be required over the next three decades (ATAG, 2021, p.5).

Figure 8

Contributions to the aviation industry's objective of net zero carbon emissions by 2050



Note. The level of contribution is based on the most ambitious scenario (41% reduction of CO_2 emissions via technological evolutionary and revolutionary developments).

Adapted from "*Waypoint 2050",* (p.26), by ATAG, 2021 (https://aviationbenefits.org/media/167417/w2050_v2021_27sept_full.pdf).

Overall, the decarbonisation of aircraft manufacturing, operations and related infrastructure is acknowledged to be a vital prerequisite for sustained long-term growth of the industry overall. In consequence, sustainability has emerged as one of the megatrends and will be an integral part of the annual corporate objectives of stakeholders of the aviation industry in future years. In 2020, OEM Airbus incorporated sustainability as a strategic goal and announced its intention to build the world's first zero emission airliner by 2035, while optimising the environmental performance of the existing fleet and reducing its eco-footprint at its sites globally by lowering energy utilisation, water consumption and waste production (Airbus, 2021).

Boeing started issuing an environmental report in 2013 and amplified its scope to focus on overall sustainability in 2021, including a consideration of environmental, social and economic aspects. In September 2020, Boeing formed a dedicated sustainability function, introducing the position of a Chief Sustainability Officer (CSO), reporting to the CEO.

Strategic procurement organisations in the aviation manufacturing sector manages 80% of external value add (Airbus, 2023b, para.2). It underlines the strategic orientation of the aircraft manufacturer predominately as an integrator and assembler and procurement's role as vital contributor to the overall company success. Hence, the procurement functions are at the forefront of integrating and achieving objectives linked to sustainability such as the carbon footprint reduction by making the level of emissions a selection criterion in a call-for-tender, for example, for components, materials, packaging, transport and logistics services. Procurement is expected to achieve formulated sustainability objectives across the supply chain. Furthermore, sustainability is understood to be strongly interrelated to Procurement 4.0 or digital Procurement (Nicoletti, 2020).

1.2.4.2 Innovation

Innovations and continuous technological advances are critical to almost any company that pursues long-lasting and sustainable business success. Technology advances at a rapid pace and aircraft manufacturers are no exception to this development. Innovations help to achieve sustainability targets and improve competitiveness, whether linked either directly to the product, services, materials, manufacturing processes, and expanded service offer to customers, or in supporting processes such as procurement.

In the aviation industry, a prerequisite to achieving the sustainability target of zero emissions, thus enabling long-term existence and growth of the industry, is technology development and innovation in aircraft and engine technology. Incremental innovations such as optimised aircraft design and fuel consumption will not suffice. All concepts for alternative power generating technologies such as electric, hydrogen and hybrid are as yet in the early stages of a life cycle, whether still in research, testing, demonstrator phase or individual production (ATAG, 2021). Following two years of research as part of the ZEROe concept aircraft programme (see Figure 9), Airbus announced in November 2022 the development of a hydrogen-powered fuel cell engine, envisaging this propulsion system as an important step towards the introduction of a zero-emission aircraft in 2035). Hydrogen-powered engines are “one of the most promising alternatives to power a zero-emission aircraft, because it emits no carbon dioxide when generated from renewable energy, with water being its most significant by-product” (Airbus, 2022c, para.4).

Figure 9

Hydrogen-powered aircraft concepts, exemplary Airbus ZEROe concept aircraft

Note. Adapted from “*ZEROe Towards the world’s first hydrogen-powered commercial aircraft”* (para.2), by Airbus, 2023c (https://www.airbus.com/en/innovation/low-carbon-aviation/hydrogen/zeroe).

Boeing started its ecoDemonstrator programme in 2012, developing technologies in more than 200 projects that “improve sustainability and safety for the aerospace industry, including a water conservation system and technologies to improve operational efficiency” (Boeing, 2023a, para.3) and testing them in an operational environment such as a test flight 100% on SAF in both engines in 2018, a project collecting and analysing data on SAF emissions in 2021 or a water conservation system in 2022. Over the years until 2023, Boeing enlarged it test fleets to 10 aircraft in total comprising 737, 757, 777 and 787 aircraft types. In

2022, Boeing announced its commitment to deliver all commercial aircraft with capabilities to fly with SAF by 2030 (Boeing, 2022a; Boeing, 2022b).

A technological and commercial scaling-up of new products, technologies and procedures will take time. ATAG (2021) estimates that by 2050, alternative propulsion technologies will potentially be used fly to regional, short-haul and some medium-haul destinations. Long-haul flights are assumed to be served still by traditional liquid fuels.

In case of aircraft OEMs, the pressure to innovate disruptively and accelerate the launch of a new and green generation of aircraft is high. The aviation industry is complex and a challenging environment relating to financial investments and compliance with a myriad of laws and regulations. Development cycles of a new aircraft programme including developing, prototyping, testing and certification by authorities, followed by the entry into service, can take up to a decade for a new aircraft. Many stakeholders and the industry as a whole would be negatively impacted by an acceleration in the adoption of environmental protective and stricter climate legislation, including aircraft operation restrictions, imposed and exclusive use of SAF or CO_2 standards. The development of environmental regulatory legislation and frameworks takes places regionally and at varying pace across regions, potentially deteriorating market conditions and increasing competitive imbalances for a globally operating industry. OEMs such as Airbus clearly recognise this circumstance as a high risk (Airbus 2022b). The risk of existing and emerging competitors innovating faster and bringing new and disruptive products to the market quicker consequently leads to a loss of revenues and market share, which could potentially imply an unfavourable market position for years.

Innovation as a megatrend is of significance for this research as it impacts the “business model” of strategic procurement. At the same time the strategic procurement function contributes to the achievement of innovation-related objectives and thus overall achievement of corporate objectives. From a function performing transactional purchase order to secure timely delivery of a certain good or service at a given time, strategic procurement has evolved to assume the role of scouting innovations within external supply chain partners, fostering and developing the existing supply base into a source of innovation and establishing the supply base for future technologies, materials, products, and services. In addition, strategic procurement plays a vital role in research and development (R&D) projects by jointly determining and selecting project partners with the technical project leaders. Further activities include access and ownership securing of developed Intellectual Property (IP) for exploitation during and after the R&D project in series manufacturing.

Airbus proclaims that future aerospace is characterised by autonomy, interconnectivity and will be free of emissions, underlining the relevance and significance of the megatrends discussed above (Airbus, 2023d).

1.2.4.3 Digitalisation

The pace and scope of the development of digital technologies, and the resultant improvements in worldwide connectivity, real-time exchange of data, and automation, has had a significant impact on companies and entire industry sectors. In 2017, Roland Berger concluded from a survey among senior executives from the aerospace and defence sector that digital transformation will translate in to “heavy disruption along the value chain” (Hader, 2017, p.17). Digitalisation is seen as one of the key success factors for companies operating in the industry, regardless of their role as airline, airport, aircraft manufacturing or suppliers providing products and services, in responding to dynamic and unpredictable changes in the business environment. In 2023, digitalisation was less evident in company agendas as the top company priority, due to the increased focus on other topics such as operational excellence, sustainability and innovation. Still, digitalisation is contemplated as megatrend and indispensable enabler. For example, Airbus formulates for 2023 the reinforced commitment to the delivery of aircraft to civil and military customers (overcoming a supply crisis in 2022 inhibiting the fulfilment of delivery targets) while staying focused on progressing with sustainability ambitions including ethics and compliance and decarbonisation (Airbus, 2023e). The company’s operational priority is the achievement of increased production rates for its best-selling and revenue-securing product: the A320 family.

At the same time, reference is made to volatile, uncertain, complex, and ambiguous business conditions, for which VUCA is used as an acronym. This refers to an environment which is highly dynamic, with unstable and unpredictable change, limited knowledge of the profoundness of such change, highly interlinked network of information and procedures and no complete comprehension of cause and effect. In practice, VUCA presents circumstances that demand a quick and adequate assessment and respective processing from an organisation, and may be viewed as the “new normal” (Bennett & Lemoine, 2014). Bennett and Lemoine (2014) identify agility, information, restructuring and experimentation as appropriate means to address VUCA conditions. VUCA is and may be a result of the ever-accelerating pace at which technological development happens and the resultant speed of flux in society, politics and business. On the other hand, digitalisation and digital transformation are understood to enable organisations to prosper in such business surroundings (Karrlein, 2019). The capability to adapt quickly to profoundly different business circumstances, such as those associated with the introduction of new technologies, is vital to an organisation’s continued success. As Pathak (2020) notes “the faster you can adapt to the changing environment, the more successful you’ll be at navigating it” (para.5). Hence, Birkinshaw et al. (2016) underline the significance of digitalisation in coping with changes under VUCA conditions. Digitalisation is a “galloping” phenomenon. It is not steady state, but inherently dynamic which translates into the necessity to continuously adapt and develop further means of adopting new technology, to adapt business models, update the skill set of people and set-up the organisational structure for continuous change. Therefore, digital transformation and maintaining or even achieving digital maturity will be a constant point of attention. Digital maturity is closely associated with enhanced resilience of an organisation (McLellan, 2022).

The aviation industry is clearly one example out of many industries that desire to become digitally mature as it is exposed to immense pressure coming from cost structure, fierce, even intensifying competition, and sustainability requirements amongst others.

Robotics, artificial intelligence (AI), the Internet of Things (IoT), blockchain technology and advanced data analytics are perceived to be a means of enhancing operational agility and achieving efficiencies by materialised cost savings and revenue increases. Further supposed advantages include a potential reinforcement of safety-related aspects and positive impacts on sustainability efforts.

For 2023, Aeologic (Pandey, 2023) identifies as top emerging technology trends in the aviation industry 1.) autonomous aircraft, 2.) IoT, 3.) Artificial Intelligence (AI), 4.) Augmented Reality (AR), 5.) blockchain, 6.) 3D printing, 7.) electric and hybrid aircraft, 8.) biometrics, 9.) virtual and augmented reality training, 10.) contactless technology, 11.) predictive maintenance, 12.) in-flight connectivity, 13.) cloud computing and 14.) advanced materials.

1.2.4.4 Geopolitical shifts

Demolished trade barriers and technological advancements allowed the emergence of global supply chains as a new business model replacing a model in 1970s and 1980s where multinational companies from developed countries established subsidiaries predominately in countries with a cost advantage in operations and/or attractive sales market (Vaughan-Whitehead, 2022). The rise of global supply chains enabled multinational companies to build an enhanced competitiveness by less self-owned operations and direct employees. On the other hand, for local suppliers, it offers the possibility to gain access to a larger market beyond the domestic customer base. A global supply chain implies coordination of several actors from different legal entities, potentially located in various regions all over the globe. The formulisation of requirements, contracting, surveillance and enforcement of compliance with agreed terms and conditions and overall management of the relationship with external suppliers as actors in the value chain, is led by the (strategic) procurement function. Despite increased competitiveness and access to new markets, the business model of global supply chains also introduced a higher level of complexity and vulnerability of this ecosystem.

From deteriorating relationships between countries and continents such as the conflict between China and the U.S., increasingly hostile behaviour in terms of trade-politics to invasion of sovereign states, e.g., Russia's invasion of Ukraine and its respective impacts on energy and material availability and pricing conditions, geopolitics shifts reveal the vulnerability of global chains that suffered from disruption and recovery from the Covid-19 pandemic. Procurement needs to respond to such challenges and potentially question the sourcing paradigms of unconditional and unlimited global sourcing as the ultimate strategic objective established in the past. Strategic procurement will have to find strategies and means to balance the economic interests of the company - such as the supply of aircraft to domestically prospering market such as China - and at the same time develop agility and alternative sourcing scenarios that are available at relative short notice following political developments or unpredictable events such as pandemics. In addition, strategic procurement could implement technology and build up capabilities to anticipate, simulate and mitigate such risks.

1.3 Research motivation

In 2016, the author became aware of the growing significance of digitalisation as a megatrend and its incorporation and respective prioritisation on the corporate agenda of her employing company, a globally operating aircraft manufacturer. However, as a member of strategic procurement for almost 10 years, the function seemed to engage in the trend slowly and seemingly missed out on the alleged benefits. Other corporate functions, such as production or logistics, seemed to be more advanced in terms of digitalisation.

A preliminary review of published books and contemporary academic journals found that strategic procurement was rarely the subject of contemporary academic research. By observations made in the company and the review of topical reports published by predominately consultancy agencies, it became clear that members from procurement executive management from various industries understood the alleged enormous potential of digitalisation. Nevertheless, measurable benefits had yet to be demonstrated. Gray literature and research papers stated that procurement had not yet recognised the enormous potential value of digitalisation such as intelligent demand forecast models, risk mitigation and cost reductions and failed to address the topic adequately. This realisation was experienced by the author through the organisation's response to the megatrend of digitalisation. Even though a corporate digital transformation programme was launched in 2015 that was translated into a digital roadmap for procurement, the focus in the procurement function was the implementation of new technology applications. In general, there was strong consensus among practitioners and academics that the response to such a profound change and the subsequent improvement the company's value proposition would set the path for procurement's role as a function in the company in the future.

Shortly after the commencement of the PhD programme in May 2017, it was noticed that a number of surveys conducted by several major consultancy agencies found that progress in the digitalisation of procurement was slow and results still unsatisfactory. Amongst others, the motivation to engage into the research study was the interest to find and propose answers to the dilemma of the function being challenged by the need to increase production efficiencies and respective ramp-up plans for aircraft manufacturing, but on the other hand supporting functions such as procurement not being able to adequately find ways to improve their digital maturity overall and enhance their performance. Strategic procurement, as a corporate function, is recognised as being critical to the future prosperity of the aircraft manufacturing industry. While new technology was adopted, staff acceptance levels of such new technology remained low and desired results such as efficiency increases, and automation of key processes and thus the reduction of a highly manual way of working did not materialise. In the author's opinion, despite the introduction of new applications, the function failed to address the topic adequately in a holistic manner. The reasons for this attitude were perceived as manifold. Underestimation of digitalisation effects, the focus of pure bottom-line efficiency or comfort derived from previously successful business models are some of these reasons in the aviation industry (Hader, 2017).

With the disruption of business and life in general caused by the Covid-19 pandemic, the ongoing recovery, recently emerging trends, and business circumstances (as discussed in section 1.2), the present status-quo of strategic procurement does not seem sustainable in the future, in the author's view. The effects of a volatile, uncertain, and complex environment call for a response encompassing an enhanced digital maturity. Not responding and not transforming could result in a systematic failure of strategic procurement to provide adequate support for the achievement of corporate objectives, in the context of an aircraft manufacturer, this impacting the delivery of aircraft and worsening inefficiencies that may subsume disproportionate resource levels. Even though the executive procurement management team had recognised the importance of digitalisation and engaged somehow in digital transformation efforts, it became apparent to the author that the focus on technology would not suffice and a holistic approach to increase the digital maturity of strategic procurement was still required.

1.4 Research subject, objectives and significance

In practice, the procurement function manages up to 80% of the external value add of a company such as in an aircraft manufacturing company (Airbus, 2023b, para.2). Widely, the function is acknowledged within organisations for its crucial contribution to business success. Both literature and practice praise the value and the pivotal position of strategic procurement, being the central node in a network of internal and external stakeholders. While preparing this research, it appeared that academic publications covering procurement are available in an abundant manner. These deal with the definition (e.g., Joesbury, 2016), significance (e.g., Paulraj et al., 2006) and development of the function over recent decades (e.g., Hughes & Ertel, 2016) managing the manifold and complex relationship to external sources of supply. On the other hand, Guinipero and Eltantawy (2022, p.48) conclude that "little formal research has been produced to examine theories used to underpin contemporary PSM (i.e., Purchasing and Supply chain Management) research". Strategic procurement is considered as an integral part of this concept.

It was noted that the statement is valid when it comes to availability of research covering the deployment of advanced data analytics and impacts on and overall status of digital maturity in strategic procurement. Research of advanced analytics in PSM, coined as Supply Chain Analytics (SCA) is available, mainly attempting to align with an adequate definition of SCA (e.g., Varela Rozados & Tjahjono, 2014) and pointing out the potential benefits (e.g., Roßmann et al., 2018). In contrast, the application of advanced data analytics in the area of strategic procurement was found to be widely under-researched. One of the very few scholarly contributions that could be identified on the application of data analytics in strategic procurement was published by Handfield et al. (2019), exploring the current and future state of procurement analytics, and finding that academic research on procurement analytics is nascent. The authors' conclusion is the identification of a research gap that highlights the need for future research in this field and the development of an analytical culture within organisations.

Batran et al. (2017) concluded that Procurement 4.0 and thus digital maturity is in its infancy. The term Procurement 4.0 emerged as a new strategic and operational framework to cope with the changes related to Industry 4.0. Innovative (big) procurement data utilisation was identified as the most important enabler to enhance organisational performance. For at least a decade, the importance of procurement engaging in digital transformation and eventually becoming one of the driving functions in a company has been emphasised. Already a decade ago, Murray (2013) accentuates that procurement had not engaged sufficiently in the digital revolution. Still at present, the status of digital maturity within strategic procurement organisations remains unclear. This holds true for the content of, and path to enhance, digital maturity. Successful exploitation of advanced data analytics is understood as a key enabler to enhance digital maturity and ultimately transform successfully into a digitally mature organisation.

Maturity models assessing the digital maturity of an organisation overall are present in the academic literature (e.g., Azhari et al., 2014). In a publication from 2019, Teichert identified

22 different maturity models, stemming from both from academic and practitioner literature. Teichert (2019) concluded that existing models “give an incomplete picture of digital maturity” and that there is a research gap of digital transformation maturity as a comprehensive phenomenon. While existing models provide a general understanding and structure for orientation, a limitation is their generic design and hence the applicability to a specific industry context. In the area of strategic procurement, a single digital maturity model could be identified. Kleeman and Glas (2020) designed, for the purpose of “4.0 Readiness”, a digital maturity model for procurement; however, the model falls short in the development of recommendations on how to improve advance in the ambition to mature digitally and in it design to address the role of advanced data analytics in strategic procurement.

This thesis contributes to the academic discourse regarding the status of digital maturity of strategic procurement with a focus on the role of advanced data analytics implementation within the strategic procurement process, understanding digital transformation in order achieve enhanced maturity as a highly contextual multi-dimensional phenomenon. The aim of this thesis is to present and further develop contemporary research in the field of digital maturity of strategic procurement. It is specific to the context and challenges in the aviation industry. Findings are derived from empirical evidence in the form of a case study from the aviation industry. The developed digital maturity model is one of the few designed to explore and provide guidance for the strategic procurement function at present. Within this industry and business context, this research aims at achieving the following research objectives:

RO1: To review and analyse the extant literature relating to the deployment of advanced data analytics in the strategic procurement process in the aviation industry.

RO2: To evaluate the use of advanced data analytics in the procurement process (using an aviation industry company as a case study) focusing on the type of applications used and their operational implications for individuals and organisational structures.

RO3: To develop and assess the application of a new model for the digital transformation of strategic procurement in the aviation industry.

The transfer of academic knowledge to practice in this field is yet to be undertaken and successfully embedded into corporate transformation programmes. According to International Data Group (IDG, 2018), more than one third of organisations have initiated digital transformation programmes. However, nearly half reported to be in an early stage of developing and implementing a digital strategy. Even though its origin cannot be clarified unambiguously, in reports and practitioners' literature, data is referred to as the "oil of the 21st century" (Wierse & Riedel, 2017, p.31). Still organisations struggle to gain value from the introduction of SCA and despite the fact that companies started to create new senior positions on data and analytics such as Chief Data Officer (CDO) or Chief Data and Analytics Officer (CDAO) (Davenport & Bean, 2023). Davenport and Bean (2023) reflect that while progress was made in the adoption of data analytics technology and data management, the transformation into a data-driven organisation is not related to technology, but to people, process, culture, or organisational issues. According to the authors the development into a data-driven organisation is still pending.

In addition to the contribution to knowledge, this research aims at encouraging procurement leaders to understand digital transformation as more than the adoption of technologies, but as an individual and organisational profound change that encompasses the deployment of advanced analytical capabilities, re-engineered processes, adaptation of structures, and appropriate upskilling of personnel. A digitally mature strategic procurement function can provide support in facing challenges in the aviation industry coming from increasing competition from emerging market players, emerging sustainability requirements to prepare for the introduction of “green aviation” and increased market dynamism. The necessity for strategic procurement to adapt quickly to the needs and opportunities of the digital era is more pressing than ever.

The following aspects characterise the uniqueness and underline the significance of this study:

1.) The study considers the strategic procurement function as principal value contributor to corporate success.

2.) It examines the current, and formulates characteristics of a future, profile of the strategic procurement function.

3.) It understands digital transformation as a multi-layered phenomenon that needs a holistic approach, comprising technology, processes, people and structure, in order to be successful.

4.) It presents a digital maturity model for strategic procurement which does not exist at this level at present.

5.) It applies the developed model in the unique context of an aircraft manufacturer in the aviation industry with its immutable requirements towards process adherence and compliance to secure highest safety standards while operating competitively and sustainably in the future.

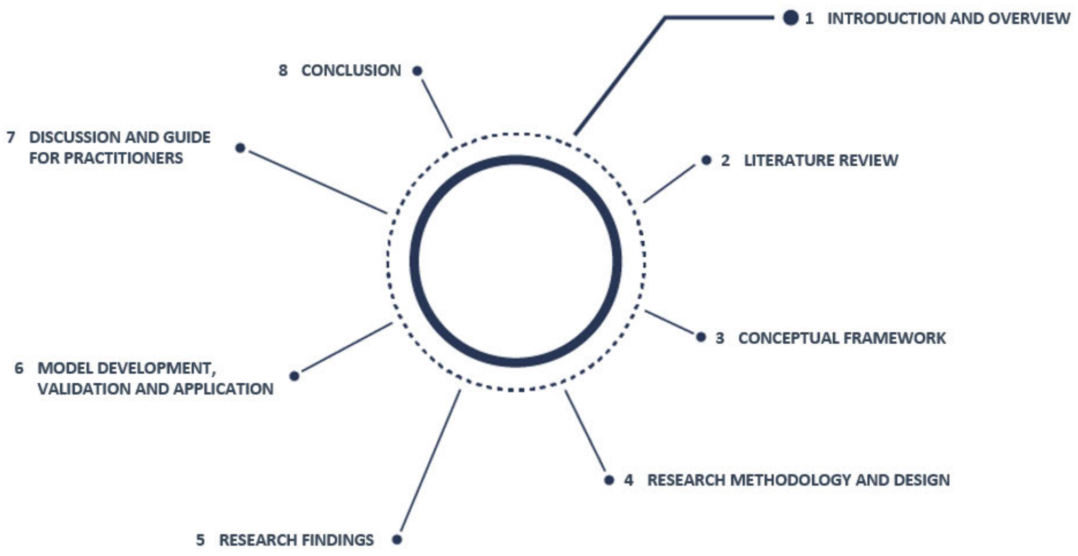
1.5 Chapter summary and thesis structure

To endure in the aviation industry under the present dynamic business conditions, continuously striving for advanced digital maturity is a prerequisite. This is an industry that is marked by strong demand and high customer expectations for a state-of-the-art technology, economic and reliable aircraft, rigid compliance to safety and airworthiness aspects, aggressive existing and emerging competition, challenging cost structure, a complex value chain and immense pressure to decarbonise the product, its manufacturing, and its operations.

The ambition to become digitally mature is valid for corporate functions such as strategic procurement which seemingly engages more slowly and half-heartedly in digital transformation. On the other hand, the function is supposed to have decisive influence on the future prosperity of the company. How does strategic procurement answer this challenge? What is the current status-quo of digital maturity within strategic procurement? In this chapter, an overview of the industry was provided and the motivation for this research discussed; the initial research gap has been identified, and research objectives have been articulated.

Figure 10

Thesis structure



This thesis comprises eight chapters (see Figure 10). Following this introductory chapter, chapter 2 reviews in depth existing scholarly and practitioners' literature to assess and discuss current knowledge as well as to gain an understanding of underlying theories and concepts relevant to the field of research. The first section clarifies key concepts and definitions relating to digitalisation, digital transformation as well as big data, advanced data analytics. In addition, some of relevant digital maturity models are reviewed and discussed. A subsequent section investigates the development of strategic procurement over the last decades, terminology such as Procurement 4.0, and the current status quo of digital maturity is explored. The chapter finishes with an alignment of the previous sections in an analysis of current research relating to the definition and significance of advanced analytics in strategic procurement.

In chapter 3, the provisional conceptual framework (PCF) is developed to provide a framework for the primary research and to respond effectively to the research objectives. In the development of the PCF, main change dimensions are identified, and their relevance delineated, and the significance of the function with an enhanced digital maturity as an interrelated and contextual phenomenon is underlined.

In chapter 4, the adopted research design and methodology is presented. Understanding strategic procurement analytics (SPA) as a nascent and complex phenomenon, this research adopts an interpretivist perspective. Findings were derived from the multiple experiences, individual opinions and contextualisation of different members of the strategic procurement function.

Chapter 5 presents the findings of 15 semi-structured interviews from the case study. It includes material on the existing perception of strategic procurement as a function, on the status of digital transformation and on the four change dimensions identified in the PCF. The target group included staff from strategic procurement at varying hierarchical levels such as procurement executives, line managers, lead-buyers and project managers.

In chapter 6, the developed PCF is reviewed and developed to provide the digital maturity model for strategic procurement. Its key characteristics are outlined. The chapter also discusses the validation of the model.

Themes that emerged from the findings from chapter 5 and model validation in chapter 6 are discussed in chapter 7. Furthermore, a guide for the application of the model in practice is provided in this chapter.

Concluding this research, chapter 8 presents the summary response to the research objectives and outlines the contribution to knowledge and practice. A discussion of limitations and implications for further research follows. The chapter closes with final comments and reflections on the research process.

CHAPTER 2: LITERATURE REVIEW

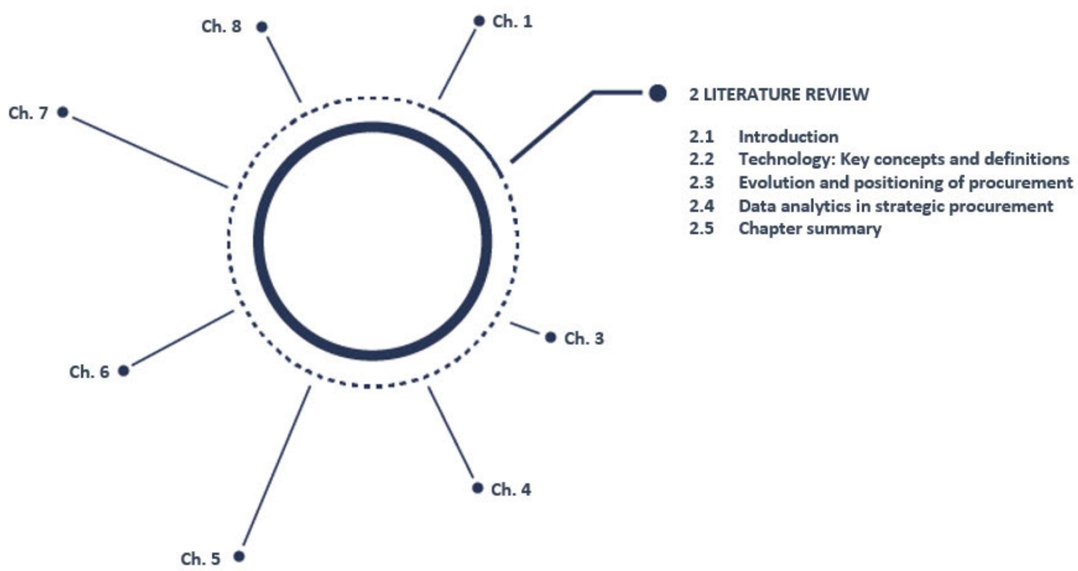
2.1 Introduction

“The aim of conducting a literature review is often to enable the researcher to map and assess the existing intellectual territory, and to specify a research question to develop the existing body of knowledge” (Tranfield et al., 2003). This chapter critically examines the present state of research relating to digital transformation, big data and the application of big data analytics in general, and in the field of strategic procurement, in particular. Journal articles, scholarly books, blog posts, reports and gray literature published by consultancy and economic research agencies were evaluated in a systematic and extensive literature review.

This chapter comprises five sections (see Figure 11). Following this introduction, key technology concepts are presented and discussed in section 2.2. The phenomenon of digital transformation is explored and the concept of digital maturity and a synthesis of maturity models is presented. Big data and advanced data analytics are examined and discussed. An evaluation of data-driven decision making concludes this sub-chapter. This is followed by section 2.3 which synthesises the evolution and current positioning of the strategic procurement function in the corporate environment and puts in perspective the value of strategic procurement at present and in the future. Section 2.4 examines data analytics in the context of strategic procurement. The chapter is concluded in section 2.5 by a summary of the literature analysis and identification of the research gap in the extant literature.

Figure 11

Structure of chapter 2 in context of the thesis



2.2 Technology: Key concepts and definitions

2.2.1 Digitalisation and digital transformation

Digitalisation is a "megatrend", which fundamentally and irreversibly has changed the nature of business (Koehler-Schute, 2016; Liu et al., 2019; Udugama et al., 2022). The term "digitalisation" is an omnipresent phenomenon covering a very broad spectrum of sectors and fields. Organisations face a rapidly changing business environment including emerging competition due to worldwide interconnectivity and real-time exchange of data and information, and are required to respond by re-thinking business models and organisational structures (Bienhaus & Haddud, 2018).

According to the Gartner IT Glossary (2023), "Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business". Other authors emphasise the radical nature of change in products and services, processes or business models (Nambisan et al. 2017). Further definitions embrace the broad impact of digitalisation as “the way many domains of social life are restructured around digital communication and media infrastructures” (Brennen & Kreiss, 2016, p.1). Despite extensive research done on the topic, a clear and - among academic researchers - widely accepted definition of the term “digitalisation” is absent.

Since the beginning of the “digital age” in 2002, when digital capacity overtook total analogue capacity, a fundamental and sustainable change in every aspect of society and economy has been witnessed (Hilbert & López, 2011). The significance of digitalisation and the fundamental shift in the business landscape is evidenced by considering the latest ranking of the most valuable companies worldwide in the second quarter of 2022. With Apple, Google Holding Alphabet, Microsoft, Amazon.com, four out of the five most valuable stock-exchange listed companies are technology companies and come from the “digital world” (Johnston, 2022).

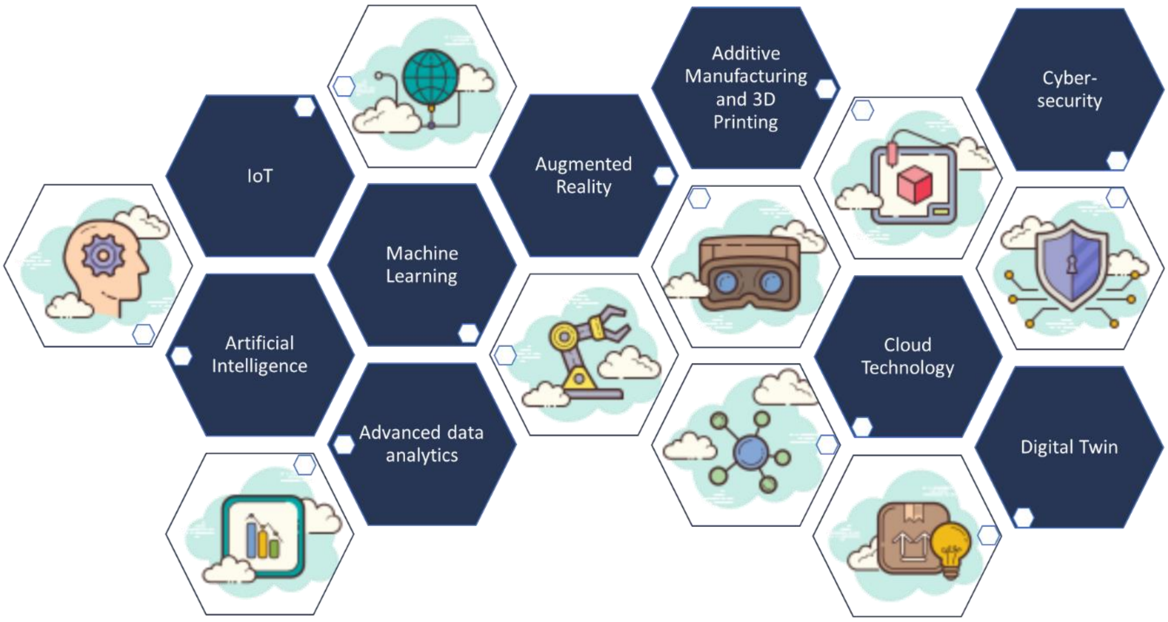
Rogers (2016) argues that compared to electrification “the impact of digital is even bigger because it changes the constraints under which practically every domain of business strategy operates” (p.4). The pace and scope of the development of digital technologies in the recent past has had a very significant impact on companies and industries. This will probably continue and with the progressive introduction of advanced robotics, virtual realities and networked intelligence, the scope of their application in business will grow further. It opens up vast opportunities, such as the reduction of costs and increased efficiency. Digitalisation is supposedly one of the key success factors for companies in response to dynamic and unpredictable change in the business environment. Concepts such as “mobile Apps, big data, Machine-to-Machine, Internet of Things (IoT), Industrial Internet, and Industry 4.0” are used to describe this phenomenon (Collin et al., 2015, p.29).

Kane et al. (2015) provides a framework for the term “digital”. It includes technologies such as advanced analytics, the Internet of Things (IoT), cloud and mobile technology, social media, additive manufacturing, virtual (augmented) reality, cognitive technology and security.

The rise of these technologies heralded an era where massive volumes of data, real-time, both unstructured and unstructured are available (Handfield & Linton, 2017). Moreover, the use of these technologies instigated a revolution in business models, operations, processes, and organisational structures. Key technologies to enable success in the endeavour of a company's digital transformation are determined (see Figure 12).

Figure 12

Key technologies in a digital transformation



Note. Adapted from "*8 Digital Transformation Technologies and Their Business Impact"* (para.8), by Perry, 2022 (https://bluexp.netapp.com/blog/cvo-blg-8-digital-transformation-technologies-and-their-business-impact).

The digitalisation of the industrial sector is subsumed under the term "Industry 4.0" through the convergence of the physical and virtual worlds and the universal interconnection of people and things (Kagermann, 2015). Big data and advanced data analytics play a major role in Industry 4.0 and are considered key "game changers" for operating successfully and enduring in an increasingly volatile business environment, as well as for supply chain management (SCM) (Bienhaus & Haddud, 2018; Waller & Fawcett, 2013). Additional technologies such as 3D printing, robots, and autonomous vehicles are expected to complement Industry 4.0-enabled supply chain systems (Yin et al., 2018). Both the pace and scope of the development of digital technologies, and the resultant improvements in worldwide interconnectivity and real-time exchange of data, has had a significant impact on companies and entire industry sectors.

Widely agreed is the view that an absence of adopting digital technologies can lead to competitive disadvantage and moreover pose existence-threatening risks. There is consensus that companies which want to succeed in the present uncertain and highly complex environment must be able to quickly and continuously introduce new technologies. The capability to adapt quickly to profoundly different business circumstances, such as those associated with the introduction of new technologies, is vital to an organisation’s continued success (Scholz, 2016; Pathak 2020).

Nevertheless, to focus solely on the adoption of state-of-the-art technologies will not be sufficient. Westerman (2017) affirms that technology does not add value to a business except for technology in products. The value stems from technology’s role as the enabler to do things differently, such as the implementation of analytics as a mean to enhance understanding and thereby derive relevant decisions. "When it comes to digital transformation, digital is not the answer. Transformation is" (Westerman, 2017, para.3).

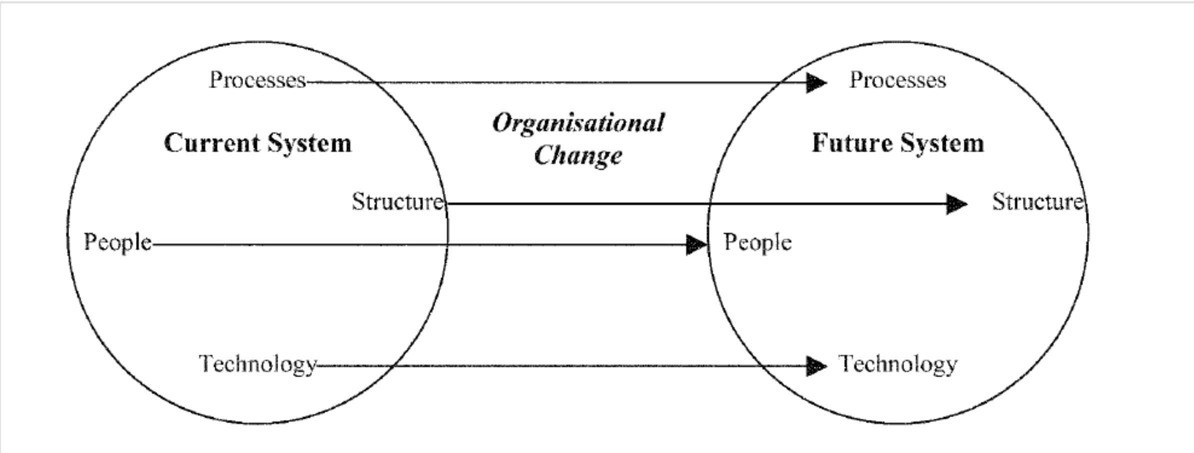
The standpoint that digital transformation is not about technology, but rather about formulating new ways of doing business and new ways of constructing corporate models, is widely accepted (Turchi, 2018). Likewise, Rogers (2016) remarks that “Digital Transformation is not about technology- it is about strategy and new ways of thinking” (p.X). There is an impact of digitalisation within the organisation on existing procedures, processes, capacities, and capabilities (Katz, 2015). Bloomberg (2018) stretches the importance of having a clear distinction between the terms digitalisation and digital transformation by pointing out that digitalisation projects aim at operational improvements and increasing efficiency by introducing digital technologies while digital transformation demands an overall organisational change and the implementation of digital technologies aiming at a customer-driven strategic business transformation.

In line with the views of Matt et al. (2015) and Damanpour and Wischnevsky (2006), Teichert (2019) highlights the profound and continuing nature of transition which affects strategy, structure as well as the distribution of power. Berghaus and Backhaus (2016) find that early engagement in a digital transformation process generates awareness about the potential benefits that digital technologies brings and a rather trial and error approach. However, they conclude that a strategic approach - including both formulation and implementation of appropriate strategies - is absent in most companies.

Heeks (2002) identified four interrelated dimensions of change that are vital in the transition to new information systems in developing world environments, namely people, structure, technology, and processes. The "Design-Actuality Gap" model (see Figure 13) is grounded on an assessment of the fit or discrepancy between local actuality and the current status quo and the intended future system design (Heeks, 2002, p.104). While the model was developed for the failure analysis of information system in developing countries, it can be applied to various business change environments.

Figure 13

Design-actuality gap model

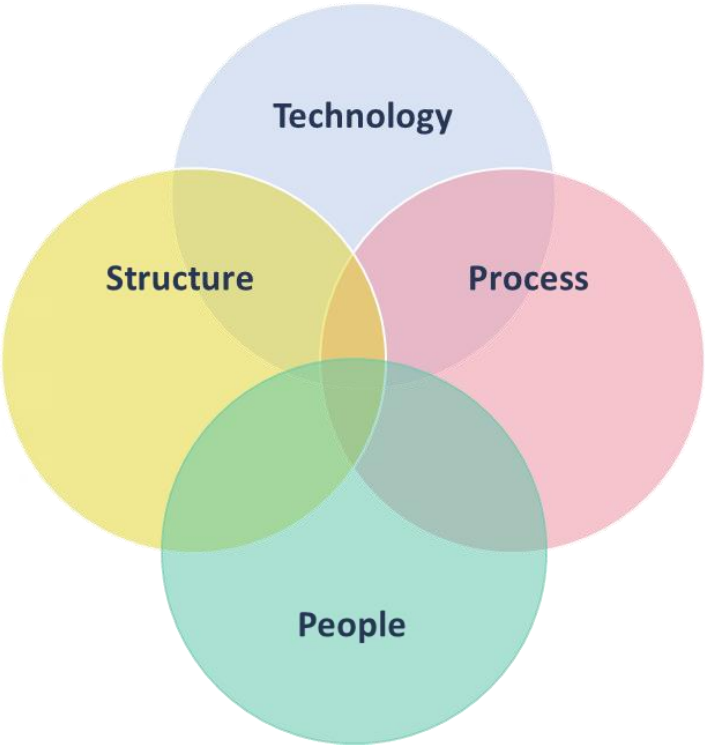


Note. From "*Information Systems and Developing Countries: Failure, Success and Local Improvisations"* (p.104), by Heeks, 2002, *Journal of Information Society*, 18(2) (https://doi.org/10.1080/0197224029007503 9).

In this thesis, the identified change dimensions, technology, process, people and structure will be applied to build the maturity model (see Figure 14).

Figure 14

Dimensions of digital transformation in this thesis



Note. Adapted from "*Information Systems and Developing Countries: Failure, Success and Local Improvisations"* p.104, by Heeks, 2002, *Journal of Information Society*, 18(2) (https://doi.org/10.1080/0197224029007503 9).

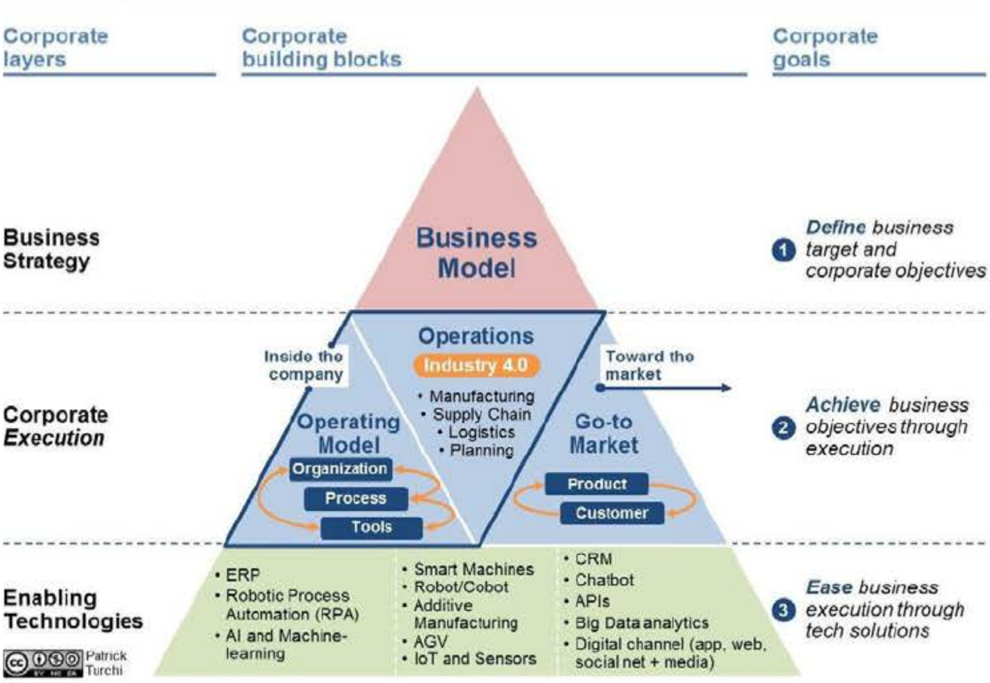
Given the multidimensionality of the term digitalisation and the lack of a generally accepted definition, it is a current challenge for both academic research and practitioners is to agree on an unambiguous definition of digital transformation (Schallmo et al., 2017; Teichert, 2019; Barry et al., 2023). Kretschmer and Khashabi (2020) conceptualise digital transformation as "the process of rapid and widespread adoption and application of digital technologies in commercial settings" (p.86). It is pointed out that adjustments in business operations, processes and organisational structures accompany the adoption of new technologies. This view is shared by Pratt and Sparapani (2021, para.1), who understand digital transformation as the "incorporation of computer-based technologies into an organisation's products, processes and strategies", pointing out the need to thoroughly review and modernise all aspects of an organisation including a reorientation of supply chain, operations, people capabilities, organisational structures to the enhanced customer focus.

Ismail et al. (2018, p.6) examine the complexity of digital transformation and define it as "the process through which companies converge multiple new digital technologies" to achieve superior business performance and competitive advantage. This process entails the transformation of various business dimensions such as the business model, customer experience, operations, people and ultimately the totality of the business value system (Ismail et al., 2018). Yokoi et al. (2019) point out the never-ending and ever accelerating cyclical nature of digital transformation and respective business adaptations. Consolidating various views, Morakanyane et al. (2017, p.9) proposes that digital transformation is "an evolutionary process that leverages digital capabilities and technologies to enable business models, operational processes and customer experiences to create value".

Schallmo et al. (2017) put forward the concept of a digital transformation framework based on a systematic literature review. "The digital transformation framework includes the networking of actors such as business and customers across all value-added chain segments; and the application of new technologies. As such digital transformation requires skills that involve the extraction and exchange of data as well as the analysis and conversion of that data into actionable information. This information should be used to calculate and evaluate options, in order to enables decisions and/or initiated activities. In order to increase the performance and reach of a company, digital transformation involves companies, business models, processes, relationships, products, etc." (Schallmo et al. 2017, p.4).

Figure 15

Digital transformation model



Note. From "*The Digital Transformation Pyramid: A Business-driven Approach for Corporate Initiatives*" (para.5), by Turchi, 2018 (https://www.linkedin.com/pulse/digital-transformation-pyramid-business-driven-approach-turchi).

In this thesis, in the context of developing a maturity model for the deployment of advanced analytics in strategic procurement, the previously elaborated appreciation of digital transformation as a multidimensional and interlinked phenomenon is assumed.

Objectives for a digital transformation are "increased efficiency and productivity, better resource management, more resiliency, greater agility, improved customer engagement, increased responsiveness, greater innovation, faster time to market, increased revenue, and continued relevancy" (Tucci, 2023, para.17). In practice, in the aerospace and defence sector, digital transformation aims at the increase of efficiencies in manufacturing by enhancing transparency, enlarging the scope of automation and reducing costs. It focuses less on the development of new products (Hader, 2020).

Digital transformation was the "hottest" item on the corporate agenda between 2016 and 2019 (Turchi, 2018). Even though other subjects, such as sustainability seem to have overtaken digital transformation in the prioritisation of corporate objectives, it will nevertheless remain an important point on the “to-do-list” of companies. While in times of economic prosperity, the execution of a future-oriented transformation is found to be difficult, a crisis like the Covid-19 pandemic has increased the focus and even led to the acceleration of digital transformation (Adam et al., 2018; Schrage, 2020). The capability to adapt quickly to fundamental different business circumstances is essential for organisations. As Pathak (2020) notes “the faster you can adapt to the changing environment, the more successful you’ll be at navigating it” (para.5).

2.2.2 Digital maturity and digital maturity models

For the successful management of the digital transformation process, an assessment of digital maturity is fundamental. It plays a vital role in determining the main axes of a digital strategy and to establish the organisation’s capability to change (Barry et al., 2023). Zaoui and Souissi (2020) suggest that the evaluation of the existing state of an organisation as an indispensable step in a digital transformation journey. Digital maturity is coined as the “state of the company’s digital transformation”, reflecting the company’s success in their ambitions to transform as well as future actions to progress and continuously adapt to a technologically-accelerating environment (Teichert, 2019; Hess, 2016). Lahrmann et al. (2011) view maturity as the perfect, complete state in the course of a development. Rossmann (2019) includes in this definition the consideration of acceptance and deployment of digital technologies into the business model. Beyond a technological aspect, digital maturity incorporates a managerial aspect - meaning the achievements in performing “digital transformation efforts including changes in products, services, processes, skills, culture and abilities regarding the mastery of changes processes” (Teichert, 2019, p.1675), thus justifying the holistic notion of digital maturity. The assessment of maturity in sociotechnical systems is commonly performed along three axles; 1.) people/culture, 2.) process/structures, and 3.) objects/technologies, coined as maturity factors (Mettler, 2011). A common and widely accepted definition of digital maturity is yet to be determined (Aslanova & Kulichkina, 2020).

Berghaus and Back (2016) find that a maturity model can help to understand the current state of the organisation including the identification of strengths and weaknesses. In addition, maturity models support the determination of gaps between an initial, current, and a desired, future, state. They assist in determining how to approach the transformation and set out possible paths and a course of actions. Teichert (2019) underlines the significance of a maturity model for providing guidance in the development of a clear roadmap in transformation activities towards an advanced digital maturity.

Dimensions and criteria are often used as measures in digital maturity models (Berghaus & Back, 2016). Digital maturity models comprise dimensions as indicators for areas of assessment and action (Barry et al., 2022). Based on de Bruin et al. (2005), Teichert (2019, p.1675) reasons that a “dimension is a specific, measurable and independent component which reflects a major, fundamental and distinct aspect of digital maturity and describes an area of action” and allows the development of a thorough comprehension of aspects for which the maturity is to be measured.

Maturity stages are considered a typical model design feature to allow identifying the position on the trajectory towards maturity and synonymously used with the term “maturity level”. A widely accepted way of describing the status of maturity is the utilisation of a five-point scale with “1” indicating a low and “5” a high level of maturity. A stage-intent-indicating label and clear definition of the stage support the design of a meaningful model (de Bruin et al., 2005; Berghaus & Back, 2016; Teichert, 2019). Teichert (2019) defines a maturity level as an “evolutionary plateau for organisational maturity improvement” (p.1675).

A variety of digital maturity models exist. Haryanti et al. (2023) identified, in a systematic review of relevant academic and practitioners’ literature, 44 digital maturity models and thus confirmed the existence of numerous digital maturity models, which were reviewed in previous studies such as those of Teichert (2019) or Barry et al. (2022). Generic and domain-specific models such as for manufacturing, banking, education or health amongst others were distinguished by Barry et al. (2022). Other digital maturity models focused the size of the company, whether the model was designed for an application in small-and medium-sized or large companies. Teichert (2019) determines the origin of published literature in his research; a number of models were issued by academic authors and practitioners, mostly from consultancies. Regardless of their area of application or origin, it is evident that the number and content of dimensions and stages vary in the numerously developed maturity models (see Table 2).

Table 2

Examples of relevant generic and industry-specific digital maturity models

Academia/ Practitioners (Development stakeholders)	**Name**	**Author/ Date**	**Key characteristics** (Focus of model incl. dimensions and stages)
Academia	Digital maturity model (DMM)	Berghaus & Back, 2016	*generic,* 9 dimensions: 1. customer experience, 2. product innovation, 3. strategy, 4. organisation, 5. process digitisation, 6. collaboration, 7. information technology, 8. culture & expertise, 9. transformation management 5 stages: 1. promote & support, 2. create & build, 3. commit to transform, 4. user-centered & elaborated process, 5. data-driven enterprise
Academia	Digital Maturity Model	Colli et al., 2018	*manufacturing industry,* 5 dimensions: 1. governance, 2. technology, 3. connectivity, 4. value creation, 5. competence 6 stages: 1. none, 2. basic, 3. transparent, 4. aware, 5. autonomous, 6. integrated
Academia	The Digital Transformation- Self Assessment Maturity Model (DX-SAMM)	Haryanti et al., 2023	*generic,* 7 dimensions: 1. structure and organisation, 2. technology, 3. strategy, 4. customer, 5. employee, 6. culture, 7. transformation process, 5 stages: 1. performed, 2. managed, 3. established, 4. predictable, 5. optimising
Practitioner	PricewaterhouseCoopers (PwC) maturity model - Industry 4.0	Geissbauer et al., 2016 (PwC)	*industry 4.0,* 7 dimensions: 1. digital business models and customer access, 2. digitisation of product and service

			offerings, 3. digitisation and integration of vertical and horizontal and value chains, 4. data & analytics as core capability, 5. agile IT architecture, compliance, 6. security, legal & tax, 7. organisation, employees & digital culture, <u>4 stages:</u> 1. digital novice, 2. vertical integrator, 3. horizontal collaborator, 4. digital champion
Practitioner	Digital Maturity Model 5.0	VanBoskirk, 2017 (Forrester)	*generic,* <u>4 dimensions :</u> 1. culture, 2. technology, 3, organisation, 4. insights
Practitioner	Digital Maturity Model - achieving digital maturity to drive growth	Ellerby, 2018 (Deloitte)	*communications industry*, <u>5 dimensions:</u> 1. customer, 2. strategy, 3. technology, 4. operations, 5. organisation and culture, 28 sub-dimensions, 179 digital criteria

Adapted from "*Stages in Digital Business Transformation: Results of an Empirical Maturity Study"*, by Berghaus and Back, 2016, Mediterranean Conference on Information Systems (MCIS) Proceedings. 22 (https://aisel.aisnet.org/mcis2016/22);

Adapted from "*Contextualizing the outcome of a maturity assessment for Industry 4.0"*, by Colli et al., 2018, IFAC-PapersOnLine, 51 (10.1016/j.ifacol.2018.08.343);

Adapted from "*The Extended Digital Maturity Model"*, by Haryanti et al., 2023, Big Data Cogn. Comput., 7 (17) (https://doi.org/10.3390/bdcc7010017);

Adapted from "*Industry 4.0: Building the digital enterprise"*, by Geissbauer et al., 2016 (https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf);

Adapted from "*The Digital Maturity Model 5.0*", by VanBoskirk 2017 (https://www.forrester.com/report/The-Digital-Maturity-Model-50/RES136841);

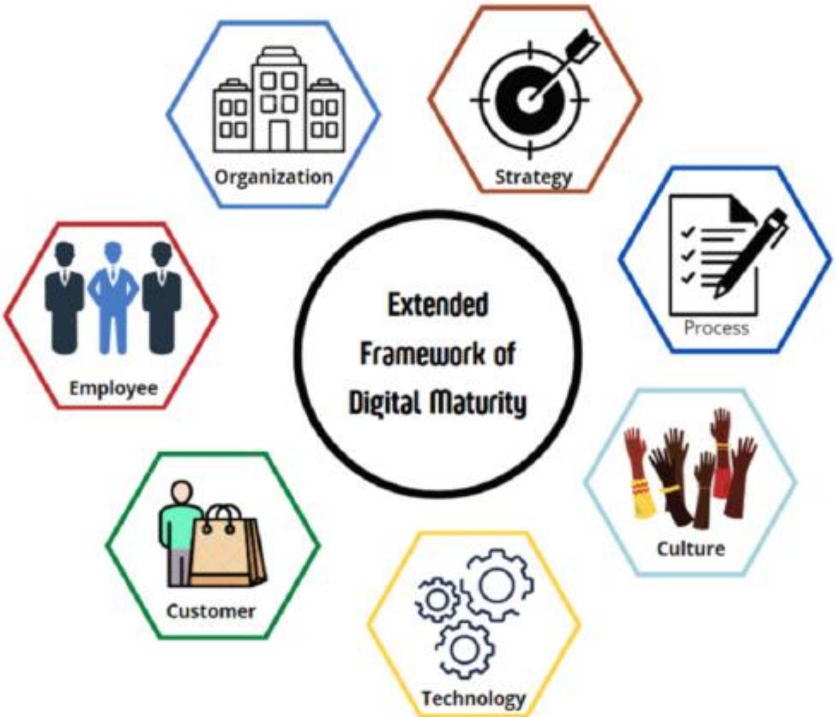
Adapted from *"Digital Maturity Model Achieving digital maturity to drive growth"* by Ellerby, 2018 (ttps://www2.deloitte.com/content/dam/Deloitte/global/Documents/Technology-Media-Telecommunications/deloitte-digital-maturity-model.pdf).

The DMM is one example of digital maturity models from academic authors and aims at enhancing the comprehension of digital transformation as a phenomenon and incorporates nine maturity dimensions and five stages (Berghaus & Back, 2016). Having reached a high level of digital maturity, namely stage five, advanced data technologies were successfully deployed for key processes such as decision making and the organisation is transformed into a data-driven enterprise. The focus on advanced data analytics makes the model particularly relevant for this research. Key findings in the development of DMM were that digital transformation is bolstered by digital affinity at individual level and prerequires a close alignment between domain-specific business and IT. Furthermore, the authors conclude from survey data that in general, companies had already started to apply digital technologies in an exploratory manner; a coordinated and strategically planned approach to digital transformation which entailed the utilization of advanced data analytics technology was an exception.

With DX-SAMM (see Figure 16), based on a methodical comparison of multitudinous existing digital maturity models, Haryanti et al. (2023) authored one of the most recent models in academic literature, claiming applicability to all sectors. The model highlights seven integrated maturity dimensions and five maturity stages. It underlines the importance of a holistic approach towards a gradual and continuous digital transformation and hence advanced digital maturity.

Figure 16

DX-SAMM



Note. From "*The Extended Digital Maturity Model"* (p.11), by Haryanti et al., 2023, Big Data Cogn. Comput., 7(17) (https://doi.org/10.3390/bdcc7010017).

The model focuses on the evaluation of existing maturity in an organisation based on self-assessment and provides recommendations for improving the level of maturity per dimension including strategic aspects (Haryanti et al., 2023). Measuring present digital maturity, and thereby developing from those insights a blueprint for a desired future state, and the continuous update of the organisational maturity, contributes to the sustainable existence of the organisation.

Despite the widely acknowledged benefits of digital maturity models, the plurality and multiple designs including diverse and/or ambiguously labelled maturity dimensions and stages, pose a notable challenge to an application in practice, for example, when assessing the present state of digital maturity and developing a transformation path. In addition, Alsufyani and Gill (2022) concluded, from a systematic review of 30 maturity models, that there was a lack of a holistic approach in most existing maturity models.

2.2.3 Big data

The concept of big data was initially introduced by Cox and Ellsworth (1997). In their article, the two NASA researchers referred to the problem of big data where visualisation of data posed challenges for computer systems caused by the large size of input data sets and limited capacity of computer systems. Since then, the term has undergone an evolutionary development in characteristics and scope. Early publications define big data based on the 3V characteristics model introduced by Laney in 2001. The 3Vs stand for Volume, Velocity and Variety. Originally referring to data in the field of e-commerce (Laney, 2001), there is wide consensus among academic authors of the generic validity/applicability regarding the afore-mentioned mentioned core criteria in the characterisation of the concept of big data (McAfee & Brynjolfsson, 2012; Waller & Fawcett, 2013; Fosso Wamba et al., 2015; Addo-Tenkorang & Helo, 2016; Sanders, 2016, Wang et al., 2016; Zhong et al., 2016; Roßmann et al., 2018).

“Volume” refers to the vast amount of data generated from any type of source, also resulting from the globalisation and the ubiquity of the internet (Kanaujia et al., 2017).

According to a study conducted by Seagate and International Data Corporation (IDC), the creation, collection or replication of data, called the Global Datasphere, will grow from 33 Zettabytes (ZB) in 2018 to 175 ZB by 2025, which means an enormous increase. To put 175 ZB in perspective; if measured in a stack of DVDs it could circle 233 times our planet. Moving to cloud-based solutions will be one of the key driving forces for this development (Reinsel et al., 2018). “Velocity” concerns the speed of the collection, analysis and transfer of the data (Kanaujia et al., 2017). Real-time data represented 15% of the Global Datasphere in 2017, and according to predictions, it will be nearly 30% by 2025 (Reinsel et al., 2018, p.3) and is considered a contributor to the efficiency of decision making. “Variety” deals with various formats of data like structured, unstructured or semi structured (Kanaujia et al., 2017). Structured data refers to data classifiable in recurring fields due the existence of variables and parameters, while unstructured information, originating in- and externally, includes emails, reports, web content, news feeds, social media postings, video clips, and other data and cannot be arranged in a pre-defined manner (Chen et al., 2015; Handfield et al., 2019).

There are diverging views with regards to the size of structured versus unstructured data. While some authors argue that approximately 80% of data in organisations is unstructured (Das & Kumar, 2013; Feki et al., 2016), others consider an average of 50% realistic (White, 2018). In the course of the afore-mentioned evolution of the term “big data”, further dimensions were added and led to a taxonomy with a variable number of “V”s and slightly diverging, but relating content. One of the most comprehensive frameworks (see Table 3) was provided by Anitha and Malini (2018).

Table 3

Taxonomy (V-framework) of big data

Volume	Amount	3V framework	Laney (2001)
Velocity	Speed of data collection, analysis and transfer		
Variety	Form		
Veracity/ Verification	Correctness/ Trustworthiness	5V framework	Zhong et al. (2016); Fosso Wamba et al. (2015); Roßmann et al. (2018)
Value	Monetary worth		
Volatility	Nature to change in a rapid and unpredictable way	7V framework	Kanaujia et al. (2017)
Validity	Accuracy and correctness to address a particular problem		
Visualisation	Graphical analysis	10V framework	Anitha & Malini (2018)
Virality	Speed of data movement inter networks		
Viscosity	Latency of data (element of velocity)		

Note. Adapted from "*A Review on Data Analytics for Supply Chain Management: A Case study*", by Anitha and Malini, 2018, International Journal of Information Engineering and Electronic Business (IJIEEB), 10(5) (https://doi.org./10.5815/ijieeb.2018.05.05).

Big data are understood as a new, dynamic and abundant form of data that are compiled from diverse information sources. Kitchin (2014) characterises big data as "being generated continuously, seeking to be exhaustive and fine-grained in scope, and flexible and scalable in its production" (p.2). A vast amount of data is stored in various systems and/or in modules rather than in one system, resulting in data that are not easily accessible, and which quite often exceed a human's capability to analyse. At present, advanced data analytics are ubiquitous and form part of many institutions' and corporations' agendas with a level of maturity and value yet to be fully understood.

The Gartner glossary (2023, para.1) define big data as "high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation" (para.1). While, as previously demonstrated, there is extensive representation of literature covering big data, one commonly agreed and validated definition of big data does not exist in research and practice. Boyd and Crawford (2012, p.663) describe big data as a "cultural, technological, and scholarly phenomenon" that entails: technology (computation power, algorithmic accuracy), analysis (identification of patterns to enable economic, social, technical, and legal postulates) and mythology (belief in "big data" as universal truth, objectivity and accuracy). "Big data can be captured, stored, communicated, aggregated and analysed and the parallel computing capacity can improve the efficiency of acquisition and analysing big data (cloud computing)" (Militaru et al., 2015, p.104).

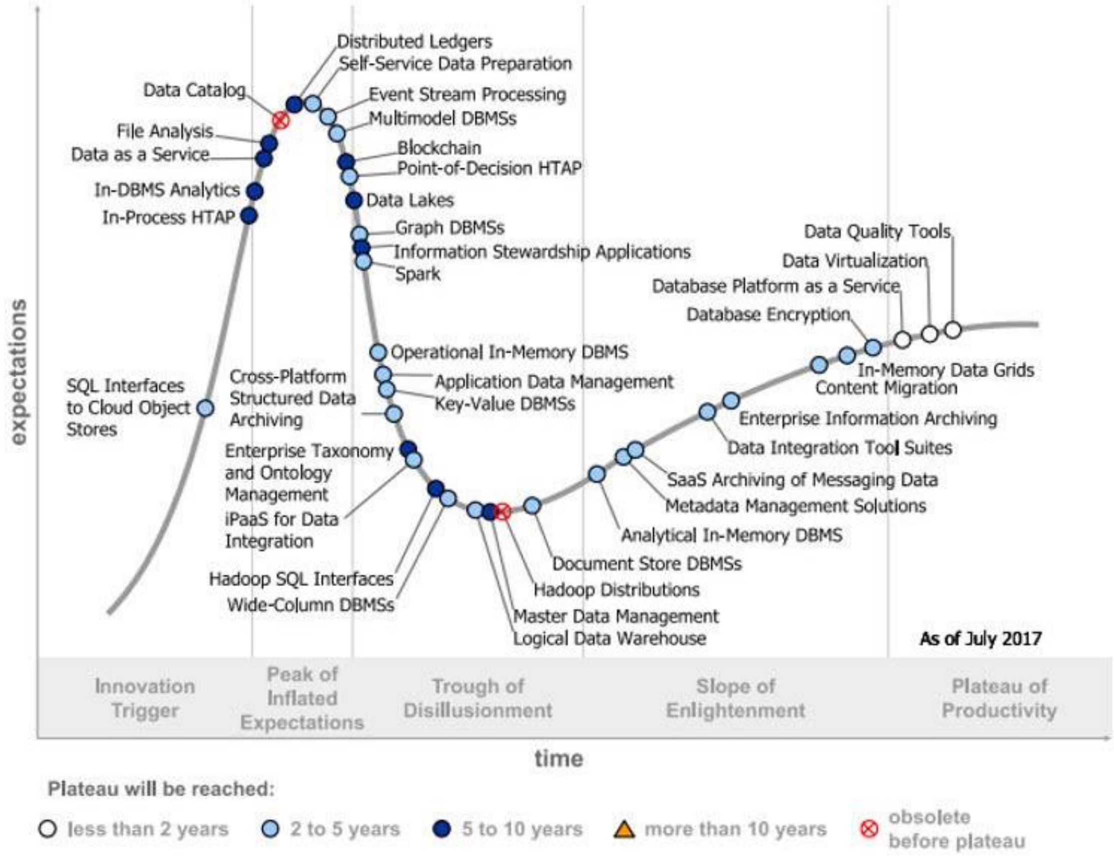
The reference to big data as a new management paradigm as "the development of management based upon logic and evidence rather than 'gut feeling'" in order to enable effective decision-making, underlines the significance that the topic has both in academic research and practice (Mortenson et al., 2015, p.585). Big data attracted and still attracts great interest from both fields. Reinsel et al. (2018, p.3) assert that "data is at the heart of digital transformation, the lifeblood of this digitization process", and others see data as the "new oil", expressing the strong desire by organisations to benefit from the exploitation of data. Waller and Fawcett (2013) acknowledge that "big data carries with it the opportunity to change business model design and day-to-day decision making that accompany emerging data analysis" (p.77).

From a business perspective, industries such as the aviation industry have an increasing appetite to exploit data in order to be ahead of competitors in a relevant market, e.g., the spare parts market. For example, in June 2017, Airbus launched Skywise, an aviation open platform, which aims to generate in-service data in order to improve its aircraft designs and support offerings (Airbus, 2017). The reference to Skywise as a “data goldmine” in a published article (Airbus, 2017a, p.22) underlines the value that users hope to generate. In general, there is wide consensus among academic authors and practitioners about the disruptive potential that big data offers (Buhl et al., 2013).

In recent years, an evolution of terminology from big to smart data can be witnessed. It is argued that it is better to concentrate less on mass data, but more on the quality of data and to use only relevant data in order to draw conclusions and make decisions (Bloching et al., 2015). Other authors such as Wierse and Riedel (2017) endorse this recalibration of focus towards meaningful findings instead of the sheer amount of data, but simultaneously state this shift takes place as a response to the positioning of big data in the Gartner hype-cycle (see Figures 17 and 18). The hype around big data has passed the “Peak of Inflated Expectations” and moves towards the “Trough of Disillusionment”. The introduction of the term smart data helps to fuel another hype that attracts a high level of attention.

Figure 17

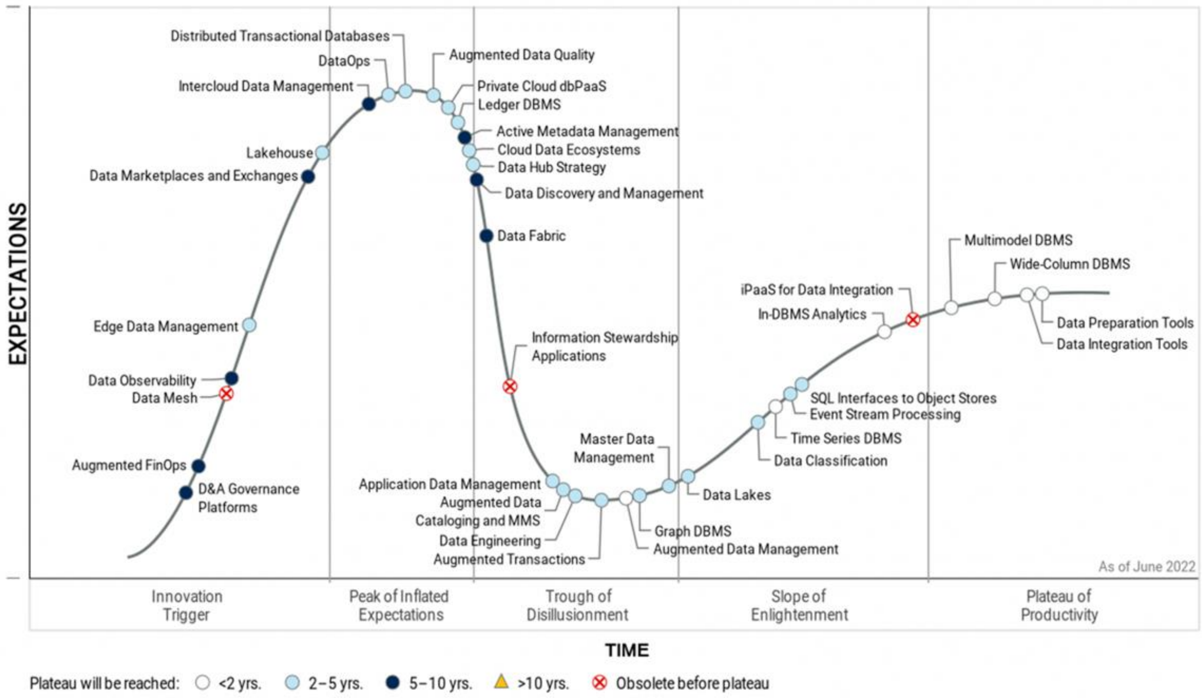
Hype cycle for data management, 2017



Note. From "*Gartner's 2017 Hype Cycle For Data Management Reflects IT's Need For Improving Data Quality*" (para. 9), by Columbus, 2017 (https://www.forbes.com/sites/louiscolumbus/2017/09/30/gartners-2017-hype-cycle-for-data-management-reflects-its-need-for-improving-data-quality/?sh=69abc4f7425b).

Figure 18

Hype cycle for data management, 2022



Note. From "*Hype Cycle for Data Management, 2022"* (para.18)*,* by Feinberg et. al, 2022 (https://www.gartner.com/doc/reprints?id=1-2B6AXOGW&ct=220920&st=sb).

2.2.4 Data Analytics and data-driven decision making

The extant literature provides a range of perspectives which underline the significance of processing and analysing large data sets; big data without data management, conversion and analysis is not more than an enormous "hodgepodge" of data (Arya et al., 2017). "The gains from big data are a combination of the size of current data sets coupled with rapidly increasing processing capability and improved predictive algorithms" (Militaru et al., 2015, p.104). While data management refers to "processes and supporting technologies to gather data, store data, to prepare and retrieve it for analysis, Big Data Analytics (BDA) is defined as "the techniques used to analyse and gather intelligence from big data" (Anitha & Malini, 2018, p.31). It involves the use of advanced analytics techniques to extract valuable knowledge from vast amounts of data, enabling data-driven decision making. It is only by combining big data and analytics that allows the generation of such valuable insights and thus supports the realisation of business objectives.

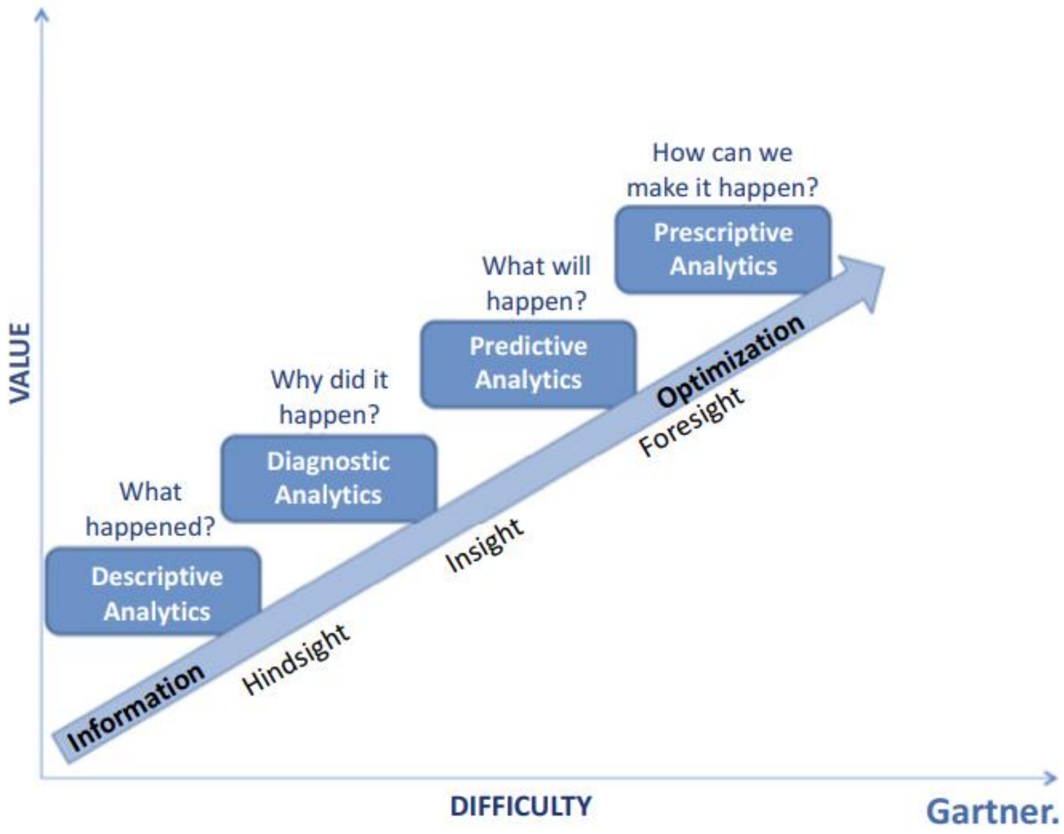
Following Gorman's distinction between analytics as being descriptive, predictive or prescriptive from 2012, Arya et al. (2017), Wang et al. (2016) and Anitha and Malini (2018) detail this categorisation as follows:

1.) descriptive, is used to analyse historical data patterns and relates to the identification of issues and opportunities within the extant processual and functional environment, answering the question, what happened;
2.) predictive, which uses mathematical algorithms and programming to detect and explore data patterns. It aims at forecasting future developments and providing answers to the question why things will happen;
3.) prescriptive, which characterises the use of data and mathematical algorithms to determine, assess and re-assess alternative events that involve objectives and requirements characterised by high volume and complexity. It targets the improvement of prediction accuracy in order to enable an advanced decision making and thus improve business performance. Prescriptive analytics is considered the most advanced and valuable form of analytics, yet most difficult to apply.

Gartner's analytics ascendancy model (GAAM) (see Figure 19) assesses the maturity of analytics implementation in an organisation (Maoz, 2013 as cited in Eriksson et al., 2020), using the identified analytics categories. In addition, the model includes another stage of analytics in between descriptive and predictive analytics, namely diagnostic analytics. Diagnostic analytics refer to a form of analytics in which the focus lies in the exploration of reasons for problems and occurrences. This type of analytics aims at responding to why things happen. The model underlines the evolutionary maturing of applied analytics and prescriptive analytics as the most advanced, thus most mature, and valuable, analytical capabilities. Furthermore, the model associates an advanced level of analytical maturity with the achievement of a competitive advantage (Eriksson et al., 2020). The categorisation by Gorman and the GAAM are of relevance for this research as they will be drawn upon in drafting the model for application in strategic procurement.

Figure 19

Gartner's analytics ascendancy model (GAAM)



Note. From *"Think with me, or think for me? On the future role of artificial intelligence in marketing strategy formulation" (p.802),* by Eriksson et al., 2020, The TQM Journal (32)4 (DOI: 10.1108/TQM-12-2019-0303).

Davenport (2013) points out the difficulties of traditional companies which attempt to implement and mature in the application of advanced data analytics, in comparison with data economy companies, where the business model, including decision making and management, is built around big data. Traditional companies are confronted with the requirement to adapt established organisational structures, traditional IT infrastructures, data sources and legacy data inventory. In conclusion, new approaches to business models, including value creation for both organisation and customer, and management are postulated (Davenport, 2013).

While business intelligence and thus data-driven decision making had become popular in the 1990s (Chen et al., 2012), the popularity in publications and the immense increase of BDA implementation initiatives in organisations provides new and valuable insights that supports improved decision making. Early publications on the topic link the effectiveness of decision making with the availability of information and organisational processing capacity (Galbraith, 1974). In contrast, more recent academic research underscores the development of BDA capabilities "to translate insights and transparency into value propositions improvements or process optimizations" (Roßmann et al., 2018, p.136).

By developing analytical capabilities, organisations target an increase in performance and measure it, ultimately to achieve a competitive advantage (Fosso Wamba et al., 2015; Arya et al., 2017). Capitalising on data and BDA results from in 1.) connectivity of data, 2.) utilisation of additional and new sources and 3.) compiling and processing data. Hence, relevant business insights are gained faster than other business stakeholders including suppliers and competitors (Bieda, 2020). Reference to analytics as "the next big frontier of innovation, competition and productivity" (Manyika et al., 2011, p.1) underlines the alleged potential that companies associate with the introduction of analytical technology.

Organisations that take strategic decisions based on data (often termed "data-driven organisations") value data as a strategic asset. Uncertainty and "gut-feeling" is replaced by measurable parameters. A prerequisite for a successful data-driven approach is a meaningful and valid data foundation that enables the capture and analysis of data, thereby deriving knowledge from and for the entire organisation in an efficient manner. Data security and respective governance is understood to be a second vital aspect (Pathak, 2020). Bieda (2020) points out that not having data and analytics capabilities, particularly in times of crisis, endangers the company's ability to survive. Covid-19, in its unpredictable nature and unexpected magnitude, revealed rigorously the state of digital maturity and the appropriateness of developed BDA. Data was not available, could not easily be extracted or processed, meaningful decisions could not be made as quickly as needed with the data at hand. Problems with data integrity such as time-lags, missing connection, inappropriate levels of granularity became apparent and delayed necessary and immediate actions to adapt the business accordingly, e.g., cancellation of purchase orders or postponement of delivery dates. In addition, simulating and modelling used to predict the future based on historical data proved irrelevant (Bieda, 2020).

In a sense the pandemic served as a catalyst for digital transformation as it clearly underlined the indispensability for developing greater capabilities to adapt in an agile and flexible manner in this volatile environment. Even in times of economic prosperity, the execution of a future-oriented transformation is often difficult, but the Covid-19 pandemic has only heightened the need for business re-focusing, forward planning and the acceleration of digital transformation in all corporate functions (Adam et al., 2018; Schrage, 2020).

The development of what Bieda (2020, para.2) calls “analytical agility” is key in responding to a highly volatile environment. This agility is rooted in in the advancement of data quality and connectivity, boosting analytical capabilities by establishing relevant business rules and parameters throughout the organisation and the availability of a pool of people skilled in data intelligence and business acumen (Bieda, 2020). Data reliability is found to be fundamentally essential (Bean, 2020). Academic research postulates the compulsory requirement to transform processes, policies, structures, and roles in order exploit the benefits of analytics capabilities established by an organisation (Roßmann et al., 2018).

The emergence of a rapidly growing market related to data analytics and management worth $135 billion by 2025 demonstrates the important role this sector of services will assume (Knowledge Based Value (kbv) research, 2023). As Scholz (2016, pp.161) affirms “not using big data will lead to a significant competitive disadvantage: if there is useful information available, the competitors will use it”. At the same time, Scholz points out that the effects of big data in economic organisations are under-researched.

Despite the attributed vast opportunities and potential that big data and analytics bring, barely any organisation has measurable evidence of the benefits. Işik et al. (2013, p.13) state organisations “are grappling to make sense of the rapidly increasing volume, velocity, and variety of data generated by both internal and external resources” and to capitalise on the value of big data. A survey conducted by Davenport and Bean (2020) finds that companies still struggle to transform into “data-driven” even though there is wide and cross-industry acknowledgement about the value of data analytics and the concept of data-driven decision making has been present for three decades. While making major investments in big data and AI, benefiting from implementation remains challenging for about three quarters of survey participants. There is almost unanimity that the challenge relates to people, process and culture and confirmation that technology is not the hurdle for harvesting success. Only half of organisations consider data as a business asset. Schrage (2020) argues that the deployment of data and advanced data analytics while continuing to operate in a legacy process set up does not result in the expected optimisation and a boost of efficiencies. “Business processes should adapt to the increasingly complex information flows to ensure that activities and process standards match the data environment” (Brinch, 2018, p.1602).

Comuzzi and Patel (2016) developed a Big Data Maturity Model (BDMM) along five dimensions (see Table 4) and with six levels of maturity (see Table 5) following Becker et al. (2009).

Table 4

Maturity dimensions in BDMM

Strategic Alignment	measuring maturity of strategy and processes, assessment of big data alignment with corporate strategy and achievement of such by exploited big data in the application operational and decision making processes
Organisation	measuring maturity of people and culture by assessing the awareness and staff's competences to apply big data technology and role of big data at organisational level
Governance	measuring the maturity of organisational structural arrangements to manage big data along defined objectives and its compliance
Data	measuring the organisational maturity to handle big data in an end-to-end (E2E) manner from acquiring, storing to analysing and derive meaningful insights
Information Technology	measuring infrastructure and information management maturity

Note. Adapted from *"How organisations leverage Big Data: a maturity model"* by Comuzzi and Patel, 2016, Industrial Management & Data Systems, 116(8) (https://doi.org/10.1108/IMDS-12-2015-0495).

Table 5

Maturity levels in BDMM

0	Non-existent
1	Initial
2	Repeatable
3	Defined
4	Managed
5	Optimised

Note. Adapted from *"Developing Maturity Models for IT Management"* by Becker et al., 2009, Business & Information Systems Engineering, 1, 213-222, (https://doi.org/10.1007/s12599-009-0044-5).

In a study conducted by Comuzzi and Patel (2016) the BDMM was developed and achievements in terms of BDA introduction by several organisations investigated. It was concluded that proof of value created in practice seems to be limited, despite individual testimonials to the contrary.

In an online article, published by Asay (2017), even the above-mentioned estimated failure rate was found to be too conservative and was in reality close to 85%, caused among other things by a mismatch between modern big data technologies and actual business structure and culture. Altair (2023), following a global survey, reported high pressures felt by companies for adopting organisational data and AI strategies. Confidence to use existing data to improve business performance rose. On the other hand, 84% (Altair, 2023, p.22) of respondents felt that the organisations face limitations that delay projects and also struggle to take advantage of data analytics, even more so if data processes are complex. The survey found that 33% (Altair, 2023, p.24) of respondents reported that more than half of data science projects never made it to production and that on average 36% (Altair, 2023, p.5) of projects failed.

Davenport and Bean (2020, p.2) conclude defiantly “one thing never changes: organizations are not becoming data-driven and do not build data-focused cultures”. Alongside the above-mentioned findings in the business environment, academic research has not been able to provide profound models on how to develop relevant capabilities and skills (Arunachalam et al., 2018; Schneider, 2018). One recent model, identified during the review process, is the capability maturity model (ADA-CMM) for advanced data analytics proposed by Korsten et al. (2022), confirming the rare available academic material that provides guidance on capability and skill development (see Table 6). The model comprises five maturity dimensions including a total of 17 sub-elements across all dimensions and four stages, ranging from “low” (level of maturity) to “top” (level of maturity). It serves the purpose of assessing the present state of advanced analytics capabilities, and aims at supporting the development of a roadmap to advance maturity. Findings from the study suggest that an advanced level of maturity in relation to advanced data analytics capabilities is associated with a positive business and hence organisational performance impact.

Table 6

ADA-CMM

Main Element (Capability Area)	**Sub-Element (Capability)**
People & Culture	Knowledge/ Commitment/ Team Diversity/ Usage
Performance & Value	Performance Metrics/ Innovation Processes
Strategy	ADA Strategy/ Strategic Alignment
Data & Governance	Data Architect/ Automation/ Data Integration/ Data Governance/ Data Analytics & Tools
Process Design & Collaboration	Competence & Skills Development Communication Portfolio Management Organizational Collaboration

Note. From *"ADA-CMM: A Capability Maturity Model for Advanced Data Analytics"* (p.270), by Korsten et al., 2022, In T. X. Bui (Ed.), Proceedings of the 55th Annual Hawaii International Conference on System Sciences, HICSS 2022 (https://doi.org/10.24251/HICSS.2022.032p.270).

2.3 Evolution and positioning of procurement

2.3.1 Definitions and perceptions of the procurement function

Originating from the Latin word "procurare" in its meaning of "to take for", the main tasks of the procurement function are to buy the right materials in the right quantities and qualities and assure the delivery to the right place and the right time (Batran et al., 2017). Academic research offers an abundant number of publications related to procurement covering topics such as definitions, organisational importance and evolution and performance measurement (Quayle & Quayle, 2000).

Nevertheless, there is no consensus about an unambiguous definition or clarity on the different terms used. The terms "sourcing", "purchasing", "buying", "supply management", and "procurement" often seem to be used interchangeably. Procurement and purchasing, for example are often used as synonyms; however academic research acknowledges a distinction between the terms. Procurement is defined as a “process by which a company (or other organisation) contracts with third parties to obtain goods and services required to fulfil its business objectives in the most timely and cost-effective manner (Elliot-Shircore & Steele, 1985)” (Quayle & Quayle, 2000, p.262). They argue that “purchasing is more concerned with establishing and managing a commercial relationship, whereas procurement is also concerned with the more physical material or service delivery control aspects after the contract has been let or the order placed” (Quayle & Quayle, 2000, p.262).

This contradicts with the view of Procurify (2023), which argues that procurement “is the process of sourcing and purchasing the goods and services a company needs to fulfil its business objectives, usually from an external source, like a third-party vendor or supplier” (para.6). In contrast, “purchasing is the act of acquiring a good or service and typically involves the immediate day-to-day transactions between sellers and buyers” (para.3). Procurify (2023) underlines the transactional and price-focused nature of purchasing opposed to the E2E value-driven orientation of procurement.

Carr and Pearson (2002) state the “goal of a strategic purchasing function is to support the firm’s effort to achieve its long-term goals. If purchasing has an integrative role in the firm’s strategic planning process, then the purchasing function can be characterized as a strategic function” (p.1033).

Smeltzer et al. (2003) defined strategic sourcing as “a systematic and comprehensive process of acquiring inputs as well as managing supplier relations in a manner that achieves value in obtaining the organization’s long-term objectives” (p.16) and concluded from a review of several existing definitions of strategic sourcing the shared emphasis on the integration of business processes. In this thesis, the definition by Joesbury (2016), following an extensive literature review aiming at a definition of effective procurement is adopted. He defines strategic sourcing/strategic procurement as “the fundamental integration of purchasing and supply chain into the strategy, decision making and operation of the enterprise” (p.33).

In the past, procurement used to be typically considered as a back-office function and thus a secondary function. Following Porter's value chain model, first published in 1985, this view used to be broadly accepted in practice. Cost-leadership was valued as the highest priority, rather than the value that derives from a long-term reliable partnership with a competitive supplier. There is general consensus about the rapid evolution of the procurement function since the rise of strategic sourcing in the 1990s, which elevated procurement from a transactional to a fundamental and integral element of company strategy in the pursuit of competitive advantage. By effective cost management and direct impact on a company's profitability, the availability of relevant information for improved decision making and close relationships with suppliers that support the on-time delivery of high qualitative products and services, strategic procurement contributes in numerous ways to the achievement of competitive advantage (Hughes & Ertel, 2016).

Yet the perception of the procurement function by internal stakeholders varies widely, from a very tactical primary function to a respected and significant contributor to value creation and competitive advantage and thus sustainable company success (Ellram & Carr, 1994). On one side, there is wide agreement that procurement is deemed a vital contributor to value creation and therefore a fundamental factor in an organisation (Tassabehji & Moorhouse, 2008; Landale et al., 2017). Paulraj et al. (2006) provide empirical evidence derived from a conducted study among procurement and supply management executives for the growing significance of the procurement function and its focus in building strategic relationships with the suppliers. It also promotes the role of procurement as the essential integrator of supply activities and driver of supply chain performance excellence.

A research study conducted by Carter and Narasimhan (1996), aiming at documenting the impact purchasing decisions have on corporate performance, finds that procurement has a decisive impact on competitive position, profitability, and market share, and formulates the imperative that procurement is to be considered as a "key component of firm competitiveness and involved at the highest level of corporate strategy formulation and decision making" (p.24).

On the contrary, Jenks (2019) summarises his experience from discussions with procurement, sourcing and purchasing professionals by stating that procurement is still viewed in many organisations as a supporting function following procurement's narrow definition in Porter's value chain model. It is argued that procurement is still a supporting and tactical function, performing low value adding activities (Tassabehji & Moorhouse, 2008; Cox et al., 2005). Strategic procurement in the organisation that is used as a case study in this thesis sources around 80% of the company's activity externally and acknowledges that suppliers and thus by implication, its procurement teams as its interface "play a crucial role in the common business success" (Airbus, 2023b, para.1). Despite the above-mentioned perspective, the perception of procurement among internal stakeholders outside of the procurement community is often one of scepticism and the procurement organisation may be viewed as complex and processes overly bureaucratic and too slow. Joesbury (2016) summarises some biased perceptions about procurement that have developed over time, including:

- "Purchasing personnel really do not understand user requirements.
- Purchasing decisions are made solely on the basis of purchase price.
- The purchasing process involves too many rules and regulation, requires too much time and adds too little value.
- Purchasing does not keep users informed regarding the status of materials and/or services requests.
- Purchasing personnel would prefer to do business with their favourite suppliers rather than those that can best served the requirements of the user" (p.34).

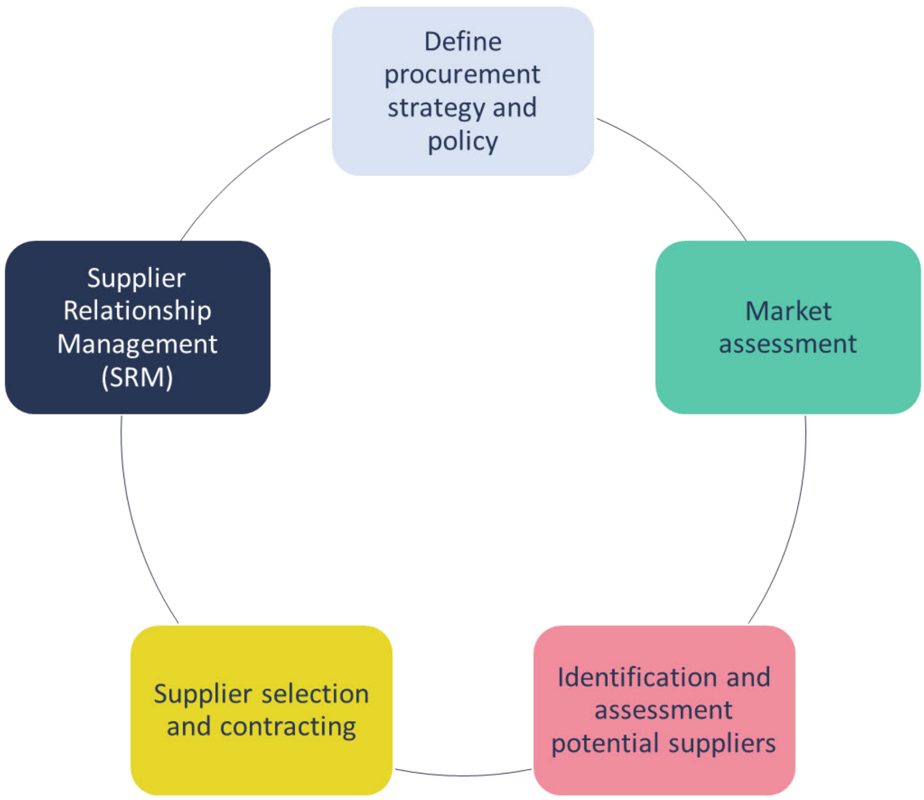
In conclusion, this poor perception of procurement has not changed significantly (Joesbury, 2016) and as Batran et al. (2017) conclude, "procurement has never been seen as a cutting- edge function" (p.121). This contradicts the factual situation that the procurement function manages on average 70-80% of the external value add at present (Batran et al., 2017). Schweiger (2016) asserts that an average value of 60% share spent on external sourcing in relation to a company's total revenue has a has a major impact on operating results.

2.3.2 Key activities in strategic procurement

"Procurement is a set of activities and processes related to acquisition of goods and services through purchase orders placed by organization employees, from external contractors" (Westerski et al., 2015, p.1357). At present, key activities of the procurement function include management of suppliers, negotiation of contracts, establishment of alliances and acting as liaison between suppliers and various internal departments (Joyce, 2006). The strategic procurement function covers, based on an E2E assessment, the areas of responsibility as shown in Figure 20.

Figure 20

Strategic procurement – scope of activities



Note. Adapted from *"Procurement Process"*, by Airbus, 2014 [Unpublished].

At the company from the aviation industry, which is subject of the case study for this thesis, the procurement function impacts strategic decisions such as make-or-buy or Mergers & Acquisitions (M&A). Its early involvement in manufacturing- and design-to-cost processes underlines the key position within the organisation. Strategic procurement makes a significant contribution to the company's value creation by structuring a competitive worldwide operating supplier base and shaping and sustaining a robust supply chain. The aim of procurement is to establish long-term relationships to its strategic partners (Airbus, 2014).

Seven key success factors for effective procurement were identified: "a clear procurement strategy, effective management information and control systems, development of expertise, a role in corporate management, an entrepreneurial and proactive approach and co-ordination and focused efforts (Smith & Conway, 1993)" (Quayle & Quayle, 2000, p.267). Quayle and Quayle (2000) recognise the relevance of the above-mentioned success factors but introduced an eighth fundamental: effective communication of the key success factors to all levels of the organisation, be it in the public or private sectors.

2.3.3 Future value of procurement

There is acknowledgement that a focus on price competition among suppliers does not suffice as value contribution by the procurement function and as Hughes and Ertel (2016) put it "the low-hanging fruit has been picked" (p.18). The authors point out the unique position of procurement as interface between external suppliers and internal stakeholders and postulate the application of a new procurement paradigm in organisations aiming "to stay at the competitive edge by making use of its procurement function in a more innovative and strategic way" (Bienhaus & Haddud, 2018, p.970) and at generating superior total supplier value (Hughes & Ertel, 2016). "Leading edge firms seek to have purchasing functions that are strategic" (Carr & Pearson, 2002, p.1050).

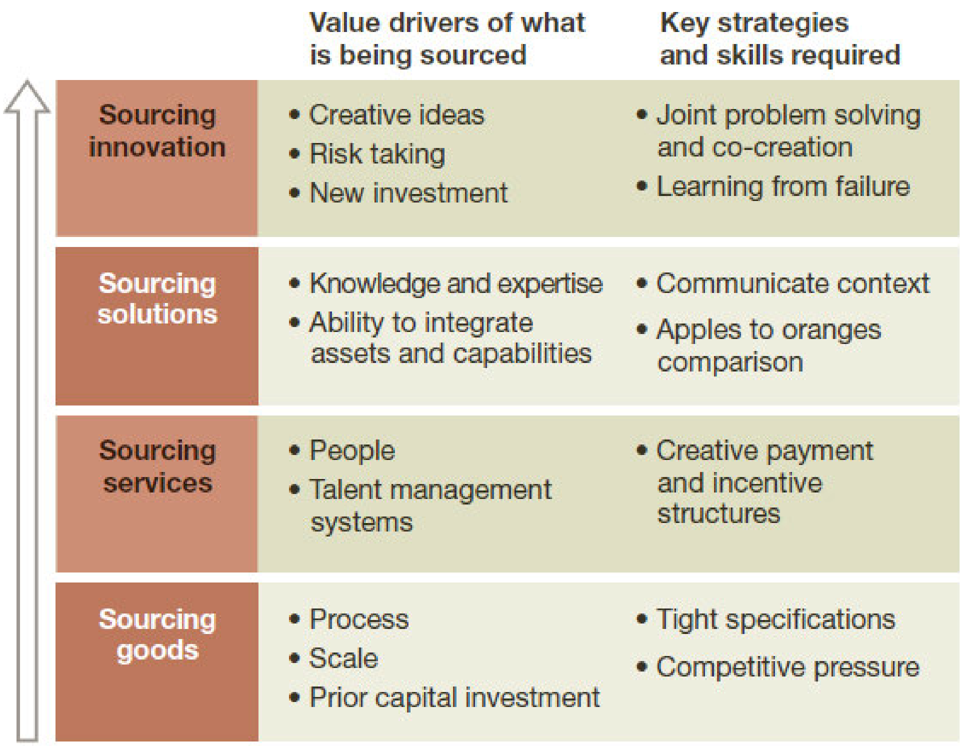
The call for recognition and further promotion of procurement's strategic role to leverage supply chain performance by Paulraj et al. (2006) remains topical. Academic publications highlight the prominence of collaboration between the supply chain parties, promoting also joint investments and the advantage of the strategic nature of such relationships (Hoejmose et al., 2013; Bienhaus & Haddud, 2018). Watts et al. (1995) recognises that an improved buyer-seller relation, characterised by trust and transparency, can benefit the corporate strategy.

Publications such as from Batran et al. (2017) and Bienhaus and Haddud (2018) adopt the position that a leading procurement organisation acts as the hub or a centric node in a procurement network that connects suppliers, partners and even competitors in a business environment where company’s boundaries dissolve. The level of connectivity between the supply chain partners and the ability to make use of abundant data are understood as a key success factor. Setting up collaborative long-term relationships with the right set of competitive suppliers, not only on 1st tier level, and maintaining them is and will remain a key priority among procurement activities (Hughes & Ertel, 2016). The trend to manage only 1st tier suppliers is reversed and n-tier management continues to grow in significance. One of the industries where this development is witnessed is the aviation industry. Reasons for this re-focus of supply chain management is the enhanced visibility throughout the value chain and close supplier surveillance to anticipate and mitigate delivery and thus production risks. This becomes vital in high production rate scenarios.

There is further argument in favour of an optimised n-tier management by recognising n-tier level suppliers as valuable sources for innovations and contractual partners for the delivery of key technologies for the Original Equipment Manufacturer (OEM) or first tier supplier. With an average external value creation of 70-80% there is vast potential to source innovation from the supply base (Batran et al., 2017). Different definitions of the term innovation exist; a broad one is to define it as “implementing new ideas that create value” (Linder et al., 2003). The reference to innovation as “the creation of new products, services, technologies, processes and ideas that are better or more effective than those that preceded them” is more limited in scope and implies a focus on an improvement, an intended result, or the accomplishment of a purpose (Batran et al., 2017, p.73). As early as 1954, Drucker had formulated the management paradigm that a company’s ability to innovate is one of the business fundamentals to gain and sustain a competitive position in the market (Drucker, 2012). Meaningful innovation sourcing demands a holistic management approach and does not refer to ad-hoc transactional sourcing initiatives. It stipulates an innovation agenda at company level which is cascaded to the procurement function and is a vital part of the sourcing strategy and followed by an implementation of organisational structures and processes for the implementation (Linder et al., 2003) (see Figure 21).

Figure 21

Sourcing innovation as part of the new procurement paradigm



Note. From “*The reinvention of procurement”* (p.20), by Hughes and Ertel, 2016, Supply Chain Management Review, 20(3) (https://www.proquest.com/docview/1802570292?accountid=59680&forcedol=true).

At present and in the future, the procurement function must meet the self-made claim to play a strategic role in the achievement of company objectives such as sustainable competitiveness and a different set of expectations expressed by internal stakeholders from the organisation. Procurement needs to develop adequately responsive organisational structures and processes to respond to externally accelerating dynamic sourcing market conditions and upcoming megatrends beyond digitalisation, for instance sustainability. It translates as well in a call for a transformation of roles, responsibilities and jobs that allow cross-functional collaboration inside an organisation.

Recently, corporate sustainability emerged as a megatrend and forms an integral part of the annual corporate objectives. Both politicians and the general public demand a substantial reduction and avoidance of emissions to stop climate change. Immense pressure is being put on the aviation industry companies to significantly contribute to it and increasingly decarbonise products, manufacturing, and operations. In addition to the environmental aspect, the compliance with human and labour rights forms the 2nd pillar of sustainability, which despite its significance, will not be further investigated in this thesis.

Strategic procurement can take a leading role in the achievement of corporate objectives by translating sustainability-related objectives into requirements for the supply chain. This entails the inclusion of environmental requirements as a selection criterion for awarding a contract and monitoring the fulfilment of these in the duration of the contractual relationship.

An evolution of the procurement business model into a “value-chain minded” procurement is postulated (see Figure 22). It is argued that “everyone in the value chain needs to compete ‘as one’ to gain maximum benefits for all” (Batran et al., 2017, p.25). It adds further aspects to the claim for a new procurement paradigm where the function engages in a transformation that entails the implementation of state-of-the-art technology, development of people and skills and the acceleration of processes and policies. Batran et al. (2017) summarise the requirements; “procurement has to be fast and agile, and still meet company requirements in terms of governance and compliance" (p.149) as strategic focus and strategic flexibility is understood as vital to enhance supply chain agility (Chen et al., 2012). Research indicates that procurement organisations of high-tech companies demonstrate better adaptation capabilities due to a lower level of formalisation and specialisation (Juha & Pentti, 2008).

One of the core competencies of the future procurement, beyond a strategic orientation, is "business acumen", meaning applied analytical skills to fully comprehend the various business models among suppliers and to determine the "best-fit to our strategic sourcing needs" model. There is consensus among academic research and practitioners that the development of relevant hard and soft skills responding to distinctly changed job profile requirements is fundamental (Hughes & Ertel, 2016; Batran et al., 2017; Accenture, 2017).

Figure 22

Procurement paradigms

Traditional procurement paradigm	New procurement paradigm
• Primary value is cost reduction and securing external supply of goods and services	• Primary value is solving business problems and delivering competitive advantage
• Competitive pressure and leverage over suppliers is key to value	• Collaboration with suppliers and balanced dependence is key to value
• Internal focus is on stake-holder compliance	• Internal focus is on being a trusted advisor to the business
• Manage transactions	• Manage relationships
• Analytical skills	• Business acumen and soft skills
• Own and execute	• Facilitate and enable

Note. From *"The reinvention of procurement"* (p.21), by Hughes and Ertel, 2016, Supply Chain Management Review, 20(3) (https://www.proquest.com/docview/1802570292?accountid=59680&forcedol=true).

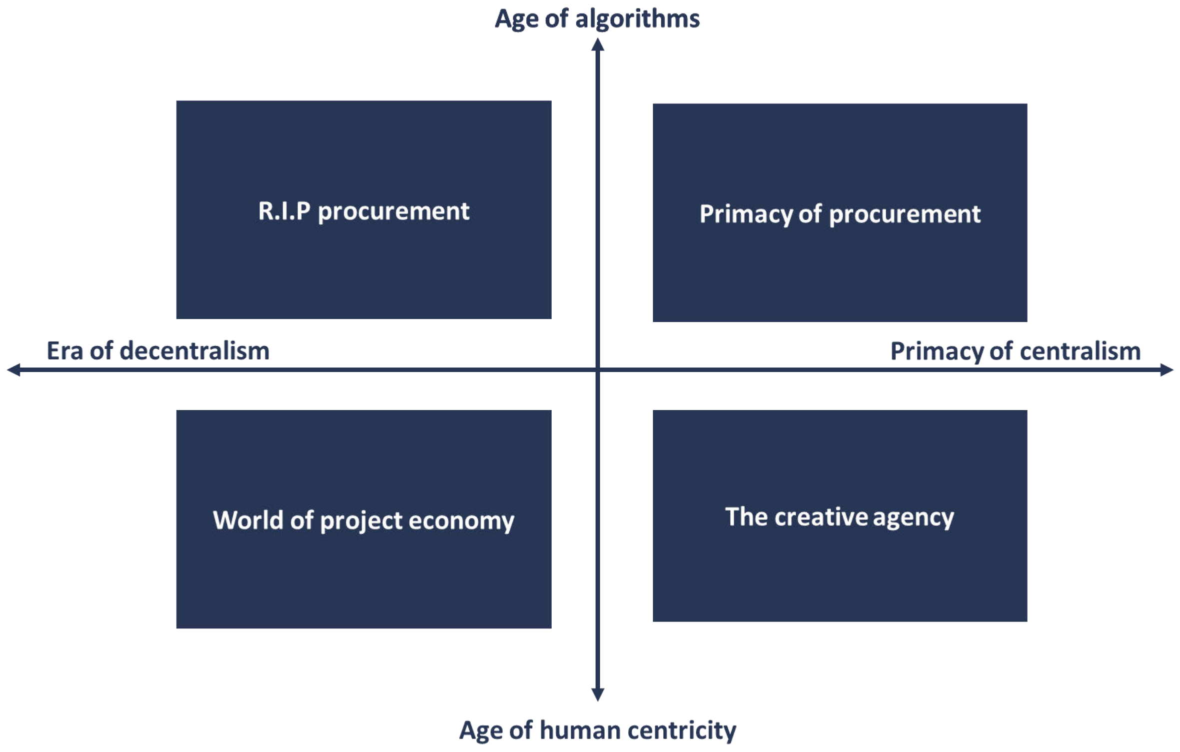
Procurement must adapt to be ready to demonstrate its future proofing and the capability to deliver the next wave of value. A report that deals with the selection of "2035^{Plus}" scenarios of how the procurement function may look like in the future forecasts drastic changes. Four different alternative scenarios are presented (von der Gracht et al., 2016). The framework (see Figure 23) is based on the organisational structure of the company and its supply chain as horizontal and the degree of digitalisation as vertical axes in recognition of the expected immense significance of those aspects in the development of the future procurement function.

The age of human centricity and the age of algorithms mark the opposite end points on the horizontal – degree of digitalisation – axis. Era of decentralism face primacy of centralism on the vertical – organisational structure – axis (von der Gracht et al., 2016).

Building upon the respective positioning along the axes in the resulting diagram, the prognosed futures range from procurement domination of operational functions over a creative agency set-up, to procurement becoming obsolete and being consigned to history.

Figure 23

The future of procurement according "Scenarios 2035[Plus]"



Note. Adapted from *„Future-proof procurement Now or never: the big procurement transformation"*, by von der Gracht et al., 2016 (https://assets.kpmg.com/content/dam/kpmg/pdf/2016/04/kpmg-studie-future-proof-procurement-sec.pdf).

The procurement as the centre of power is assumed to be likely in a set-up where advanced technology has widely penetrated the centralised structured organisation but has not replaced procurement staff who act now as supply chain integrators and innovation promotors. Procurement is the nucleus of the external and internal supply chain network. The function has evolved into the centre of gravity in the organisation for making strategic decisions at company level.

In a so-called “R.I.P scenario”, significant technological advancement and a high degree of decentralisation has led to the complete replacement of operational procurement by artificial intelligence and a system of fully automated processes. Strategic procurement in the form of an organisational entity ceases to exist and is integrated into product management and development of company management (von der Gracht et al., 2016).

2.3.4 Procurement 4.0 and digital maturity

Digitalisation is assumed to be key in the transformation into a value-driven and value delivering procurement function in the future. As a customer-focused E2E approach, digitalisation can enhance visibility, integrate processes and interfaces and diminish risks of failure in complex value chains such as in the aviation industry (Batran et al., 2017). Key elements are “connectivity, collaboration, transparency as well as governance and leadership” that fundamentally and pervasively alter supplier relationships (Batran et al., 2017, p.115).

The digitalisation of the industrial sector is subsumed under the term Industry 4.0. As a key concept for “increasing intelligence of products and systems, their intra-company cross-linking and their cross-company integration into value creation networks” (Schneider, 2018, p.803), the topic of Industry 4.0 has been researched extensively. Industry 4.0 involves a profound and encompassing transition of products, processes, business models, organisation, and procurement (Nicoletti, 2018).

Following the derivation of Industry 4.0 as a term composed of firstly, a common industry definition and secondly, 4.0 as expression for the fourth industrial revolution, the term procurement 4.0 emerged. Procurement 4.0, or the impacts of Industry 4.0 in procurement, reflects the aim of describing the global and all areas-of-life-impacting phenomenon of digitalisation, but focusing explicitly on procurement related aspects and support for Industry 4.0. At present, there is no comprehensive definition of procurement 4.0. However, following Nicoletti’s (2018) understanding, it is the deployment of advanced digitalisation and automation both internally in the organisation and externally with actors of the value chain.

Fundamental elements are a high level of connectivity which thereby enhances the integration of suppliers in the value chain network, many-to-many communication via platforms, access to real-time data and analytic capabilities through machine learning and artificial intelligence (AI) (Bag et al., 2019, Accenture, 2017). Mobile technology is identified as an enabler of decentralised decision support systems such as running through approval loops on the smartphone (Batran et al., 2017).

In this thesis, the term digital procurement is adopted, being synonymous with the concept of procurement 4.0, and can be defined as the "application of advanced analytics of big data, process automation and new collaboration models with suppliers and business users to significantly improve the effectiveness of the procurement function and reach higher impact, faster, and more sustainable". Following the model for industrial revolution stages, characteristics have been identified that mark the different phases of procurement evolution (see Table 7).

Table 7

Stages of procurement evolution

	Procurement 1.0	Procurement 2.0	Procurement 3.0	Procurement 4.0
Purpose	▪ support of basic functions (What? Where? When?) ▪ cost reduction as predominate priority ▪ slow response speed in demand changes resulting in overstocking, bottlenecks and delays, unacceptable service levels, and product obsolescence ▪ initial recognition of strategic importance of procurement	▪ development of integrated procurement services ▪ fair value as key priority ▪ global sourcing kicks-off	▪ management of complete purchasing cycle ▪ global sourcing is established	▪ procurement as corporate value creation centre ▪ processes fully mapped via e-procurement ▪ autonomous processes, e.g., ordering ▪ use of e-commerce and virtual marketplaces ▪ digital supplier integration via cloud ▪ establishment of reliable digital contract/business models
Technology application	▪ system of completed transaction recording	▪ technologies to deep dive analysis and retrieve contextual information (foundation to apply predictive AI-technologies ▪ advances in communication technology	▪ e-procurement systems that manage the complete purchasing cycle with multi-company capabilities ▪ application software for demand forecasting and submission to the supplier ▪ application to place orders to suppliers via a shared platform	▪ real-time data ▪ advanced and cognitive analytics ▪ shared platforms (cloud-based) ▪ embedded RPA
Nature of supplier relationship	▪ relationship following 'arm's length' principle ▪ price competitiveness as key selection criteria ▪ predominately local suppliers ▪ gradual development of supplier relationships management	▪ development of collaborative and durable relationships ▪ expansion of supplier base location	▪ focus on collaboration and partnership	▪ focus on partnership development and management

Note. Adapted from *"Agile Procurement Volume II: Designing and Implementing a Digital Transformation*", by Nicoletti, 2018 (https://doi.org/10.1007/978-3-030-35979-9);

Adapted from *"Next Generation Digital Procurement Upgrade your thinking"*, by Accenture, 2017 (https://www.accenture.com/_acnmedia/PDF-129/Accenture-Next-Generation-Digital-Procurement.pdf).

In 2017, according to Batran et al. (2017) there had been 12 million hits on a Google search for procurement 4.0.

Figure 24

Trend curve web-search for "digital procurement" worldwide between 2017- 2023

Note. The figure displays the interest, its relative popularity, over time.
From *"Digital Procurement",* by Google trends, 2023
(https://trends.google.com/trends/explore?date=2017-01-01%202023-10-20&q=digital%20procurement&hl=de).

In the recent past, the interest in exploiting the alleged potential of procurement 4.0 or digital procurement has significantly increased among practitioners. Numerous publications from consulting entities reflect on this fact. PwC (2019) highlights digitalisation as a strategic priority for procurement organisations in companies across Europe. Forrester (2019) marks procurement as the potential leader in corporate digital transformation and Roland Berger's (Hader et al., 2020) yearly survey among procurement executives and professionals from the aerospace and defence industry ranks digitalisation as the second highest priority between the years 2017 and 2019. PwC reports that 55% of procurement organisations struggle to leverage data (Fischer et al., 2022, p.4). Digital transformation is driven by ambitions to optimise processes for more than half, and reduce costs for less than half, of the responding organisations (Fischer et al., 2022).

In contrast, only a limited number of publications covering the digitalisation of procurement resulting from academic research could be identified. Relevant articles use the term procurement to include "purchasing and supply management, along with managing inbound and outbound logistics” (Bag et al., 2019, p.2). As outlined in the research objectives; the strategic aspects of the procurement process and organisation are the centre of this research. Following an extensive literature review, Bag et al. (2019) concludes that the term procurement 4.0, as the application of Industry 4.0 in procurement, has only been found in one article (Bienhaus & Haddud, 2018) with a focus on the underlying business processes and exploration of potential barriers that organisation must overcome.

Results from academic research which relate to maturity, measurement of performance and measurement and satisfaction resulting from the implementation of digital tools are yet to be found. However, numerous reports and gray literature from business and consulting entities relating to the potential, challenges and maturity of procurement 4.0 exist. The results of these reports are often supported by studies in the form of questionnaires among procurement professionals of different hierarchical levels. A critical evaluation is indispensable due to the utilisation of topical buzzwords, and because the ultimate objective of such reports is to market services.

Procurement in general has lagged behind the introduction of technological applications, the subsequent linking of systems and a sufficient consideration of process and organisation change models. Procurement has not yet been able to fully exploit the potential benefits of digitalisation such as intelligent demand forecast modelling, risk mitigation and cost reductions (Murray, 2013). Others argue that procurement as a function and organisation has not got sufficiently engaged into the “digital revolution” and claim immediate reconsideration is appropriate. Even though e-procurement solutions are implemented widely and the introduction of cloud-based tools proceeds, there is a tendency for companies to operate new tools in a pre-digitalisation processual and organisational set-up (Accenture, 2017).

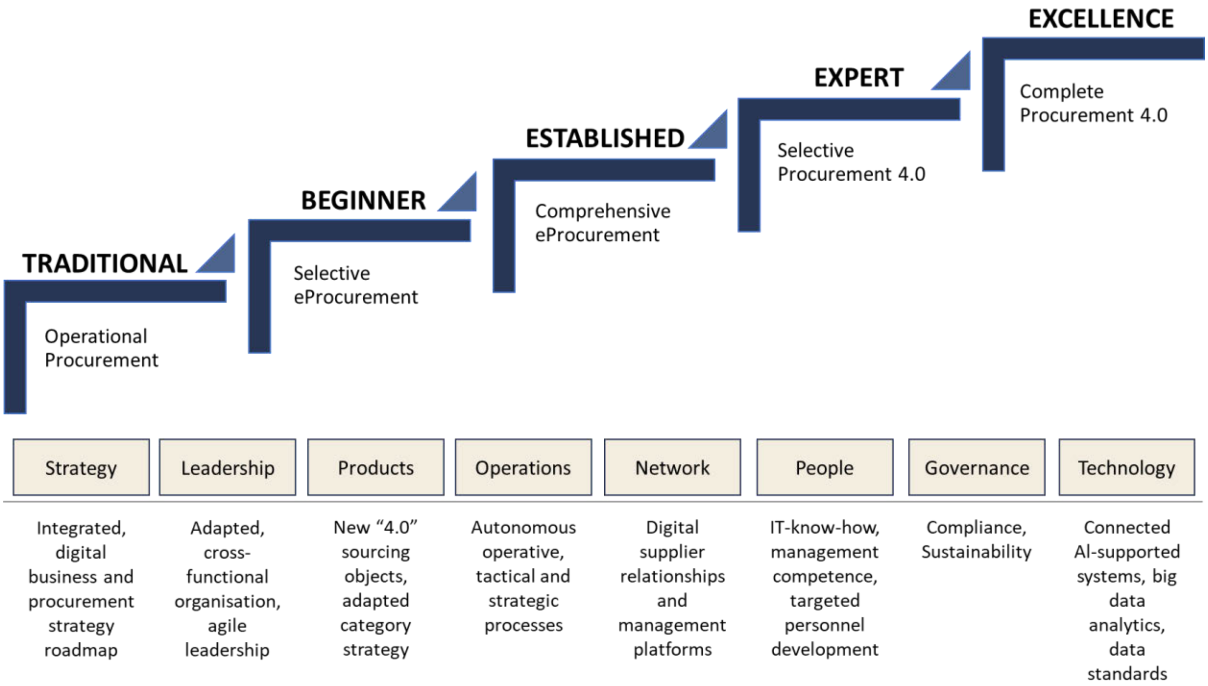
Similar statements are expressed by interview partners with an industrial background in Batran, 2017: “we want Procurement 4.0, but we have staff 2.0 and even leadership 1.0” (p.9). Harvard Business Review Analytics Services (2021, p.1) call procurement a “late bloomer” in the adoption of digital technology. Even though organisations have progressed in transforming digitally, procurement as a function has not engaged in such corporate transformation at the same speed. It is broadly supported by both academic researchers and practitioners that engaging in procurement 4.0 goes far beyond the implementation of new technology, and also entails a change of the fundamental procurement business models including people, processes, and culture (Batran et al., 2017, Nicoletti, 2018, Accenture, 2017).

Divergent perceptions exist regarding the digital maturity of the procurement organisation. On the one hand, a survey (PwC, 2019) finds that digitalisation of procurement processes is well advanced and points out the leading role of German companies in the transformation of procurement processes and implementation of technology. On the other side, according to Deloitte (2019), companies demonstrate different levels of maturity. However, the majority of the responding CPOs is not satisfied with the achieved results by implementing digital technology. In 2023, Deloitte reported an acknowledgement of digital transformation advantages by CPOs, but declared uncertainty where and how to get started (Addicoat et al., 2023).

To date, it has not been possible to identify a maturity model for the assessment and advancement of digital maturity in strategic procurement, recognised by academic research and in its conceptualisation following digital maturity models as presented in sub-section 2.2.2. An initial synthesis has been provided by Kleemann and Glas (2020) adopting the “Digital Maturity Model” from Azhari et al. (2014) and Kreutzer et al. (2016) (see Figure 25).

Figure 25

4.0-Readiness- Digital maturity model for procurement



Note. Adapted from "*Einkauf 4.0 Digitale Transformation der Beschaffung [Purchasing 4.0 Digital transformation of procurement] (2nd ed.)", by* Kleemann and Glas, 2020 (https://doi.org/10.1007/978-3-658-30790-5).

The model comprises five stages in the transformation, moving from a broadly manual transaction-oriented function into a fully integrated procurement 4.0 operation characterised by real-time data utilisation, application of AI-based systems and high connectivity within and between supply chain parties. The positioning of a procurement organisation in one of the presented stages is the result of answering a questionnaire that covers certain aspects from each of the eight dimensions as illustrated in Figure 25.

The relevance and validity of the results achieved by such self-assessment must be viewed with caution due to a misunderstanding by leaders when it comes to objectively evaluating the company procurement digital maturity. Forrester (2019) assesses the digital maturity as less advanced than survey participants themselves, and ascertains that the transformation into a truly digital and advanced procurement function is yet to be performed (Forrester, commissioned by Ivalua, 2019). Kleemann and Glas (2020) hypothesise that most assessments tend to indicate a position in an early phase in the evolution to procurement 4.0. The assessment of the status-quo can serve as an orientation in the development and execution of a purposeful digital procurement strategy.

2.4 Data analytics in strategic procurement

The definition of Supply Chain Management (SCM) by the Council of Supply Management Professionals (2013, p.187) as “an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model” and by Christopher (2023, p. 3) as the “management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole implies” the embedding of strategic procurement in the field of SCM. Sahay and Ranjan (2008) formulate the objective of SCM systems to “provide operational and transactional efficiencies in the fields of manufacturing, sourcing and distribution within an organisation and across its supply chain” (p.39).

The development of BDA capabilities in global and volatile SCM networks is understood as game changing due to the alleged real-time visibility and respective enhanced response to market dynamics (Roßmann et al., 2018). SCM is predestined for the application of BDA due to its function as a hub in the organisation’s exposure to an immense amount of data both from internal and external sources. In recent years, BDA in the domain of SCM has seen an enormous interest in practice and academic research, coining the term of Supply Chain Analytics (SCA). SCA targets the measurement of performance, identification of cost reductions, improvement of supplier management, enhancement of manufacturing efficiencies and optimisation of delivery (Sahay & Ranjan, 2008). In previous research studies, various definitions of SCA have been developed as summarised by Varela Rozados and Tjahjono (2014) (see Table 8).

Table 8

Definitions of Supply Chain Analytics

Author	**Definition**
Smith (2000)	"Supply chain analytics is the process by which individuals, organizational units, and companies leverage supply chain information through the ability to measure, monitor, forecast and manage supply chain related business process."
Marabotti (2003)	"Supply chain analytics is the process of extracting and presenting supply chain information to provide measurement, monitoring, forecasting and management of the chain."
Sahay and Ranjan (2008)	"Supply chain analytics provides a broad view of an entire supply chain to reveal full product and component. Supply chain analytics provides a single view across supply chain and includes pre-packaged KPI, analytics."
Pearson (2011)	"Supply Chain Analytics is […] using quantitative methods to derive forward-looking insights from data in order to gain a deeper understanding of what is happening upstream and downstream, being as a result able to assess the operational impacts of prospective supply chain decisions."
O'Dwyer and Renner (2011)	"Advanced supply chain analytics represents an operational shift away from management models built on responding to data. Advanced supply chain analytics can help supply chain professionals analyze increasingly larger sets of data using proven analytical and mathematical techniques."
Waller and Fawcett (2013)	"SCM data science is the application of quantitative and qualitative methods from a variety of disciplines in combination with SCM theory to solve relevant SCM problems and predict outcomes, taking into account data quality and availability issues."
Sanders (2014)	"Analytics is applying math and statistics to these large quantities of data. […] big data without analytics is just lots of data, Analytics without big data is simply mathematical and statistical tools and applications."

Note. From *"Big Data Analytics in Supply Chain Management: Trends and Related Research"* (p.6), by Varela Rozados and Tjahjono, 2014 (DOI:10.13140/RG.2.1.4935.2563).

Varela Rozados and Tjahjono (2014) combine previous conceptualisations of SCA thus: “SCM Big Data Analytics is the process of applying advanced analytics techniques in combination with SCM theory to datasets whose volume, velocity or variety require information technology tools from the Big Data technology stack; leveraging supply chain professionals with the ability to continually sense and respond to SCM relevant problems by providing accurate and timely business insights” (p.6).

Numerous publications underline the significance of SCA and point out significant research opportunities (Waller & Fawcett, 2013; Srai & Lorentz, 2018; Anitha & Malini, 2018). Chae and Olson (2013) classify SCA as an underdefined construct. Srai and Lorentz (2018) conclude that there is a major research gap in the Purchasing and Supply Management (PSM) literature pointing out the scarce research undertaken with regards to big data, basing their findings on a systematic review of academic literature in this field. After an analysis of extant literature, Brinch (2018) suggests that “the perception of big data is somewhat confused and existing SCM literature have lacked a thorough understanding of big data and its value” (p.1605). Even though there are academic contributions such as that from Brinch (2018) on how value of big data in SCM is created and captured, further research is considered necessary to enable companies to benefit from applied big data and data analytics in utilising big data for sustainable business value. Roßmann et al. (2018) confirm that future research in the area of SCA should address the extension of knowledge about impacts on SCM and as well impacts that SCA has on organisational aspects such as roles and structures.

The lack of academic research on advanced data analytics applied in the domain of strategic procurement, which is the focus of this thesis, is more significant again. The concept of advanced data analytics in the field of strategic procurement is scarcely mentioned in the context of publications dealing with SCA. Sahay and Ranjan (2008) point out that “ordering products, global outsourcing, and web-based buying and selling, and JIT manufacturing are the major key business drivers for supply chain analytics” (p.38). Potential applications in strategic procurement, where decisions are made based on predominately unstructured data, are supplier ratings and performance to support a sourcing event by applying artificial intelligence (Accenture, 2017). Most organisations are only beginning to explore the power of analytics through early steps to cleanse and categorise spend data and adapting a more rigorous procure-to-pay process that embodies a disciplined data governance approach. The Harvard Business Review Analytics Services (2021) study found that organisations do not collect enough data or the right type of data.

Sanders (2016) articulates BDA as lever in supplier negotiation by analysis of customer choice and buying behaviour and accredits a great savings potential in the field of procurement. Pulling up historical data on previous purchases can help in identifying patterns and improve negotiation positions. Procurement analytics is used to visualise and manage company spend and help to generate insights used for improved decision making and to achieve the overall business objective to gain a competitive advantage. Handfield et al. (2019) envisions the application of predictive “should-cost” models. Tan and Lee (2015) conclude advanced data analytics can assist in the development of meaningful sourcing strategies, in terms of costs and effort by uncovering procurement patterns.

In this context, Batran et al. (2017) highlight the provision of real-time information in the formulation of relevant sourcing strategies. Applying analytics is understood to be particularly beneficial in category management, for example, by managing the tail-end spend category by helping to understand structure and drivers, automate operational processes and if possible, consolidate them (Sanders, 2016; Oelcer et al., 2019). Oelcer et al. (2019) suggests there is a 5% to 10% average cost reduction when using digital technology in tail end spend management. The management of risk exposure including supplier risk, risk of fraud, bribery, or corruption (Fosso Wamba & Akter, 2015; Sanders, 2016) is considered a further potential field of the application of analytics. The application of analytics in procurement can support the detection and prevention of fraud (Tan & Lee, 2015). Contract analytics used to monitor and ensure the compliance to agreed terms such as payment terms and is yet another field for the application of advanced analytics in strategic procurement (Handfield et al., 2019). Handfield and Linton (2017) conclude that data visibility enhances reactivity to shifts in demand and disruptions.

Overall, the application of advanced data analytics in strategic procurement is assumed to increase speed of procurement processes and to free up capacity that is used for tactical and manual activities at present, allowing a shift in focus to more strategic tasks (Harvard Business Review Analytics Services, 2021).

Batran et al. (2017) record that “procurement needs lots of information to shape and manage high performance value chains” (p.124). A differentiated view is critical as stated previously; the sheer existence or even the capability to collect and store the data is worth nothing. It is the analysis of the relevant data, the processing, the interpretation of it and the deriving of meaningful conclusions that enable optimised decisions that provide companies with a competitive edge and make a leading procurement function. In the absence of an academically agreed and recognised definition of Strategic Procurement Analytics (SPA), in this thesis the following definition, derived from the stated definition for SCA is applied: Strategic Procurement Analytics (SPA) is the process of applying advanced data analytics techniques in combination with strategic procurement theory to leverage procurement data to derive accurate, timely and meaningful business insights, apply data-driven decision making and manage procurement-related business processes with enhanced effectiveness and efficiency. Following McCormick (1981), effectiveness is understood as “a measure of the success in achieving a clearly stated objective” whereas efficiency describes “cost effectiveness. The efficient solution is that which is most effective at least cost” (p.299).

2.5 Chapter summary

This chapter reviews the status of extant academic and practical publications, and to some extent unpublished business information, following a systematic and comprehensive literature review, and provides the basis for addressing RO1.

It was found that digitalisation is a phenomenon that encompasses a wide span of profoundly and irreversibly impacted areas of economic and business life, is highly dynamic and at times difficult to predict. Organisations face a dynamic business environment in which they are challenged by emerging competition, speedy technological developments, and economic and geopolitical frictions. It is necessary to find answers to navigate through this volatility by adapting new technologies, and re-thinking business models and organisational structures. With the emergence of digital technologies such as IoT, cloud and mobile technology, real-time data exchange and advanced data analytics, a massive transition of business models, operations, processes, and organisational structures has been triggered. Digitalisation was identified as a trend that cannot be ignored or avoided. Not engaging in digitalisation risks a business' continuity and a company's well-being. The capability to adapt quickly to both evolving and abruptly materialising transitions in the business environment is necessary for all organisations. Business objectives that may trigger a digital transformation include increased efficiency and productivity, better resource management, more resiliency, greater agility, improved customer engagement, increased responsiveness, greater innovation, faster time to market, increased revenue, and continued relevancy.

However, the focus on adoption of new technologies is not enough. While technology is recognised as the enabler, wide consensus among academic authors and practitioners exist that digital transformation is a key undertaking and must comprise procedures, processes, capacities, and capabilities.

Heeks' "Design-Actuality Gap" model identifies four dimensions of change, namely people, structure, technology and processes in the transition to a new information systems environment, which will also be considered in the development of the maturity model in this thesis. This chapter highlights digital maturity and its continuous assessment as an indispensable prerequisite to any digital transformation. The purpose and design of maturity models as an enabler to understand the present state of an organisation's digital maturity, and to formulate potential approaches to enhance maturity, were presented in this literature review.

Big data and advanced data analytics are viewed as one of the key technological enablers in a digital transformation. Some even refer to data as “the heart of digital transformation” underlining the aspiration of benefitting from utilising data. Big data are understood as an abundant form of structured and unstructured data, being generated continuously and compiled from various sources. The so-called “10-V” taxonomy identifies 10 characteristics of big data: Volume, Velocity, Variety, Veracity, Value, Volatility, Validity, Visualisation, Virality, Viscosity. The aviation industry is one industry example which is determined to turn the exploitation of big data into a competitive advantage. The categorisation of analytics into descriptive, predictive or prescriptive can be seen as the evolutionary path in the maturing of the application of analytics, with an advanced level contributing to the achievement of the objectives that are associated with digital transformation. Traditional companies, opposed to data economy companies, face a more difficult implementation because IT infrastructure, data inventories, organisational structures and decision making were built and developed prior the big data era. However, the gains from big data do not come from the data alone. Technology and techniques to process, analyse and gather intelligence from it enable effective decision making, based on the data. BDA or advanced data analytics can be categorised as descriptive, predictive, and prescriptive responding to different needs for information. The GAAM adds diagnostic analytics to this categorisation and associates the categories to a level of maturity with prescriptive being the most advanced and valuable form of analytics and thus facilitating the attainment of an advantageous business position.

Developing individual and organisational BDA capabilities and respective data-driven decision making are referred to, by some authors, as game changing, thereby enhancing business performance in areas such as innovation, competition and productivity. Analytical agility is key in responding to a highly volatile environment. Even though abundant scientific research exists for the examined technological concepts (digitalisation, digital transformation, digital maturity, digital maturity models and advanced data analytics), unambiguous and academically agreed definitions do not exist. Literature from practice maintains that despite efforts and investments, organisations have not been able to exploit advanced data analytics for the last three decades.

This chapter provides clarification over the terms “purchasing” and “procurement” which are often used synonymously. In this thesis procurement is understood as the fundamental integration of purchasing and supply chain into the strategy, decision making and operation of the enterprise with an E2E value-driven orientation. In recent decades procurement has undergone an evolution from a rather transactional and price-oriented function towards a strategic function contributing significantly to competitive advantage. Contemporary procurement functions manage on average 70-80% of the external value add. Despite its rise in importance within the business, the perception of procurement by stakeholders still varies.

On the one hand procurement is perceived as playing a significant role in achieving a competitive position, overall company profitability, and thus is an integral part of a corporate strategy, and hence is of strategic nature. On the other hand, procurement is viewed as overly complex, bureaucratic, slow and rather tactical in acquiring goods and services based on the best price. Key activities of strategic procurement, and thus relevant for this thesis, include definition of procurement strategy and policy, market and supplier assessments, supplier selection and negotiation of contracts, establishment of alliances, and acting as liaison between suppliers and various internal departments’ management of suppliers.

Contemporary strategic procurement functions are understood to be in a pivotal position as the interface between external suppliers and internal stakeholders. This supports the emergence of a new procurement paradigm as a hub or a centric node in a procurement network that connects suppliers, partners and even competitors in a business environment where company’s boundaries dissolve. Connectivity, collaborative long-term partnerships, and visibility throughout the supply chain along with data analytics capabilities are seen as contributors to the strategic procurement new value proposition. In addition, by recognising procurement partners whether contracted directly or as a sub-tier, as a valuable source of innovation, strategic procurement bolsters a company's relevance and longevity. It can be concluded that strategic procurement needs to evolve into a value-chain minded function, adapt new technologies, develop skills of procurement staff, and accelerate processes to offer the value that the function claims to offer.

Neither the procurement 4.0 concept, derived from the term Industry 4.0, nor digital procurement have been defined explicitly, but are nevertheless understood to mean the application of advanced analytics to big data, process automation and new collaboration models with suppliers and business users to significantly improve the effectiveness of the procurement function and attain a greater impact, faster, and more sustainably. Academic publications about digitalisation of strategic procurement are scarce. With their 4.0-Readiness model, Kleemann and Glas put forward the first digital maturity model for procurement. Extant literature, predominately from practice, highlights the potential of a digital procurement function, but indicates overall a delayed and slow engagement in digital transformation by (strategic) procurement, starting with the adoption of new technology, the adaptation of processes and evolution of organisational structures and business models.

The chapter concludes with an overview of literature on advanced data analytics in strategic procurement. In the main, existing literature refers to SCA which includes the consideration of strategic procurement and acknowledges, in line with the overall perception of BDA potential and yet to be developed BDA capabilities at organisational and individual level, the value in SCM. Identified objectives of SCA relate to enhanced performance, cost improvement, and an increase in operations and delivery efficiencies.

However, a considerable research gap in thoroughly comprehending the value, the utilisation, and the impacts of SCA was identified. This lack of academic literature in relation to advanced data analytics for strategic procurement is significant. Potential areas of application include category, spend, risk and fraud management. Contract analytics were identified as one further beneficial field of analytics. In practice, hardly any strategic procurement organisation has managed to harvest advanced data analytics and many are just getting started with category and spend analytics. In this thesis, SPA is understood as the process of applying advanced analytics techniques in combination with strategic procurement theory to leverage procurement data to derive accurate, timely and meaningful business insights, apply data-driven decision making and manage procurement-related business processes with enhanced effectiveness and effectivity.

In this context, and given the gaps in the extant literature identified above, this research aims at providing a digital maturity model with focus on the role and implications of advanced data analytics in strategic procurement. More specifically, as noted in chapter 1, this thesis addresses the following research objectives:

RO1: To review and analyse the extant literature relating to the deployment of advanced data analytics in the strategic procurement process in the aviation industry.

RO2: To evaluate the use of advanced data analytics in the procurement process (using an aviation industry company as a case study) focusing on the type of applications used and their operational implications for individuals and organisational structures.

RO3: To develop and assess the application of a new model for the digital transformation of strategic procurement in the aviation industry.

Chapter 3 now looks at the development of a conceptual framework - derived from the literature – which will act as a frame of reference for the primary research.

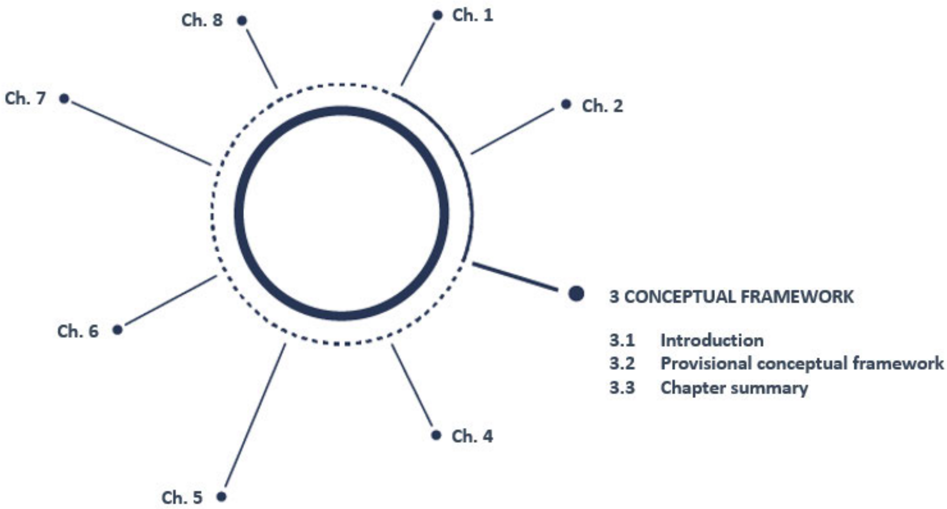
CHAPTER 3: CONCEPTUAL FRAMEWORK

3.1 Introduction

This chapter (see Figure 26) addresses the development of a provisional conceptual framework (PCF) for the deployment of advanced data analytics in the strategic procurement function.

Figure 26

Structure of chapter 3 in context of the thesis



The proposed PCF consists of four dimensions: technology, process, people and structure which allows the investigation of digital transformation as a holistic phenomenon (Altundag, 2022). Following this introduction, the term "conceptual framework" is discussed, and related objectives and use are elaborated upon. Furthermore, maturity models, identified in chapter 2 are drawn upon and relevance for this research is pointed out. Sub-sections 3.2.1 to 3.2.4 detail the identified change dimensions (technology, process, people and structure), synonymously used with the term maturity dimensions, in light of the intended application of the framework in strategic procurement in the aviation industry.

3.2 Provisional conceptual framework

Miles and Huberman (1994) emphasise the value of the conceptual framework as it "explains, either graphically or in narrative form, the main things to be studied- the key factors, constructs or variables- and the presumed relationships among them" (p.18). Research studies are often founded on a conceptual framework, summarising a set of the researcher's key assumptions, beliefs and concepts of the phenomenon investigated (Maxwell, 2008). Part of the conceptual framework is the formulation of the research problem, including the formulation of a road map of how the research problem will be examined. Different from a theoretical framework, the conceptual framework is constructed by the researcher proposing an answer to the research problem identified (Adom & Hussein, 2018).

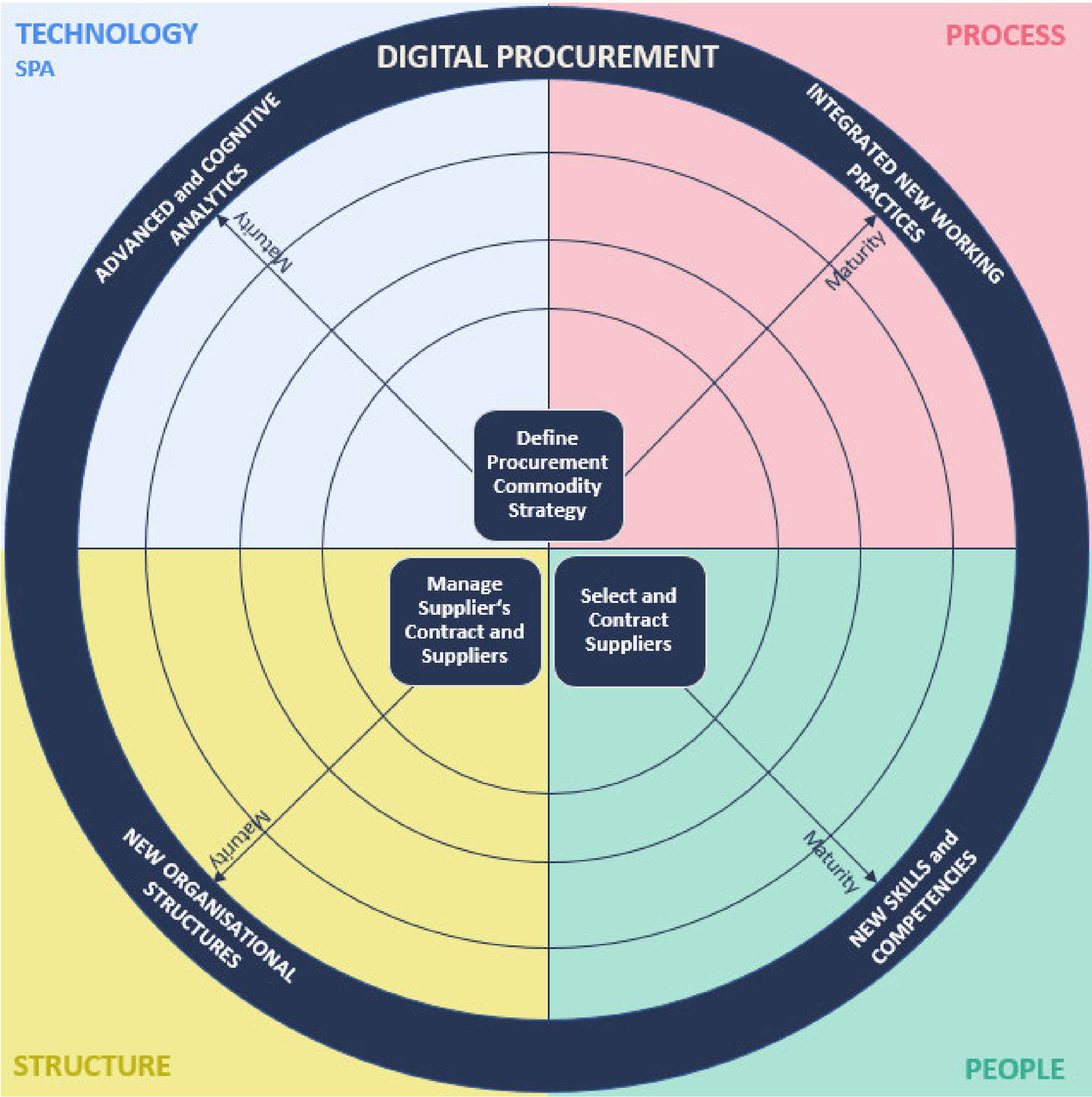
In chapter 2, the theoretical background to this thesis was identified and reviewed. The PCF developed in this chapter draws upon this theoretical foundation. It takes into consideration key concepts and models of transformation, digital maturity and maturity models. The design of the PCF contemplates the understanding of big data and advanced data analytics, established in the previous chapter. The application of this PCF in a strategic procurement context means that the PCF has a domain-specific focus. The framework is underpinned by the understanding of transformation as a multidimensional, cross-functional, organisation-wide phenomenon, which challenges its management to continuously adapt strategy, business models and operations (Horney et al., 2010).

As Westerman (2017) affirms, technology does not add value to a business, except for technology in products. The value stems from technology's role as an enabler to do things differently, such as the implementation of analytics as a means of enhancing the understanding of issues and deriving relevant decisions from that analysis. Digital transformation involves, but is not limited to, conversion of business operations, products, and processes. Organisational structures need to be reconfigured by companies to manage their complex transformations (Matt et al., 2015). Additionally, individuals are impacted by digital transformation due to the fast and radical change in digital technologies, which impacts on their lives as well as markets (Ebert & Duarte, 2018). There is almost unambiguous agreement that the challenge relates to people, process and culture and confirmation that technology alone is not the main hurdle for achieving success. However, technology is understood to set the velocity of adaptation required. Applying this conceptualisation to the specific corporate function of strategic procurement, the PCF consists of four change dimensions: technology, process, people and structure and aims at 1.) assessing the current maturity throughout the strategic procurement life cycle and 2.) to facilitate its transition to a digital function which is in line with the function and design of maturity models analysed in chapter 2 (sub-section 2.2.2).

The PCF builds upon Heeks' (2002) "design-actuality gap" model that assesses the transition "gap" from a current state - "actuality" - to an intended future - "system design". The transition between these two states and the closure of the gap is viewed as transformation and can be supported by maturity models. Heeks identified technology, process, people, and structure as four key interrelated dimensions of change, which were incorporated into the design of the PCF (see Figure 27).

Figure 27

Provisional Conceptual Framework (PCF)



Although Heeks' model was initially applied in developing world environments, it has been used in diverse business change contexts, and is of relevance to the analysis of the application of advanced data analytics in strategic procurement, as both a conceptual framework and the basis for to be developed maturity model.

Even though this thesis investigates all four change dimensions, it is recognised that the analysis of structural impacts and organisational restructuring may be limited, as they are yet to take place. However, the conceptual framework attempts to explore potential limits of the current strategic procurement structure and offer recommendations on how to advance it into a future digital strategic procurement function.

In full acknowledgement that there is unanimous agreement in academic publications that without a fundamental change of corporate culture into a “data-affine” or data-driven culture - with a natural understanding of data as a company asset - the digital transformation is incomplete, this will not be not be the main focus of this thesis. In the case study organisation studied here, there are initiatives to effect a cultural change, but it is not currently in a formalised manner or part of a structure change programme. Nevertheless, it is understood that companies need to transform, and so must the strategic procurement function, to enable the development of a new value proposition for continued existence in the future.

Building upon academic and practitioner literature reviewed in chapter 2, the key areas of activities within strategic procurement are the development of a procurement commodity strategy, market and supplier intelligence, consolidation of technical and commercial requirements, the development of procurement requirement definition, call-for-tender management, contracting and supplier relationship management, including performance and contract management. The transformation into a truly digital procurement function follows the aforementioned principle of multidimensional progress. The implementation of advanced data analytics technology is assumed to act as an enabler that triggers process, people and structural change in a business environment that can adapt quickly and effectively to gain competitive advantage for the long-term survival of the organisation. By advancing all four dimensions, the strategic procurement function matures digitally, and eventually transform into a truly digital function. It can be assumed that this evolution of the individual elements of the conceptual framework is neither homogenous in speed nor extent, but highly interrelated.

In accordance with the popular and widely accepted outline of maturity models, besides the consideration of the four change dimensions, stages of maturity are indicated in the PCF by the incorporation of four circles. Maturity stages allow the measurement of the existing state of maturity per change dimension. They reflect the organisation’s performance in terms of achievement along the transformation path and can be used for formulating specific milestones towards transformation objectives. Even though not labelled and numbered explicitly in the graphical presentation of the PCF, the circles, arranged around the centre, represent maturity stages ranging from 1" (low) to "4" (high). The circle closest to the centre indicates a low level of maturity, while the outer ring implies a digitally advanced organisation. The maturity is understood to advance by moving from the centre to the outer edge of the PCF. The further away the circle is located from the centre, the more digitally mature is the specific change dimension and the organisation as a whole. During the interviews, this was explained to the participants.

In summary, the PCF allows an assessment of overall digital maturity in consideration of an, as yet absent, academically recognised maturity model, focusing on the role and impact, at individual and organisational level, of advanced data analytics in strategic procurement. This will be applied to the investigated case study organisation.

3.2.1 Technology

The technology dimension of the conceptual framework focuses on the utilisation of advanced data analytics, which have been described as "the heart of digital transformation, the lifeblood of this digitization process" (Reinsel et al., 2018, p.3). It also entails an examination of the desire by organisations to benefit from the exploitation of data and the respective engagement in data-related projects. The developed conceptual framework will allow clarification of whether the attributed role of advanced data analytics as the pivotal in digital transformation remains valid in the context of strategic procurement. The PCF incorporates consideration of different levels of analytics maturity following Gorman's (2012) classification into descriptive, predictive, and prescriptive analytics and Gartner's analytics ascendancy model (GAAM) (Maoz, 2013 as cited in Eriksson et al., 2020) as provided in sub-section 2.2.4, by indicating optimal behaviours and actions. It aims at the clarification of which type of analytics is used, for what purpose and the business need that is supported.

Ancarani and Di Mauro (2018) conceptualise the capability to manage, process and analyse data, and transfer the insights into valuable decisions, as a fundamental corporate capability, and thus a source of competitive advantage in a volatile and uncertain business environment. The development of advanced data analytics capabilities can be considered a dynamic capability, as it can trigger change and a reconfiguration of processes, structure, and resources in response to market dynamism (Teece, 2011). Teece's concept of dynamic capabilities elucidates how certain firms outperform others and experience continuous competitive advantage (Teece, 2011). By re-configurating processes, human resources, and structure, triggered by the utilisation of advanced analytics, strategic procurement can acquire a dynamic capability and thereby formulate a new value proposition which contributes to the achievement of company objectives.

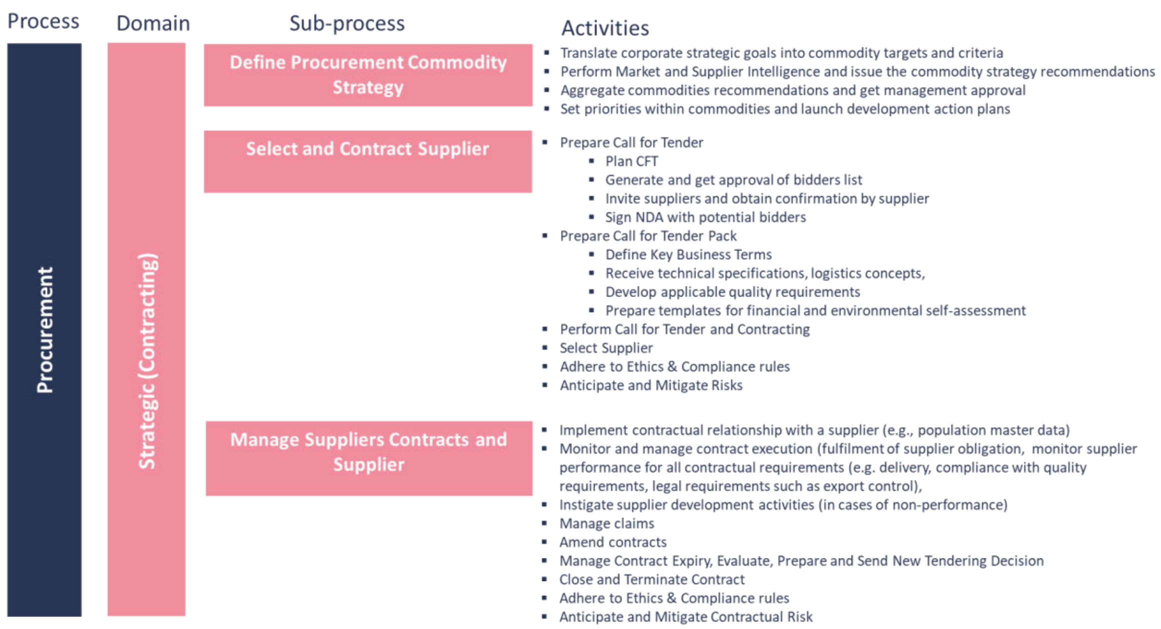
3.2.2 Process

The PCF grounds its understanding in the academically aligned opinion that successful organisations evolve and advance legacy processes to become agile, lean and digitised (Bean, 2020; Nicoletti, 2020). Big data has the capability to put an organisation in the position to proactively manage processes (Schildt, 2017), but Schrage (2020) points out that the introduction of data and advanced data analytics in a legacy process set-up, inhibits the desired optimisation and efficiencies boost. Brinch (2018) argues, in the context of supply chain performance, that data-driven and thus better decision-making offered by advanced data analytics results in improved firm-level and process-level performance. The corporate function of strategic procurement is challenged to evolve its processes to support a fast, agile and, at the same time, compliant way of working. In the aviation industry, the adherence to processes to fulfil the company's and authority's governance requirements is of the utmost, and essential to the proof of airworthiness of products.

To comprehend the processual dimension of the PCF in the context of strategic procurement, a mapping of relevant processes and sub-processes was undertaken, based on the case study company's internal documentation. This identifies processes and sub-process central to the strategic procurement business operation and helps to assess the deployment of advanced analytics in each of them. This approach corresponds with the process redesign philosophy by Harmon (2019), which considers, in addition to top level processes, also lower-level activities and how are they managed day-to-day, including activities such as planning, communication, organisation, monitoring and controlling. Key processes and sub-level process of strategic procurement with particular focus on an aircraft manufacturer are depicted in Figure 28.

Figure 28

Key processes, sub-processes and activities of strategic procurement



Note. The figure illustrates the strategic procurement process in a simplified manner and is based on "*Define Sub-Commodity Sourcing Strategy*", by Airbus, 2016a [Unpublished]; *"Supplier Selection and Contracting"*, by Airbus, 2018 [Unpublished]; & "Manage Suppliers Contracts and Claims", by Airbus, 2021 [Unpublished].

The sub-process "define procurement commodity strategy" aims at preparing future supplier selections and leveraging the supply chain. Deliverables of this process include the availability of sourcing scenarios of products or services to be sourced and a recommendation of potential suppliers to be involved in future call-for-tenders. Activities in this sub-process include the identification and cascading of business targets derived from corporate goals and objectives such as functional strategy objectives, make-or-buy decisions, and sourcing models. Furthermore, external impact factors, for example geopolitical developments, competitors and market dynamics are contemplated.

Market assessments, referred to as “market intelligence”, as shown in Figure 28, comprises the identification of market players, commodity specific evolutions and stakeholder intelligence. Resulting commodity strategy recommendations and market assessments provide the foundation for commodity recommendations. A key outcome is a consistent and well-articulated procurement commodity strategy from which mid- and long-term goals and action plans can be derived.

“Select and contract supplier” is the second key sub-process in the strategic procurement process. The key sub-process defines how a call-for-tender is prepared and conducted and suppliers are selected and contracted. The main result of this sub-process is the agreement and execution of a binding contractual document which translates into a financial commitment for the organisation towards third party partners. Ethics and compliance rules covering fair competition in compliance with applicable laws and regulation, anti-corruption, environmental laws, labour laws, human rights, employment practices, information practices are expressed in the code of conduct, in addition to provisions in the contract (see Figure 29). The performance of risk management prior and throughout the call-for-tender and awarding is integrated in this sub-process.

Figure 29

10 bricks of supplier code of conduct

Note. Adapted from “Supplier Code of Conduct”, by Airbus, 2021a (https://www.airbus.com/sites/g/files/jlcbta136/files/2021-10/Airbus-Supplier-Code-of-Conduct%20%282%29.pdf).

Following the establishing and formalising the contractual relationship with a partner, the third sub-process, “manage supplier’s contracts and suppliers”, defines the monitoring of the supplier’s fulfilment of contractual obligations and the management of the supplier contract. It includes the implementation of the contractual relationship with a supplier including the initial population and the maintenance of commercial master data, the monitoring and managing of contract execution and contractual coverage of legal, technical or business policy changes. At the same time, ensuring the supplier’s obligations and monitoring of supplier performance are activities performed in this sub-process. Performance measurement incorporates aspects such as delivery performance, compliance with quality requirements and legal and contractual requirements. Managing contract amendments and claims, and instigating supplier development activities, for example in case of non-performance, are further activities in this sub-process. The closure and termination of the contractual relationship form part of this sub-process in the strategic procurement process.

The identification and execution of development and strategic projects with suppliers is described as part of the strategic procurement process in the case study organisation, but is not shown in Figure 28 as core sub-process. It aims at strengthening the relationship with, and performance improvement of, specific suppliers.

3.2.3 People

Technology - being understood as the key enabler of digital transformation - is operated by people. Processes - and their re-design as an indispensable element in the transformation into a digitally mature organisation - are managed by people. The people dimension is a key element in digital transformation. Advancements in digital maturity call for new ways of working, managing, and leading, and thus a revision of tasks, roles, and responsibilities is often required. In this research of the strategic procurement function in an aircraft manufacturer, people-related aspects are seen as the third dimension in the conceptual framework.

The acquisition of relevant data analytics skills and the development of “digital thinking” are of importance. The acquisition of analytics skills is advanced by Hughes and Ertel (2016) in the context of establishing “business acumen”. Business acumen is understood to be the capability to apply advanced analytics while understanding “the very different business models of different suppliers and how they make money (even when those suppliers operate in the same industry), and based on that, to determine how best to design an engagement model with a given supplier and construct contract terms as well as informal incentives to motivate that supplier to deliver maximum value” (p.23). This view is supported by Ancarani and Di Mauro (2018), who suggest that the most valuable future employees are the ones with a digital mindset, capable of drawing relevant conclusions and engaging in critical thinking. A digital mindset is receptive to increased human-machine collaboration.

Waller and Fawcett (2013) claim that the integration of both profound domain knowledge and analytic skills are of importance, even though it is assumed that the acquisition of broad analytical skills will outweigh domain knowledge to a certain degree. Accenture (2017) highlight the significance of cross-functional teams - incorporating competences on advanced data analytics, domain/category, IT - and design as a value driver in the transformation of procurement and point out the challenges in forming such teams. Other authors suggest that the development of new digital business models calls for the empowerment of employees to leverage digital technologies and allow autonomous decision making (Westerman et al., 2014; Roblek et al., 2016; Schildt, 2017). Organisations that fail to adapt their workforce, in terms of data and process skills, and mindset, are deemed to be left behind by other market participants (Roblek et al., 2016). Nicoletti (2020) identifies three core elements in the advancement towards a truly digital procurement function: 1.) training, 2.) redesign of ways of working and interaction, and 3.) recruitment.

3.2.4 Structure

The need for rapid and continuous adaptation, considered vital for successfully navigating the dynamism of a volatile, uncertain, and complex business environment, also applies to the organisational set-up. Structure represents the fourth dimension in the preliminary conceptual framework and is arguably the least mature and the most challenging to move forward. Schildt (2017) calls for more academic research, in particular, in the field of organisational theory, on how big data and advanced data analytics impact organisational structure and leadership. There is consensus in academic research and practice that organisations struggle with the necessary design adjustments to fully exploit the potential of digitalisation (McAfee & Brynjolfsson 2012; Mirković, 2019; Haldipur, 2023). Schildt (2017) predicts an era of “digitalisation of management” using the increased connectivity within organisations, and the utilisation of advanced data analytics to challenge traditional tasks, roles, responsibilities, and present leadership models.

The organisational structure must allow the free flow of information across the organisation, both intra- and cross-functional, and thus allow a high level of transparency to deliver the potential benefits from the data and its utilization. Such change is hampered by the well-formalised hierarchies that are still widespread, “silo thinking”, and alleged protection of information which inhibits organisational evolution. As in many other traditional companies, the case study organisation studied here, including the strategic procurement function, is currently characterised by rigid and hierarchical structures with a high degree of division of work. Juha and Pentti (2008) conclude that procurement organisations of high-tech companies demonstrate better adaptation capabilities due to a lower level of formalisation and specialisation.

A digitally mature organisational set-up “must be collaborative, flexible, and agile to a sufficient degree, while keeping the rest of the activities running efficiently (Desmet et al., 2015)” (Ancarani & Di Mauri, 2018, p.14). Choices in structural re-arrangements need to consider the appropriate balance between level of flexibility (to allow swift adjustments) and stability. Kotter postulates the integration of a “hierarchy and flexible network to form a twofold operating system (Kotter, 2014)” (Ancarani & Di Mauri, 2018, p.14). In addition to structural adjustments, new ways of organising work - such as self-organising teams and cross-team coordination, fostered by the implementation of data analytics - are yet to be fully explored and applied.

3.3 Chapter summary

In this chapter the PCF for the application of advanced analytics in strategic procurement in the context of an aircraft manufacturer is developed. The introduction of advanced data analytics is understood to be a fundamental part of digital transformation. In line with the understanding of transformation, elaborated in chapter 2 and following Heeks’ “design-actuality gap” model, a multidimensional and highly interlinked phenomena, the developed PCF comprises four dimensions of change - technology, process, people and structure. Each of the dimensions is examined and their relevance for the PCF is established.

The transformation into a digitally mature strategic procurement function to be a leading contributor to company success can only be achieved by a multidimensional, coordinated and timely synchronised advancement of the individual dimensions and overall maturity. Technology is considered as the enabler and pace maker of transformation. The process dimension acknowledges that implementation of new technology triggers a modernisation of processes in order to be operated at an optimum level and to realise the desired efficiency boost. In the aviation industry, process adaptations pose a tremendous challenge due to the imperative agreements between corporate governing bodies and aviation authorities. Core processes are incorporated in the PCF. The people dimension is a crucial part of digital transformation. Digital maturity requires new capabilities, ways of working, managing, and leading, both at individual and organisational level. Ambitions associated with digitally maturity include greater empowerment, self-organisation and autonomous decision making. Organisational structure, being the fourth change dimension, is understood as the least mature and most challenging. Both academic and practitioner research literature suggest that organisations still struggle to adapt organisational design and leadership and collaboration models adequately. A balance between tolerable flexibility and required stability is a significant challenge.

In the following chapter, the methodology and design used to perform the research in the case study organisation are presented and discussed.

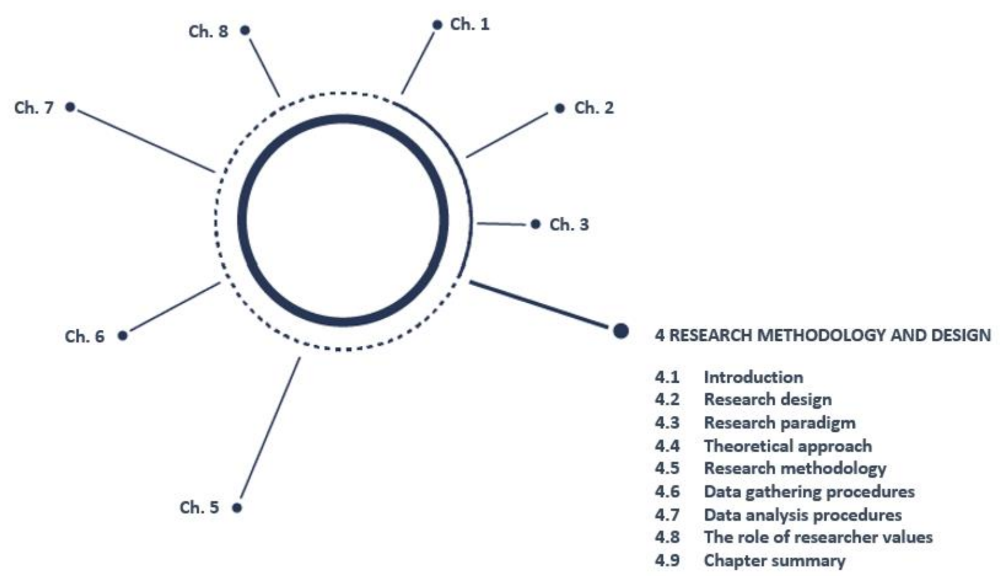
CHAPTER 4: RESEARCH METHODOLOGY AND DESIGN

4.1 Introduction

Research has been described as a systematic investigation of a determined problem targeting the contribution to knowledge (Burns & Burns, 2008). This systematic inquiry is performed “to collect, analyse, interpret and use data” striving to “understand, describe, predict or control an educational or psychological phenomenon or to empower individuals in such contexts” (Mertens, 2019, p.2). This chapter (see Figure 30) presents a comprehensive overview of how the research project was conducted to develop a new digital maturity model for strategic procurement in an aircraft manufacturing company.

Figure 30

Structure of chapter 4 in context of the thesis



It aims to justify that the methods chosen for this research are the most appropriate to meet the research objectives. Figure 31 presents the overall research process.

Figure 31

Research process

This chapter comprises nine sections. Following this introduction, the design of the research process is presented and the selected research paradigm justified. The theoretical approach, in alignment with the research paradigm, is presented in section 4 of this chapter. Section 5 discusses the methodologies and the time horizon of the study. Data gathering procedures such as interviews and participant observation are introduced in section 6 followed by the review of data analysis procedures in section 7. The role of the researcher as practitioner is reflected upon in the following section. The chapter is concluded with a summary in section 9.

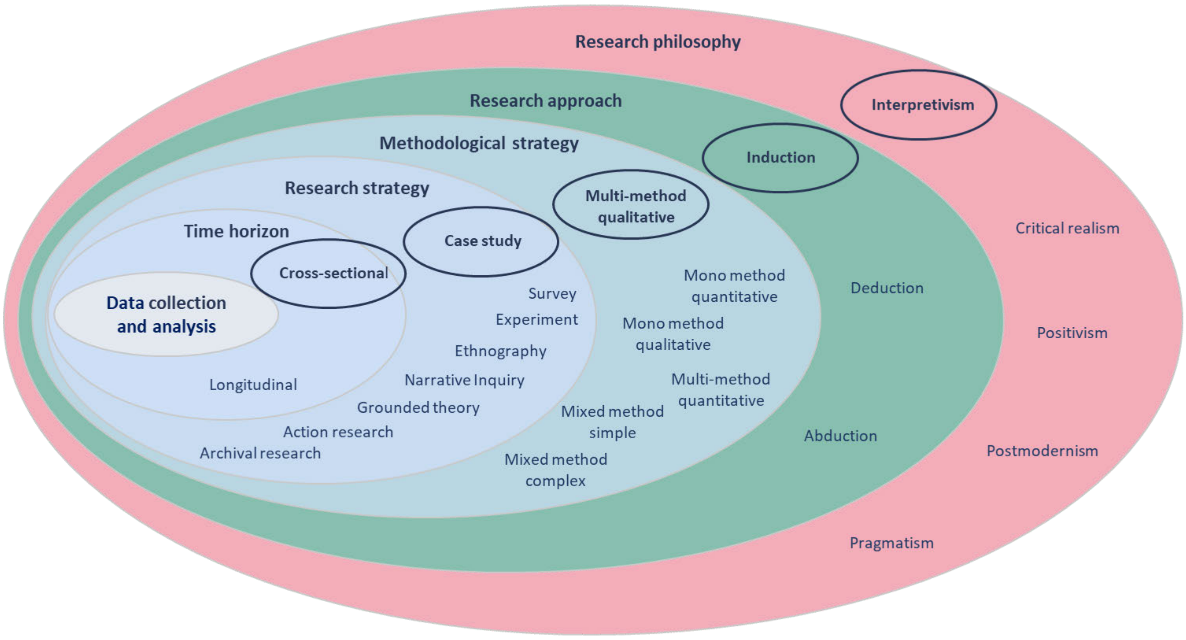
4.2 Research design

Every research work has an “umbrella strategy” or a plan that the researcher follows to collect and analyse data. It enables the researcher to draw relevant conclusions to answer to the research questions or achieve the research objectives. The research design allows the researcher to follow the “critical path” and accomplish the overall research aim (Yin, 2018). The design serves as an “architectural blueprint of a research project, linking design, data collection, and analysis activities to the research questions and ensuring that the complete research agenda will be addressed” (Bickman & Rog, 2009, p.11).

During the research process, the researcher makes a series of decisions, beginning with the determination of the overall research objective, philosophical standing, methodological choices to the collection and analysis of data. By making certain choices among a given set of alternatives, the researcher implements the research design - either by implementing a pre-determined course of actions or by modifying and newly constituting the research design, paving the way towards the answering the initial research inquiry in a coherent manner throughout the complete research, as presented in Figure 32.

Figure 32

Research design



Note. Adapted from *"Research Methods for Business Students (9th ed.)"*, by Saunders et al., 2023, Pearson.

Following the "research process onion" by Saunders et al. (2023), decisions for formulisation of the research design are made in accordance with the model's various layers:

1. Research philosophy: "beliefs and assumption about development of knowledge" (Saunders, et al., 2023, p.161),
2. Approach to theory development,
3. Methodological choices,
4. Research strategy,
5. Time horizon,
6. Data collection and analysis techniques and procedures.

In this thesis, data collection was done through in-depth interviews, an online survey, informal discussions, participation in relevant conferences, primary and secondary material, and participant observation, hence has been conducted as multi-method qualitative research. In-depth interviews were the primary data gathering procedure. Following a pre-designed interview guide, the interviews left adequate opportunity for the formulation of other questions, further enquiries, feelings, and experiences of the interviewees.

This research was carried out as a cross-sectional single company case study as it centres on the strategic procurement organisation in an aircraft manufacturer.

The involvement of humans in an organisation makes the research processes complex and highly contextual, which is central to qualitative research (Holliday, 2016). Research adopting a qualitative approach is considered particularly “valuable for research that seeks to explore real organisational goals, linkages and processes in organisations; to understand the failure of policies and practices” (Irizar Borao, 2019, p.80). The contribution of the exploration of digital maturity enhancement or digital transformation in strategic procurement in a qualitative manner may improve transformation practices or provides a deep understanding through lived experiences by stakeholders and eventually leads to setting a course of action.

The classification of advanced data analytics as a complex phenomenon, and the need to look at it in a holistic and broad manner makes this approach appropriate. Even though computational skills have improved and there are experts highly skilled in extraction and analysis, modelling the data for extraction and turning the data into knowledge poses big challenges, which has led to the understanding of big data as part of the social world. Mayer-Schönberger and Cukier (2013) claim that big data have a significant impact at the human level and a major influence on people and society. Scholz (2016) concludes in his research “big data are a social phenomenon and, therefore have an extensive impact on society, organization, and individuals” (p.171). Miller et al. (2004) point out that there is a growing interest in the exploration of processes and explanation of how outcomes are achieved. The involvement of humans in an organisation makes processes complex and highly contextual which is central to qualitative research. Qualitative research attempts to illuminate and develop a deep understanding of a phenomenon, and facilitate the transfer of knowledge to similar situations and contexts. On the other hand, quantitative researchers pursue causal determination, prediction, and generalisability of findings (Hoepfl, 1997).

Quantitative research is related to the precise and accurate quantification of a problem by generating numbers and practising “context-stripping”. In contrast, qualitative research profoundly examines qualitative aspects of a phenomenon (Holliday, 2016; King & Horrocks, 2010) which is particularly relevant for this research. Flick et al. (2013) trace back the attractiveness and the topicality of qualitative research to its open approach and its nature of being an insider and thus much closer to the subject compared to rather numerical and standardised inquiries. The exploration of diverse variables, underlying meanings and motivations is the prime aim of a qualitative study. In addition, the motivation to undertake research often roots intrinsically and relates to a problem, inconsistency, or shortcoming that one has come across in previous experience and with the aspiration to look further into it. In this thesis, it is the author’s perception that the organisation, subject to this research, neglects the modernisation of supporting processes such as strategic procurement activities.

The claim for generalisability is limited in qualitative research due to uniqueness of setting and its focus on theoretical/analytical rather than statistical generalisation meaning the extrapolation of findings to a large sample. “The aim of analytical generalization is still to generalize to these other concrete situations and not just to contribute to abstract theory building” (Yin, 2018, p.38). Quantitative research validates its claim for generalisability by the exploration of patterns in a large population by simultaneously reducing contaminating social variables. One of the key success factors in a qualitative investigation are the research questions which have a vital impact on the design of the study. While there is the necessity for a clear and unambiguous formulation very early in the research process, the research questions and objectives are specified, further refined and revised in due course of the research (Flick et al., 2013; Yin, 2018).

Even though it is not possible to raise a claim for an inter-subjective verification as for quantitative research, Flick et al. (2013) suggest the documentation of research processes, interpretations by groups and application of codified procedures as a mean to ensure transparency (traceability). Further core quality criteria for qualitative research are adequacy of the research process (indication), empirical anchoring and limitation of validity (generalisability of developed theory). The check for coherence (consistency), relevance and reflected subjectivity complement the core quality criteria.

Guba and Lincoln (1994) developed a set of criteria to assess trustworthiness which is considered an appropriate measure of the quality of study conducted in a qualitative approach: credibility (plausibility, “truth” of research findings), dependability (replicability of the research), confirmability (relationship between findings and data) and transferability (application of findings to another context and group). Stenfors et al. (2020) added reflexivity (reflection of the own role in the research) as an additional criterion to evaluate trustworthiness (see Table 9).

Table 9

Key criteria for assessing trustworthiness of qualitative research

Criteria	**Demonstrating**	**Exemplary techniques how to establish**
Credibility	Research process performed with integrity and trustworthy results	Prolonged engagement Persistent observation Triangulation
Dependability	Consistency and reproducibility of research findings (when process is repeated under similar conditions)	Inquiry audit (external researcher examines the research product and results)
Confirmability	Assurance that findings are derived from collected and analysed data	Confirmability audit Audit trail Triangulation
Transferability	Findings can be applied to another context, setting or unit of analysis	Thick description
Reflexivity	Awareness and communication of role as/background of the researcher in the context of research	Reflexive journal/report

Note. Adapted from *"How to … assess the quality of qualitative research",* by Stenfors et al., 2020, The Clinical Teacher, 17 (DOI: 10.1111/tct.13242);

Adapted from "Qualitative Research Guidelines Project", by Cohen and Crabtree, 2006 (http://www.qualres.org/HomeEval-3664.html).

A qualitative research approach was pursued, involving inductive reasoning, which is often associated with an interpretivist paradigm.

Saunders et al. (2023) classify the purpose of a research as exploratory, descriptive, explanatory or evaluative. A combination of or a change in research purposes over time is possible. This research follows more than one direction. It is exploratory in the sense to explore what is happening in the study topic of digital transformation in the strategic procurement function. The study is descriptive as it aims to establish an accurate profile of the digital transformation following the implementation of data analytics in the strategic procurement function and its members. The explanatory feature targets the identification of causal relationships between variables such as why the implementation of advanced data analytics changes other dimensions such as processes, people and structure. This research is also of evaluative nature as it aims at clarifying how advanced data analytics technology is integrated in the organisational landscape and to what extent the alleged potential is exploited at present.

4.3 Research paradigm

Any approach to research is based on a set of assumptions and beliefs about the nature of the social world, which have an influence on the subject under study (Burrell & Morgan, 2016). Ontology refers to the system of assumptions about the understanding of realities of the world (Burrell & Morgan, 2016). Extreme ends of the continuum are formed by objectivism and subjectivism. At one end, objectivists take a “realist” stand, view the world as existing, enduring, entity, not influenced by numerous actors that experience one universal truth. At the opposing end, subjectivism refers to the existence of multiple, continuously developing realities that are built by numerous differing perceptions by actors and the interaction between them (Saunders et al., 2023).

According to Kuhn “a paradigm constitutes an accepted way of interrogating the world and synthesizing knowledge common to a substantial proportion of researchers in a discipline at any one moment in time (Kuhn, 1962)” (Kitchin, 2014, p.3). To contextualise the choice and implementation of methods, and in association with the ontological stand, an epistemological positioning is required. The term epistemology refers to assumptions about the basis of knowledge, in which forms knowledge can be acquired, how to determine whether true or false and how to communicate knowledge to others (Burrell & Morgan, 2016). Saunders et al. (2019) define a paradigm as “a set of basic and taken-for-granted assumptions which underwrite the frame of reference, mode of theorising and ways of working in which a group operates” (p.142). Crotty (1998) suggests that an interrelationship exists between the theoretical stance adopted by the researcher, the methodology and methods used, and the researcher's view of the epistemology. In addition, "methods and methodology do not exist in a vacuum; rather they are subject to new and extended ways of thinking about the world" (King & Horrocks, 2010, p.16). An interpretive research paradigm is often seen as connected to a qualitative research approach (Denzin & Lincoln, 2011).

The topic under study is transformation of an organisation aiming at enhanced digital maturity. Advanced data analytics is introduced to reduce complexity, make relevant decisions based on real-time, abundant, and multi-source data. The use of advanced data analytics targets improved performance, added value creation and avoidance of risks for the company. The expected benefits of the introduction of analytics technology are seemingly accompanied by a tendency to purely rely on the data. In strategic procurement, for example the award of a work package to a particular supplier could be done relying predominately on "target must" prices calculated by, e.g., a digital costing tool. Numbers and their technological, factual nature and resulting apparent objectivity legitimate decisions. Data are considered precise, objective and almost impeccable. This claim for objectivity and accuracy stems from the abundance of data and variety of sources (Scholz, 2016). Seemingly, an objective, universally true ontological positioning, aligned with a positivist epistemological stand could be appropriate. However, the impact of humans, for example in the design, implementation and operation of advanced data analytics technology would be totally undervalued if not ignored.

However, data needs to be converted, put into context, and interpreted to create meaning and knowledge. Krech and Crutchfield (1948) claim "data are perceived and interpreted in terms of the individual perceiver's own needs, own connotations, own personality, own previously formed cognitive patterns" (p.98). Scholz (2016) concludes in his research that "big data are a social phenomenon and, therefore, have an extensive impact on society, organization, and individuals" (p.171). In his research, Scholz (2016) confirms that there is a widely existing misconception that data are objective and without bias. Even though computational skills have improved and there are experts highly skilled in the extraction and analysis, modelling the data for extraction and turning the data into knowledge poses big challenges, which has led to the understanding of smart data as part of the social world. Mayer-Schönberger and Cukier (2013) claim that big data have a heavy effect at the human level and influence people and society extremely. In addition, Scholz (2016) concludes in his research “big data are a social phenomenon and, therefore have an extensive impact on society, organization, and individuals” (p.171). Big data and advanced data analytics can therefore under no circumstances become decoupled from humans.

At present, the strategic procurement function and its members in the considered aircraft manufacturing company are not, given the relative novelty of utilisation of advanced data analytics, mature and skilled in the extraction, processing and analysis of the vast amount of available data. Competences have simply not been developed yet. This organisational and individual immaturity with regards to the topic even increases the tendency of subjectivity of the data. Data need to be converted, put into context, and interpreted to create meaning and knowledge. The analysis and use of data are embedded into a certain context. The interpretation of data is subjective, not value free and not without bias. Walsham (1995) confirmed the emergence of interpretive approach in information systems research in the areas of technology design, organisational engagement, and management, as well as social repercussions and thus opposing to the dominating practice of adopting a positivist approach in research related to information technology at the time.

Even within the same organisation that shares identical norms and values the interpretation of data by different stakeholders leads to diverse results. Krech and Crutchfield (1948) claim “data are perceived and interpreted in terms of the individual perceiver’s own needs, own connotations, own personality, own previously formed cognitive patterns” (p.98). Therefore, any use of big data and advanced data analytics is influenced by the context it is used in and the subjective multiple perceptions of involved people, understanding how members of strategic procurement experience the world around them when the organisation engages into a transformation. Furthermore, King and Horrocks (2010) oppose the idea of knowledge being produced in an objective and value-free process but consider that human beings are a vital part of it. Only by the involvement of humans meaning emerges. It does not happen by pure objective existence.

This research follows an interpretive approach to understand big data, advanced data analytics and the enhancement of overall digital maturity of strategic procurement as complex phenomenon in a business environment by interrogating multiple experiences, subjective opinions and contextualisation made by the different members of the strategic procurement function by gaining deep insights into and building knowledge of a nascent phenomenon (see Table 10). Following Thomas (2003) this choice of research paradigm enables to portray “a world in which reality is socially constructed, complex, and ever changing” (p.6).

Table 10

Digital maturity in strategic procurement as interpretive researched phenomenon

	Ontology	***Epistemology***	***Typical methods***
Interpretivism as research philosophical position	Complex, rich socially constructed through culture and language Multiple meanings, interpretations, realities, flux of processes, experiences, practices	Theories and concepts too simplistic, focus on narratives, stories, perceptions and interpretations, new understandings and worldviews as contribution	Typically inductive, small samples, in-depth investigations, qualitative methods of analysis, but a range of data can be interpreted
Digital maturity in strategic procurement	Strategic procurement in a global aircraft manufacturer with a high level of division of labour, fragmented technology landscape, rigid and extensive process architecture, complex organisational structures, diverse workforce	Meaning is created through interaction with individuals and their perception of digital transformation in a complex and dynamic, yet classically organised environment, exploration of the nascent phenomena of deployment of advanced data analytics in strategic procurement	Inductive, small samples comprising members from different strategic procurement commodities including several hierarchical levels, in depth interviews, participant observation, qualitative research approach

Note. Adapted from *“Research Methods for Business Students (9th ed.)”*, by Saunders et al., 2023, Pearson.

4.4 Theoretical approach

Every research study involves using theories (Saunders et al., 2023). Reichertz (2014) refers to induction, deduction, and abduction as “logical reasoning” or forms of thinking used in every research. Induction is understood as approach to enrich the existent theoretical foundation or building up theory opposed to deduction where testing previously established theories and confirmation or rejection of formulated hypotheses is the primary goal (Saunders et al., 2023; Bryman & Bell, 2011). Induction as theoretical approach generally involves a rather small sample to account the importance of context in which the phenomenon is studied. Using an abductive reasoning means starting with an incomplete observation and generate hypothesis that are likely to explain the observation with limited information (Hassan, 2022).

The inductive approach “is a systematic procedure for analysing qualitative data in which the analysis is likely to be guided by specific evaluation objectives” (Thomas, 2006, p.238). Thomas (2006) identifies as purposeful for an inductive approach the following circumstances:”(a) condense raw textual data into a brief, summary format; (b) establish clear links between the evaluation or research objectives and the summary findings derived from the raw data; and (c) develop a framework of the underlying structure of experiences or processes that are evident in the raw data” (p.237). Even though acknowledging certain weaknesses opposed to deductive reasoning such as small sample size and thus drawing incorrect general conclusions from even accurate observations; when using an inductive approach, it can still produce valid and reliable findings in a simple and efficient manner.

This research adopted an inductive approach to explore the phenomenon of implementation of advanced data analytics in the context of strategic procurement and generate theory relating to digital maturity by the collection of data by interviews, participant observation and documentary data and the provision of a conceptual framework.

4.5 Research methodology

This thesis looks to explore the status of digital maturity of strategic procurement. Furthermore, the research investigates how the deployment of advanced data analytics is experienced and perceived by strategic procurement staff members at individual and organisational level. The phenomenon, the subject of this research, is studied by adopting an interpretive approach, as it aims to understand the individual perceptions, interpretations and subjective meanings of the people involved (Saunders et al., 2023). At the same time, it reflects the researcher's epistemological position that reality is understood as, and knowledge is created through, the interaction and interpretation of individuals and is highly contextual.

An interpretive research paradigm is frequently linked to qualitative research methodology (Denzin & Lincoln, 2011). Qualitative research intends to illuminate how humans experience and feel impacted by the phenomenon under study - in this thesis, the implementation of advanced data analytics and digital transformation in strategic procurement.

A qualitative research methodology is applied when the main focus of the study is an in-depth examination of qualitative aspects of a phenomenon, such as relationships, activities, and situations in consideration of the uniqueness of specific contexts (Holliday, 2016; King & Horrocks, 2010; Fraenkel et al., 2015). With humans being a central element, the research process is complex and highly contextual, making a qualitative research approach well-suited.

According to Flick et al. (2013), the enormous interest in and topicality of qualitative research is associated with its open approach allowing the researcher becoming much closer to the research subject, compared with standardized quantitative inquiries.

Collecting full and rich data sets enabling the development of such deep understanding of a complex phenomenon is viewed possible by involving a relatively small sample of the impacted population.

Furthermore, a qualitative research design is appropriate for topics that have not been explored extensively yet. As the findings from the literature review in chapter two demonstrated, the utilisation and impacts of data analytics in the context of strategic procurement are under-researched and gaps in theory exist. Qualitative methods are viewed as offering flexibility in the exploration of such novel research subjects (Ritchie & Ormston, 2013).

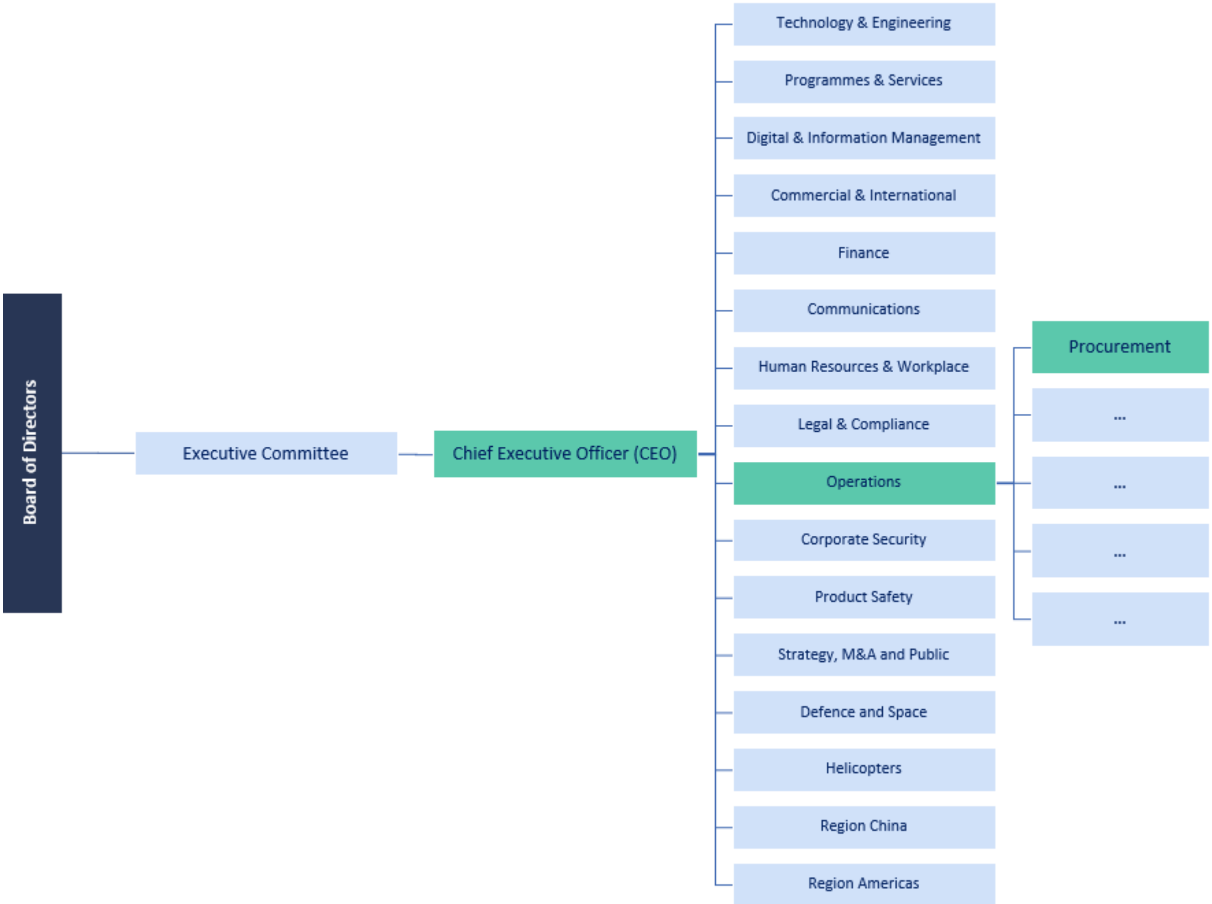
4.5.1 Case study

Case study represents one of the main basic research designs in qualitative research. This form of social research is preferred when the focus is a contemporary phenomenon in a real-world context. In this thesis, it is the implementation of advanced data analytics in the strategic procurement of a globally operating aircraft manufacturing company and its impacts on procedural, people's and structural level.

The setting for the case study is the strategic procurement organisation of a global OEM in the aviation industry. At group level, three main business divisions exist: commercial aircraft, helicopters and defence and space. The commercial aircraft business division (see Figure 33) has approximately 79,134 (Airbus, 2023e, p.132) employees and revenues of over €41.4 billion in 2022 (Airbus, 2023e, p.15). At group level, with an overall external sourcing volume across the company of approximately €44 billion in 2022, almost 80% of its activities is sourced externally (Airbus, 2023e, p.118).

Figure 33

Procurement in the overall aircraft manufacturer organisation at group level



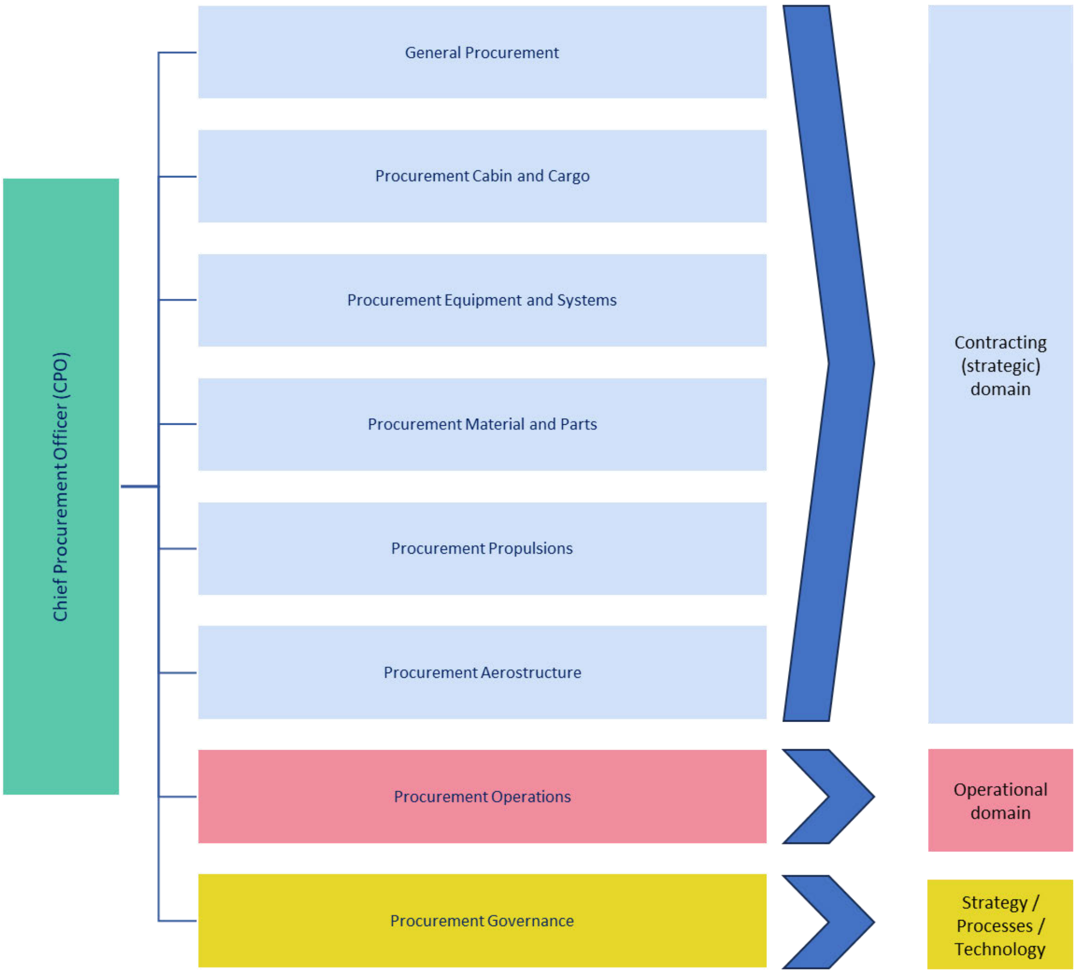
Note. The figure illustrates a simplified group organisation chart of the case study organisation and is based on *"Organisation chart"*, by Airbus, 2023f [Unpublished].

Thus, suppliers and external partners are fundamental contributors to overall business success. Having its supplier base with a global orientation developed continuously, the company works with more than 18,000 suppliers from over 90 countries that provide products and services for flying and non-flying business areas (Airbus, 2023e, p.118).

Besides an operational domain, which manages the E2E supply operations, the contracting domain of procurement is accountable for the commercial relationship with the suppliers (see Figure 34).

Figure 34

Procurement organisation



Note. The figure illustrates a simplified organisation chart of the case study organisation and is based on *"Organisation chart"*, by Airbus, 2023f [Unpublished].

With its approximately 1,000 members, the contracting domain of procurement is mainly structured by product, termed as the "commodity" such as Aerostructure (e.g., airframe, fuselage), Material and Parts (e.g., aluminium, detail parts, standard parts), Propulsion and Cabin (e.g., lavatory, monuments, seats). An additional axis in the organisational structure are functional-related archetypes (e.g., strategy and services per commodity across various hierarchical levels). The focus in this thesis is the contracting domain, hence the area which is considered as the strategic procurement function.

Relevant roles within the strategic procurement organisation in the OEM are multifunctional team (MFT) leader, lead buyers, category manager, sub-commodity leader, buyer and project managers. The MFT is a regular forum comprising representatives from various functions such as Procurement, Quality Procurement, Engineering, Finance, Programme, Operations and Customer Support, dedicated to perform activities along the procurement process, in particular call-for-tenders, de-risking, production ramp-up initiatives or cost reduction projects.

The case study is particularly suitable when the main research questions are “how” and “why”. In relation to this thesis, the main interest is how the strategic procurement as a function is positioned in a wider organisation and challenged to prove that its present and future value responds to corporate digital transformation objectives. A further point of interest is, how the introduction of advanced data analytics tools will alter procurement processes if at all. In addition, the research investigates how the strategic procurement members are affected at individual and organisational level.

As in other case studies, the researcher’s desire to give responses to these questions is rooted in the personal perception of managerial and organisational deficits in dealing with the requirements that digitalisation poses to the company. Choosing case study research as the design for this work allows the focus on a specific phenomenon (the introduction of advanced data analytics) in a specific context (strategic procurement organisation in an aircraft manufacturer, at present) from practice. Case study as a research method allows exploring these two aspects in a holistic way.

Yin (2018) defines case study as a research method with regards to scope and features, in a twofold manner. With reference to scope, it is understood as “an empirical method that investigates a contemporary phenomenon (the “case“) in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident” (Yin, 2018, p.15). The features in a case study consider a high number of variables of interest, the multiplicity of evidence and the advantageous epistemological positioning before data collection and analysis. This case studied was carried out in a single-case design. This approach is justified by the value that the consideration of the organisation as centre of the research as vital source of information in a novel study context.

The strategic procurement function, as the key contributor to digital transformation and the most important node in the internal and external network, is the unit of analysis for this research. The selection of the company as one market player in the duopoly in the aircraft manufacturer industry takes into consideration the intensified pressure by production rates, emerging competitors and megatrends, elaborated on in chapter 1.

The strategic procurement organisation as the single-unit of analysis represents the adoption of a holistic type of single-case study design opposed to an embedded design (multiple units of analysis) (Yin, 2018). Yin (2018) argues five rationales for selecting a single-case study: 1.) critical case proving theory or identifying needs for reconsideration, 2.) extreme or unusual case, 3.) common case, 4.) revelatory case that has just become accessible to research or 5.) longitudinal case. This research is positioned as a revelatory case where the phenomenon has just become accessible to research and aims to contribute to theory building in the under researched area of digital maturity in strategic procurement organisations.

As presented previously, case study research does not claim generalisability with regards to population (statistical generalisation). However, it is the objective of this thesis to potentially expand the results to theory (analytic generalisation) in the field of process maturity research in a similar context.

There are well-documented concerns with regards to qualitative research in general and to case study research in particular. These concerns involve doubts with regards to the appropriate rigour of case study research and potential confusion with teaching cases where alterations are allowed. The aforementioned arguments set out the high standards that doing a case study properly requires. Further issues of concern include the design of the case study as manageable in terms of time and resources (Yin, 2018).

4.5.2 Time horizon

The character of this research is cross-sectional, meaning the creation of a status-quo "snapshot" of the strategic procurement organisation's digital maturity at a particular point in time (Saunders et al., 2023). The field research was conducted over a period of six months where the interviews were prepared and performed. In addition, an online survey was performed over a period of two weeks, taking place approximately a year after the interviews.

4.6 Data gathering procedures

4.6.1 Interviews

An interview is understood as a communicative act and "a powerful technique capable of developing accurate information and getting access to material otherwise unavailable (Kahn & Cannel, 1957)" (Larsen, 1958, p.83). In this case study research, interviews are the central source of information. It is the method of choice to concentrate precisely on the study topic. Yin (2018) suggests that there are two jobs while interviewing the participant: "(a) to follow your own line of inquiry, as reflected by your case study protocol and (b) to ask your actual (conversational) questions in an unbiased manner that also serves the needs of your line of inquiry" (p.118).

In accordance with Saunders et al.'s (2023) interview typology relating to the level of formality and structure, the nature of the interviews conducted was semi-structured and on a one-to-one basis. The selection of this type of interview was influenced by the previously presented epistemological positioning; a pre-designed interview guideline was used, however leaving adequate space and flexibility in the formulation of questions, further enquiries, expressed feelings and experiences of the interviewed partner. Adopting an interpretive approach, the objective was to capture the interviewees' feelings, perceptions, and interpretation with regards to the utilisation of advanced data analytics technology within the strategic procurement function and potential impacts. The predominant focus was set on the quality of the data instead of quantity, as the ambition of this research is not the discovery of a representative truth but the contextual exploration of the implementation of advanced data analytics technology. Yin (2018) recommends in this context to ask good questions, be a good listener, stay adaptive and avoid biases. The questionnaire contains eight sections to explore various aspects related to the researched phenomenon, deployment of advanced data analytics in strategic procurement (see Table 11). The researcher used the questionnaire presented in Appendix 10.1.

Table 11

Structure of the questionnaire

General information
Strategy
Data
Technology
Process
People
Structure
Culture

The design of the above presented questionnaire addresses the RO2 set out in chapter 1. The questionnaire was designed in an easy-to-understand way. The questionnaire started with some general introductory questions and then addressing questions that draw from knowledge gained in the literature as well as covering the four dimensions from the provisional conceptual framework. In total, the questionnaire comprised eight sections and 59 questions.

4.6.2 Selection of interview partners

For the selection of interviewees, a sampling technique was used. Sampling is understood as the collection of data of a sub-group only opposed to census where data from all possible members of a population is gathered (Saunders et al., 2023). The sample was selected by taking into consideration the population of strategic procurement, the target population, also termed as the strategic procurement “community”, for flying material except propulsion as the procurement population sourcing this product category is based at the company’s headquarter. The non-flying strategic procurement, coined as General Procurement population, was excluded because it is a group-wide cross-divisional function.

The sample includes members from the strategic procurement function of the Aerostructure, Cabin and Cargo, Equipment, Material and Parts and Procurement Strategy and Processes (renamed into Procurement Governance) commodities based in Hamburg, one of the Germany-based branches of the aircraft manufacturer, thus yielding a balanced ratio from a strategic procurement organisational perspective. The limitation, to only interview employees based in Hamburg, resulted from the local area of responsibility of the works council. Assurance that the approval of the works council is available was a vital prerequisite to take part in this study. Before interviewees could be approached and interviews could be performed, the formal approval from the works council of the site Hamburg had to be obtained. The approval process included the completion of a standardised form and the submission of the questionnaire which was discussed and agreed to in one of the works council body periodic reviews.

Furthermore, in order to obtain the approval of the procurement senior management and promote visibility within the strategic procurement community, the study was presented in a procurement site meeting that takes place as a regular management routine and involves representatives from Human Resources as well. The validation by the procurement senior management facilitated the approach of the function members at operational level and the request to them to participate in the study.

Like in many other qualitative studies, the selection of interviewees did not result from probability-sampling, but non-probability sampling. It was found more appropriate for an in depth-analysis of this phenomena. No standard selection procedure was followed but rather the confidence of the researcher based on the experiences in the organisation to make valuable judgements to identify a sample that capacitates the collection of data answering the formulated research questions. In addition, support in the identification of interview partners was provided by the company supervisor. The second decisive criterion for the interview partner onboarding was the accessibility of this person along with the willingness to support this research. Following the logic of purposive or judgemental sampling the sample did not constitute a statistically representative sample of the target population (Saunders et al., 2023).

As stated in section 4.5, a qualitative research methodology is applied in this thesis to develop an in-depth comprehension of the recent exposure of strategic procurement members to advanced data analytics in particular and digital transformation in general. In contrast to quantitative research, which claims generalisability by exploring patterns in large populations while concurrently decreasing the pollution by social variables, a qualitative approach does not seek generalisability or only to a very limited extent. However, in qualitative research, the analysis of a variety of social influencing factors enables new insights to be gained and hence the creation of new knowledge of the studied phenomenon. Instead of achieving statistical generalisation, which is the objective for quantitative researchers, a qualitative research design focuses on, what Yin (2018) refers to as, an analytical generalisation. It aims at transferability to similar contexts and situations.

According to Islam and Aldaihani (2022), qualitative research does not normally include a large sample population because the collected data is not quantifiable. In this thesis, data was acquired in in-depth interviews with 15 members from the strategic procurement function, from varying commodities, hierarchical levels and diverse roles, and this comprises the main source of data. Further details relating to the key characteristics of the interview respondents are provided in Table 12.

The extant literature suggests that through adequate sampling, a small but relevant sample of participants is identified and data is gathered until a point of saturation is reached. Saturation is understood by Hennink and Kaiser (2022) as “the point in data collection when no additional issues or insights are identified and data begin to repeat so that further data collection is redundant, signifying that an adequate sample size is reached” (p.2). Bowen (2008) concluded that “saturation is reached when the researcher gathers data to the point of diminishing returns, when nothing new is being added” (p.137).

Saturation is found to be a commonly accepted governing principle in determining an adequate sample size and an indicator that the nature of the studied phenomenon is captured in an accurate and complete manner. The application of saturation as the point where no new information is discovered in the collected data set is a common practice to justify purposive sampling sizes. However, the appraisal of saturation as methodological standard is relatively novel and lacks explicit and clear guidance for justifying sample sizes (Hennink & Kaiser, 2022).

The first well-recognised publication in the field of saturation was authored by Guest et al. (2006). Concluding from a literature review, it was argued that there was a substantial gap in the academic literature as regards how the concept of saturation was described and the point of data saturation was determined in qualitative research. Furthermore, practical guidelines for identifying adequate sample sizes in interviews were perceived as absent.

Guest et al. (2006) found in their study based on 60 semi-structured, open-ended interviews using a non-probabilistic, purposive sampling approach that saturation had already occurred within the first twelve interviews with basic elements emerging already after the first six interviews. Hennink and Kaiser (2022) confirmed these findings in their review of 23 articles using empirical tests assessing saturation in qualitative research aiming at the identification of sample sizes for saturation, assessment strategies, and the provision of guidelines developed from the analysed studies. “Despite using different approaches to assess saturation, different datasets, varying saturation goals (codes vs categories), and homogenous and heterogeneous study populations, studies still reached saturation within a narrow range of interviews” (Hennink & Kaiser, 2022, p.7). An average of 12-13 interviews suffice to reach the point of data saturation, the authors adjudged.

Hence, the sample size of 15 interview partners in this thesis is considered to be relevant and adequate.

For this case study 1.) procurement executives and line managers (MFT leader), 2.) sub-commodity leaders, 3.) (lead-)buyers and 4.) members from the strategic procurement community that had been participants in digital procurement projects, however, remained in their daily job were approached. To permit a distinction of views and perceptions, which is eventually impacted by hierarchical ranking, members from different hierarchical levels, including procurement senior management were approached. To each interview partner, a two-digit abbreviation (e.g., R01 for the first participant) was assigned.

Table 12

Interview partner's profile

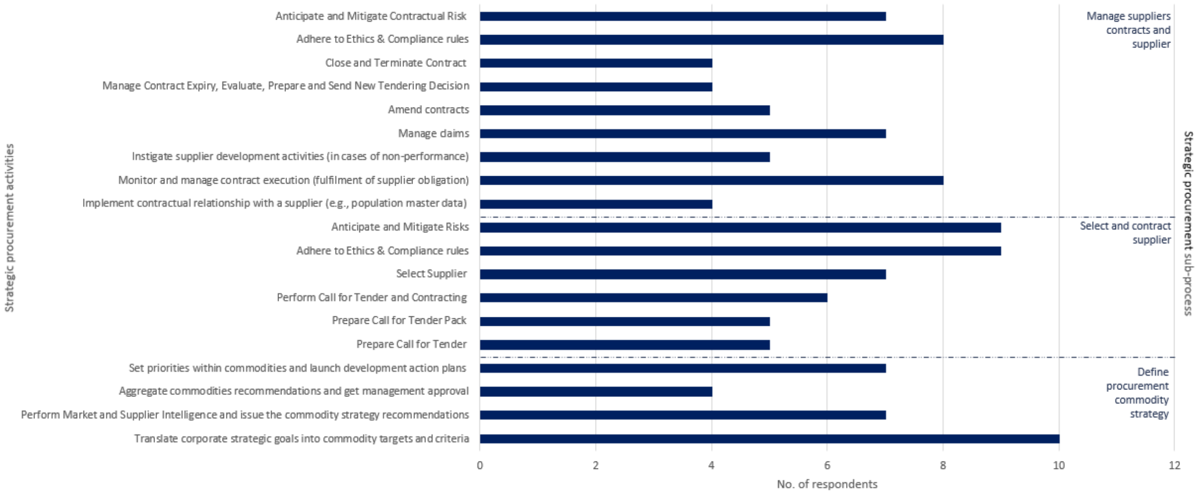
No.	Procurement Commodity	Role	Strategic procurement experience in years
R01	Strategy and Processes (Procurement Governance)	Project manager	12
R02	Material and Parts	MFT leader	25
R03	Equipment and Systems	Vice president	30
R04	Equipment and Systems	Project manager	5
R05	Aerostructure	Lead buyer	10
R06	Cabin and Cargo	Executive assistant	2.5
R07	Aerostructure	Vice president	16
R08	Material and Parts	Vice president	2
R09	Equipment and Systems	Sub-commodity leader	12
R10	Material and Parts	Buyer	5
R11	Cabin and Cargo	Commodity leader	8
R12	Aerostructure	Buyer	8
R13	Aerostructure	Sub-commodity leader	8
R14	Aerostructure	Project support	16
R15	Cabin and Cargo	Project manager	7

The interviewees were initially approached requesting their general availability and willingness to participate in the study. When agreeing to engage into the research, an interview date was scheduled. Out of 17 contacted candidates, two persons declined due to time constraints. At least one week in advance to the scheduled date an interview brief (see Appendix 10.2), the consent form (see Appendix 10.4) and the questionnaire (see Appendix 10.1) were sent for preparation. The participant was offered a phone call or videoconference meeting to clarify questions, raise concerns or provide any other comments.

In an introductory section, respondents were asked to provide the main activities performed in their role (see Figure 35), based on the company's defined and formulised procurement process (see Figure 28 in chapter 3).

Figure 35

Activities mostly performed in present job per respondent



In the questionnaire, in addition to open questions, several questions were designed as multiple-choice (see Figure 36) or using a five-point Likert scale (see Figure 37).

Figure 36

Example for a multiple-choice question (extract from questionnaire)

24. Do your think the application of Procurement Analytics adds any value?
If yes, do you agree with the following results of the utilization of Procurement Analytics?
Can you please establish a ranking in the importance of the benefits listed below?
(Instructions: Please tick the relevant box. Furthermore, please use the third box to establish your ranking, starting with 1 being most important.)

		yes	no	Ranking
1.	Better terms	☐	☐	
2.	Reduced supply disruption	☐	☐	
3.	Improved supplier performance	☐	☐	
4.	Facilitated supplier collaboration	☐	☐	
5.	Reduced working capital	☐	☐	
6.	Reduced transactional activity	☐	☐	
7.	Reduced risk	☐	☐	
8.	Work on higher value activities	☐	☐	
9.	Improved category strategy	☐	☐	
10.	Improved purchasing power	☐	☐	
11.	Lower prices	☐	☐	
12.	Improved visibility on potential suppliers	☐	☐	
13.	Improved visibility on technology/innovation developments	☐	☐	
14.	Improved adherence to compliance rules	☐	☐	
15.	Better contribution to sustainability initiatives	☐	☐	

Figure 37

Example for a Likert scale question (extract from questionnaire)

12. On a scale from 1 to 5, how do you perceive the quality of data to support your decision-making?

1 (poor)	2	3	4	5 (advanced)
☐	☐	☒	☐	☐

The interview partners were asked to complete those questions before the interview and return the partially completed questionnaire to the researcher. By choosing this modus operandi, it was ensured that an initial review by the participant took place and potential comprehension questions were raised before the actual interview.

Due to the Covid-19 pandemic and the contact restrictions, all interviews had to be performed remotely and online, even though less common in business research (Bryman & Bell, 2011). Not using remote interviewing would have resulted in a substantial delay in the research. All participants had been asked for permission to be audio-recorded prior to the interview. None of the interview partners that had agreed to get involved in the study had any constraints with this way of working.

The interviews were performed via Google Meet, which features a recording function, between April and August 2021, each interview lasting approximately 90 minutes on average. Even though Frey (2004, as cited in Bryman & Bell, 2011) states that a telephone interview is unlikely to last more than 20-25 min, the average duration of a Google Meet meeting in the case study organisation, facing the Covid-19 pandemic circumstances, ranged between 60 and 150 minutes. All interviewed procurement members had a great level of familiarity with this way of working and the application as it is the main communication and collaboration tool within the company. During the interview the interviewee was informed when the recording was started and ended.

4.6.3 Participant observation

Participant Observation, as data collection technique involves the researcher becoming part herself of the activities and setting of the case studied. “It involves data gathering by means of participation in the daily life of informants in their natural setting, watching, observing and talking to them in order to discover their interpretation, social meanings and activities” (Brewer, 2000, p.59). DeWalt and DeWalt (2010) emphasise that researcher using participant observation aim to “develop a holistic understanding of the phenomena under study that is as objective and accurate as possible given the limitations of the method” (p.110). In this research, pure participant observation is used as complementary technique. Firstly, by applying this method, the role as researcher and as active participant (existing role) in digital initiatives within the strategic procurement organisation (familiar setting) is acknowledged. The understanding sensitises the researcher to strive for an adequate balance as an “insider” and a researcher. Being part of the target population and assimilated in a complex organisation with its values, formalised and underlying behavioural codes enables a thorough understanding and the full comprehension of the studied phenomenon of digital transformation. Guba and Lincoln (1994) emphasise prolonged engagement as one key activity in participant observation to establish trustworthiness.

By watching, listening to, and trustfully interacting with stakeholders, this technique is valuable for capturing the attitude of the workforce towards the use of data analytics and the overall climate of the organisation dealing with a high level of uncertainty with reference to future way of working and organisational changes. Even though there is an underlying danger of manipulating (conscious or unconscious) the data, the method can also be used to illustrate that the data based on the individual interviews will not necessarily coincidence with the researcher’s observations. To a certain degree, participant observation can verify the plausibility of the data gained from the interviews.

4.6.4 Documentary data

In conjunction with before mentioned techniques, documentary information and archival records in form of secondary data is used to complete the case. Company documents such as corporate manuals, yearly established key objectives, progress presentations of the digital transformation programme, announcements, articles, or minutes of meetings are used with care to corroborate the information from previously stated sources. Some of this document secondary data could be accessed publicly on the company's website such as the annual reports or press releases. Other data such as minutes of meetings, process or organisational charts and other company records can only be accessed because of the researcher's role as member of the studied organisation. Even though being of immense value, this documentary information is understood as complementary and is also checked for their plausibility and congruence with organisational reality.

4.6.5 Online survey

The practical relevance and validation of the developed model of digital maturity for strategic procurement, presented in chapter 6, was performed using an online survey (see Appendix 10.4). Google forms, as a simple, easily available and familiar technology to all respondents, was used for the set-up and distribution the survey. A sample from the interview partners was approached again and requested to participate in the online survey. Based on the respondents' consent, a brief video conference meeting was scheduled to explain the purpose. The online survey comprised an introduction of the purpose and guidance how to complete the survey, an illustration of the developed maturity model and seven statements relating to the model. A five-point Likert scale (ranging from Strongly Agree to Strongly Disagree) provided the frame of possible responses. In addition, respondents were asked to repeat the rating of the digital maturity, using the introduced maturity stages from in relation to each of the change dimensions in strategic procurement. The survey was launched in August 2022 and left online for 14 days. All six requested participants responded.

4.7 Data analysis procedures

The data analysis in this research focuses on the transcripts produced that stem from the audio recorded interviews. Miles et al. (2014) emphasise the imperative nature of transcribing to gain a complete and true reflection of semi-structured interviews. Nevertheless, multiple diverse qualitative data, including verbal, textual and visual, was gathered and analysed. Using a qualitative research approach can result in an immense "lake" of unstandardized and unstructured data, which is complex and not clear-cut to analyse, however yields rich findings. Analytical techniques involve summarising, structuring, condensing, and categorising the data, allowing the development of a continuous and meaningful thread to answer the research questions (Bryman & Bell, 2011; Saunders et al., 2023). Transcribing and developing data familiarity by studying the further collected data are understood as vital steps in the data analysis process (Saunders et al., 2023).

Three simultaneously performed and interactive streams of activity are taken into consideration by Miles et al. (2014): data condensation, data display, and conclusion drawing/verification. Data condensation implies the selection, focusing, simplification, abstraction and/or transformation of the collected data which is then displayed ("Data display") in a structured and compact way. The concluding and rigour verification of those conclusions permits a true, in frame of a qualitative research, depiction of the phenomenon under study. Miles et al. (2014) highlights the importance the nature of data condensation opposed to data reduction used by, e.g., Namey et al. (2008), to demonstrate the strengthening of the data by condensing.

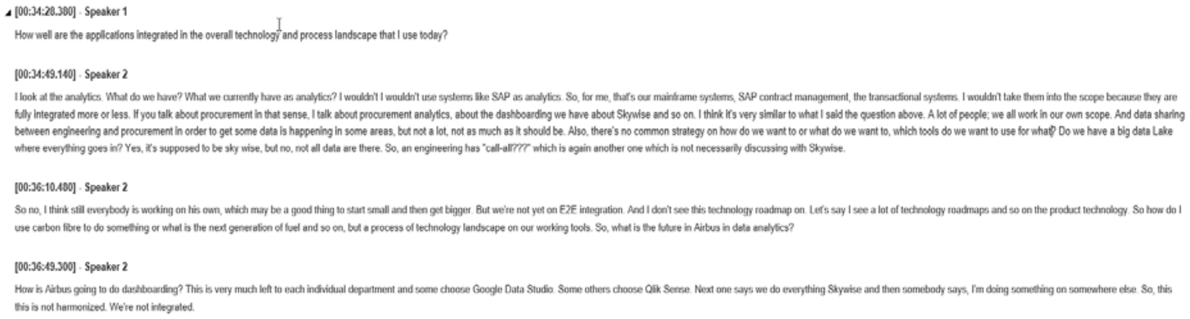
Three steps of data analysis are suggested by Creswell (2013): "1.) Preparing and organising the data in transcripts, 2.) reducing the data into themes through coding and condensing the codes, and finally 3.) representing the data in figures, tables, or discussion" (p.180).

In alignment with the philosophical underpinning of this research as interpretive, the data analysis accounted for the highly contextualised nature of the phenomenon of digital transformation in strategic procurement. Following Saunders et al. (2023), it appreciated the variations in data because of diverse experiences made and beliefs of the interviewees. The meaningfulness of this study rooted in the consideration of their individual and subjective perception and the richness of their statements.

Shortly after the individual interview was performed, the audio recording was transcribed verbatim (see Figure 38). For the transcription of the recordings, the application Happy Scribe (www.happyscripe.com), offering the automatic conversion from audio to text data, was used. For this, an account was established and the audio recordings were uploaded into a personal work space and transcribed. This transcribed raw data was then checked manually line-by-line, complemented, and corrected by carefully re-listening to the interview recordings. This process was undertaken not only to document what was said by the person, but also to capture sentiments and feelings expressed. The resulting word document per interview was then stored under a filename that allowed the anonymity of the individual person and confidentiality of the data.

Figure 38

Example of a transcript extract (R015)



[00:34:28.380] - Speaker 1

How well are the applications integrated in the overall technology and process landscape that I use today?

[00:34:49.140] - Speaker 2

I look at the analytics. What do we have? What we currently have as analytics? I wouldn't I wouldn't use systems like SAP as analytics. So, for me, that's our mainframe systems, SAP contract management, the transactional systems. I wouldn't take them into the scope because they are fully integrated more or less. If you talk about procurement in that sense, I talk about procurement analytics, about the dashboarding we have about Skywise and so on. I think it's very similar to what I said the question above. A lot of people; we all work in our own scope. And data sharing between engineering and procurement in order to get some data is happening in some areas, but not a lot, not as much as it should be. Also, there's no common strategy on how do we want to or what do we want to, which tools do we want to use for what? Do we have a big data Lake where everything goes in? Yes, it's supposed to be sky wise, but no, not all data are there. So, an engineering has "call-all???" which is again another one which is not necessarily discussing with Skywise.

[00:36:10.480] - Speaker 2

So no, I think still everybody is working on his own, which may be a good thing to start small and then get bigger. But we're not yet on E2E integration. And I don't see this technology roadmap on. Let's say I see a lot of technology roadmaps and so on the product technology. So how do I use carbon fibre to do something or what is the next generation of fuel and so on, but a process of technology landscape on our working tools. So, what is the future in Airbus in data analytics?

[00:36:49.300] - Speaker 2

How is Airbus going to do dashboarding? This is very much left to each individual department and some choose Google Data Studio. Some others choose Qlik Sense. Next one says we do everything Skywise and then somebody says, I'm doing something on somewhere else. So, this this is not harmonized. We're not integrated.

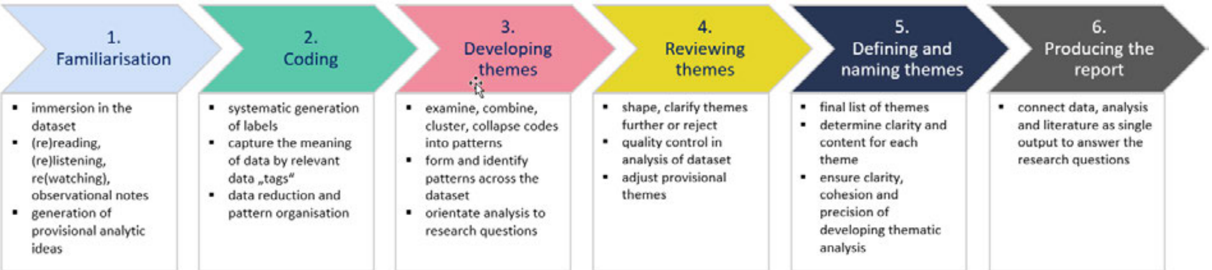
Following the transcribing activity, thematic analysis was used as analytic approach to analyse the collected data. Thematic analysis was applied to systematically, yet in a flexible and engaged manner, explore the data content, and identify themes and patterns and take account for the contextual nature of the phenomenon (Clarke & Braun, 2017; Namey et al., 2008; Joffe & Yardley, 2004). It allows the researcher to: "

1.) comprehend often large and disparate amounts of qualitative data;
2.) integrate related data drawn from different transcripts and notes;
3.) identify key themes or patterns from a data set for further exploration;
4.) produce a thematic description of these data; and/or
5.) develop and test explanations and theories based on apparent thematic patterns or relationships;
6.) draw and verify conclusions" (Saunders et al., 2023, p.664).

Thematic analysis involves six phases (Terry et al., 2017): 1.) Familiarisation, 2.) Coding, 3.) Developing themes, 4.) Reviewing themes, 5.) Defining and naming themes and finally 6.) Producing the report (see Figure 39).

Figure 39

Phases of thematic analysis



Note. Adapted from "*Thematic Analysis",* by Terry et al., 2017, In C. Willig & W. Stainton-Rogers (Eds.), The SAGE Handbook of Qualitative Research in Psychology (2^{nd} ed.). SAGE Publications.

Saunders et al. (2023) call for a familiarisation with the data as vital prerequisite and concurrent activity. Even though, the familiarisation of data started with engaging into the topic and was a continuous flow of activity throughout the entire research, getting familiar with the transcript data produced from the interviews was the centrepiece. During the revision of transcripts - including re-listening to the recordings and reviewing the transcript in depth - a good level of familiarisation with the data was achieved, and initial ideas for structuring the findings were developed.

In thematic analysis, coding enables the reduction and classification of the collected data. Following Saldaña (2015) a code can be defined as “a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data” (p.3). Coding aims at the categorisation of data by analysis of the transcripts, labelling relevant information as it falls in specified categories and thus form units of data.

For this research, firstly clusters (which corresponded mainly to the headlines of the questionnaire) were used for structuring the data. Clusters included the topics: general information, strategy, data, technology, process, people, structure, culture, success factors and emotions. To achieve a higher level of granularity of results, labels detailing aspects of each cluster were allocated to each cluster. In total, 78 labels were distributed between the clusters (see Figure 40). Through re-reading the interview transcripts, data segments including words, passages and sentences, interesting and seemingly relevant for the research, were marked in a different colour and allocated to a corresponding label.

Figure 40

Extract from label mapping

TECHNOLOGY		
	23_type of application	
	24_value	
	25_purpose	
	26_Maturity of Analytics	
		Descriptive
		Diagnostic
		Predictive
		Prescriptive
	27_Beneficial but not used	
	28_Integration within technology and process landscape	
	30_Real-time data	
	31_App-ability	
PROCESS		
	32_most beneficial	
	32_currently used	
	33_sustainability	
	34_change occurred	
	35+37_change in the future	
	36_efficiency increase	
PEOPLE		
	39_Engagement in digitalisation projects	
	40_trainings attended	
	41_adequately skilled	
	42_job profile changes	
	43_analytical skills necessary	
		44_Skills (hard + soft)
	45_way of working changed	
	47_coordination between people	
	48_additional roles	
	50_ideas around digital leadership	

By iteratively going through the allocated data segments, data was condensed and themes emerged. Valuable insights were provided by the interviewees. Information that served the purpose of completing the research objectives but also of illuminating topics around the organisation’s status of digital transformation, the role of strategic procurement and data were retrieved.

Themes are referred to as patterns identified from the collected data or coding category. The total set of codes is referred to as the coding frame. In this research, themes have been developed from the raw data itself, thus inductive coding, opposed to deductive coding by founding themes in existing theoretical ideas (Joffe & Yardley, 2004).

Following the creation of thematic ideas, a review of themes and attached data was performed leading to the further development and refinement of the themes. A few themes were found interesting but not relevant for the research, and hence were not further developed.

In addition to the analysis of the transcripts, the responses in multiple choice- and Likert scale-format from the questionnaire were transferred into a consolidating excel sheet and analysed (see Table 13).

Table 13

Extracts excel-based questionnaire analysis (for multiple choice/ Likert scale responses)

SECTION			R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
1.	What is your role in Strategic Procurement?																
2.	In which Procurement Commodity do you work? (1) Aerostructure, (2) Cabin, (3) Equipment, (4) Material&Parts, (5) Strategy & Processes	1-5	5	4	3	3	1	2	1	1	3	4	2	1	1	1	2
3.	Which of the following activities do you mostly perform in your job?	1(Y)/0(N)															
	Define Procurement Commodity Strategy	1(Y)/0(N)															
	Translate corporate strategic goals into commodity targets and criteria	1(Y)/0(N)	1	1	0	1	0	1	1	1	1	1	1	0	0	1	0
	Perform Market and Supplier Intelligence and issue the commodity strategy recommendations	1(Y)/0(N)	1	1	1	0	0	0	1	1	1	0	1	0	0	0	0
	Aggregate commodities recommendations and get management approval	1(Y)/0(N)	0	1	1	0	0	0	0	0	1	0	1	0	0	0	0
	Set priorities within commodities and launch development action plans	1(Y)/0(N)	0	1	1	1	0	1	1	1	1	0	0	0	0	0	0
	Select and Contract Supplier	1(Y)/0(N)															
	Prepare Call for Tender	1(Y)/0(N)	0	0	0	0	1	0	0	0	1	0	1	1	1	0	0
	Prepare Call for Tender Pack	1(Y)/0(N)	0	0	0	0	1	0	0	0	1	1	0	1	1	0	0
	Perform Call for Tender and Contracting	1(Y)/0(N)	0	0	0	0	1	0	0	0	1	1	1	1	1	0	0
	Select Supplier	1(Y)/0(N)	0	1	0	0	1	0	1	1	1	0	1	1	0	0	0
	Adhere to Ethics & Compliance rules	1(Y)/0(N)	0	1	1	1	1	0	1	1	1	0	1	1	0	0	0
	Anticipate and Mitigate Risks	1(Y)/0(N)	0	1	1	1	1	0	1	1	1	0	1	1	0	0	0
	Manage Suppliers Contracts and Supplier	1(Y)/0(N)															
	Implement contractual relationship with a supplier (e.g., population master data)	1(Y)/0(N)	0	0	0	0	1	0	0	0	1	1	0	1	0	0	0
	Monitor and manage contract execution (fulfilment of supplier obligation)	1(Y)/0(N)	0	0	0	0	1	0	1	1	1	1	1	1	1	0	0
	Instigate supplier development activities (in cases of non-performance)	1(Y)/0(N)	0	1	1	0	1	0	0	0	1	0	1	0	0	0	0
	Manage claims	1(Y)/0(N)	0	1	1	0	1	0	0	0	1	1	0	1	1	0	0
	Amend contracts	1(Y)/0(N)	0	0	0	0	1	0	0	0	1	0	1	1	1	0	0
	Manage Contract Expiry, Evaluate, Prepare and Send New Tendering Decision	1(Y)/0(N)	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0
	Close and Terminate Contract	1(Y)/0(N)	0	0	0	0	1	0	1	0	1	0	0	1	0	0	0
	Adhere to Ethics & Compliance rules	1(Y)/0(N)	0	0	1	1	1	0	0	0	1	0	1	1	1	1	0
	Anticipate and Mitigate Contractual Risk	1(Y)/0(N)	0	1	1	1	1	0	0	0	1	0	1	1	0	0	0

Reflecting findings of an extensive review of literature, Skjott Linneberg and Korsgaard (2019) offer a synthesis of advantages that coding brings: “1.) Acquire deep, comprehensive and thorough insights into your data: 2.) Make the data easily accessible and retrievable, 3.) Sorting and structuring your data, 4.) Ensuring transparency, 5.) Ensuring validity, 6.) Giving a voice to one’s participants” (p.7).

Data analysis was based around defined themes and consolidated using an excel spreadsheet. These findings are presented in chapter 5 below.

4.8 The role of researcher values

In this research, the author assumes the role of a practitioner-researcher, as part of the strategic procurement organisation, even as a member of the unit of analysis. The researcher has been working in the organisation for more than a decade, thus possessing in-depth knowledge of applied technologies, processes, and organisational structures. To a considerable extent, this position within the organisation facilitates the access to material and interview partners. Golafshani (2003) attributes to the researcher an indispensable role in qualitative research, as the researcher needs to appreciate her/his engagement and part within the research.

On the other hand, easy accessibility does not dispense with the vital need to build a trustworthy and respectful relationship with the interviewee. Being part of the researched organisation poses challenges around familiarity, and a high level of reflexivity and rigour to step out of “the system” is central in this approach to make the familiar strange again, which is acknowledged to be central to qualitative research (Holliday, 2016). This study is a co-production between the researched person and the researcher. The epistemological positioning within the interpretivist research paradigm is reflected by the co-construction of meaning. Furthermore, being part of the researched organisation poses challenges around familiarity eventually omitting basic inquiries because it is assumed to be elementary knowledge or inhibiting the exploration of certain aspects of the phenomenon.

While Yin (2018) suggests ways to avoid bias, Holliday (2016) calls for the acceptance of the ideological nature of qualitative research and that there is no value and bias-free design. Instead, Janesick (2000) suggests that “the qualitative researcher early identifies his or her biases and articulates the ideology or conceptual frame for the study” (p.385). By means of triangulation, e.g., data triangulation and the application of the so-called interviewing-the-investigator technique, bias is addressed and managed in practice (Chenail, 2011). Being positioned as an insider within the case setting for quite a substantial time, makes the reduction or even the absolute avoidance of bias-thinking a challenge. Some of the interview partners that are involved in this research are dealt with in professional daily life. Other interviewees participating are interacting with the researcher for the duration of the study only. The participation in the study is completely voluntary (informed consent, see Appendix 10.3) and on the manager’s good will to allow the respondents to do so in their work time. The researcher is conscious of the duty to be totally transparent about the purpose of the study and to protect all interview partners at each stage of their involvement. The respondents are not influenced by the researcher. To ensure confidentiality and not to put them in an unfavourable position is key in the co-operation with them. While the researcher withdraws from the function after the research, the person involved remains in her/his former role within the organisational set-up. Yin (2018) suggests such a study of a real-world context is as ethical as in medical research. The research is based on the freely given informed consent of participants. The respondents were informed about aims, nature, conduct, funding, duration, purpose and consequences of research and how results would be disseminated. It was further explained that the responses would be anonymised and the respondents have right to withdraw at any time during the process or refuse to answer. Personal information is kept confidential and secure. The original data were stored separately from coded data. Both data sets were be stored and secured and under strict access control. The findings were only used by the researcher and for this research.

Furthermore, members from senior management were interviewed as key sources of information regarding “if”, “how” and “what for” data is used. At the same time, it is the management that determines the course of action with regards to the preparation of the organisation for the digital future and to develop the competences within the workforce. In some cases, there was a significant power imbalance between the member of the management and the researcher’s position as a member of that organisation. This could pose a potential barrier for, and a challenge to, the quality of the interview. The power gap is of particular importance as middle-aged white men dominate the procurement executive team with very few exceptions. The researcher firmly positioned herself clearly as an equivalent counterpart in her role as researcher, not as a subordinate in the procurement community.

When planning qualitative research, the researcher accepted there was no clear routine, or standard research design and process. Such research does require a certain degree of fluency with methods. The researcher remained flexible and be able to adapt the plans as the case could take unforeseen turns. There is a likelihood that digitalisation disappears from the corporate agenda or other aspects are given higher priority. In addition, the support of topics not directly related to the function and/or operation is highly dependent on the mind-set of the person in charge. So, any alteration in management personnel, regardless of the level of hierarchy, will be eventually followed by a re-calibration in focus. Simultaneously, it is of extreme significance to keep focused on the original purpose of the study.

In addition to the issues discussed above, the author of this study is committed to strive for the highest ethical standards and take full responsibility of the work produced. This includes an accurate and comprehensible documentation of sources and the rejection of any sort of plagiarism. It also incorporates no falsification of information even in case of contrary findings, e.g., the acknowledgement of a high digital maturity of the studied procurement processes and organisation.

4.9 Chapter summary

Chapter 4 presented the research design and methodology used in this study. The crafting of the blueprint for the research, understood as research design, was performed in alignment with the overall interpretivist philosophical standpoint, and ontological and epistemological position of the researcher as argued in this chapter. In association with interpretivism, a qualitative research approach was pursued. The justification and the appropriateness for the exploration of digital maturing of a strategic procurement function in an aircraft-manufacturing context, by deploying advanced data analytics technology as nascent phenomenon, was provided in this chapter. An inductive approach for theory development and the use of case study as the methodological choice were developed and reasoned. Details of the case study organisation were provided.

Interviews, as the main data gathering procedure in this research, complemented by participant observation and an online survey were explained and justified. Thematic analysis as, main data analysis procedure, were outlined. The chapter was concluded with a reflection of the researcher’s role in this study as a practitioner researcher. The following chapter reports the findings derived from the data gathering and analysis procedures discussed above.

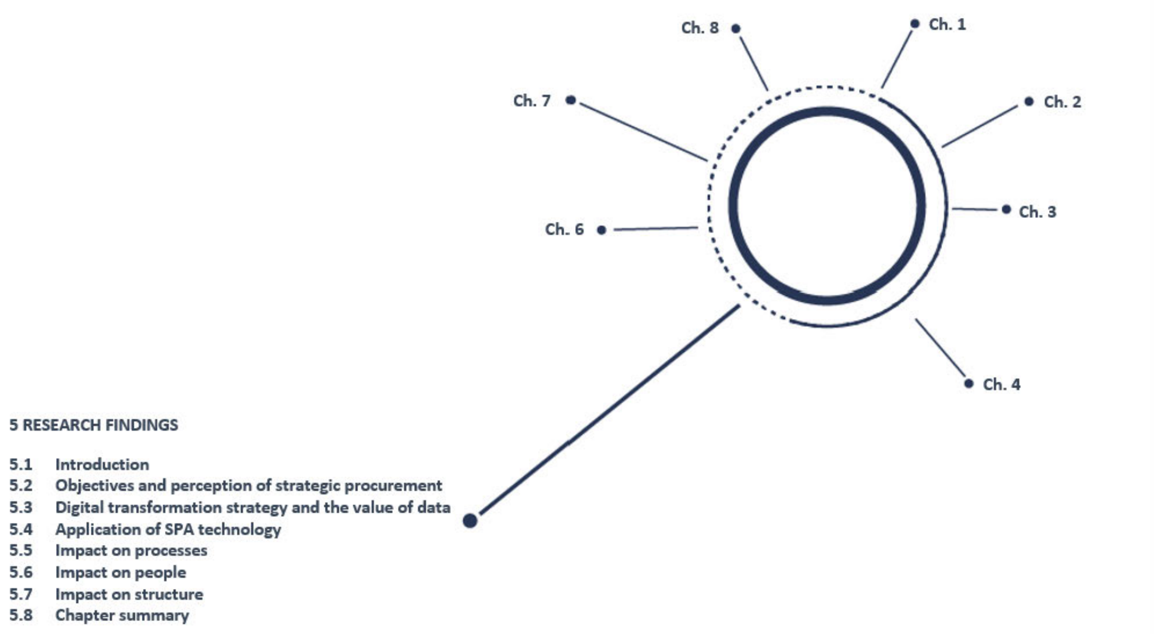
CHAPTER 5: RESEARCH FINDINGS

5.1 Introduction

In chapter 5, findings from the fifteen in-depth interviews are summarised and analysed. The interview material includes discussion of the four change dimensions (technology, process, people, and structure) of the PCF, introduced in chapter 3. This chapter is divided into eight sections (see Figure 41).

Figure 41

Structure of chapter 5 in context of the thesis



Following this introduction, section 5.2 examines the objectives and perception of strategic procurement. It assesses the overall position of the function in the case study organisation in comparison with findings from the literature review in chapter 2. Section 5.3 explores the role that strategic procurement plays in corporate digital transformation and interviewees' opinions regarding data integrity and value. In sections 5.4 – 5.7, perceptions, statements and views articulated by the interview partners to questions in relation to the individual change dimensions are reflected upon and examined. At the end of each section, the main findings are depicted in an illustrative figure. In section 5.8, a summary of this chapter and a synopsis of research findings in a consolidated figure are presented. Further explanation of passages in the quotations from interviewees, for example abbreviations used in the case study organisation or for clarification of meaning, are included in brackets in non-italicised text within the quotations.

5.2 Objectives and perception of strategic procurement

5.2.1 Objectives of strategic procurement

All interview partners showed a clear understanding of the objectives of strategic procurement in the case study organisation (see Figure 42) and pointed out the critical role that strategic procurement has in the organisation and the expected contribution to the company’s overall success. Depending on the individual role in the organisation, interview partners, such as members of the executive management or multifunctional team (MFT) leaders, contribute actively to the definition of a sourcing strategy based on company targets, while other respondents such as buyers execute the designed strategy, the performance of calls-for-tender and supplier selection.

Procurement strategies are found at various levels that partially reflect structural arrangements and embody market and supplier landscape scanning. Strategies are developed at commodity (e.g., Material and Parts), sub-commodity (e.g., Detail Parts), and even at material group level (e.g., Detail Parts Sheet Metal Soft Alloy).

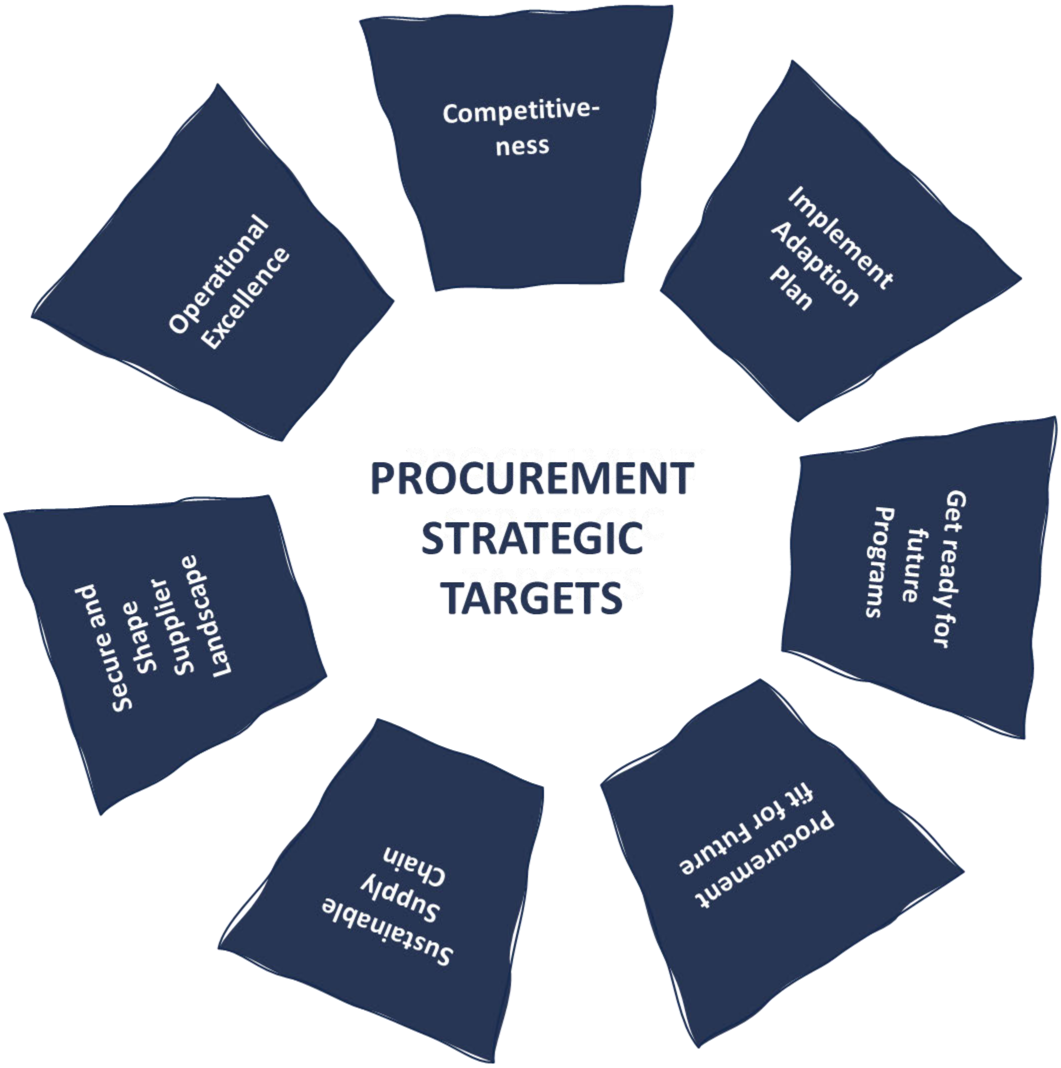
The assurance of on-time, on-cost, and on-quality supply of products and services highlights one of the fundamental objectives of strategic procurement and confirms findings from the literature review. To contribute to the sustained competitiveness of the company, strategic procurement is expected to “*lead, execute, and deliver cost reduction programs and the projects related thereto*” (R02). One respondent (R15) accentuated a “*strong focus on cost reduction.*” A number of respondents (R06, R08, R09) noted the focus on Total Cost of

Ownership (TCO) in the selection process and on the consideration of non-quality costs caused by the supplier, which they feel were not appropriately applied. "*I would say that we still need to recognise or stronger recognise* (i.e., recognise more strongly) *the end- to-end performance of a supplier, including not only the price of the product we procure but all the lifecycle costs as well, and to make a fair business case means including, for example, elements like reactivity and on-site-support*" (R06). Long-term supplier relationship management, including contract and claim management and supplier development, underpin the contemporary understanding of the strategic nature of procurement.

To ensure a robust supply chain, mitigating risks, and avoiding disruption to production are key to support the industrial system that aims at a production rate for Single Aisle aircraft of 75 per month in 2025 in the case study company (Koenen, 2021). Some of the respondents emphasised the importance of promoting research and technology development and shaping of the supplier landscape and related aspects to "*get ready for future aircraft programmes*" (R11) and "*green aircraft*". The responses reflected one of the main themes which has been manifested in the corporate agenda in recent years, namely "Preparing for the Future". In September 2020, Airbus revealed three different concepts regarding how to achieve a zero-emission aircraft by 2035 (Airbus 2020d), which are all based on hydrogen as the primary power source (see Figure 9 in chapter 1). Several interview partners noted the reinforcement of established objectives such as ethics and compliance, and the addition of new objectives - for instance, the contribution to sustainability targets.

Figure 42

Summary of strategic procurement targets, simplified



Note. Adapted from *"Mission, Vision and Activities"*, by Airbus, 2023g [Unpublished].

5.2.2 Perceptions of strategic procurement

The opinions articulated with regards to the perception of strategic procurement by cross-functional company stakeholders were characterised by heterogeneity and based on individual experiences. Statements made in the interviews offered a wide range of opinions, from negative to positive sentiments of the participants. One respondent (R01) commented that "*certain stakeholders do not even know that we exist*" but, on the other hand, remarked that "*others who are in contact with us appreciate that we are there*". Individual views regarding strategic procurement are found to be highly dependent on the level of interaction with the strategic procurement process. A positive perspective is closely tied to the recognition that strategic procurement sources around 80% added value creation (R03). The company's core business model relates to the role of an integrator. Thus, strategic procurement was understood as a key contributor to, and valuable member of, corporate success and "*is a very powerful and very much needed*" function (R06). In the context of the immediate response to the Covid-19 outbreak and business adaptation, strategic procurement played a vital role in the achievement of cash-containment ("*stop bleeding cash*"). In summary, strategic procurement is "*well respected in terms of financial contribution*" (R04) and has a good standing within the organisation. R07 reported from a recent company internal survey, initiated by the CPO, where participants recognise strategic procurement as "*the main driver and the main key for success in driving the competitiveness of all products*", this referring to the positive contribution that procurement had in past cost reduction programmes.

Interview partners highlighted other issues concerning strategic procurement, such as the robust process orientation, provision of guidance, ensuring performance with low level of disruptions in the supply chain, and the delivery of aircraft which is a top-priority company objective. Notably, strategic procurement is given credit for constructive and collaborative business relationships with the suppliers. Although the strict adherence to the processes is appreciated, it is deemed as being too rigid, overly complex, and the root cause of slowing down the rest of the organisation, e.g., in the introduction of new products where an accelerated time-to-market is of the essence. Strategic procurement is perceived as not overly pragmatic, but rather as blocking (R05) and not valued as a very proactive supportive function. Other company stakeholders struggle with the complex organisation of procurement, where "*you have to get in contact with five different persons inside procurement*" (R14) and a related lack of transparency. Negative testimony included the fact that strategic procurement is "*a bit old fashioned, not leveraging digital possibilities sufficiently*" (R01) with a lack of agility (R15).

Sometimes, procurement was not seen as strategic as the function itself claims, but more reactive, operationally driven and often in crisis mode (R01). One respondent (R12) voiced a poor perception of strategic procurement, with production considering the work of the procurement function as a threat to their jobs (i.e., procurement outsource some of the production activities) "*because we outsource part of their work*". Feedback to members of strategic procurement carried criticism of the function being too far away from the operational business as strategic procurement covers activities around setting-up the contractual relationship before the actual operational business with a supplier starts (R07, R08). One respondent (R13) put it more overtly by stating "*usually we are seen as a pain in the ass because we are always asking not just the technical questions, but we are also challenging people to assess if things are really necessary, and we are always asking for quantifying of requirements (*i.e., we always ask them to quantify the requirements)". Two other participants (R04, R11) noted an improved perception by other corporate functions in recent years, in particular following the introduction of an MFT and the respective clarification of roles and responsibilities. The creation and the composition of an MFT within the case study organisation is formalised in a company directive.

5.2.3 Section summary

The strategic procurement function in the case study organisation pursues classic procurement objectives, such as the assurance of on-time, on-cost, and on-quality supply of products and services. The contractual domain of procurement is expected to take a leading role in the organisation to secure sustained competitiveness of the company by leading and delivering on cost reduction initiatives. The strategic orientation of procurement and the long life of contracts, characteristic for the aviation industry, require long-term oriented supplier relationship management, including contract and claim management and supplier development.

In addition, the detection, analysis, and mitigation of risks to avoid disruptions of the supply chain or, worse, operations, are part of the strategic procurement's portfolio. Contemporary objectives such as the identification of supplier innovation and securing the access to research and development of aviation products and processes for aircraft manufacturing, coined as "*innovation sourcing*" and contribution to sustainability targets demonstrates the important role strategic procurement plays in the response to megatrends.

Even though the perception of strategic procurement varied in the organisation, generally the function was seen as vital contributor to the company's overall success. Reflecting on the company's core business model as an integrator, strategic procurement was understood as powerful and essential to company business continuity. The function was credited for process adherence, constructive business relationship with the suppliers and assurance of performance with low level of disruptions in the supply chain, whereas criticism related to strategic procurement being complex, inflexible and slow, thereby impacting negatively other functions such as operations. This perception has improved in recent years by the introduction of the MFT and the formalisation of accountabilities.

Figure 43

Synopsis of section 5.2 - objectives and perception of strategic procurement

1 Contemporary strategic procurement pursues classic and modern procurement objectives in response to industry specificities and megatrends.

2 Strategic procurement is acknowledged as a contributor to overall company success but needs to adapt more quickly to the business environment and company dynamics.

5.3 Digital transformation strategy and the value of data

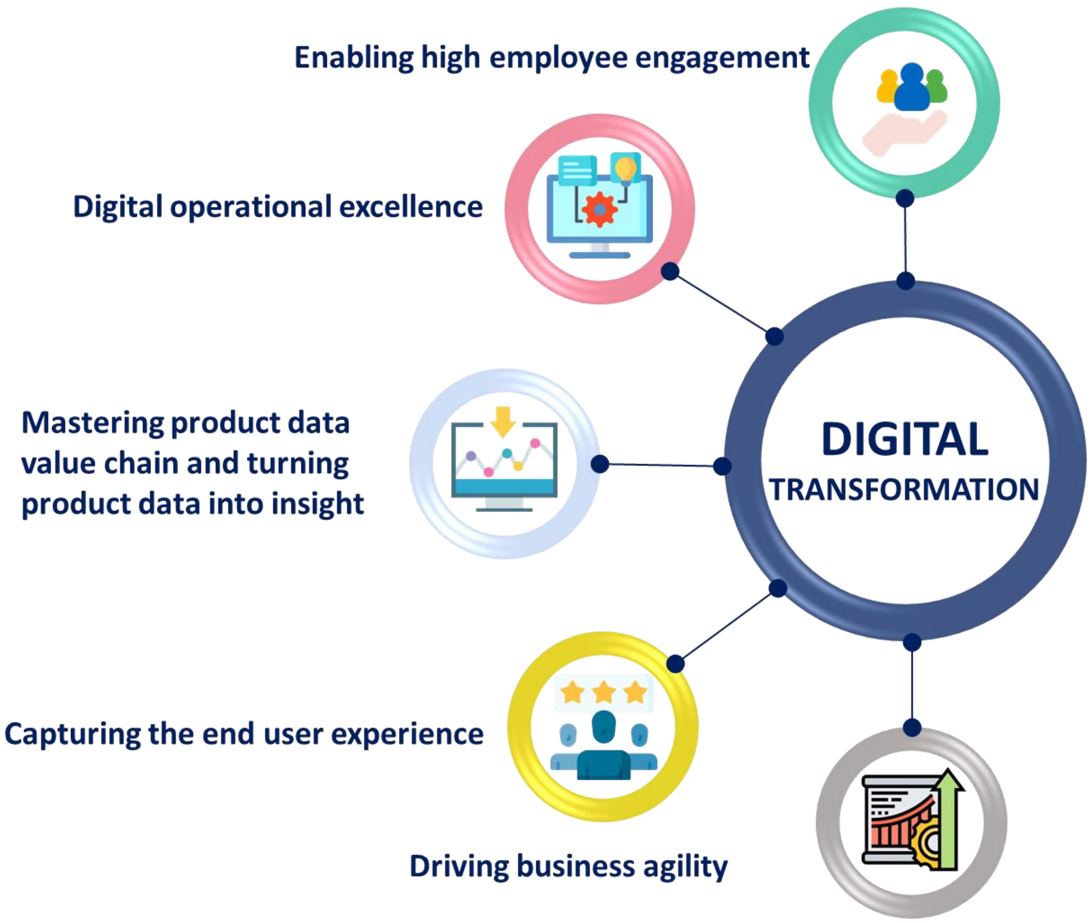
5.3.1 Digital transformation strategy and present digital maturity

The case study organisation launched a groupwide digital transformation initiative in 2015 (Airbus, 2016). It was considered as a "strategic imperative and will be central to our operating systems for the foreseeable future. We need to get faster, bolder and, at the same time, better in operational execution!" (Airbus, 2016, p.12). The motivation for the project was based on the understanding of digitalisation as a lever for change and was embedded in the overall company strategic objective of “Preparing for the Future”. The introduction of a roadmap and programme for the use of digital technology was formulated as a key priority for 2016 (Airbus, 2016) and the years thereafter.

In the annual report of 2015, digitalisation was added as a “further lever for change” (Airbus, 2016, p.24). Five axes (see Figure 44) of focus were defined: “(i) enabling high employee engagement, (ii) digital operational excellence, (iii) mastering our product data value chain and turning product data into insight, (iv) capturing the end user experience and (v) driving our business agility” (Airbus, 2016, p.25).

Figure 44

Five axes of digital transformation



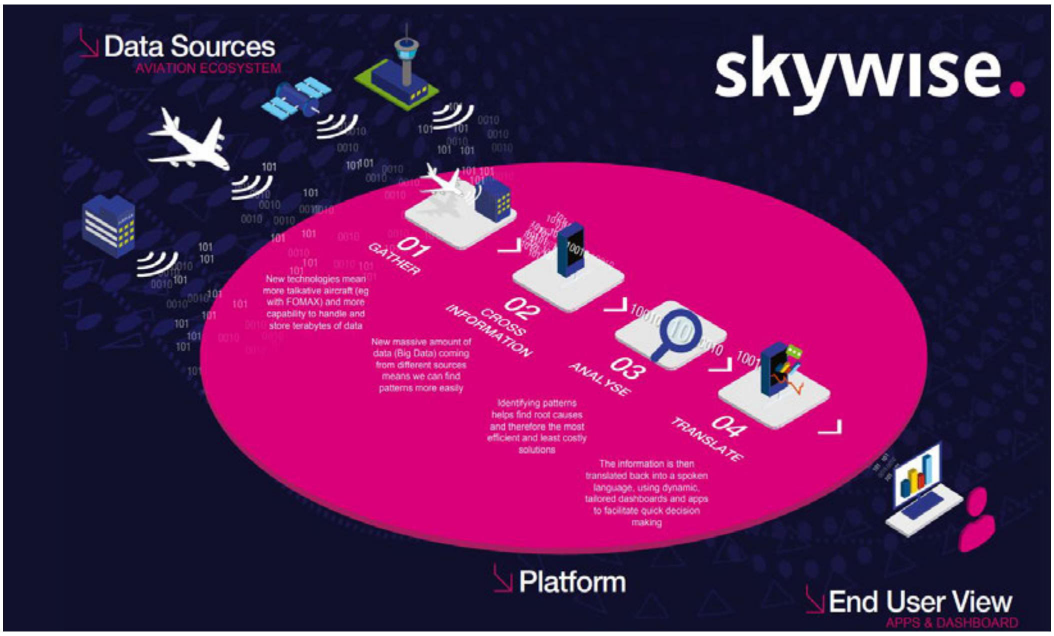
Note. Adapted from “Annual Report 2015 Flying ahead”, by Airbus, 2016 (https://www.airbus.com/sites/g/files/jlcbta136/files/2021-07/airbus-ra-2015-en-03.pdf).

In 2016, the case study organisation reported the application of smart solutions and the building of a digital back-bone for future operation. For the first time a Digital Transformation Officer (DTO) was appointed (Airbus, 2017) and a central digital transformation office established to lead approximately 500 projects, including the creation of a data lake of aircraft in-service data for the commercial division of the case study company, Augmented Reality (AR) and Virtual Reality (VR) devices for employees, the use of Internet of Things (IoT), and the use of collaborative robots (Cobots) as part of Industry 4.0, amongst other initiatives. In addition, all employees were connected to a new intranet platform known as “The Hub” (Airbus, 2017, p.33).

During 2017, digital capabilities were reported to be maturing and implemented at scale. In addition, Skywise - a data platform for the aviation industry developed as a joint initiative with Palantir - was launched and understood to be the major digitalisation initiative for the case study company (see Figure 45). Data was acknowledged to be at the heart of any digital capabilities. The platform collects data that is produced during the sourcing, production, and operation life cycle of an aircraft. It “applies analytics to help them to make better and more informed decisions that improve the engineering, maintenance, and flight operations of aircraft” (Airbus, 2022d, para.5). Stakeholders of the entire supply chain including suppliers, OEMs, aircraft owners and operators are the target group to benefit from the platform in the form of savings due to enhanced efficiencies and opportunities to grow revenue. Typical applications include “events tracking and resolution, turnaround time analysis, operations analytics, predictive maintenance, reliability analysis and benchmarking, and maintenance decision support” (Airbus, 2022d, para.5).

Figure 45

Skywise platform



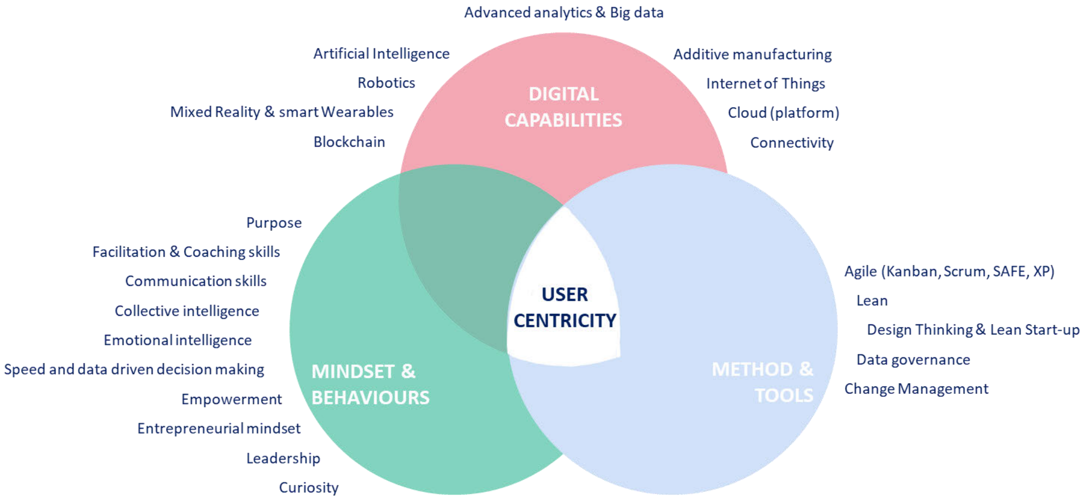
Note. From *"Annual Report 2017 Connecting the skies"* (p.9), by Airbus, 2018a (https://www.airbus.com/sites/g/files/jlcbta136/files/2021-07/AIRBUS_Annual_Report_2017.pdf).

During 2018, the industrialisation and further deployment of the digital concept were the centre of activities (Airbus, 2019). While throughout 2016, digital transformation was incorporated as a key group priority, in 2019 it was considered a key enabler to support the company's strategy around growing as the leader in aerospace, increasing the capacity to invest by blending growth, profitability and resilience optimally, and leading the industry-wide transformation to be prepared for "emerging environmental, social and governance standards" (Airbus, 2020, p.25). DDMS was formulated as a key priority for 2019 and is highlighted on the company's website which states "digital design, manufacturing and services (DDMS) is a digital-first approach to the way aerospace products are designed, manufactured, and operated" (Airbus, 2021b, para.1).

Focusing on the subject from an individual strategic procurement member perspective, R01 commented on the existence of a transformation strategy a couple of years ago with a focus on leveraging digital technology such as big data, connectivity and 3-4D printing, customer orientation and also on people and processes. However, the current status quo is not clear. A digital transformation strategy dedicated to strategic procurement seems not to be in place at present or not known by members of strategic procurement. New ways of working like empowered teams are part of the digital transformation strategy. Transformation at the case study organisation is understood as human-centric transformation, powered by digital capabilities as presented in Figure 46 (Airbus, 2023h).

Figure 46

Digital transformation at the case study organisation



Note. Adapted from *"Digitale Transformation [Digital Transformation]",* by Airbus 2023h [Unpublished].

At present, the cornerstone of transformation is the digitalisation of manufacturing data, with strategic procurement as one of the stakeholders (according to interviewees R02, R04, R05, R07, and R08). R04 linked DDMS to a fostered TCO approach in the organisation and future enablement. One outcome of this initiative, which is of particular relevance to strategic procurement, should be more accurate information for the sourcing of products and services, allowing the development of a call-for-tender requirement pack with enhanced accuracy and validity, and the selection of the most appropriate supplier. The majority of respondents, including R02 and R14, were not aware of a fully integrated digital transformation strategy "*focusing specifically on the procurement processes*". For R08, there was a procurement digital strategy, which was linked to DDMS and includes a road map for all digital key initiatives within procurement. R08, R11, and R12 assumed that a central procurement strategy paper exists, but they have neither access to, nor knowledge of, it and its key elements and communication within the case study organisation is deficient. The organisation was perceived to be in the early stages of digital transformation with a lot of tools at hand, but these were not evident in all areas of the organisation and not properly integrated yet (R11). R02 stated that corporate digital transformation is technology driven and there is no clear road map in place for procurement that defines a vision, targets, and measures, or how to achieve them. For R14, the transformation was applications driven, although there were no answers to questions such as "*Where do we want to go?", "What is our vision?"* and *"How will we be working in the future?*" In addition, there was lack of clarity over roles and responsibilities when it comes to strategy definition and implementation (R07). Overall, one participant (R13) maintained that there are a "*lot of initiatives improving the use of digital media or digital data or whatever data processing*" or, as R15 put it, "*there are bits and pieces here and there (…) but I do not see that there is a big picture bringing all the different streams togethe*r" (R13). R05 felt that "*it's more a buzzword (…) and not really a concrete strategy*" and without granting access to budget and human resources, it can be deemed as constituting "*fake objectives*".

There are different initiatives and specific solutions; yet they do not appear to fit within an overarching strategy. Although these applications have enormous potential, this is yet to be realised, and requires the necessary connection and coordination (R06). R13 expressed, with some noticeable frustration, that strategic procurement tried to connect tools, but this has failed to deliver benefit over many years. Reasons for this failure are a missing top-down approach, a silo-thinking mentality, and the complexity of existing legacy systems, e.g., various applied SAP system modules. "*We have a lot of sticking plaster solutions in place*" (R13). R12 summarised the situation as follows: "*I think people are speaking a lot of ("about") digital transformation, but nobody really knows what we want or we don't communicate it*". R04 remarked that projects have not been finished because of the Covid-19 pandemic and it would take some time to assess whether and how to re-start them, taking into consideration budgetary constraints as well.

It was noted that the transformation of the business model itself has not been explicitly targeted. The respondents were asked in the pre-designed questionnaire to assess the level of digital maturity on a Likert scale from 1 (lowest) to 5 (highest) at corporate and strategic procurement functional level. Results are summarised in the Table 14.

Table 14

Digital maturity of the case study organisation at corporate and strategic procurement level

		R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	AV
1.	On a scale from 1 (early stage of digital transformation) to 5 (fully digitally transformed), where do you perceive the organisation as a whole to be?	3	2	2	3	2	3	3	3	2	4	2.5	1	2	2	2	2.4
2.	On a scale from 1 (early stage of digital transformation) to 5 (fully digitally transformed), where do you perceive Strategic Procurement to be?	3	3	2	2	1	3	3	3	2	3	2	1	1	2	2	2.2

The overall impression expressed by the respondents was that both the company, and the strategic procurement function itself, were in the middle of the "*digital transformation journey*".

The organisation is "*not really so advanced in really deploying it or using it*" (R01). "*I don't see it, I don't feel it*" opined R05, and then used an analogy to express the current situation: "*whereas other people are having a laptop, we have a (…) typewriter in front of us*". Although there are many applications available, several interviewees pointed out the missing connectivity and restrictions in accessibility (R06, R09, R13, R15). Their frustration is illustrated in the statement "*but for me, there's much more to be done to make it really efficient and useful and not so painful as it is today for the employees to do a better job*" (R09). Another aspect, illuminated in this context, is the sheer number of applications which seems to be too numerous to be fully understood and operated by many function members. R08 and R10 saw the case study organisation being ahead of other companies, with the transformation ongoing, using robotics and AirSupply. AirSupply (see Figure 47 and 48) is "a single supply chain solution for direct procurement shared by the main European aerospace companies within the BoostAeroSpace hub" covering core processes such as forecasting, ordering, invoicing and quality, as well as enabling collaboration between Airbus and its suppliers in a bilateral collaboration (Airbus, 2022e, para.1). AirSupply is not used for strategic procurement activities such as contract negotiations, but supports the submission of purchase orders and collaboration of demand planning, delivery dates and quality performance indicators.

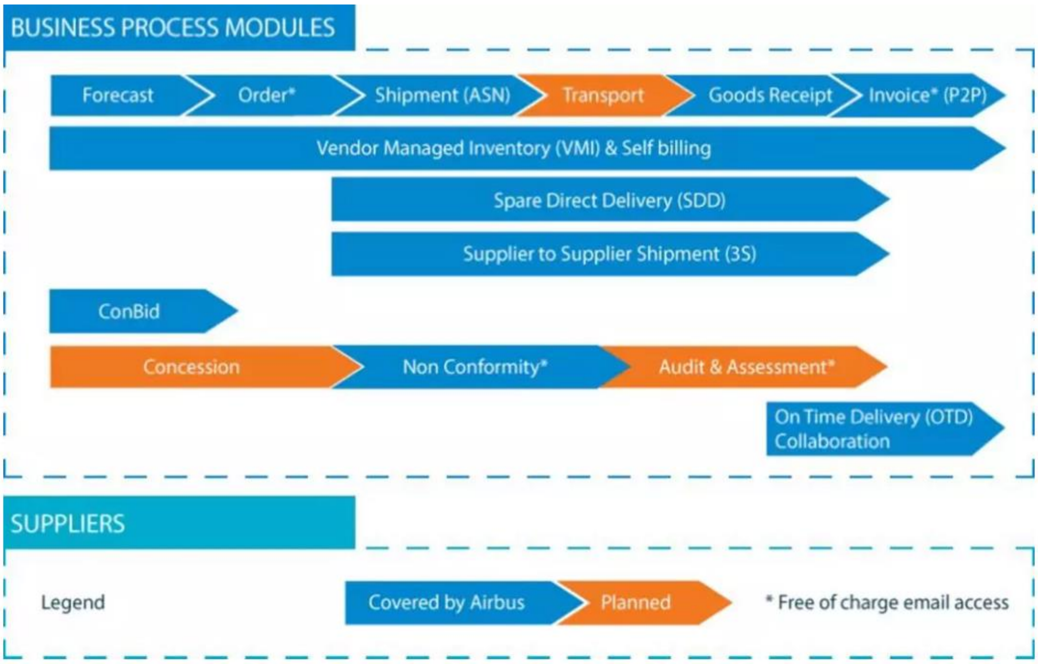
Figure 47

AirSupply platform

Note. From *"AirSupply A collaborative hub for ordering and invoicing management"* (para.2), by Airbus, 2022e (https://www.airbus.com/en/be-an-airbus-supplier/airsupply).

Figure 48

AirSupply platform – Processes covered



Note. From *"AirSupply A collaborative hub for ordering and invoicing management"* (para.6), by Airbus, 2022e (https://www.airbus.com/en/be-an-airbus-supplier/airsupply).

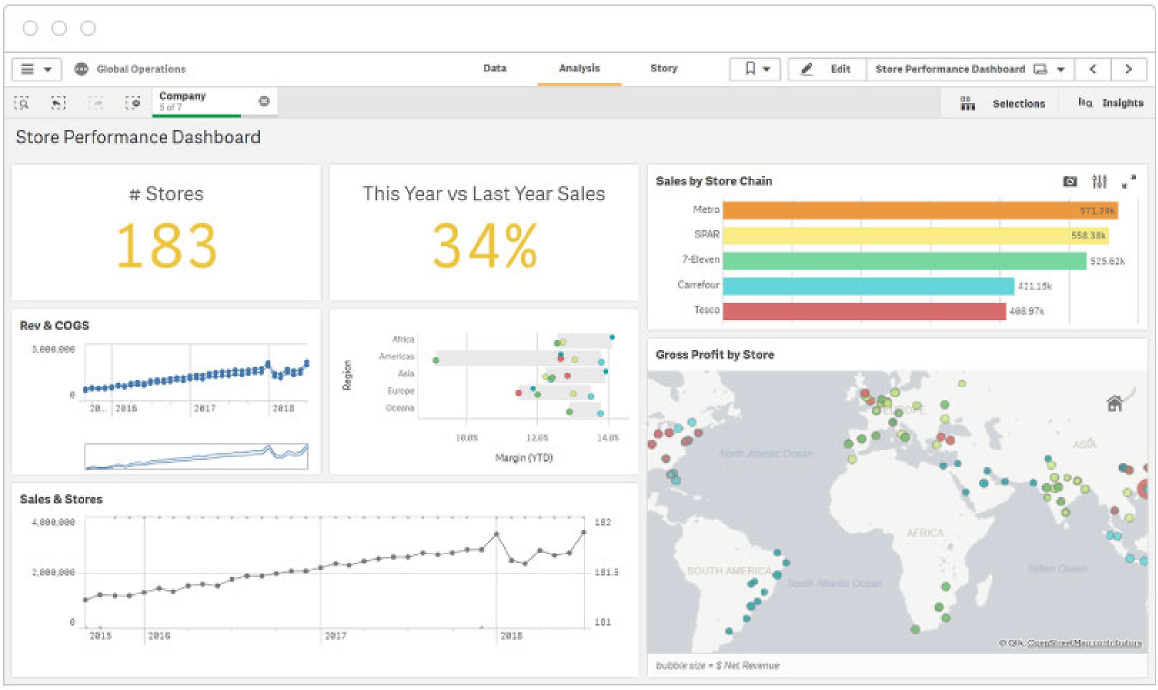
"*In terms of using basically big data analytics, (…) we are well ahead of our suppliers*" (R08). At the same time, it was mentioned that the company could not be viewed as "*a benchmark across various industries. I think there are much more digitally embraced* (i.e., digitally advanced) *companies*" (R08). In addition, R13 commented on the missing management engagement when it comes to implementation and utilisation of digital tools. "*I'm missing the willingness also from our management to implement it. I think, in my day-to-day perception, our procurement management team doesn't care at all about digital tools. Just because it's fashionable and it's in their objectives, they have to do something. But they do not live up to this principle*" (R13). On the other hand, R14 acknowledged the potential and willingness of advancing and applying digital technologies in theory but highlights the practical difficulties of putting this into practice.

The situation in the strategic procurement function is perceived to be similar to the entire company, but at a slightly lower level of digital maturity. Other corporate functions such as Engineering are thought to be a bit ahead when it comes to digital maturity due to greater involvement in DDMS. R02 raised the issue of the ePROC i.e., the technical solution for flying parts procurement to perform calls-for-tender and a data base for contract storage and management) platform which is "a shared, single strategic space for buyers and suppliers across all Airbus entities to perform all aspects of calls-for-tender- from the identification of potential suppliers to the selection of successful parties" (Airbus, 2022f, para.1). Therefore, the exchange with the suppliers is in a digital format, although all loading of data is manual. The preparation of the supplier selection report (used as basis for supplier selection) is also performed manually.

In line with the corporate transformation strategy, strategic procurement focuses mainly on implementing applications to facilitate visualisation of past business transactions, such as Qlik Sense (i.e., a cloud-based, self-service oriented end-to-end platform which offers data visualisation and exploration) (see Figure 49), and a contract data analytics software, Seal (R04) (i.e., software for contract discovery, data extraction, and analytics).

Figure 49

Features of Qlik Sense



Note. From *"Qlik Sense Capabilities-Interactive Dashboards"* (para.8), by QlikTech International AB, 1993-2023 (https://www.qlik.com/us/products/qlik-sense).

Furthermore, the reluctance or even disinterest by the strategic procurement management to engage in the digitalisation process, and by employees to use the applied tools, was observed (R04). A few interview participants (R04, R13) pointed out that newly implemented cloud-based platforms or applications would not support contemporary procurement processes, which every person carrying out related activities is obliged to follow. This results in a situation where either the technology is not properly working or not used because people are frustrated at not being able to take advantage of the technology.

Any kind of data used for activities such as reporting, monitoring or decision making requires manually performed updates and checks due to data quality issues or inconsistencies (R06, R15). As R12 concluded "*it's basically the same reason, master data is very underdeveloped*". Here, it is worth noting Vayghan et al.'s (2007) three data categories: master data (which defines basic characteristics e.g., products or suppliers), transactional data, and historical data. In this thesis, the term *"master data"* relates to key data incorporating master and transactional data as defined by Vayghan et al., 2007). R13 added, "*they are more or less in the Stone Age and strategic procurement is not so easy to digitalise anyway, because it's not a transactional business. But I think we have made several attempts in the past years, but they all failed because there was no more budget or there was a poor tool decision, or there was a decision for a technology solution that in the end did not fit our processe*s".

5.3.2 Value of data and data-driven decision making

A series of questions in the questionnaire touched upon topics around data quality and availability. The intention was to give room for some interpretation of how data is valued in the case study organisation. Overall, data quality seemed to be perceived as relatively poor. R01 commented that "*as long as we have bad data quality in there, the overall quality of data extracted and analysed will suffer*". Most participants felt an inherent mistrust of the data quality throughout the organisation (R01, R02, R07, R15). Disappointment and a state of exhaustion could be noticed when it comes to using data: "*you cannot simply rely on them*" (R01), "*not simply believing what you receive*" (R02), "*as long as it's not 100% robust, people will be doubtful and that as long as they will be doubtful, they will not fully rely on* (i.e., after due consideration are unlikely to trust in the data)" (R10), "*a lot of our time we spend on data-harvesting*" (R12), "*so in the end, despite everything that we do, nobody trusts the system because the data is not good enough*"(R15). Manual cross-checking, updating (including the reminder to update) and processing are necessary to use the data for a given purpose such as management enquiries (R06, R13). R07 reflected "*as regards SA* (i.e., Single Aisle)*, when we do call-for-tenders, what we have is often not fully up-to-date, not accurate. You need to work* (i.e., use) *with workarounds here*". Supplier performance data is predominately manually gathered and then subject to interpretation (R12). It takes a lot of coordination with other functions to understand how the data is produced.

If data is received, a skilled organisation member with extensive experience may detect flaws in the plausibility of the data. R13 was convinced that "*if you don't have the background, if you rely just on what you get from the systems without being able to challenge it, there's a high risk that you get bad data*". Data is not consistent, e.g., allocated to a wrong procurement organisation and harmonised material group (R07). The reason for the generally low level of data quality is rooted in old legacy SAP systems (R01). R08 thought "*the quality of the data we have today in all our digital tools, like especially SAP, is really poor*". Relevant data is not updated (R06) and updates are seen as a burden (R13). "*The master data is very underdeveloped*" (R12). Data, most of the time, derived from past business transactions, is often found to be out of date (R06), e.g., for certain performance reviews the data is 4-6 weeks old. KPIs measure the past, meaning that decisions are made based on outdated and already irrelevant data. Data has not always been considered important. Parts of the procurement master data entries and updates, e.g., complementing missing master data, are performed by selected external service providers.

R12 recognised a lack of harmonisation and integration in the deployment of some technologies, e.g., there is a separate instance of the SAP system for each country. Few respondents regard the level of data quality as good or even adequate (R10). However, R03 stated "*the quality of data is good*" but questioned if the most relevant data was present. The overall data quality perception expressed by the individual participants is summarised in Table 15.

Table 15

Data quality in the case study organisation

		R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	AV
1.	On a scale from 1 (poor) to 5 (advanced), how do you perceive the quality of data to support your decision-making?	3	2	4	2	4	4	2	2	3	3	2.5	2	1	1	1	2.4

The *availability* of data (see Table 16) to make business decisions seems to be only marginally better than the *quality* of data. R01 found that technologies are available in general, but data is often missing in existing systems. One example cited here is the absence of an overview of the supply chain including first, second, and n-tier suppliers and their financial information to evaluate the immediate impact of the Covid-19 pandemic. This had to be created in a manual and time-consuming exercise. Data that is produced internally is available in an abundant manner. Nevertheless, R02 raised the issue of whether relevant data and meaningful KPIs are ready for use. "*So maybe we are overwhelmed by data. We cannot check all of them*" (R02). R06 informed that "*a bit* (i.e., of information) *is missing or just wrong, but then if everything were available, then my role (comment from author: executive assistant to the Head of commodity) wouldn't exist*". R08 viewed the availability of newly deployed data platforms such as Skywise positively. "*We have now copied all the data from our aftermarket SAP system into Skywise*" (R08). The fragmentation of applications and technology, and the technology landscape in general, impedes easy access to the available data (R10, R15).

Knowing the right people within the organisation eases the access to, and availability of, data. R12 pointed out that the information is not available in the application and often needs explanation. In addition, it was suggested that data is often not shared between functions due to confidentiality reasons (R12).

Table 16

Data availability in the case study organisation

		R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	AV
1.	On a scale from 1 (poor) to 5 (advanced), how do you perceive the availability of data to support your decision-making?	3	3	4	3	3	4	3	4	3	3	2	1	2	2	2	2.8

The decision making process at the case study organisation is usually highly centralised within the MFT or other steering committee forums. At the personal level, decision making is often a combination of intuition and data-driven (see Table 17). Expertise and personal experience were found to be as important in providing the basis for making decisions (R01). R08, however, affirmed the value of strong data-driven decision making. "*I try to gather as much information as possible, and if I have perfect data-available, I take it. (…) And I would rather spend a bit more time having a good database and delay the decision*" (R08). The aspiration for data-driven decision making is clearly supported and this exists in part in practice, because decisions need to be backed up by relevant data. However, it is pointed out that there is often "*an element of gut feeling or opinion*" in making decisions (R9). R15 concluded that there is "*a lot of manually digging and manual manipulation of the received data. So, you need to know somebody who knows the system well, who can extract for you the subject and the data, and then the entry it into Excel*".

Table 17

Decision making at personal level

		R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	AV
1.	On a scale from 1 (intuitive) to 5 (data-driven), how do you take decisions?	3	4	3.5	4	3	4	4	5	4	3	3	2	3	3	3	3.4

There are mixed perspectives on how management takes decisions, but this is slightly different to personal decision making (see Table 18). "*It's more intuition than really believing the data you have. (…), there is a lot of socialising, a lot of relationship management all around, and it's not so much driven by data*" (R13). With a lack of availability and trust in the data, a lot remains on the intuitive side. "*That's why I put ourselves* (i.e., the case study organisation) *in the middle and same for management* (i.e., assessing decision making at personal and managerial level on the Likert scale)" (R15). R12 suggested that management needs to take decisions on a factual basis, being data-driven, "*however when data is presented, it gets challenged and challenged again until the data shows the result they want to have*".

Table 18

Decision making at managerial level

		R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	AV
1.	On a scale from 1 (intuitive) to 5 (data-driven), how do perceive management takes decisions?	3	3	3.5	3	4	4	4	5	4	2	3	4	2	3	3	3.4

5.3.3 Section summary

Digital transformation has been a key priority for the case study organisation in recent years. Launching a groupwide digital transformation initiative in 2015 was imperative for the company's ambition of "Preparing for the Future". The creation of a data lake of commercial aircraft in-service data, the introduction of AR and VR devices for employees, the use of IoT and Cobots were referred to as technologies deployed. All employees were connected to the new group-wide intranet platform. The introduction of Skywise, as one of the key cornerstones of digital transformation, underpins the understanding of data as fundamental in the development of digital capabilities. Since 2019, DDMS is portrayed as being the centre of transformational efforts with strategic procurement being a contributor and beneficiary of enhanced aircraft data. At the time of the interviews, the existence and status of a strategic procurement strategy was not visible for most interview partners.

In general, participants shared concerns with regards to data integrity. Data quality was perceived as relatively poor and a widely shared mistrust in existing data was expressed. Frustration was shared about time-consuming activities that need to be invested in data collection, cross-checking, updating and processing before the data could be used for a specified purpose. It takes a lot of coordination with other functions to understand how the data is produced. Thus, the timeliness and relevance of data was a key concern. Data produced internally was perceived as available in an abundant manner and reflecting past business transactions. The significance of the available data was questioned. The state of master data was referred to as clearly underdeveloped. Master data is not accessible by everyone in the organisation due to restricted access rights and confidentiality reasons. Expertise and personal experience were found to be key parameters in the decision making process, both at personal and managerial level, even though backed-up by data. Among strategic procurement members, there is a strong appetite to expand data-driven decision making.

Figure 50

Synopsis of section 5.3 (digital transformation strategy and the value of data)

3 Digital transformation has been a key company priority in recent years. The existence and status of a digital transformation strategy at strategic procurement level is unclear.

4 Data is abundantly available, but data integrity and relevance of accessible data are concerns.

5.4 Application of SPA technology

5.4.1 Types of SPA and integration in the case study organisation

Numerous purpose-specific applications are available in the case study organisation. R06 commented "*there are a lot of tools available and a lot of different solutions*" but both R01 and R06 noted that there is a lack of interconnection and harmonisation between the applications. R01 pointed out "*a typical situation* (i.e., in the case study organisation) *is that it's a bit here and there…* (i.e., there are) *a lot of things already available,* (i.e., that) *are not automatically linked*". When reflecting on the present technology set-up, several respondents, coming from different commodities (R05, R06, R15), reported the utilisation of manually maintained databases, e.g., for annual supplier performance reviews or contract overviews. In one commodity, a central database was required to be updated by members with predefined information, e.g., received or sent claims, value, aircraft programme, components and expected settle date. Usually, these databases are used for management reporting purposes.

At present, DDMS, with strategic procurement as one of the stakeholders, was mentioned as being at the heart of the digital transformation (R02). Respondents (R01, R02) marked the technical focus of the digitalisation programme. One outcome of this initiative, which is of particular relevance to strategic procurement, should be the digitalisation of manufacturing data.

Respondents described their individual experiences and knowledge about the specific applications. Qlik Sense, was known by several interview partners and actively used by some of them (R02, R06, R15). R02 informed that Qlik Sense is used for visualisation of “actual supplier performance, to have an overview of all our suppliers’ capabilities and current capacity at any time”. In addition, a recent transition from SAP Business Warehouse (i.e., application used for price and spend analytics) to Qlik Sense for spend analysis was witnessed. In the past, it was extremely difficult to determine the spend per supplier for a specific product group, e.g., simple aluminium sheet metal. The identification of the supplier is relatively simple, but the allocation to a specific procurement commodity and thus the determination of business volume with a certain supplier for a specific group of products has, to date, been often inaccurate and out-of-date.

When a new part is introduced into the SAP ERP system, a harmonised material group is allocated, based on people’s knowledge and experience, to the part, determining the classification of a material and, thus, it’s belonging to a particular strategic procurement commodity. However, this allocation is often prone to errors. R15 concluded that Qlik Sense is used heavily as a visualisation tool including several interactive dashboards. A few interview partners (R01, R02, R03) mentioned corporate business intelligence, where published information about suppliers, customers, competitors, and the aviation industry as a whole, are received in a consolidated form. P360 was described as an application platform consolidating data from different internal procurement systems, such as SAP and the company-wide sourcing tool ePROC, while also including external web-based data.

The application P360 provides an overview of all procurement E2E activities and enriches it with external data, e.g., for proactive risk management (R01, R04, R05, R06). It enables the creation of individual dashboards (self-service analytics) containing all data of interest, e.g., supplier spend, performance, contractual documentation and external alerts. Drill-down menus allow a high level of granularity up to the part level, e.g., to indicate which suppliers that are managed across various commodities, and still handled in local SAP systems, have delivered a specific part in the past. As for Qlik Sense, most interview partners knew the name of the platform or at least were aware of it, but only a few respondents actively used it. R06 acknowledged that the "*data is somewhere available centrally* (i.e., stored in the NatCo (National Company) ERP system, e.g., SAP PDA for Germany) *where you had in the past to request many different departments or basically PY* (i.e., central department Procurement Governance) *to provide spend reports*". However, R06 mentioned noticeable master data integrity issues and missing simple user manuals. The frustration about unreliable data entries (R07, R13) was shared by other respondents. R13 mentioned that instead of being able report a broad overview for management purposes, the technology should rather support the buyer's day-to-day activities.

Some general reference was made to Skywise (an open data platform developed for the aviation industry), but at the same time, it was pointed out that it was used more often by operational procurement (R04, R06, R07, R08, R15). R11 and R15 were aware that within procurement, the platform was used for the extraction of data for strategic procurement KPI building but not for further data analysis for procurement commodity management. A few respondents reported the use of Google Data Studio (R04, R14) where the application connects data from Google Sheets and visualises data into a picture or report. In one commodity, Google Data Studio was implemented to create an easy-to-understand picture of low performing suppliers that were managed by this specific strategic procurement function, and thereby avoid the manual creation of several Microsoft PowerPoint presentations. R15 summarised today's application of SPA. It "*serves for the creation of dashboards to facilitate* *visualisation and reporting of past transactional data*". Ideally, SPA would be used for forecasting purposes, which is performed on a limited basis via forecast methods built into the SAP system at present.

Figure 51

SPA solutions mapping in the case study organisation

Note. Adapted from *"Mission, Vision and Activities"*, by Airbus, 2023g [Unpublished].

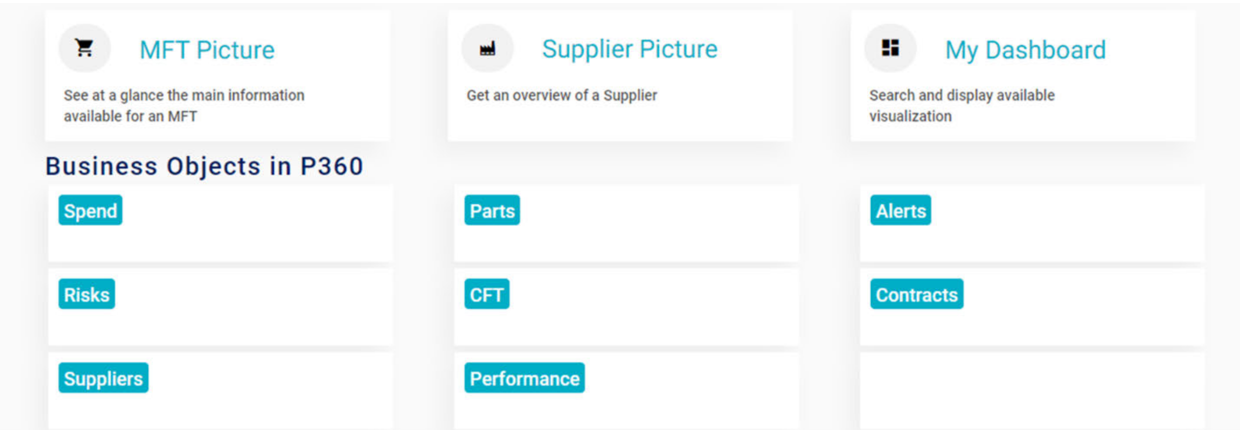
Figure 52

Example GSA dashboard

Note. From *"GSA user guides",* by Airbus, 2023i [Unpublished]. Reprinted with permission.

Figure 53

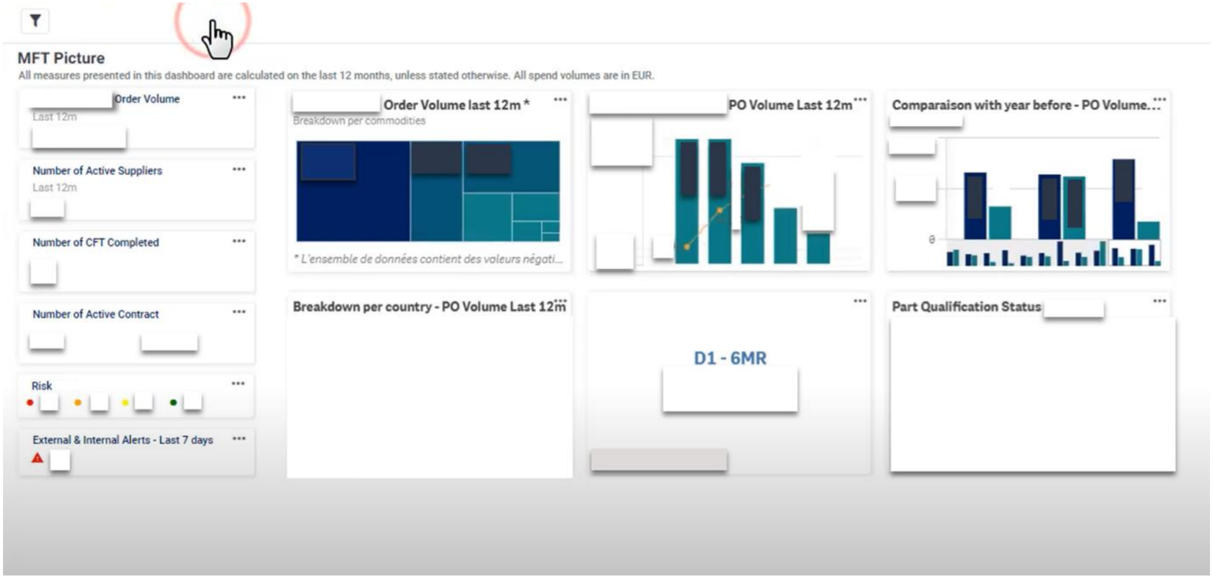
Example P360 dashboard



Note. From *"P360 user guides",* by Airbus, 2023j [Unpublished]. Reprinted with permission.

Figure 54

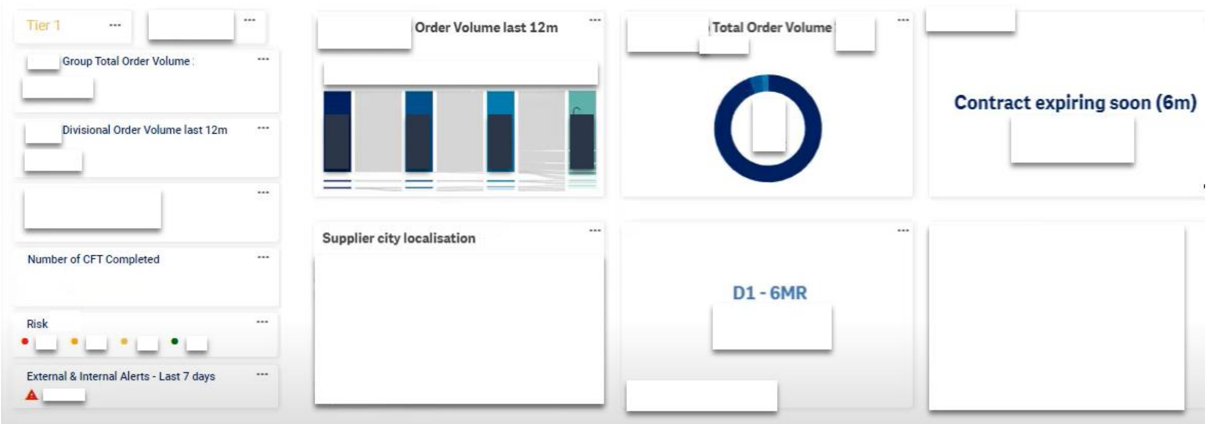
Example P360 MFT picture dashboard



Note. From *"P360 user guides",* by Airbus, 2023j [Unpublished]. Reprinted with permission.

Figure 55

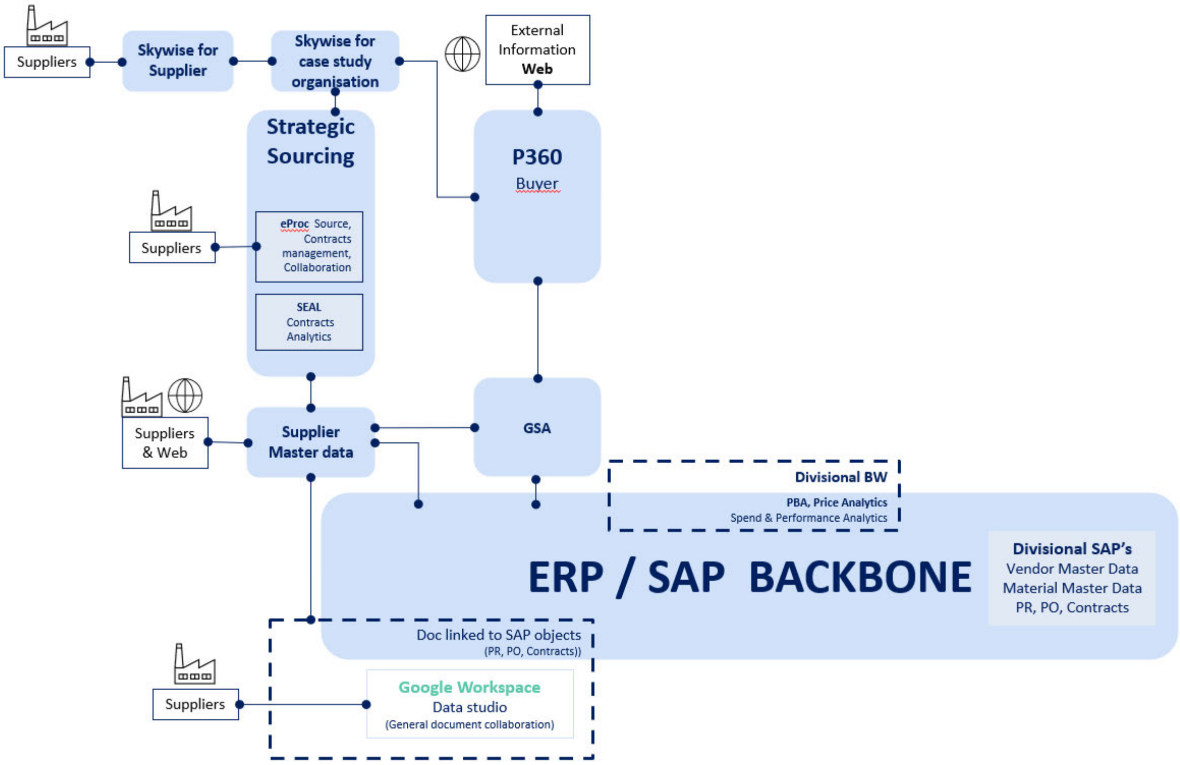
Example P360 supplier picture dashboard



Note. From "P360 user guides", by Airbus, 2023j [Unpublished]. Reprinted with permission.

Figure 56

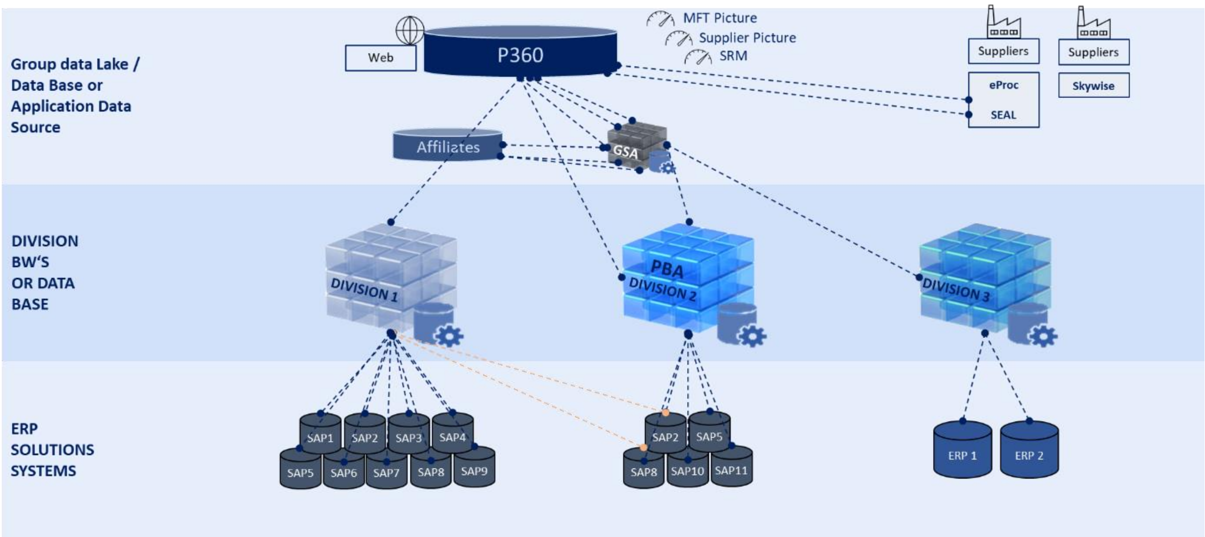
Application landscape for strategic procurement, simplified



Note. Adapted from *"Mission, Vision and Activities",* by Airbus, 2023g [Unpublished]

Figure 57

Data lake and data base landscape, simplified

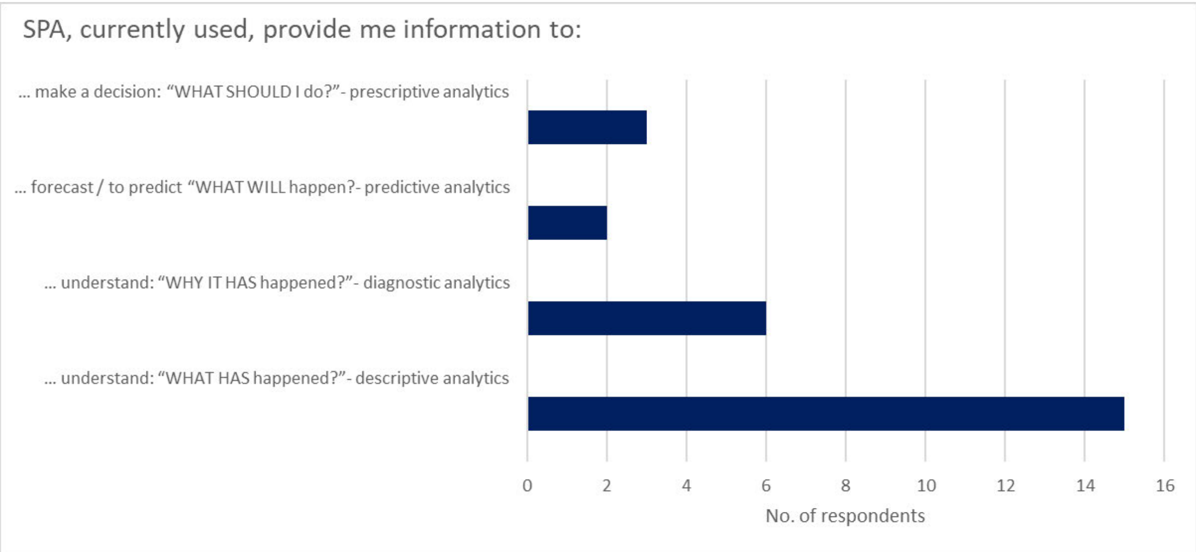


Note. Adapted from *"Mission, Vision and Activities"*, by Airbus, 2023g [Unpublished].

Overall, there was a perception among interview participants that they were aware of the existence of the specific applications and could name the applications, but they could not operate them (R05, R06, R09, R11, R12, R13, R14). "*There are a lot of tools, but I think most of us are not in contact with the tools*" (R06). One respondent mentioned that the introduction of a technology is left to the individual commodity management to decide upon (R15). R01 consistently emphasised that he/she was not aware of a strategic procurement technology strategy. The responses to the question concerning the type of information provided by presently available SPA, revealed different understandings of data analytics applications by the interview participants (see Figure 58). The applications implemented to date are generally of a descriptive character, providing insights on historical data.

Figure 58

Perception on the type of information delivered by contemporarily used SPA



The full potential of advanced data analytics has not yet been exploited. R1 found that good progress has been made applying the Skywise platform, but "*the power of analytics really leveraging information from, for example our suppliers, our supply chain, maybe Engineering, I would say we're not really there yet there*" (R01). R01 envisaged the utilisation of SPA for strategy development by leveraging all available internal and external data, for example, market views or new possible entrants, suppliers, or technologies. Participants evidenced that currently this knowledge is put together manually. Furthermore, the introduction of contract analytics or applications that simulate different negotiation strategies was estimated to be of particular interest (R01). R07 reflected on the positive progress made by deploying Skywise for procurement data, but still sees the case study organisation being on the "*starting blocks*" of digital transformation, and that there is "*a long way to go*" in terms of applying data analytics, such as automating, managing, and accessing contractual and commercial data as well as finding new ways to collaborate with suppliers. However, positive feelings about the future were expressed.

The perception as to whether the existing data analytics applications are well integrated within the technology and process landscape ranges from "*partially*" to "*poorly*" or "*almost zero*" (R02, R04, R05). R02 noticed a partial integration but observed the lack of a systematic approach to allow "*the backflow of this data into the technology, especially technology or process landscape of other functions*" (R02). The respondent criticised the current separation of data storage and extractions and applications for analysis (i.e., there is no end-to-end visibility in one function), suggesting that they might be available in another department. Insights are predominately shared in rather traditional ways such as discussions, emails, and Excel files. The landscape of used applications is neither harmonised nor integrated between functions, e.g., Engineering and strategic procurement. Overall, insights from one function are not considered or do not trigger technological or procedural change in another function. The exchange of information or data depends on experience and people. According to R02, this process works well between the strategic and operational domains of procurement. Potential problematic issues are the complexity, the vast amount of data, and difficulties in technology operation by staff members, even after training. The long lifetime cycle of the product, and thus the requirement to maintain data over a long period of time is a peculiarity of the aviation industry which is identified as another obstacle to establishing proper data integrity. R04 reported that a project involving the replacement of the current sourcing tool ePROC had to be stopped due to the incompatibility of the proposed new tool and existing procurement processes. Furthermore, the view was expressed that the high number of different data pools leads to a lack of clarity regarding where the master data sits and which functions maintains it. The integration of different technologies was poor, and some are not connected, e.g., sourcing tool and SAP ERP systems (R06).

Digital transformation projects such as DDMS or specific technology developments launched by the central function Procurement Governance tend to be integrated in the overall technology and process architecture. However, it seemed that within the strategic procurement organisation team or material group, specific standalone solutions, which were developed by external service providers or internally by the central function Procurement Governance, are not integrated at all (R08). R11 remarked that there is only limited integration, although there is a push for integration from central functions and projects like DDMS, "*but I don't think it's in line with the process* (i.e., way of working between different functions and putting resources and skills in place) *of the company*". It would take substantial effort to fully integrate all technologies. The question on how to integrate other functions and interact with them by putting resources, skills, and capacities in place has not been answered satisfactorily. Participants, who noted that there are no advanced analytics applied yet in the strategic procurement, reflect "*I don't see the landscape* (i.e., the bigger picture with regards to the corporate use of analytics)*. This is the problem*" (R13). An overall network of data bases that adhere to a corporate data model, that everyone can use and exploit, is not in place. "*It's all scattered*" (R13). R15 remarked that SAP ERP systems, as transactional systems, are more or less fully integrated, but in terms of making use of data analytics in strategic procurement, every function gathers and uses its own data. It is not sufficiently shared and there is no end-to-end integration of all process steps.

5.4.2 Advantages of SPA for strategic procurement

Among the participants, there is unambiguous acknowledgement that applying SPA can add value even though variations exist regarding the expected benefits (see Table 19)

Table 19

Ranking of benefits expected from utilisation of SPA

	What benefits can be derived from the utilisation of procurement analytics? Please rank their importance (1-15).	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	AV
1.	Better terms	15	4	1	5	5	-	10	4	9	9	2	11	-	11	7	**7.2**
2.	Reduced supply disruption	2	5	-	-	2	2	9	5	8	8	5	4	-	6	4	**5.0**
3.	Improved supplier performance	14	6	4	-	8	9	3	6	10	2	4	2	-	5	5	**6.0**
4.	Facilitated supplier collaboration	13	8	8	-	11	8	6	8	7	1	14	10	4	8	3	**7.8**
5.	Reduced working capital	10	-*	3	-	1	-	7	7	6	11	12	5	-	7		**5.8**
6.	Reduced transactional activity	3	11	9	11	12	10	2	3	5	12	13	9	2	-	1	**7.4**
7.	Reduced risk	4	7	5	4	4	11	11	1	4	7	6	7	-	2	-	**5.6**
8.	Work on higher value activities	5	9	6	2	10	1	1	9	3	6	10	8	1	3	2	**5.1**
9.	Improved category strategy	11	1	7	3	13	3	-	10	2	5	7	12	-	1	-	**6.3**
10.	Improved purchasing power	1	2	2	1	9	-	4	8	1	4	1	6	-	4	-	**3.6**
11.	Lower prices	12	3	10	8	3	-	8	2	12	3	3	3	-	-	-	**6.1**
12.	Improved visibility on potential suppliers	9	10	-	7	6	6	-	14	14	10	8	13	3	10	6	**8.3**
13.	Improved visibility on technology/innovation trends	8	-	-	6	7	7	-	13	15	13	9	-	-	9	-	**8.7**
14.	Improved adherence to compliance rules	6	-	-	9	14	4	5	11	13	14	15	-	5	-	8	**9.5**
15.	Better contribution to sustainability initiatives	7	-	R01	10	15	5	12	12	11	15	11	1	-	-	-	**9.9**

*- assessed as not relevant

Note. Benefits list is adopted from *"Emerging procurement technology: data analytics and cognitive analytics"*, by Handfield et al., 2019, International Journal of Physical Distribution & Logistics Management, 49(10) (https://doi.org/10.1108/IJPDLM-11-2017-0348).

Perceived benefits were linked to classic objectives, related to cost and quality leadership. The highest ranked benefits of SPA, on average, were "*improved purchasing power*" and "*reduced supply disruption*", which relate to the top procurement objectives of on-time and on-quality delivery performance and their contribution to the company's overall competitiveness. The lowest ranked benefits were "*improved adherence to compliance rules*", which could indicate a sufficient level of governance has already been achieved by rigid processes; and "*better contribution to sustainability initiatives*", probably because sustainability has not yet been fully embraced by the procurement function nor incorporated into the procurement strategy. One respondent (R5) remarked that relevant criteria and KPIs to measure sustainability aspects are not yet defined, and how to map the value of SPA is unclear.

Applications are typically used for strategy preparation, operational supplier management, call-for-tender preparation, and MFT management (R02). R03 reemphasised the limitation of data. It was pointed out that supplier performance is not just driven by data, but also by a strategic decision of the company to take risk. While the data itself identifies the that are not performing, the root cause for such non-performance needs to be explored.

5.4.3 Section summary

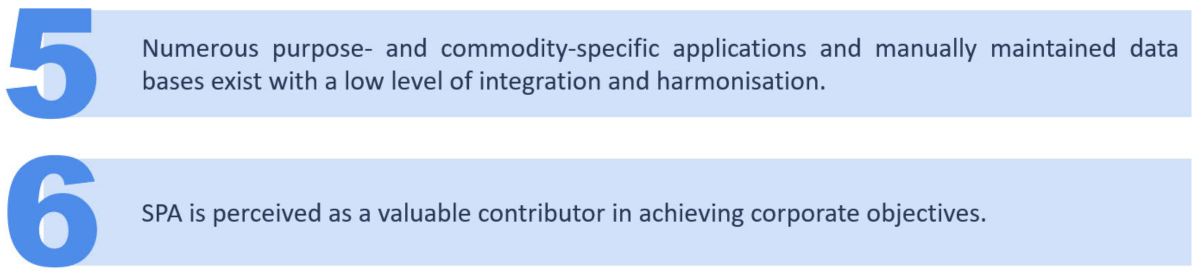
The technology architecture of strategic procurement in the case organisation was characterised by a high number of purpose-specific applications. A lack of interconnection and harmonisation between the applications and the manual creation and maintenance of commodity-centred databases were reported. Predominately, applications, such as Qlik Sense, were used to allow supplier/commodity/material spend analysis and, to some extent, the reporting of KPIs, such as supplier delivery and quality performance. Corporate business intelligence consolidates and distributes, to a pre-determined list of recipients, published information about suppliers, customers, competitors, and the aviation industry.

The corporate data platform Skywise was known but used only in a very limited way by members of strategic procurement. Another data platform, P360, is dedicated to strategic procurement, consolidating data from different internal procurement systems, such as local SAP ERP systems and the sourcing tool ePROC. It also uses external publicly available web-based data, such as news about Mergers and Acquisitions (M&A) of suppliers or eventual hazards in supplier facilities. Hence, P360 aims at providing an overview of all procurement end-to-end activities, e.g., managing contracts, monitoring, and developing suppliers. Overall, currently deployed technologies were used for the creation of interactive and customisable dashboards to facilitate visualisation and reporting of past transactional data. Present SPA was currently not identified to be used for forecasting or simulating purposes, even though firmly advocated.

In general, there was unambiguous acknowledgement that applying SPA can add value to the activities of strategic procurement. The implementation of SPA facilitates the achievement of cost efficiencies and aircraft quality leadership, as well as robustness in the supply chain.

Figure 59

Synopsis of section 5.4 (application of SPA technology)



5.5 Impact on processes

5.5.1 Processes impacted by currently used SPA

Depending on the individual's role and the necessities to fulfil the requirements of this role, the application of SPA is generally seen as beneficial for procurement activities, which are presented in Table 20.

Table 20

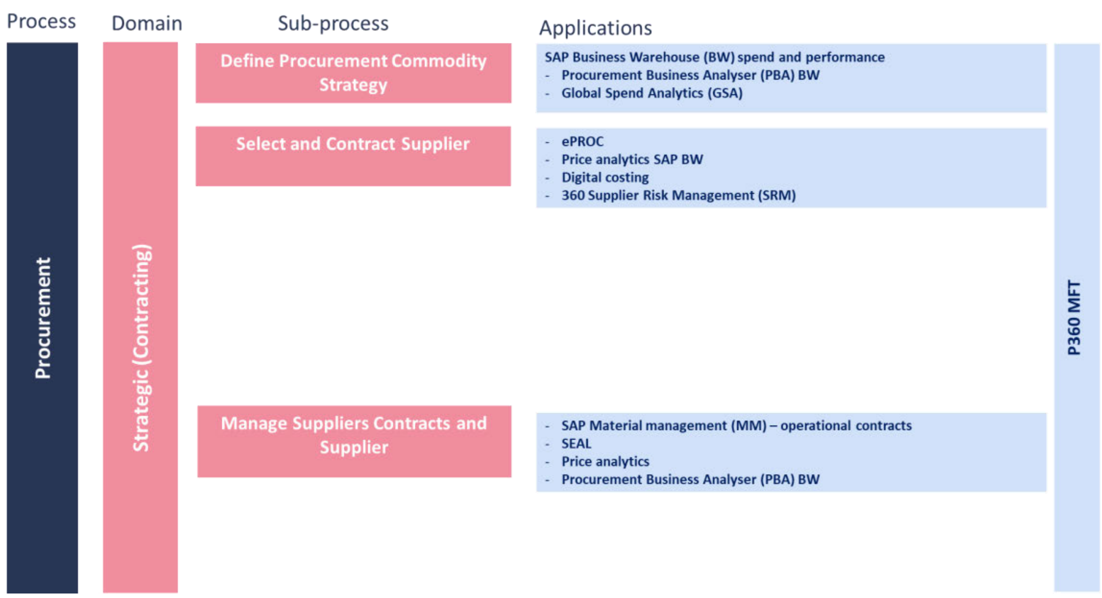
Identification of procurement processes for which SPA is considered most beneficial

	For which of the following activities do you consider the utilisation of procurement analytics most beneficial?	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
1.	Translate corporate strategic goals into commodity targets and criteria	Y	-	-	-	-	-	-	Y	Y	-	Y	-	-	Y	-
2.	Perform Market and Supplier Intelligence and issue the commodity strategy recommendations	Y	Y	Y	Y	Y	-	Y	Y	Y	-	Y	-	Y	-	Y
3.	Perform Call for Tender and Contracting	-	Y	-	-	-	-	Y	-	Y	-	Y	Y	Y	-	-
4.	Select Supplier	-	Y	Y	Y	Y	-	-	-	Y	-	-	-	-	Y	Y
5.	Adhere to Ethics & Compliance rules	-	Y	-	-	-	Y	-	-	Y	-	-	-	-	-	-
6.	Anticipate and Mitigate Risks	-	Y	Y	Y	Y	-	-	Y	Y	-	Y	Y	Y	-	Y
7.	Monitor and manage contract / Monitor supplier performances for all contractual requirements	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8.	Instigate supplier development activities (in cases of non-performance)	-	Y	Y	Y	Y	Y	-	-	Y	Y	Y	-	-	Y	-
9.	Manage claims	-	Y	-	Y	Y	Y	-	-	Y	Y	Y	Y	-	Y	-

At present, available SPA technology is predominately used in procurement activities related to strategy drafting as well as in performing market and supplier intelligence. To a certain extent, call-for-tender preparation and performance is supported by SPA (see Figure 60).

Figure 60

Mapping of SPA technology per sub-process



Note. Adapted from *"Mission, Vision and Activities"*, by Airbus, 2023g [Unpublished].

There is consensus amongst the interview participants that the application of SPA can be beneficial throughout the procurement process, which is currently performed by the strategic procurement function in the case study organisation. The potential benefits include leveraging of internal and external data to support the development of a procurement and respective commodity strategy, which takes into consideration the latest market developments, current and emerging competitors, new entrants, suppliers, and assessment of new technologies. The call-for-tender and selection phase could also be improved by the implementation of analytics. Currently unexplored activities are related to contract and claim management. Contract analytics is seen as valuable when it harmonises the fragmented contract landscape and enables the optimisation of terms and conditions. The deployment of artificial intelligence to enable the application of smart contracting was also highlighted. Analytics-assisted risk management could strengthen the anticipation, rather than the mitigation of risks.

In addition, R01 recommended the support of customs and export control activities by SPA to comply with import and exports laws and regulations, such as delivery of attributes, for example, weight and dimensions or price details. R01 mentioned using block chain technology to allow transparency throughout the entire supply chain in the context of corporate social responsibility (child labour, slavery) and sustainability improvements. At present, the visibility of the supply chain hardly surpasses tier 2 supplier level, which poses a potential risk to the brand, company, and reputation. “While it takes a lifetime to build a good reputation, it takes only a moment to destroy it” (Airbus, 2019a, p.2). R01 strongly envisaged advanced data analytics being implemented in support of achieving sustainability targets. Nevertheless, meaningful targets and KPIs are yet to be formulated and cascaded down through the organisation. (R01, R05). Sustainability criteria may become significant for future supplier selection - for example, assessment of Co_2 emissions during production and transport, and of the form of energy used. Currently, the suppliers are obliged to sign a “Supplier Code of Conduct” and thus confirm adherence to the case study company’s commitment “to conform to all applicable laws, regulations, and ethical business standards and principles, as well as to develop a culture of responsibility, integrity, and sustainability" (Airbus, 2021a, p.1). Today, with the restricted visibility of the entire value chain, there are limited possibilities to check compliance (R02).

Overall, the benefits are not seen to include the complete removal of sub-processes (sometimes called "disintermediation"), or greater flexibility in the process itself, but rather are assumed to be related to increased speed of the procurement process, including decision making, improved efficiencies, and the substantial reduction of manual work. Nevertheless, with accurate and reliable data, there is the potential for automation, or even abolition, of approval loops that are performed at multiple functional and hierarchical levels at present. One respondent, however, voiced an alternative view - that lack of trust in the data would result in even more rigid procurement processes for some time to come, when implementing SPA.

5.5.2 Current and future process change perspectives

To date, respondents have not witnessed any fundamental changes to the core procurement process in general. There was neither a remarkable addition nor an elimination of process steps or activities. Variations exist in perception in relation to the level of change as well as processes that are linked to strategic procurement. Impacts were associated with easier data access and improved visualisation (R01, R11). R04 commented in outline about trials with adjusted contract templates in the context of DDMS and makes the point "*because we have those (..) tools, we had to implement some kind of new processes*" (R04). The same notion was expressed by R08, "*I would say for me, digitalisation usually goes hand in hand with process improvement*". Other participants responded that they had not seen any changes at all in their immediate process environment (R05, R10, R13). R13 concluded that processes have not changed much over the last year. Process adaptations were triggered by business requirements and not by digitalisation. R06 did not necessarily consider change necessary when reflecting on the existing claim process, as an example, where a local data base had been developed to follow up on received and sent claims. "*The process itself doesn't change for a claim for* (i.e., irrespective of) *how you manage claims with the supplier*" (R06).

On the other hand, R07 reported some slight adaptations of activities, following the implementation of SPA, that are performed in the surveillance of supplier's financial health and stability. The introduction of an analytics technology for contract management, Seal was referred to by R14. However, the interviewed strategic procurement members barely used it. Reasons included the overly complex design in accordance with the existing procurement process and the lack of consideration of users' needs. R14 summarised the situation thus: *we are still in that mode where we have our processes in place and we try to work the tools around our processes*".

However, interviewees envisaged more significant future changes, and share the view that processes need to be adapted to exploit the potential benefits of SPA. R01 considered the utilisation of SPA and automation of activities related to export control, involving, for example, the gathering, storage, and retrieval of attributes, e.g., classification numbers. In addition, SPA could be used to improve and accelerate strategy development by early identification of emerging technologies and suppliers, or market intelligence in general (R01, R13). The clear traceability of pricing records and simulation of possible negotiation scenarios was considered another area of potential for the utilisation of SPA (R01, R07). The exploitation of contract analytics technology was expected to deliver massive improvements (R01, R09), for example, in the harmonisation of contracts or work sharing between humans and machines in contract negotiations.

Process adaptations were triggered by business requirements and not by digitalisation. Participants (R01, R03) did not draw the conclusion that the implementation of SPA allows greater flexibility in the procurement process. On the contrary, R12 even thought that processes become more rigid for an uncertain period of time after the deployment of SPA because of the deep distrust in existing data. However, some interviewees pointed to the positive impacts on efficiency, speed, and the development of improved decision making capabilities through improved data access and analysis, e.g., avoid typical time consuming "*data-crunching*" or data validity checking tasks (R01, R02, R04, R05, R13). In the performance of risk management, the focus could shift towards anticipating, rather than mitigating and managing issues. Hopes were expressed that processes are leaner, and less manual work will be needed. R02 claimed "*for me it should be a bit leaner, so there is less manual work to put through for the people running the process and making sure it delivers the right process because they simply can rely on the data provided and it's less time consuming, so definitely more efficient and more effective*". An area of clear potential optimisation is the accuracy and reliability of the bill of materials (BOM) used as a baseline for a call-for-tender and supplier selection. Furthermore, by recognising the nature of parts in the BOM, the bidders list could be generated automatically. At present, the bidders list creation is a highly manual activity and entails various validation loops (R02).

In contrast, R03 advocated the present way of working "*because it gives a high level of protection against wrong decisions and wrong selections*". R06 envisaged the automatic preparation of call-for-tender templates, e.g., contracts, and other questionnaires that need to be completed by the supplier in preparation of the offer. R14 would appreciate enhanced and quicker signature loops and sees potential benefits of the implementation of a new digital signature software. Concluding, the process itself would not change but the highly manual and administrative workload would decrease (R06, R12, R15) and improve data consistency (R07). R08 commented on changes in governance processes and additional processes about data analytics and master data.

It was argued that process change will not be driven by the introduction of SPA. It will, however, be part of such change, "*but probably not designing or influencing the process that much*" (R03). Others (R04) disagreed and stated that "*we have to change or to rethink our processes because otherwise we will not have compliance with our data governance in general*". R13 and R15 opined that SPA could identify deficits in the process, but that, rather than the tool driving the process, the process should drive the tool. Several respondents shared thoughts about accurate and maintained master data, improved data integrity and consistency, and emphasised those aspects as an indispensable prerequisite to capitalise on SPA (R12/R14).

5.5.3 Section summary

Today, SPA applications are principally used to support strategic procurement process activities such as strategy creation and performing market and supplier intelligence as part of the commodity sourcing definition sub-process, as presented in sub sub-section 3.2.2.1. The preparation of call-for-tender packs (as part of supplier selection and contracting, as presented in 3.2.2.2) and supplier performance measurement are assisted by SPA to a limited extent. There was wide consensus that SPA applications are advantageous throughout the strategic procurement process.

Contract analytics and smart contracting were perceived as key areas of interest and beneficial for the future deployment of SPA by harmonising the dispersed contract landscape and optimising group-wide application of terms and conditions in supplier contracts. Anticipation instead of mitigation of risk, and improved issues management, were seen to be achievable by the introduction of analytics-assisted risk management technology. Block chain technology could allow transparency throughout the entire supply chain in the context of corporate social responsibility (child labour, slavery) and sustainability improvement initiatives.

SPA was not considered powerful enough for disintermediation of process steps. No profound changes, neither the elimination nor the addition of process steps to the core procurement process, were reported. Processes were adapted in line with business requirements and not necessarily by digitalisation. Expected future benefits include greater flexibility, enhanced speed in the strategic procurement process including decision making, improved efficiencies, the substantial reduction of manual work and abolishment of validation loops. Processes were defined and technology deployment usually took place around this legacy-process set-up. Substantial future procedural changes, including process reengineering, will be necessary to allow the full exploitation of SPA.

Figure 61

Synopsis of 5.5 (impact on processes)

7 SPA deployment is, at present, predominately associated with improved efficiencies and reduction of manual work, but not with fundamental process change.

8 SPA is beneficial all along the strategic procurement process, but process adaptations are necessary.

5.6 Impact on people

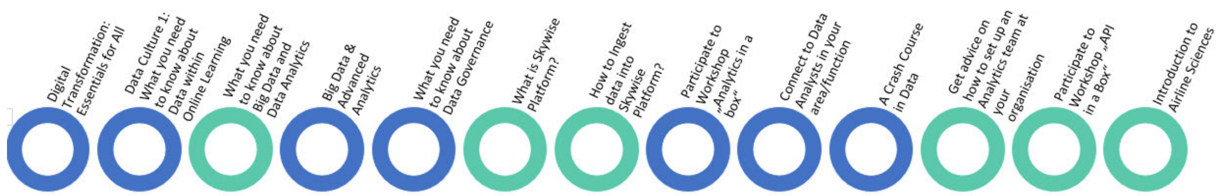
5.6.1 Skills profile

Most respondents felt more or less adequately skilled in operating the SPA tools and technologies currently available in the company and known to the individual. Knowledge and skills assessment range from "*good basic knowledge*" (R01), covering the needs of the job, "*partially*" (R02), "*not at all*" (R05), "*in principle yes*" (R07), or "*adequately prepared*" (R12). R15 considered that basic skills are existent, but demurs "*once you go to a more detailed level, I don't think that people are sufficiently trained*". Some members of strategic procurement reported being overwhelmed by the vast number of applications in which they are required to be skilled (R01, R11). In addition, feelings were shared that a lot is going on, but the totality of tools is neither fully known nor understood. "*I think there is a lot going on where I should skill myself, but for a lot of things I simply don't know them* (i.e., applications)" (R01). R05 reported on the need for familiarisation with the application is difficult to achieve, and thus harms the acceptance of new technology in the first place; *"…this is, at least for me, one of the biggest borders* (i.e., hurdles)*. I feel that everything is just so complex that I would need to invest too much time in order to understand first what they want, what I can gain out of it*". Some interview partners touched upon that fact that the tools could be designed more intuitively and be more user friendly (R05, R07, R09). There are some improvements recognised over the past year, but these are "*still not fully integrated*" (R07). R13 was positive about the general attitude towards using new technology but feels that no procurement analytics technology is deployed in the case study organisation at present.

Beside mandatory training, such as e-learning modules, on-the-job training and frequent use were viewed as key to mastering the technology (R02). R08 commented that "*you need to work with it, otherwise you never get your skills*". Interview partners from a higher management level reported a lower level of skills in operating existing SPA tools due to their role (R03). Various training courses are offered, but they are exclusively in the format of e-learning at present, due to the Covid-19 pandemic.

Figure 62

Exemplary advanced data analytics training offered



Note. The colour coding indicates the target population: blue: managers and key users, green: all employees. Adapted from "*Procurement Digital & Business Capabilities",* Airbus, 2020e [Unpublished].

Among the interview partners, there was wide consensus that employees should have or should acquire analytical skills. R01, R06, R08, and R13 stated that a basic knowledge of data analytics is required, and thus having an understanding where the data is stored, how the data is extracted and processed, and how analytics result can be visualised are clear advantages. In general, an openness to use and to work with data was declared paramount. An understanding of the business and the acknowledgement of the value of data and the potential of SPA was considered worth mentioning (R03). Nevertheless, a detailed understanding of how to build algorithms would not be necessary and should not be part of a buyer's skill profile (R05, R13).

The willingness to use new procurement analytics technology, to develop capabilities to adapt ways of working and to cope with constantly evolving business requirements and applications, were mentioned as key skills. Some respondents (R01, R06) commented on the necessity to be open-minded towards a potential evolution of what is today the traditionally perceived buyer's job profile (R01, R06). R04 underlined the importance of understanding and embedding the concept of TCO in the decision making process. Trust in data (R10) and technology, and thus opposing the statement "*I'm not relying on data, which I didn't calculate myself on the paper*" (R05) were understood as enablers for exploiting the benefits of SPA. R12 did not foresee any adaptations in the skills profile as analytical skills are already part of the present qualification profile. However, with an expected shift from today's high number of still transactional and data gathering activities towards negotiation- and supplier relationship management-related tasks, negotiation, and people management skills will become predominate (R05, R12). A crucial element for a valuable deployment of SPA application was connecting the data and giving it meaning in relation to the core missions of the strategic procurement function, such as the development and execution of a sourcing strategy, supplier or contract management, as well as leadership and communication with direct/indirect reports (R11). The willingness to adhere to the sourcing process, such as the mandatory contract uploading to a sourcing and contract management platform, in particular with regard to the setting of an aircraft manufacturing company, was thought to be a key competence for a member of strategic procurement (R15).

5.6.2 Job profiles

Interview partners expressed mixed feelings about how the implementation of SPA could impact their job profile. For some, there will be little to no change to their role (R02, R03). Others (R01, R05, R06) did not foresee any alterations in core activities of the strategic procurement members; it was rather said that implementing SPA will increase speed, and enhanced efficiencies could be achieved. R01 explained that certain time-consuming activities to gather and check the data, and develop a sophisticated view for any purpose, are assumed to be reduced significantly. "*The more we use procurement analytics, the more we advance the usage of the technology, the more these parts of my job will simply stop*". R05 added that those efficiency gains could also be used for re-prioritisation of topics. R04 was convinced that jobs would change in line with the progress of the overall transformation. Another participant argued that the nature of the products to demand compliance with high quality and safety standards as part of an aircraft do not allow fundamental changes to the buyer role itself, rather this shifts the focus from today's operational tasks to strategic negotiation and supplier management topics (R07). "*So, I think, there could be a shift in terms of activities and how to do things*" (R07). R09 suggested that an upgraded affinity to data visualisation would be necessary, however pointing out that the job profile would remain the same.

Figure 63

Exemplary contemporary job profile

Job Title	**Procurement and Supply Chain Digitalisation Manager**
Responsibilities	▪ Develop, continuously enhance and support the end-to-end applicable process framework, data and associated business information system. ▪ Build a strategic vision and roadmap of methods and tools. Manage the function/area improvement projects being the interface to Information and communications technology (ICT). ▪ Manage the internal and external change process and control information modification. ▪ Provide consistent information through baselines and other status reports (as-required/as-designed/as-built). ▪ Support audits and verification of compliance of design and realised characteristics with contractual and legal requirements. ▪ Support function/area users for ICT equipment and services.
Qualifications	Agile methods project management, IT Supply Chain Management, Business performance and improvement management, Basics in Supply Chain Management, Intrapreneurship Thinking, IT-/ Change management, SAP-SCM, Supply Chain digital capabilities and technology management, Support to management and decision making

Note. Adapted from *"Jobs hub"* by Airbus, 2022g [Unpublished].

The appetite to use and interpret data instead of trying to harvest or dig for it was emphasised (R12, R13). R13 and R15 hoped for a significant shift from today's tedious transactional tasks such as "*placing orders, looking at purchase orders, gathering data to create an amendment in Microsoft Word, which takes ages to be processed, sending around letters to suppliers, propagating data because it's done through people and not through systems*" to a high level of automatization of business transactions. Participants believed that interpreting the data derived from those transactions and drawing conclusions could boost the overall performance of the strategic procurement function, and thus value in the overall organisation (R13, R15).

For members of the strategic procurement management, the aspiration to improve decision making based on "*real*" facts was remarked upon (R08). A change in mindset and trust in both data and technology were referred to as key enablers for handling applications proficiently, and delegating parts of the job to a machine (R10, R14). R12 assumed that the staffing of the buyer role could become open for a wider pool of applicants, because the optimised utilisation of data analytics potentially reduces the need for a technical background or understanding.

For strategic procurement members that already use SPA, R01 reported that the way of working has clearly changed. Much more information could be taken into consideration for decision making, e.g., country specific information for offset activities. In addition, it was stated that using SPA amplified the perspective of what is possible. R02, working for more than 25 years in strategic procurement, reflected on a transition from acquiring knowledge based on experience to data-supported knowledge, also discovering that experience-based knowledge is eventually outdated. Furthermore, it was noted that trust in data and technology has increased and thus the willingness to use SPA has also progressed. Others responded that they had not yet experienced a change in the way of working. One participant lamented the absence of process adaptations (R13). An appetite for using SPA was clearly expressed (R03, R04, R07, R12, R13, R13), while R06 and R14 acknowledged the efficiency gains due to SPA. The exploration of unexpected information and data sources was highlighted (R14). R15 described an evolution from "*Excel manipulation to a more database driven programming of data*" resulting in the possibility to reuse some of this programming, e.g., a developed data visualisation framework in which a generic rule engine was created. Some expressed an increased level of trust in the data compared to previous years as the data integrity improved notably (R02, R10). R09 recognised the fact that less people need to be involved in data gathering activities.

In terms of additional roles in strategic procurement, R03 saw advantages in introducing the role of digital ambassadors. For the respondent, the digital ambassador would be "*someone who is interested and able to work on digital tools or to, let's say, to move in this digital world and make this digital world to his or her comfort zone*", and thus promote the acceptance and foster the application of digital technologies throughout the organisation. R04 elaborated on the idea of having SPA experts, but clearly stated the need to have a deep understanding of the business domain as well. Many respondents (R05, R06, R07, R08, R14) thought that additional digital profiles, such data analyst, or data designer, add value when organised in a permanent central procurement support organisation, or a "*support desk*" (R10, R15), and offer their expertise to the members of the strategic procurement teams. R09 stated that a profile mastering digital systems and applications could be embedded within each strategic procurement team directly. In this case, participants referred to the companywide migration from Microsoft's Office 365 to Google's G Suite in 2021. In every MFT, so called voluntary "Champions" helped users to get familiar with the programme and accompanied the migration of the programme into the various teams.

Some other participants did not foresee any additional roles (R02, R13) or were not sure (R12). In an ideal world, technologies "*would more or less do the job*" (R13) and no support would be needed in the day-to-day operation, but only in the improvement of the application or process. These participants thought that adding specialist roles contradicts the idea of digitalisation (R13).

5.6.3 Coordination between people

The advantageous exploitation of SPA was associated with an end-to-end data availability and one data lake at corporate level (R01). At present, there is a need to have resource-intensive cross-functional discussions around existing data deficiencies and retrieval of part attributes. Master data, such as pricing information per component, needs to be available and accurate for the export of aircraft components to other productions sites, but because of various pricing models or ordering (per assembly), it is not. In such cases, the export is prohibited or delayed until the master data is provided, which in the worst case stops production, and results in substantial penalties to the customer.

One common data lake, or data base, allows access to the same information across the organisation (R01, R06), implying that the MFT as an exemplary forum will focus on what to do with the analysis instead of how to get the information (R12). At present, data is not freely shared with other strategic procurement commodities or other functions such as Finance or Engineering due to confidentiality issues, amongst other reasons. It is expressively forbidden behaviour to distribute data in an uncontrolled manner within the organisation. According to R01, this business practise: not to share data, maintains silos. Transparency and data sharing principles, while respecting security aspects, enable the breakdown of these silos and help facilitate insights from other functions, such as Engineering, to have an impact on the development of a strategic procurement vision. R02 asserted that a shared data platform "*makes life easier as (everyone works) to the same data*". An example of a supplier monitoring platform was cited. Every MFT member had access to the same topical information of how the pandemic impacted the supplier delivering products to a particular strategic procurement department. The traditional approach, prior to the introduction of the supplier monitoring platform, was that the programme organisation asked the procurement MFT leader to initiate a time-consuming data gathering process and assess the supplier's situation. The same approach was used for routine supplier performance reviews (R02). R03 and R04 linked the increased transparency to an enhanced level of cooperation.

While efficiencies could help organisational members to spend less time in coordination meetings with other corporate functions, R05 still recognised the need for personal interaction. R09 and R10 agreed on the fact that less cross-functional communication and interaction will be needed in the future when a commonly accessed data platform exists. R08 elaborated that the data architecture does not mirror the organisational structures, and thus the coordination of people; "*the data (…), it's not following an organisational structure. Data is like a network*" and thus the coordination between members of strategic procurement organisations and other functions ideally evolve into such a network approach. "*More efficient coordination of topics and less dependent on individual alignments*" was expected by R11. R15 mentioned the necessity to enhance the cross MFT coordination as the acquired digital capabilities allow an optimised management of suppliers that have relationships to multiple strategic procurement commodities, e.g., delivering products for aircraft structure and cabin. The first cross-commodity initiative to explore such synergies started recently. The sole focus on KPIs, ignoring soft skills, and the risk of losing the older generation of employees, were pointed out as negative coordination aspects (R14).

5.6.4 Section summary

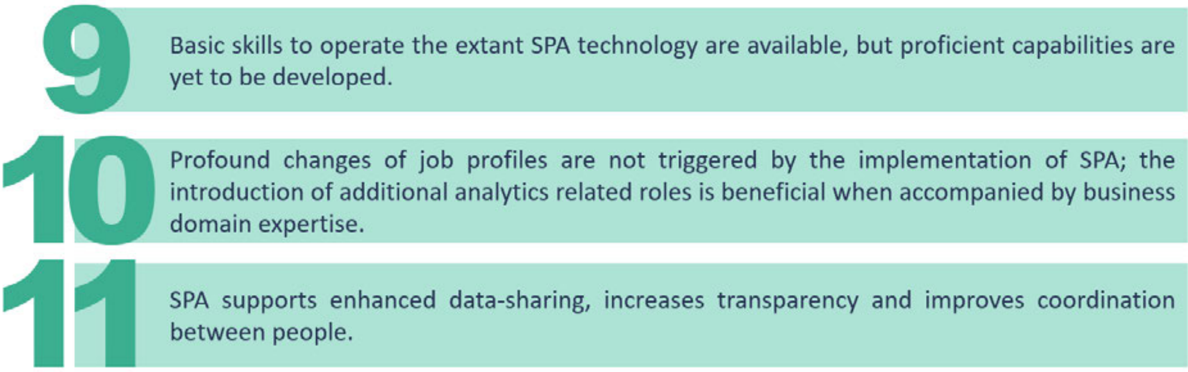
The level of skills attained for the operation of extant SPA technology was perceived as more or less appropriate for the requirements of the current job profiles. Awareness sessions and e-learnings are available and accessible, but on-the-job training and frequent use were considered necessary to develop and maintain digital capabilities.

It was commonly stated that the number of applications, effort and time to get trained overwhelmed members of the strategic procurement community. A full understanding of the analytics applications currently available in the procurement organisation would be difficult to achieve. Overall, the ambition to develop skills to master digital technologies exists. The job portfolio and, respectively, the role of strategic procurement members, was not envisaged to change fundamentally, partly because of the continued requirements for strict process adherence. Hope was expressed that there would be a shift of focus from today's operational tasks to strategic negotiation and supplier management topics. The addition of new roles, such as data analysts, in a central team was viewed as potentially beneficial. It was reaffirmed that an indispensable prerequisite to adding value would be a thorough understanding of the business domain. Aspirations were articulated for mature data-driven decision making. Mindset and trust in data and technology were mentioned as key prerequisites for this evolution.

The implementation of SPA technology was seen to improve coordination between people, but there remains considerable scope for further enhancement. SPA are considered as an enabler that increases transparency and grants easy access for everybody to the same data. At present, data is shared restrictively in the organisation due to confidentiality issues, amongst other reasons. Even though the significance of the continuing interaction between humans was emphasised, there was strong support for the role SPA can play in the enhancement of coordination with other areas of procurement or other functions.

Figure 64

Synopsis of 5.6 (impact on people)



5.7. Impact on structure

5.7.1 SPA impacts on organisational structure

Interview partners expressed diverse views on how and if the utilisation of SPA technology alters organisational structure. R01 sensed that the use of SPA is not in the DNA of strategic procurement at present, and trusting in analytics, could "*break some management hierarchies*", along with a true empowerment of buyers. Hope was expressed that digital transformation would demolish functional silos and spark structural change as well as a departure from the today's prevailing commodity-structure. A number of interviewees (R04, R12, R14) picked up on the idea of empowered or even self-organised teams. Full exploitation of SPA and associated transparency could lead to much more autonomous working. However, respondents felt that those concepts are in the very early stages of development within the strategic procurement function. R04 reflected critically on the experience of being involved in a pilot project, where self-organisation and empowerment were tested. It had to be realised that those existing processes which demand rigid validation did not support such change. In addition, if consent could not be achieved through empowerment, those involved would often fall back into traditional work patterns when the manager was asked for a decision.

R01, R04, and R06 commented that the deployment of SPA applications supports overall digital transformation, but they would ideally be accompanied by organisational change. However, none of the respondents were aware that the implementation of SPA triggered any modifications of organisational structures in the company yet. The general perception was shared that there is no direct correlation between newly introduced SPA technology and organisational change (R09). R04 pointed out the fact that the case study organisation went through an overall transformation due to changes of top management and reorganisation due to resource adaptations. "*There are a lot of influencing factors that need to be taken into accoun*t" such as "*procurement data analytics*" (R04). R05 and R12 concluded that even though there is no immediate impact on the structure of the strategic procurement function, there is the possibility that the number of team members decreases over a mid-term time horizon due to gained efficiencies. In addition, the potential removal of certain management layers could be a consequence (R05, R12). An improvement in structural maturity, by having embedded teams dedicated to procurement strategy including digital transformation initiatives in each procurement commodity (e.g., Aerostructure or Material & Parts) was acknowledged (R06).

Other interview partners did not envisage any organisational change and were not convinced of the expected advantages (R03, R07), even the minor ones (R09). In addition, a couple of respondents believed that despite a company-wide transformation, the present commodity structure is and will be appropriate. R13 highlighted that "*strategic procurement is already pretty lean and pretty flat in terms of hierarchy. I don't think that there's a big impact*".

5.7.2 Optimum organisational structure

While there were no organisational adaptations to date following the introduction of SPA or as an integral part of the corporate digital transformation, respondents shared ideas around an ideal organisational structure. R01 hoped that today's "*my commodity first-thinking*" would stop as "*we are really suffering from thinking too much in commodities*". The importance of cross-functional data sharing and collaboration as essential prerequisites to overcome barriers was stressed (R01, R10, R14). R06, R11, and R13 strongly believed that data, even in consideration of a determined data confidentiality classification, must be available for everyone. Several respondents (R04, R08, R11, R14) advocated the transition to self-organising structures and thus a delegation of decision making to the MFT. Rather than focusing on a particular organisation form, R02 emphasised the requirement for strengthening the E2E accountability of this forum. R08 could not identify the most suitable organisational archetype, but noted there was some sort of neglect with regard to the importance of organisational structure. Nevertheless, the respondent was convinced of the benefits of less focus on hierarchical arrangements, referring to the current predominant mentality and perceptions, as a combination of "*Who is managing what and how many employees*? *As long as you try to organise boxes, you will fail*" (R08). At the same time, the potential advantages of having a base hierarchical framework as reference, "*like a home base*" (R08), was shared. Self-organised structures and autonomous decision making were linked to an increased level of flexibility (R08) and a reduced number of management levels (R12). R12 believed self-organised teams, which are appropriately equipped with all relevant and, above all, reliable data, could make independent decisions, except for matters of a highly strategic nature, and therefore only a very flat hierarchy would be required.

A couple of respondents (R06, R08) envisaged an organisation built on a purpose-driven network, e.g., agile procurement teams for the performance of strategic call-for-tenders or recovery "missions" to improve supplier performance (on-time, quality). Once a network had achieved its purpose, it would be dismantled, and nodes would be re-shuffled to serve a different mission. This type of organisation was aligned with the understanding of data like a network. "*Data is like a network, you know, when you connect the dots where you need them. And I think this reflects how future organisations will be built*" (R08).

When asked for an assessment of the development of strategic procurement as a function during the next decade, the majority of respondents envisaged a powerful and truly digital procurement (see Table 21). None of the interviewed persons envisaged a less important role of strategic procurement or even the complete dissolvement of the function.

Table 21

New value proposition by digital procurement

Where do you see Strategic Procurement in the overall organisation in 10 years from now?		R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15
1.	New value proposition because of evaluation to a truly Digital Procurement, supported by Artificial Intelligence	Y	Y	-	Y	Y	Y	Y	Y	Y	Y	Y	-	-	Y	Y
2.	No change compared to today's position	-	-	Y	-	-	-	-	-	-	-	-	Y	Y	-	-
3.	Less important than today	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.	Dissolved because of technological advancement and integrated into business	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

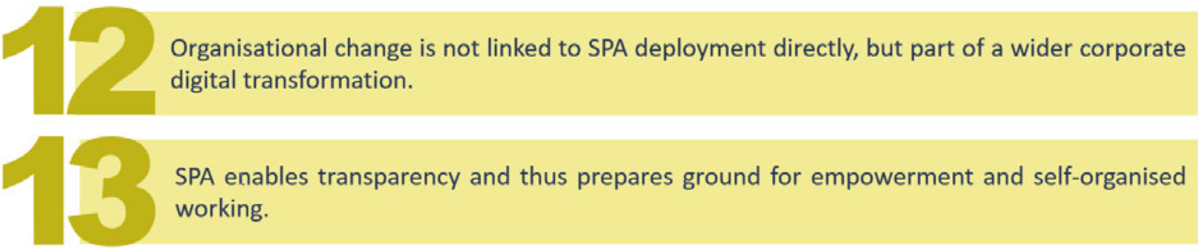
5.7.3 Section summary

The implementation of SPA did not trigger modifications to organisational structures in the company. Ideally, SPA technology implementation is part of a wider corporate digital transformation that is accompanied by organisational change. A true digital procurement function includes the flattening of management hierarchies and facilitating agility. Ideas involving parts of the strategic procurement function as a purpose-driven network were shared. On the other hand, the present commodity structure was considered apt by others. The integration of teams that manage digital transformation projects - at present centralised - into the commodity structure was perceived as beneficial.

Furthermore, full exploitation of SPA and associated transparency would result in an enhanced level of autonomous working. In general, concepts such as empowerment and self-organising teams were perceived to be in the very early stages of development. It was found that existing processes that demand rigid validation do not support such change. The acceptance and enforcement of the MFT as the main decision making body was seen as the first step to progress the empowerment of employees. Strategic procurement will attain a new value proposition within the company over the next decade based on its development into a mature digital function.

Figure 65

Synopsis of 5.7 (impact on structure)



5.8 Chapter summary

This chapter presents the findings and analysis of 15 in-depth interviews conducted with members of strategic procurement. Besides the achievement of what are considered classic procurement objectives, such as on-time, on-cost and on-quality performance, contemporary strategic procurement incorporates objectives centred around contribution to promoting research and technology development activities by suppliers, coined as “innovation sourcing” and a TCO-focus throughout the business relationship lifecycle with a supplier. In the case study organisation, the strategic procurement function is understood to be a key contributor to overall company success.

A group-wide digital transformation initiative was launched in 2015 and has remained one of the top company objectives since then, but with a consolidation of focus in 2019. Since then, the corporate digital transformation strategy has centred around digital design, manufacture, and operation of aerospace products, which is generally referred to as the

DDMS programme. Strategic procurement benefits from this technical-focused programme through the availability of enhanced data quality for technical data, e.g., bill of materials and drawings used in call-for tenders. The group-wide deployment of Skywise as a data platform for collection and applied analytics throughout the aircraft lifecycle in 2017 marked a milestone in the understanding of the value of data for the entire company.

The impact of an unpredictable event such the Covid-19 pandemic, starting in Q1 2020, reinforced the necessity to accelerate digital change; “the need to become more efficient has become vital. The combination of this need with the emergence of digital technology…are, for me, the triggers for this generalized digital transformation” (Polek, 2021, para.7). The case study organisation as a whole and the strategic procurement as a unit of analysis are perceived to be progressing in their ambition to digitally transform, but are still in an early stage of digital transformation. A formalised strategy dedicated to the digitalisation of strategic procurement was not identified.

In general, data is available and is sometimes perceived as overwhelming. However, issues were highlighted with regards to relevance and meaningfulness of the extant data. Overall, data integrity was perceived as poor and a transition of mindset to consider data an asset has seemingly just started in the domain of strategic procurement. This is despite the deployment of the Skywise platform in 2017, and the overall recognition of the value of data at corporate level, as stated in the company annual report: “unlocking the potential of data will do nothing short of revolutionise the aerospace industry” and “in the digital age, data is the fuel that powers thriving businesses” (Airbus 2018a, p.6). Data used for reporting, monitoring, or decision making requires consultation of different sources (systems and stakeholders) to retrieve it, followed by manual checks, updates, and/or cleansing before being able to use it for the desired purpose. This results in an inherent lack of trust in the data quality which consequently influences the way data is used e.g., in decision making and perceived reliability of decisions.

A variety of applications that support a specific purpose exist in the strategic procurement function. Applications such as P360 focus on the consolidation of data from different sources including internal and web-based publicly available external data. Qlik Sense visualises past business transactions in the form of self-service oriented interactive customisable dashboards. Spend analysis, supplier performance monitoring, and risk management are typical areas of utilisation. Newly implemented technology are cloud-based platforms. To some extent the numerous applications overpower the members of the strategic procurement even though training is available. Business intelligence technology was mentioned for the collection of market data, be it competitor or supplier related information, providing market intelligence at corporate level.

In the case study organisation, examples exist where technology deployed or planned for deployment do not support existing procurement processes to which adherence is compulsory. For some applications, access rights are limited to a determined pool of users. These circumstances result in technology being perceived as not working properly and not supporting the need of the targeted user population. A low level of acceptance among users and a biased reluctance to apply new tools are the consequential behaviour. The individual technologies often exist in isolation, e.g., at commodity-level, with a lack of harmonisation and integration in the overall organisation's technology and process architecture, even though integration is a declared priority by central functions, such as Procurement Governance (see Figure 34 in chapter 4), demonstrated by data-aggregating applications such as P360.

Furthermore, commodity-specific applications, in the form of manually maintained databases are used to satisfy reporting requests by the management. Data collection often depends on establishing contact to knowledgeable stakeholders from within strategic procurement or in other functions and manual retrieval. Data processing usually involves manual manipulation of spreadsheet applications. Strategic procurement members have knowledge of additional applications deployed at corporate or procurement domain level, such as Skywise, but rarely use it, or not at all. Collaboration platforms exist such as ePROC, that allow the exchange and collaboration with the supplier in a call-for-tender, but with manual data up- and downloads of documents, e.g., contract templates.

SPA is viewed as unambiguously beneficial by the strategic procurement members. There are aspirations to fully capitalise the value of data and data analytics and use SPA for forecasting and simulation purposes. However, the full power of SPA technology is yet to be unleashed. Overall, the present utilisation of SPA focuses on the visualisation and "dashboarding" of past transactions and contract analytics to a very limited extent. SPA is assessed advantageous throughout the procurement process. The potential area of application ranges from leveraging internal and external data for strategy development, call-for-tender, contract and claim management, risk management and early technology and supplier trend recognition. Almost unexplored, but presumed beneficial, is the field of smart contracting, SPA-augmented negotiations, and application of SPA technology that allow E2E transparency throughout the entire supply chain involving suppliers that deliver directly to the case study organisation, but also at multiple sub-tier levels.

To date, the introduction of SPA has not yet produced any fundamental procedural change in the case study organisation, in either an addition to, or an elimination of, process steps or activities. A direct correlation between the deployment of SPA technology and the evolution of legacy processes could not be determined. Overall, the benefits are not seen to include the complete removal of sub-processes (sometimes called "disintermediation"), or greater flexibility in the process itself. The impacts of SPA on processes are assumed to relate to enhanced speed of performing the procurement process including decision making, improved efficiencies, and substantially less manual work in data collection and processing. It was foreseen that increased automation and SPA potentially lift some of the heavy validation processes that are performed at multiple functional and hierarchical levels at present. In addition, SPA could support the identification of process deficits. A successful implementation of SPA is closely linked to process change but is not seen as influential enough to cause it.

Process adaptations in the case study organisation resulted from business requirements and not of digitalisation.

Strategic procurement members feel more or less adequately skilled to operate currently available SPA technology. Training courses in the form of e-learnings are existent and accessible by all users. The high number of applications implemented for specific and occasionally performed activities in the procurement processes and the requirement to be familiar with them at any time, overwhelms strategic procurement members and leads to notable demotivation. In addition, a full understanding of all analytics applications seems difficult to achieve. In general, strategic procurement members are open to the use of SPA technology, but demand user-friendly design, conditions for an intuitive usage, and applications centred around the needs of the targeted audience. Broad consensus exists in the understanding that basic analytics skills, limited to an understanding of data extraction, processing and visualisation, should be part of the job profile for any strategic procurement role. Hitherto, using SPA has not had impacts on the job profile itself and is not expected to produce fundamental changes. SPA is attributed to potentially stopping highly transactional and data gathering activities and to allow re-prioritisation of strategic procurement objectives. Benefits already in evidence of using SPA are the inclusion of more information from different data sources in the decision process and building capabilities and confidence to make well-informed decisions. When using SPA, a transition from experience- to data-based knowledge was witnessed. It was noted that certain roles could be become more open for a broader base of potential recruits as SPA potentially reduces the need for a technical background.

A strong appetite to use data analytics and consequently achieve a data-driven procurement management exists in the case study organisation. However, trust in the data and technology must be established as indispensable prerequisites. The addition of new roles, such as data analysts, in a central team was viewed as potentially beneficial. It was reaffirmed that a clear necessity for adding value would be a thorough understanding of the business domain. Only then was bringing in such analytics experts perceived positively. Roles like so-called “digital ambassadors” or “digital champions” within the organisation support the implementation and foster acceptance of new technologies. The introduction of SPA and a commonly available and accessible database was seen to improve coordination between people, but, to date, there is still considerable scope for further enhancement. Resource-intensive MFT exchanges still play a vital role in the case study organisation. At present, data is not freely shared between strategic procurement functions or other corporate functions. SPA is considered an enabler that increases transparency by granting easy access to the same data for everybody. Even though the significance of the continuing interaction between humans was emphasised, there was strong support for the role SPA can play in the demolition of functional silos, both within the procurement function and the organisation as a whole.

The implementation of SPA has not yet triggered modifications of organisational structures in the company. Digital procurement is assumed to flatten management hierarchies, facilitating agility and an optimised structure. For example, agile procurement teams could be solely dedicated to performing big call-for-tenders. Alternative organisational structures include purpose-driven networks, meaning an architecture built less around “boxes”. Once a network had achieved its purpose, it would disintegrate, and nodes would be re-shuffled to serve a different mission. On the other hand, the present strategic procurement structure, built around commodities, was seen as appropriate, but the currently centralised functions, which manage digitalisation initiatives, should be integrated in, or added to, the commodity structure, supporting it in a decentralised manner. It was also pointed out that overall, the transition into a digital procurement function is corroborated by, but not attributed exclusively to, the utilisation of SPA.

Reliability of data was seen to be linked to empowerment. Full exploitation of SPA and associated transparency would lead to much more autonomous working. In general, however, concepts such as empowerment and self-organising structures are in the very early stages of development within the strategic procurement function. Pilot projects demonstrated continued incompatibility with existing processes that demand rigid adherence and managerial validation.

Utilisation of SPA could boost the overall performance of the strategic procurement function and generate value and thus contribute to corporate performance. Among respondents, two-thirds expect to see the strategic procurement function evolving into a truly digital procurement operation during the current decade.

Figure 66 consolidates the research findings derived from the interviews. The colours represent different aspects investigated within the overall deployment of SPA. While the taupe-coloured blocks (1-4) summarise general aspects around the objectives of strategic procurement, the status of digital transformation and data integrity, the other colour codes (blocks 5-13) refer to the four change dimensions of the PCF.

Figure 66

Synopsis of chapter 5

This enhancement of the PCF and its change dimensions provides the basis for the development of the maturity model in chapter 6.

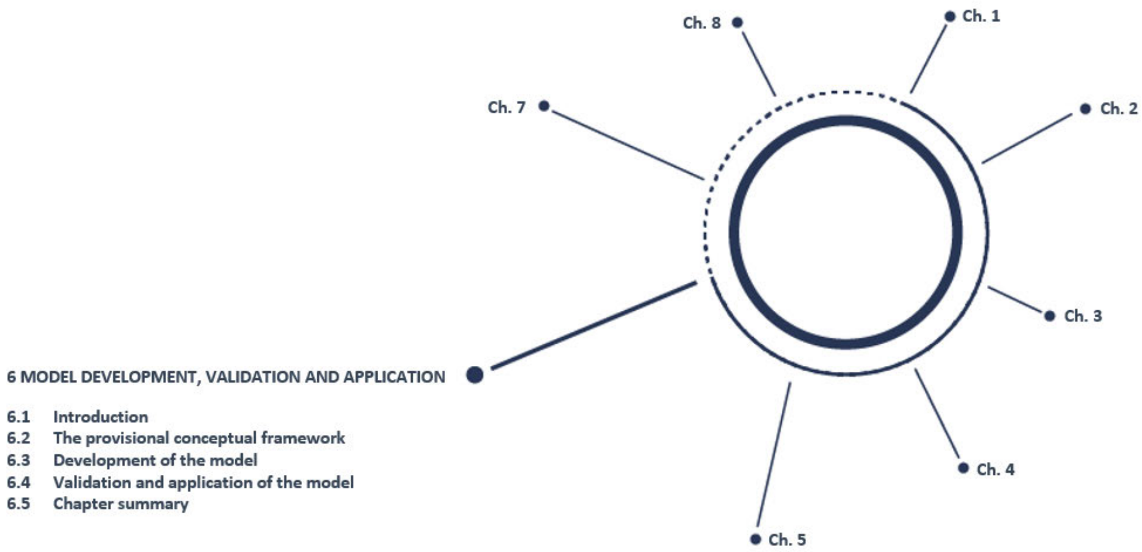
CHAPTER 6: MODEL DEVELOPMENT, VALIDATION AND APPLICATION

6.1 Introduction

In chapter 5 the findings from the in-depth interviews, concerning the change dimensions embodied in the PCF, were reported and analysed. Chapter 6 (see Figure 67) now details the development of the PCF set out in chapter 3, into a maturity model, by introducing and specifying maturity stages. In this chapter, the model as a whole is validated and applied.

Figure 67

Structure of chapter 6 in context of the thesis



The chapter is divided into five sections. Following this introduction, section 6.2 reflects on how the PCF was further developed for the assessment of the status of digital maturity of the strategic procurement function, based on the findings from in-depth interviews. Section 6.3 builds on the literature review in chapter 2, the findings in chapter 5, and section 2 of this chapter, to present and explain the outline maturity model. Key characteristics of each change dimension and the maturity stages in the model are detailed. Section 6.4 provides the results from an online survey which validates and confirms the applicability of the model. Conclusions from this chapter are drawn in section 6.5.

6.2 The provisional conceptual framework

A PCF for the digital maturity model for the deployment of advanced analytics was developed in chapter 3 (see Figure 27) based on the concepts found in the extant literature, outlined in chapter 2. It was applied in the strategic procurement function of an aircraft manufacturer. This PCF embodies four change dimensions - technology, process, people and structure. It reflects the importance of digital transformation as a complex and multi-dimensional phenomenon and underlines the need for an integrative approach at the same time.

In the interview process, each of the respondents was presented with the PCF, and asked to indicate the current maturity level for each change dimension in strategic procurement, according to his/her personal perception. In the PCF, the concentric circles (from the centre to the outside) represent the levels of digital maturity, to which are assigned numerical values 1 (low) to 4 (high) as perceived by the 15 interviewees, with the positions furthest from the centre indicating greater maturity of the change dimension. This understanding was shared with the respondents before asking them to identify the present digital maturity of each change dimension in the strategic procurement function (see Figure 68). The PCF was used also to a certain extent to verify opinions and perceptions expressed in the interviews and present them in a visual synopsis.

Figure 68

Individually perceived digital maturity per change dimension

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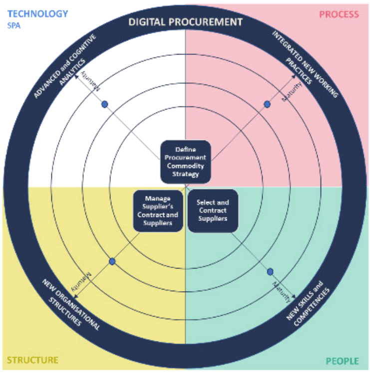
<td>
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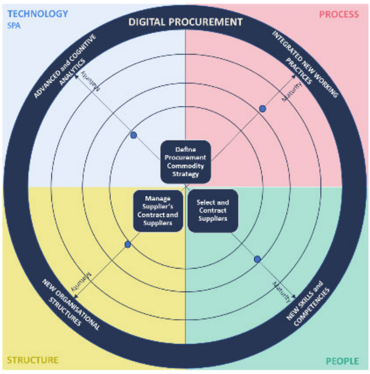
<td>
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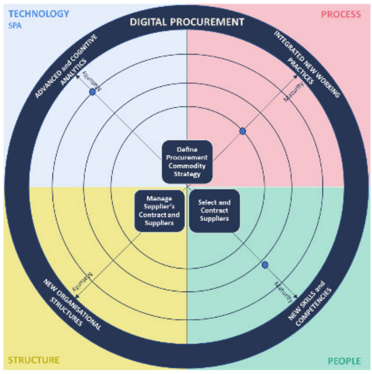
<td>
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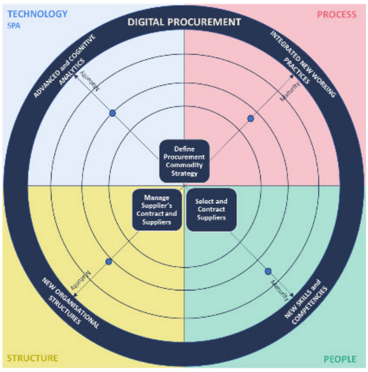
<td>
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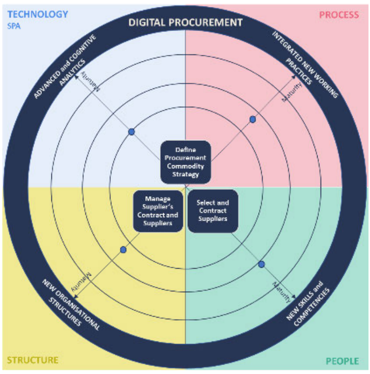
<td>
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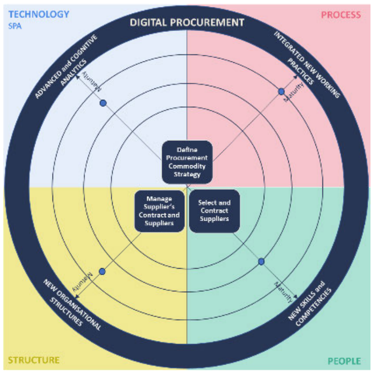
<td>
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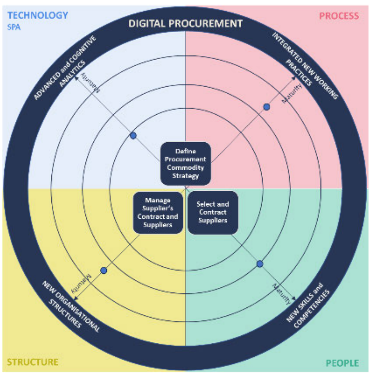
<td>
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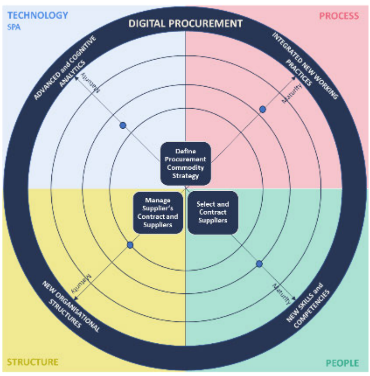
<td>
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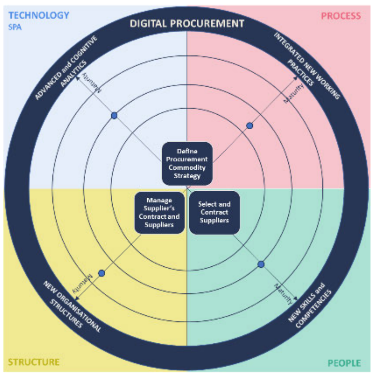
<td>
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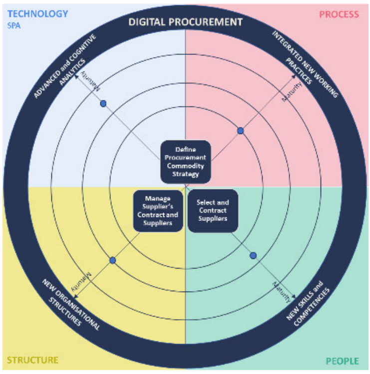
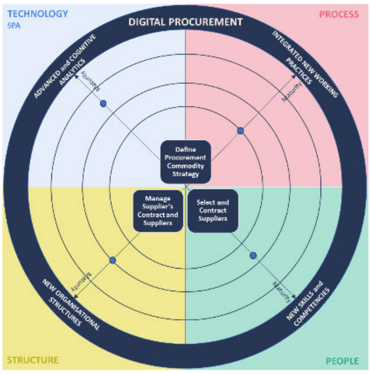


R10



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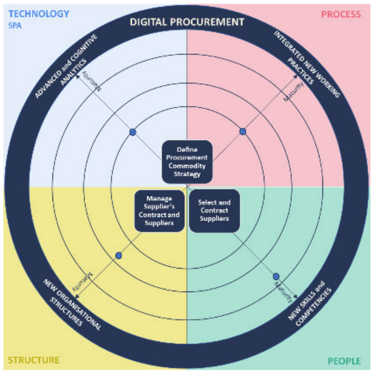

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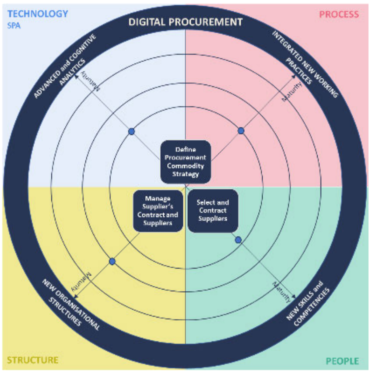
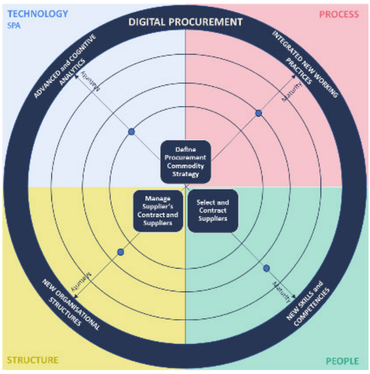
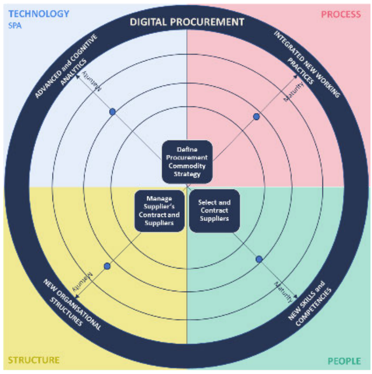


R13



R14



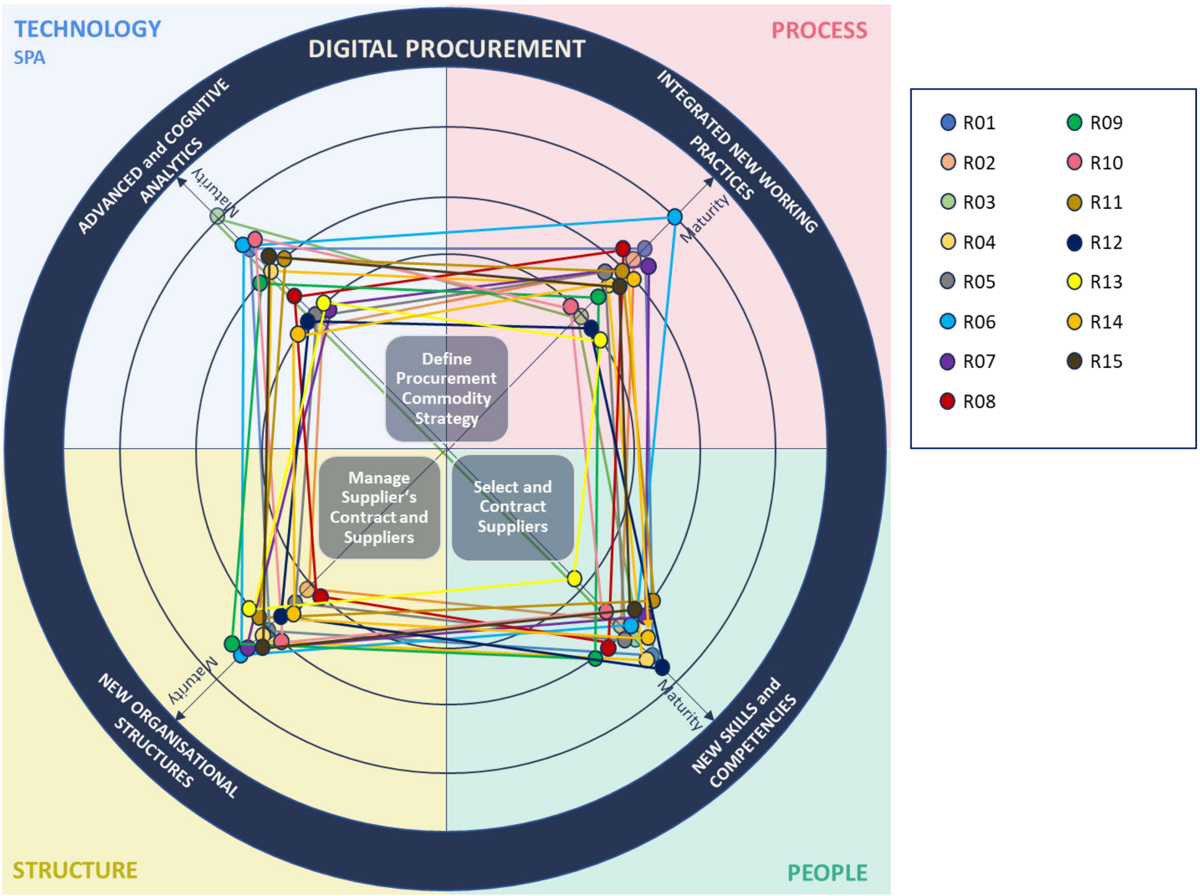
R15

The assessment by the respondents varies the most for the technology and process change dimensions. While one respondent (R03) considers the technology dimension relatively mature in the organisation, some (R05/ R12/R13/R14) perceive it to be in an early stage of maturity. R06 sees process maturity as being relatively high, whereas others discern it a lot less developed. The assessment of the people dimension is more homogeneous and balanced between respondents except one rating (R13). The structure dimension displays the lowest level of diversified perceptions.

It is noticeable that, except for the responses from R03 and R12, the maturity rating of the individual change dimensions per respondent is coherent. At individual level, there are no wide gaps between the dimensions, meaning that there are individual dimensions which are perceived to be digitally mature, while others are not significantly lagging behind. It underlines the understanding of digitalisation as a multi-dimensional phenomenon with the change dimensions being interlinked. Furthermore, it presents a consistent presentation of the overall maturity of the strategic procurement as an organisation. While the people dimension seems to be slightly more advanced, the maturity level in the technology, process and structure change dimensions are positioned on average inside the second ring, indicating a lower level of perceived digital maturity. The consolidation of individual ratings by the respondents provides an illustrative synthesis of opinions expressed during the in-depth interviews (see Figure 69).

Figure 69

Consolidated summary of perceived digital maturity per change dimension



In the PCF, four concentric circles represented the stages of maturity (1-4). Converting the graphical positioning of the individually perceived maturity per change dimension, shared by each of the respondents during the interview and presented in Figure 68, into numerical values (see Table 22), an average value indicating the current level of digital maturity per change dimension, and overall, of strategic procurement was determined.

Overall, the strategic procurement function in the case study organisation was perceived by interview participants to be in the early stages of development (2) of digital maturity.

Table 22

Results of perceived maturity per change dimension by the interview partners

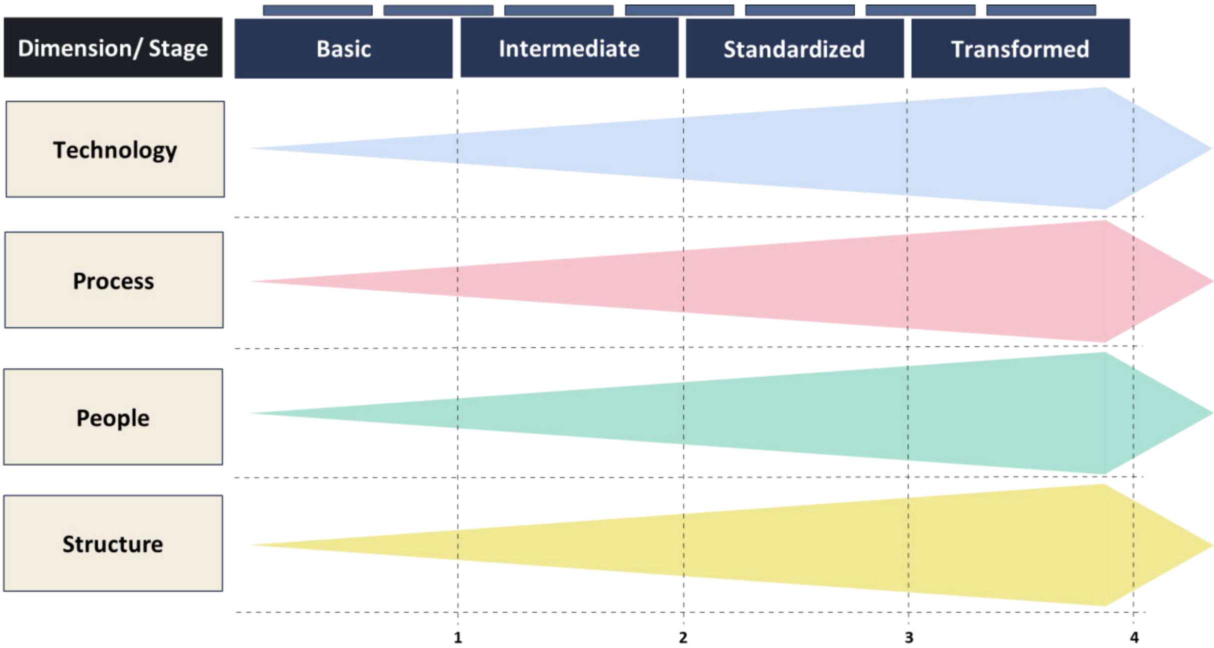
	R01	R02	R03	R04	R05	R06	R07	R08	R09	R10	R11	R12	R13	R14	R15	AV	max	min	range
Technology	2.4	0.9	3.0	2.0	1.0	2.5	1.9	1.5	2.0	2.5	2.0	1.0	1.0	1.0	2.1	1.79	3.0	0.9	2.1
Process	2.4	2.2	1.0	1.7	1.8	3.0	2.4	2.3	1.4	1.0	2.0	1.0	1.0	2.0	1.8	1.80	3.0	1.0	2.0
People	2.5	1.9	2.2	2.5	2.1	2.0	2.0	2.0	2.0	1.7	2.0	2.7	0.8	2.3	1.9	2.04	2.7	0.8	1.9
Structure	2.0	1.1	n/a	2.1	1.4	2.5	2.4	1.0	2.5	2.0	2.0	1.7	2.0	1.5	2.3	1.89	2.5	1.0	1.5

6.3 Development of the model

The development of the maturity model based on the respondent's opinions allows the assessment of the current digital maturity status-quo of the strategic procurement in the case study organisation. To advance the framework and identify key characteristics of different digital maturity levels in the course of deploying advanced analytics in the strategic procurement function, the model was enriched by determining maturity stages (x-axis). In accordance with Berghaus and Back (2016), the maturity stages reflect the evolutionary path towards maturity. Following this principle, four maturity stages have been identified, namely basic, intermediate, standardised and transformed (see Figure 70).

Figure 70

Framework for the deployment of SPA in strategic procurement incorporating change dimensions and maturity stages



Building upon some of the concepts identified in the literature review, the analysis of interview responses and the author's reasoning, key characteristics for each maturity stage per change dimension are specified in the following paragraphs.

6.3.1 Technology

Basic stage: SPA utilisation is limited to applications that respond to the question "What has happened"? Descriptive analytics are applied to gain insights from the analysis of past transactions. Data is mostly stored in purpose- or commodity- specific databases which are updated and maintained manually. Spreadsheet applications and local ERP systems are accessed to retrieve data that requires manual processing before using it for analysis and reporting.

Intermediate stage: Diagnostic analytics are more in evidence, answering the question "Why has it happened?". The incorporation of external (web-based) data starts. Individually customised dashboards are used for enhanced visualisation of data. Awareness that data integrity is a fundamental prerequisite for meaningful analysis exists. Nevertheless, limited data accuracy and consistency hinders the exploitation of analytics potential.

Standardised stage: Organisations use predictive analytics to identify patterns and trends which is then applied for the development of future scenarios ("What will happen?") including simulations. Visualisation has advanced by deploying real-time automated dashboards. External data is updated automatically. Data integrity practices result in an improved level for new data to be entered. Legacy data reliability remains an issue.

Transformed stage: Organisations use integrated and connected best of breed analytics. Prescriptive analytics ("How can we make it happen?") capabilities, including contracts management and Supplier Relationship Management (SRM) have been developed and used for the development of business recommendations for the strategic procurement process. Both new and legacy data demonstrate a mature level of integrity.

Figure 71

Key characteristics per maturity stage for the change dimension technology

Dimension/ Stage	Basic	Intermediate	Standardised	Transformed
Technology	Descriptive analytics. Analysis of local databases, updated part manually, but with some automation. Speadsheets and corporate ERP systems dominate for reporting and analysis.	Diagnostic analytics starts to emerge. Data analysis includes some external data. Dashboards for visualisation are implemented. Raw data reliabilty is a concern.	Predictive analytics. Real-time dashboards are deployed. Visualisation advances. Automation of external data feeds and updates. Newly introduced raw data is deemed reliable. Legacy data reliability starts to improve, but remains patchy.	Best of breed, integrated, and organisation-wide connected analytics. Prescriptive analytics capability, Real-time data is readily available, Raw data is fully reliable and trusted.
	1	2	3	4

6.3.2 Process

Basic stage: Procurement is recognised as a corporate function and the majority of procurement activities follow documented processes. However, maverick buying still exists within the organisation. Process adherence is patchy because of limited compliance monitoring.

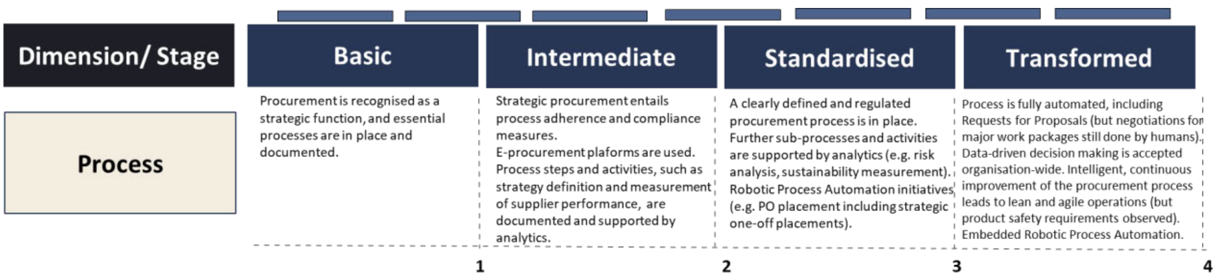
<u>Intermediate stage:</u> Process adherence and compliance to procedures are widely embedded in working practices, measured and audited. E-procurement platforms are deployed for the performance of call-for-tenders with interfaces to the bidding suppliers and to awarded suppliers for contract management activities. However, upload and downloads e.g., contract and validation templates are performed manually. Supplier performance KPIs are in place and assessment of such is supported by SPA.

<u>Standardised stage:</u> Processes are clearly defined in an E2E approach and strictly adhered it by all members and audited. The scope of analytics-assisted processes has been expanded and Robotic Process Automation (RPA) such demand management and one-off order placement, including validation loops are deployed. SPA supports contract management and supplier life cycle management, such as risk management have been expanded along the procurement process.

<u>Transformed stage:</u> The organisation relies on a fully automated procurement process including the management of call for tender, selection and contracting. Data-driven decision making is implemented according to business needs and bought off by all strategic procurement members with no subjective interference. The process passes through iterative reviews to identify process weakness and improve continuously which is supported by SPA.

Figure 72

Key characteristics per maturity stage for the change dimension process



6.3.3 People

Basic stage: Analytics competences in the strategic procurement organisation relate to the operation of software programmes that allow predominately manual collection, manipulation and analysis of data such as table calculation programmes.

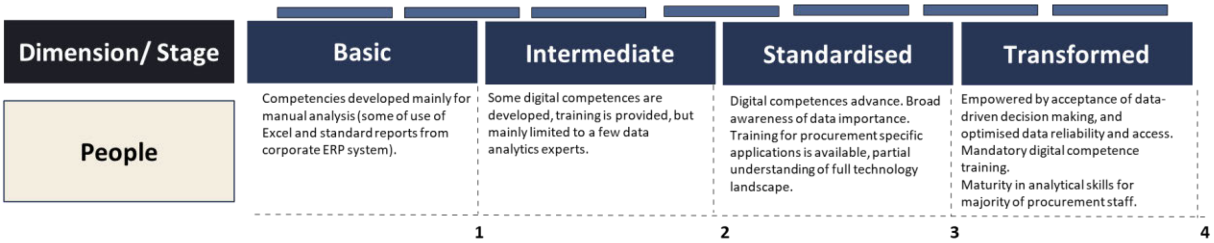
Intermediate stage: The capability profile includes some digital competences. Access to the technology and respective trainings to SPA is restricted to key users or analytics experts in central procurement functions.

Standardised stage: Access to, and training for SPA become available to a broader set of staff. In consequence, digital competences are developed by a bigger population of the strategic procurement function. The understanding of data as an asset and requirement for accurate data entries and maintenance practices improves.

Transformed stage: The development of digital capabilities is key and related training becomes mandatory for the staff. Most people possess mature analytics skills. Empowerment is enabled by process automation and full acceptance of data-driven decisions making. Data is understood as an organisational asset and data integrity requirements are embedded into working practices.

Figure 73

Key characteristics per maturity stage for the change dimension people



6.3.4 Structure

Basic stage: The strategic procurement function is organised along objectives to be purchased (commodity/category-focused) and structured with strong hierarchical levels. The predominate focus is cost optimisation. Information with other functions is shared in a rather informal and uncoordinated manner. Procurement is considered a supporting function, often perceived as tactical. Coordination with other functions is predominately organised in bilateral exchanges.

Intermediate stage: Functions achieving this stage follow a commodity-centric management principle. Even though company-wide procurement objectives are aligned and well communicated throughout the entire function and the strategic procurement top management, representing the commodities aligns, a “my commodity first”-mentality exist. Therefore, organisational silos exist. Hierarchical structures are the typical form of organisational structure. The perception of strategic procurement within the company ranges from “value contributor” in the achievement of company objectives to “tactical enabler for business continuity”. The coordination between strategic procurement and other company stakeholders has improved following the introduction of a dedicated multi-functional forum and communication.

Standardised stage: Organisations witness a reduction of hierarchical levels, eliminating, in particular, the middle management layer. Strategic procurement is appreciated within the company as contributor in the achievement of corporate objectives and innovation partner (innovative sourcing from suppliers). Coordination in the multi-functional teams is supported by cloud-based communication platforms and enhanced accessibility to commonly available and updated data.

Transformed stage: There are no longer silos, and information, stored in data-lakes or on data platforms, are accessible by all members. Strategic procurement has attained a new value proposition within the company having evolved into a network hub which connects internal and external partners. An optimised balance between an agile organisation consisting of purpose-driven self-organised network nodes and steady state teams allowing an optimum resource allocation prevails as the organisational structure.

Figure 74

Key characteristics per maturity stage for the change dimension structure

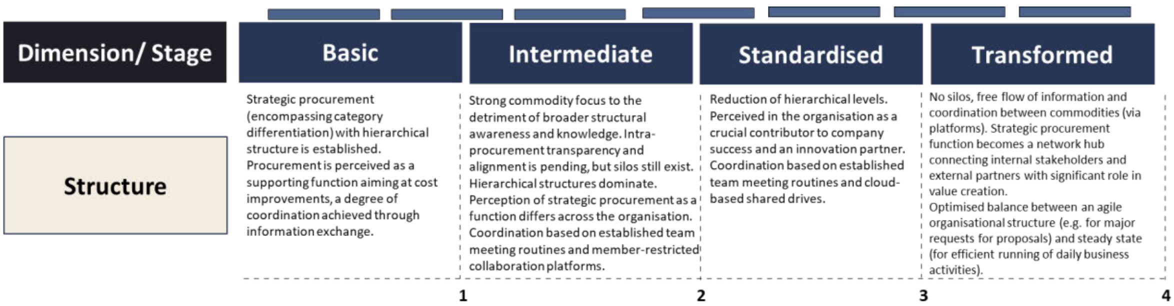


Figure 75 summarises the developed key indicators per change dimension and maturity stage, hence provides the consolidated top-line model for the deployment of SPA.

Figure 75

Top-line digital maturity model for the deployment of SPA including key characteristics

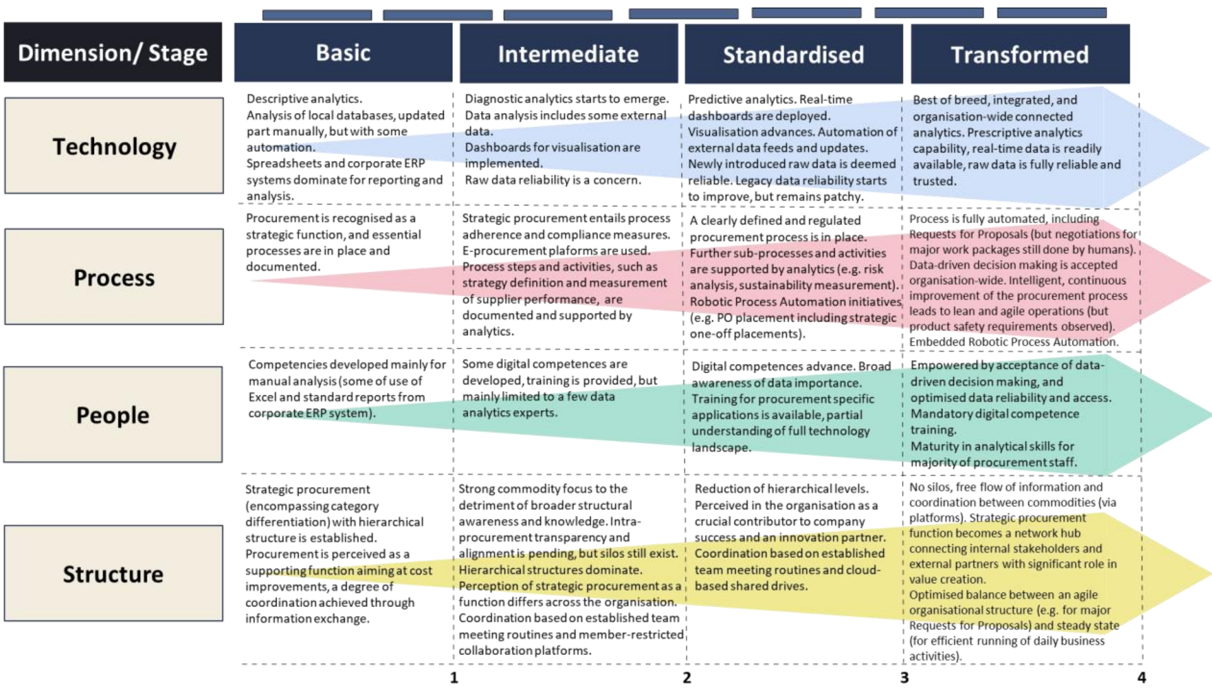
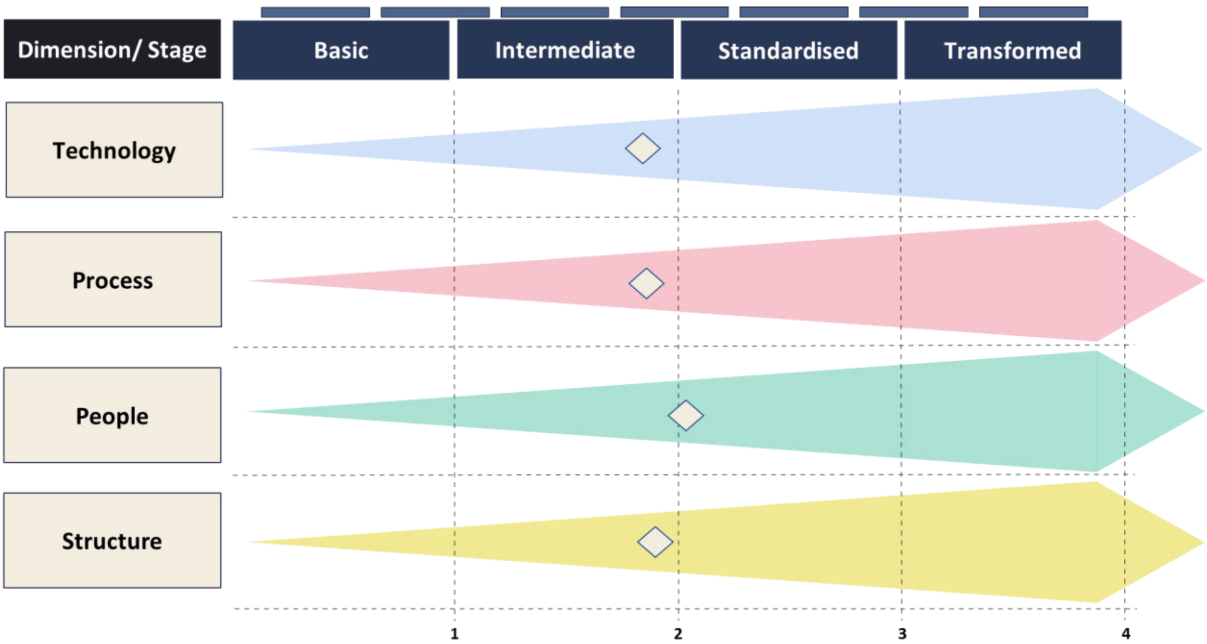


Figure 76 demonstrates an overview of the approximate current positioning of strategic procurement in the case study organisation.

Figure 76

Maturity model for SPA indicating approximate current positioning of the case study organisation



Within the continuum of maturity stages along the four change dimensions, the digital maturity of the strategic procurement in the case study organisation overall indicates an intermediate level.

6.4 Validation and application of the model

To validate the value and practical relevance of the model, an online survey involving six participants from the in-depth interviews was conducted. The survey comprised seven statements (numbered 1-7) as Likert items and a five-point scale (see Table 23). In case of disagreement or strong disagreement with a statement, the instructions requested a brief explanatory comment.

Table 23

Online survey statements

	Statement
1.	Overall, the model supports the realistic assessment of the current level of digital maturity in strategic procurement
2.	The four dimensions of maturity (technology-process-people-structure) are appropriate for the model and allow for a comprehensive assessment of the level of maturity.
3.	The descriptors for the four stages of maturity in the model are appropriate, balanced, and allow a realistic assessment of the different dimensions of change.
4.	The model can be used in practice as a guide to progress the deployment of advanced analytics in strategic procurement.
5.	The model supports the development of data-driven decision making.
6.	The model, if used effectively, can trigger and support an improvement in data quality.
7.	The model can be used periodically to assess the level of digital maturity and act as the basis for action planning in the different change dimension.
8.	Can you please again look at the model and assess where the strategic procurement function is for each dimension of maturity.

In addition, a further item (no.8) asked for the re-assessment of the currently perceived level of digital maturity of strategic procurement, using the grid structure of the model per change dimension and maturity stage. This renewed inquiry into the present maturity level took place approximately 12 months after the initial assessment as part of the in-depth interviews. The online survey was conducted using Google Forms as Google Workspace is the corporate cloud-based solution for office-tools and services (as of August 2022).

A random sample of six of the previous interview partners was contacted again to request their engagement in the online survey. After confirming their participation, each contributor was invited to a brief preparation session via video-conference of approximately 15 minutes where the purpose of the online survey was explained, the initially introduced PCF was revisited, and the adjusted model was presented. Before concluding the online briefing session, the understanding of the participant was confirmed, and further questions were invited and answered.

Overall, the developed model was considered by five respondents as appropriate to assess the status of actual digital maturity and determine the organisation's position in the context of strategic procurement in an aircraft manufacturer (statement no.1).

The design of the model framework encompassing the four maturity dimensions (technology-process-people-structure) and the maturity stages allowing an extensive assessment, was similarly endorsed by five respondents (statement no.2). The indicators per change dimension and maturity stage were judged as meaningful and sophisticated for the evaluation of the present digital "footprint" of strategic procurement (statement no.3).

The model addresses the deployment of SPA in strategic procurement and the experts from the function taking part in the survey acknowledged the practical utility of such, and the guidance the model could provide for the implementation of SPA (statement no.4).

Broad consensus was expressed that the model could be used repeatedly over time to re-assess the level of maturity. It was also suggested that the model allows the development of action plans per change dimension and could potentially be used as a support tool for determining and detailing the objectives and actions of a digital transformation programme in strategic procurement (statement no.7).

While two respondents expressed strong agreement to statement no.5 (support for the development of data-driven decision making), half of the participants could not form an opinion whether the developed model has the capability to engender DDD. An underlying issue, as identified in the previous chapter, is the presently limited acceptance and consequential application of data-driven decision making across all hierarchy levels. It was stated that the perceived decision making in the case study organisation varies between intuitive and data-driven, both at individual and managerial levels. One reason is the distrust in the accuracy of data. While it was expressed that decision making in strategic procurement was to some extent naturally based on facts and figures, it still highly relies on personal experience and subjective opinion, and that the true incorporation of data-driven working practices is still to be attempted.

Divided feedback was provided to statement no.6, regarding whether the model could trigger and help to boost data quality. Half of the participants agreed or strongly agreed, while the other half disagreed or even strongly disagreed. R01, in signalling his strong disagreement, stated *“PMT (i.e., Processes Methods Technology) architecture with core (and limited amount of) tools to be defined and clear accountability for data lakes to be added. Dashboards to drive attention of leadership to improve data quality. Clear priority as top company objective to drive data maturity”.* The enhancement of data integrity was considered a management task or at least it would require management focus to cascade top-down and develop a sensitivity for data integrity organisation-wide. R03 commented on his/her disagreement thus: *“we can implement high-tech tools and still struggle with (maintaining) master data maintenance. I do not think that it depends on the model used but more on the willingness of the organisation in general”.*

Throughout the online-survey there was one respondent (R04) who disagreed or strongly disagreed consistently with the statements, pointing out the short-comings of the model, and commenting, in response to statement no.1, that the model “*could be a first point of orientation but especially process and technology should be somehow amalgamated*”. The dimensions of change were perceived to be too distinct and would hamper an integrative approach for the assessment of digital maturity in the strategic procurement function. The response to statement no.2 further underlines this opinion: *“I would not distinguish process / tools because the integration of the process in a "digital" environment is the key driver for optimisation. Structure could be seen as part of the process”.* In consequence, it was opined that the change dimensions technology, process and structure should form one big block of change. Statement no.4, referring to the potential of the model as a guide to progress the deployment of SPA, was disagreed with: *“a mature E2E process is the core, and the data and* *tools are the enablers in a holistic sense. The structure is a matter of product structure and industrial strategy, and people are looking at skills and "acceptance". I think the matrix is too silo-like and should become more scenario-driven*".

A follow-up interview was scheduled with the respondent to further explore the concerns with reference to the model. A high degree of discontent and frustration of how the case study organisation progressed with process modernisation to respond to technological change was shared. When new technology gets deployed in the case study organisation, it usually happens without re-consideration and adaptions of legacy processes for various reasons. There is a strong tendency to only focus on the implementation of the technology. The lack of willingness, resources, and capability to truly simplify and adapt processes can result in the deployment of state-of-the-art technology in a legacy process environment. This would then inhibit the successful application and exploitation of state-of-the-art technology, that would impact assessment against the model. The person concerned, with a long career in strategic procurement, reported his/her involvement in several digitalisation projects and the witnessing of failed attempts to deploy technology due to missing integration of other change dimensions. Summarising, the respondent perceived the developed model and its presentation as a matrix as not holistic enough. However, there is broad consensus amongst the academic and practitioner communities that using several interrelated change dimensions as points of reference for the construction and operation of digital maturity models is appropriate, and the respondents' views were thus taken on board, but were not deemed to undermine the validity of the model.

The developed model highlights the importance of, and the high dependences between, the dimensions. It explicitly emphasises the necessity to encompass all dimensions and progress them at a similar pace to successfully transform to a digital organisation.

Table 24

Summary of results to statement no.1-7 of the online survey

	Statement	**SA**	**A**	**N**	**D**	**SD**
1.	Overall, the model supports the realistic assessment of the current level of digital maturity in strategic procurement	3	2		1	
2.	The four dimensions of maturity (technology-process-people-structure) are appropriate for the model and allow for a comprehensive assessment of the level of maturity.	3	2		1	
3.	The descriptors for the four stages of maturity in the model are appropriate, balanced, and allow a realistic assessment of the different dimensions of change.	3	2		1	
4.	The model can be used in practice as a guide to progress the deployment of advanced analytics in strategic procurement.	2	3			1
5.	The model supports the development of data-driven decision making.	2		3		1
6.	The model, if used effectively, can trigger and support an improvement in data quality.	2	1		2	1
7.	The model can be used periodically to assess the level of digital maturity and act as the basis for action planning in the different change dimension.	3	2		1	

Following the request to respond to provided statements, participants were asked to repeat the assessment of the current digital maturity of the strategic procurement of the case study organisation, applying the adapted model, per change dimension and maturity stage.

The technology change dimension was perceived consistently to be in an intermediate stage by five respondents (R01/R02/R03/R04/R05). Even though the advanced data analytics used in strategic procurement are predominately of a descriptive nature, the introduction of diagnostic analytics is an objective.

The deployment of the P360 application is an example of how external supplier data can be used for enhanced risk management. Applications for the visualisation of supplier spend and supplier performance with interactive and customised dashboards are widely used. Data integrity is still one of the key issues in the case study organisation. R06 considered technology to have advanced to the standardised stage. This person has a deep understanding of, and is predominately working with, the Skywise data-platform, with real-time updates, in the role of a data analyst. In a discussion that was held following the online survey, it was mentioned that data integrity, foremost for new data updates (e.g., materials) is improving.

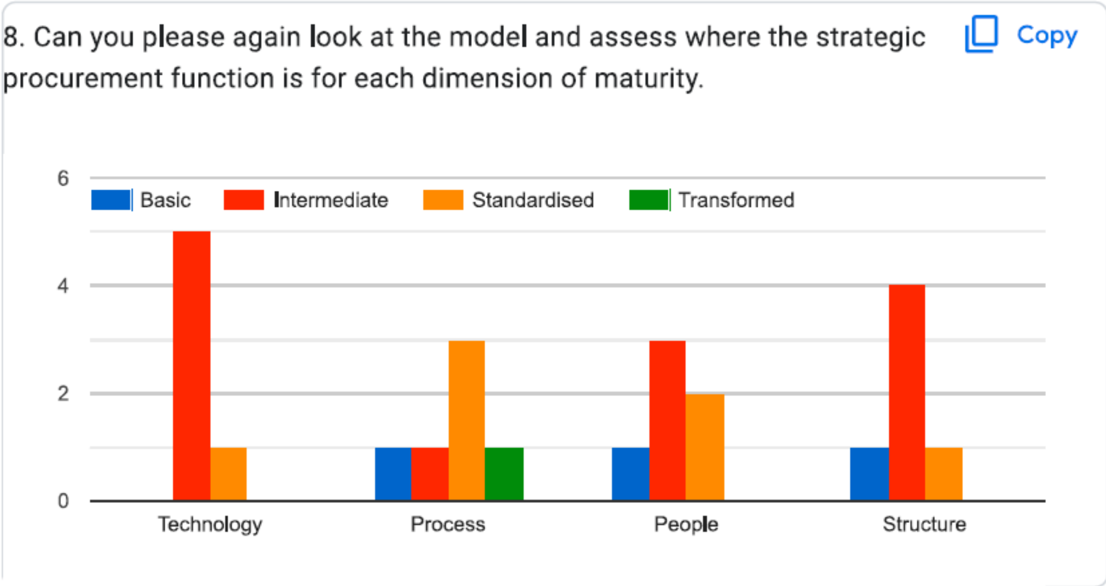
The positioning in terms of process maturity was less homogeneous (see Figure 77). R01/R05/R06 concurred in their perception of the process change dimension as being at the standardised stage, which could be interpreted as a reflection of the rigid procurement process applied in the organisation, and emerging RPA applications. However, other respondents gave basic (R03), intermediate (R04), and transformed (R02) assessments of process maturity.

Half of the participants (R01/R02/R06) assessed the people change dimension to be at the intermediate stage, reflecting the level of digital competencies that the staff of strategic procurement possess. SPA capabilities are still limited to few trained experts. A comprehensive appreciation of the value of data and the importance of maintaining it has not yet been achieved. R04 perceived the level of skills and working practices, as components of the people dimension, as basic. On the other hand, R03 and R05 saw this dimension to be more mature, at the standardised stage.

Structure was assessed to be at the intermediate stage by a large portion of respondents (R03/R04/R05/R06), acknowledging the strong commodity focus and present associated silo mentality. The organisation is characterised by a hierarchical structure and a strong line of command. Meanwhile, R02 perceived “structure” to be at the basic stage, and R01 at the standardised stage.

Figure 77

Positioning of digital maturity per change dimension, as indicated in the online



6.5 Chapter summary

At the beginning of this chapter, the assessment of the subjectively perceived level of digital maturity in strategic procurement was presented, both at individual and collective level. In the in-depth interviews, respondents were requested to identify the position per change dimension in the PCF in the case study organisation based on their personal experience and perception. This PCF acknowledges, by embodying the four change dimensions - technology, process, people and structure - digital transformation as a multi-dimensional and contextual phenomenon.

Perceptions of maturity differed between interview partners. Applying a range of maturity between 1 (low) and 4 (mature), on average, technology (1.79), process (1.8) and structure (1.89) are recognised to be at an early stage of maturity endeavours. People (2.04) as a dimension is seen to be at a slightly higher level. Overall, the strategic procurement function in the case study organisation is viewed to possess a rather low degree of digital maturity (1.88). The findings support the view that all change dimensions are interlinked and matured at approximately the same velocity.

Following the analysis of responses and conclusion of the organisational level of digital maturity in strategic procurement, the PCF was advanced by adding four maturity stages, namely basic, intermediate, standardised and transformed. It allows the revelation of a path towards a fully advanced digital strategic procurement function and the identification of key characteristics for each change dimension and maturity stage. Technology as a dimension includes the application of descriptive analytics at the basic level of maturity, while transformed organisations deploy real-time prescriptive data analytics. The process dimension at the basic stage is characterised by key procurement processes being in place and documented. Fully automated processes and accepted data-driven decision making throughout the organisation define a transformed organisation. People capabilities in a basic digital organisation are adequately developed to perform manual data analysis in table calculation applications. At a transformed stage, staff have developed advanced analytics capabilities, predominately used for the extraction and interpretation of information. Structural arrangements in a basic stage organisation entails a strong hierarchical focus, while transformed organisations enable a high level of collaboration and free flow of information. Having an optimised balance between a steady state organisation and agile teams, strategic procurement is set-up as a purpose-driven network.

Concluding the onward development of the PCF, the top-line digital maturity model for the deployment of SPA has been outlined in this chapter. Subsequently, the model was validated to demonstrate its value and practical relevance. In an online survey, six participants who had been interviewed previously, were asked for agreement or disagreement to seven statements relating the deployment of the model. The model was backed by respondents regarding its design including change dimensions and maturity stages as model axes. Respondents endorsed the model in its practical utility to assess the organisational maturity and repeat such assessment periodically. The indicators describing the key characteristics per change dimension and stage were viewed as valuable. Overall, the model was acknowledged to have the capacity to provide meaningful guidance and support to set objectives and a course of action for a digital enhancement. DDD could be facilitated and fostered by applying the model. Problems are rather associated with the inherent distrust in data integrity and acceptance of DDD than with shortfalls in the model. The improvement of data integrity is less related to the application and capacity of the model but would have to be addressed by management as a top company priority which necessitates cultural change.

Finally, a re-assessment of the actual digital maturity and determination of the organisation’s position, based on the enhanced model for the deployment of SPA, revealed a slight advanced positioning in relation to all change dimensions. In the second evaluation, “technology” was overall perceived to be in an intermediate state and processes at a standardised level, compared to slightly lower values from the initial assessment during the interviews. There could be several reasons for this change. It could be either because people became familiar with the content of the individual stages and felt confident to perform the evaluation with predefined and specified maturity stages. Another reason could be a perceived enhanced digital maturity of the organisation itself, e.g., by improvements in mastering newly deployed technology.

The next chapter addresses emerging themes identified in the analysis of interviews and online survey. It also provides practical recommendations on how to apply the developed maturity model.

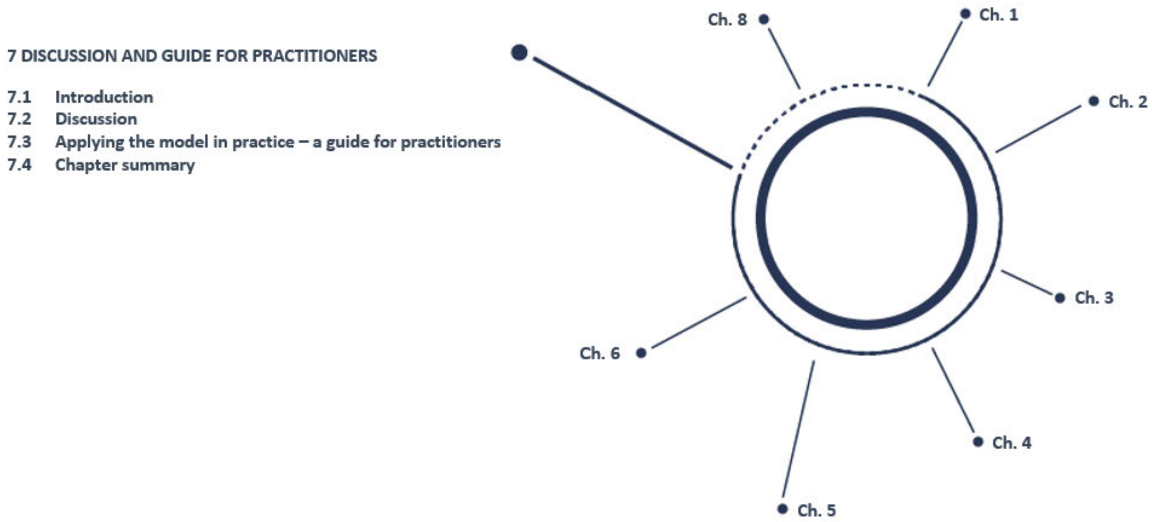
CHAPTER 7: DISCUSSION AND GUIDE FOR PRACTITIONERS

7.1 Introduction

This chapter (see Figure 78) debates themes that emerged from the analysis of findings in chapter 5 and the model validation in chapter 6. Furthermore, it provides guidance for the application of the model in practice and how to plan and execute the implementation of advanced data analytics in the strategic procurement function in a contextual and holistic manner.

Figure 78

Structure of chapter 7 in the context of this thesis



Following this introduction, aspects in relation to shortcomings in contemporary deployment practices of SPA and concerns shared by participants in the field research are discussed in section 7.2. In section 7.3, a guide for practitioners is developed. 7.3.1 provides guidance at corporate level and aims at encouraging management and transformation stakeholders to successfully advance maturity in the organisation in the context of digital transformation. 7.3.2 puts forward some guidelines for the practical application of the maturity model in particular in strategic procurement. Concluding this chapter, section 7.4 provides a chapter summary.

7.2 Discussion

7.2.1 The importance of an integrative and strategic approach

One question that was raised by one of the respondents belonging to the management of the case study organisation during the in-depth interview was whether strategic procurement as a function had fully grasped what digital transformation can bring and what a digital world has to offer? Further members from management expressed uncertainty over the added value of the deployment of SPA. Almost unanimously confirmed was the lack of awareness of the existence and status of a digital strategic procurement strategy, whether embedded into a larger corporate transformation strategy, or as a distinct functional digital strategy. If there is a digital strategy at functional level, it is not known to the members of strategic procurement or it is highly fragmented and managed at individual commodity level. A fragmentated strategy can benefit individually the authoring and managing entity; however, at the collective level it can lead to misalignment, overlap, cost increase and additional complexity in the effort to digitally transform (Wade et al., 2021). A study conducted by the Global Center for Digital Business Transformation at the IMD Business School found that having a coordinated and integrative digital strategy resulted in better digital and financial performance than those companies with a fragmented strategy (Wade et al., 2021).

At present, a commodity patchwork landscape of data analytics applications hinders the exploitation of SPA in the strategic procurement function of the case study organisation. The introduction of tools has, to date, largely been limited to certain commodities and tactical in scope, and “bottom-up” (Earl, 1989). The above-mentioned examples illustrate some of the characteristics of the early stage of digital maturity in the strategic procurement in the case study organisation.

It underlines a position widely advocated by numerous academic and practitioner publications (Westermann et al., 2014; Tucci, 2021; Wade et al., 2021; McKendrick, 2022): transformation starts at the top. Management engagement is of immense importance at any time in the transformation undertaking as change is associated with uncertainty and to some extent even resistance. There is a clearly expressed desire from non-managerial staff members to upper and middle management to lead by example. This claim is not new yet remains challenging for executives even now. Even if digital transformation forms part of the management priorities and was given impetus by the Covid-19 pandemic, there is a struggle for C-level executives to adequately address it and business managers to implement it. Sometimes attempts seem half-hearted and rather opportunistic. Sometimes members of top and middle management have difficulties in embracing the full potential of digital technologies, the necessity to transform beyond technology and how to plan and execute a transformation. One of the previous CPOs of the case study organisation - who linked digitalisation purely to the adoption of new technology and related training – stated “you deploy new technology and train your people and that’s it”.

Onboarding the strategic procurement community members involves keeping them informed by communicating the vision, strategy, and implementation in a transparent manner. Willingness to adjust, and the development of a mindset that supports organisational transformation, are key. Executives play a fundamental role in making the digital transformation a success by formulating and cascading a coordinated strategy, setting the tone and behaviours throughout the organisation, and making available adequate financial and human resources. By the same token, it is the management that triggers and fosters a development of a digital affine-culture that staff are expected to adopt.

The successful process of transformation entails the development of a vision, planning of strategy and implementation. This includes, as well, sharing that vision throughout the organisation and getting people engaged. There is a need for a comprehensive integrated strategy for the deployment of SPA, which will be most effective when part of a wider corporate or digital transformation strategy. Digital transformation programmes need to be managed at corporate level, incorporate all business lines, and not be limited to certain functions, such as a predominant technical focus, as may be the case when transforming and modernising the design of the product such as an aircraft, and the methods and technology to do so.

Moreover, literature suggests that when a dedicated functional-level strategy for strategic procurement is in place, it forms part of an integrated organisation-wide transformation strategy including the elements “What?” (objectives), “Why?” (vision/motivation), “When” (roadmap including milestones) and a committed “How?” (resource). The strategy at functional level defines how the function contributes to the achievement of the targeted corporate digital maturity and business objectives that are tied to a successful digital transformation. The acknowledgement that strategy development, implementation, revision, and adaptation is not a static, but a dynamic, endeavour, reinforces the ability of the business to navigate change instead of being pushed to only react to it.

An honest assessment of the current digital maturity status within the organisation is required prior to launching a transformation initiative, as well as iterative reviews of the progress and redirection, if necessary, at intervals along the transformation process are essential components of digital transformation programmes.

Technology is one of the key facilitators of digital transformation; however, it is not the only component of a digital transformation. Furthermore, the adoption of new technologies alone is not digital transformation. As pointed out in chapter 3, the role of technology in a digital transformation is to enable and to set the velocity of transformation. Still, the continuous update of the technological architecture contributes to securing the business’s long-term existence well as signalling the organisation’s will and capability to navigate in a dynamic environment that is constantly changing at an ever-accelerating speed.

For the implementation of new applications such as SPA, alignment with overall business and digital transformation strategy is essential. Advanced SPA are seen as a means of simplifying and achieving increased efficiencies. Strategic considerations and the definition of an overall procurement technology architecture instead of implementing purpose-specific applications that exist as island-solutions are key. It is recommended that adoption of new technology supports the achievement of business strategy objectives. The strategic procurement technology architecture is developed from a consistent corporate business and technology strategy and consists of interconnected and standardised applications and has an integrative character. For example, in the case study organisation, a technological bridge between applications for sourcing and contract management is yet to be built. Even though both these main blocks in the procurement lifecycle are deployed in the same technological system, there is no integration and no exchange between the two isolated modules. Instead, portable document format (.pdf) files need to be up- and down- loaded for storing and accessing documents. Connecting technologies and data is paramount. Individual, isolated applications, dedicated to performing a single job, possibly being used in only one single commodity, inhibit the exploitation of the benefits of the adopted new technology and restrict the desired contribution to increased efficiency.

7.2.2 Contemporary SPA application and value recognition

Despite digital transformation being a top company priority in recent years and the acknowledgement of data and advanced data analytics as a key contributor to digital transformation (as demonstrated by the deployment of the data platform Skywise for harnessing aircraft lifecycle data), the present utilisation of SPA in the case study organisation is at an early stage in its deployment cycle. To date, implemented SPA are predominately of a descriptive character, providing insights on past transactions and thus the analysis of historical data.

Embedding SPA technology into the strategic procurement process is associated with the exploration of benefits of leveraging of internal and external data to support the development of a procurement and respective commodity strategy, taking into consideration the latest market developments, current and emerging competitors, new entrants, suppliers, and assessment of new technologies.

It is acknowledged that the full potential of SPA has not yet been exploited in the case study organisation, even though the base data for such analysis is assumed to exist. The current deployment of advanced data analytics in strategic procurement is largely restricted to the strategy review process with some information analysis to support strategy definition (the Define Procurement Commodity Strategy sub-process). Furthermore, SPA is used to measure supplier spend and performance during the life of the contractual relationship (the Manage Suppliers Contracts and Supplier sub-process) and external web-based data relating to specific suppliers is included to enrich risk assessment.

There is a clear recognition of the potential value of SPA in the case study organisation, and a strong appetite amongst the majority of strategic procurement management and staff to expand its use, both in terms of capability (e.g., predictive analytics) and also in scope of applications (see Figure 79).

Figure 79

Top expected benefits, derived from the deployment of SPA in the case study organisation

At present, associated benefits are linked to the achievement of traditional procurement objectives such as improved pricing and the avoidance of supply chain disruption. The assessment corresponds with the current understanding of the main objectives and role of strategic procurement in the organisation and its business model maturity which focuses the sourcing of products and services. Lowest ranked potential benefits include the contribution to sustainability initiatives that could be interpreted as a poorly developed response to emerging megatrends such as sustainability, attributed to the evident and accelerating climate change, and demands, both from the public and politics, to substantially reduce emissions. Following the procurement paradigm shift from product to innovation sourcing, as suggested by Hugh and Ertel (2016), improved visibility on technology and innovation scouting and respective sourcing as result of applied SPA, identified as least beneficial, would indicate an advancement of the strategic procurement business model.

Keen interest was expressed in the possibilities of implementing predictive analytics to support strategic decision making and related operations, predictions of risks based on a wider data foundation, and/or simulation of key activities such as price negotiations. Contract analytics is considered as being one of the areas where SPA enables harmonisation of the heterogeneous contract landscape and enhancement of terms and conditions. Strategic procurement as a function has not yet been able to reach a level of digital maturity in the deployment of advanced data analytics in comparison with other functions such as customer service which offers user-centric value-adding solutions based on and by means of advanced data analytics.

The strategic procurement of the case study organisation is not an exception to what seems to be a rather universal trend. Both academic publications and white paper reports suggest there has been only limited progress in the transformation of procurement for years, even though it is part of the CPO’s agenda in order to achieve cost reductions, improved efficiencies and effective and enhanced data-driven decision making (Murray, 2013; Forrester, 2019). It is maintained that procurement is one of the last functions in an organisation that evolve digitally (Harvard Business Review Analytics Services, 2021).

Exploiting data, however, is understood to be key in navigating the post-pandemic business environment with new challenges such as inflationary developments, higher risks of supply chain disruption, caused by geopolitical shifts and an incapability of the supply chain to support adequately the ambitious ramp-up of the aircraft manufacturer following vital Covid- 19 adaptations. The successful deployment of digital technologies such as SPA is seen to improve efficiencies by the automation of processes, thus reducing tactical and manual work for strategic procurement members, to increase speed by enhanced collaboration within the organisation and partners, and to create opportunities to pave the way for a new business model, not only in strategic procurement. Success in maturing the "business model" of strategic procurement could allow the function to evolve into a leader in "innovation sourcing" within the organisation, which requires the appreciation of the supplier as partner and source of innovations, or in the development of the function into a key participant in a value- and user-central-driven ecosystem. The advancement of strategic procurement by maturing the portfolio (from single products/services to innovation and solution), the function underlines its understanding as elementary contributor to corporate competitive advantage and position within the organisation as of truly strategic nature.

According to Lewrick (2021), the ecosystem is understood as a complex network or a highly connected system focusing the collaboration of the various actors along the entire value chain to truly solve a customer's problem instead of providing a product or a service. The customer is the ultimate centre of gravity; it is neither the product nor the own company. The concept goes beyond the ideas of Hughes and Ertel (2016) where innovation sourcing is the new paradigm of strategic procurement as presented in chapter 2.

The claim that procurement could be a pioneer in advancing the digital maturity at corporate level is also repetitively expressed. Across companies and industries, the procurement function is often still in an "experimenting" phase, where they explore what to do with digital technologies such as advanced data analytics, blockchain technology and Internet of Things (IoT) (Radell & Schannon, 2018). Strategic procurement has clearly not been able to assume this role yet, neither in maturing its own digital architecture nor in the evolution of the business model.

7.2.3 Data as a strategic asset

The majority of interviewees shared concerns over data integrity, and accessibility and relevance of existing data. In the past, deficiencies in data integrity led to unacceptable issues and unfavourable business decisions. One of numerous examples of this is the inevitable elimination of approximately one third of a work package at negotiation stage with suppliers in a running call-for-tender, because of the realisation that there was no demand for the material, and this thus posed incalculable risk in the decision making process.

Only slowly, the value of exploiting data by the implementation of SPA and the importance of maintaining data is being grasped. Advanced capabilities at individual level to apply advanced data analytics and utilise the results are yet to be developed. The willingness to enter and maintain data quality is often limited, not only by staff of strategic procurement. It holds valid for almost any function in the case study organisation that owns data, for example Engineering for technical aircraft component data. Data entry and maintenance are not considered strategic or core activities, often subcontracted externally or handled without a lot of care. Issues around data integrity are less related to limits of technology, whether already existing in the organisation and envisaged to be deployed. Currently, human intervention is necessary to confirm the validity and reliability of data, either by generating cross-referenced analytical reports manually, or by information checks by “gate-keepers” (knowledgeable procurement members), before distribution to a wider audience including management.

Overall, there is an inherent suspicion that data is of a poor quality, which prevails in the organisation, and inhibits the exploitation of SPA even if technology is properly implemented and working. Digital transformation entails the mindset and handling of data within the organisation. In a mature strategic procurement function, data is viewed and managed as an asset throughout the strategic procurement organisation. As noted by Marr (2022), “companies that view data as a strategic asset are the ones that will survive and thrive” (p.1). Relevant data that support the achievement of organisational objectives are identified. People understand the value of data and reflect on it their working practices. Full data integrity is existent and preserving of such is a key company objective. Data completeness, consistency and correctness are key characteristics of data integrity (Schuh et al., 2017).

Adequate data management practices defining what, how, how often and by whom are in place and are adhered to, ideally supported by automated solutions. Cleansing of legacy data is a resource-intensive, yet important, endeavour. The assurance of legacy and newly introduced data allows the organisation to move forward into a more advanced use of SPA. Data from various functions, e.g., production or engineering, are connected or stored in modern data architecture such as data lakes and increasingly advancing state-of-the-art cloud-based data bank management systems (Lutz, 2022).

Information such as short- and long-term material demand and supplier performance are available instantly and up-to-date. For buyers, for example, there is a visibility and access to accurate engineering data, manufacturing data and customer service data, not only by a tool but also by process. When the customer service is defining prices for spare parts, this would in effect require a direct linkage to all contracts managed by the strategic procurement as the provision and conditions of spare parts are included in the contract for the supply of serial parts, although they are handled by the customer service. Ideally, there is automated feedback of this change of information from customer service to the contract holder in strategic procurement as a mandatory step in the process, and not like today a voluntarily and opportunistic provided information.

The development of a digital price database to support and enhance negotiation and identify commercial levers is another example of a potential key area of application of SPA in the case study organisation. At present, even though having this data available somewhere in the corporate ERP system and thus presenting an enormous, yet unexplored, value, supplier pricing data is not managed continuously and systematically but extracted, manually checked, and processed when there is a specific request. Instead, the data is often stored in an ad-hoc and manual manner in a segregated commodity data base. Visibility exists at individual supplier level but rarely at commodity level for a specific point in time. On the other hand, to have prices available, as well as the reference price baseline and evolution, would enable proper benchmarks to be set and measured, and assessments that support the negotiations to be made, e.g., for the same and comparable products and overall contemporary price management. The same reliability and accuracy need to exist when assessing supplier performance data such as on-time, on-quality, and on-cost delivery. It would allow a constructive content-related discussion with the supplier and a chance to jointly aim at improvement instead of debating the nature of the KPI, how it was generated and whether it can be trusted at all. At present, the available collaboration applications are not perceived as working properly and establishing and agreeing on delivery performance remains a highly manual and disputed activity in the management of the supplier relationship.

Transparency and the free flow of information needs to exist in the organisation. From the strategic procurement community, ideally there are linkages to all other stakeholders inside and outside of the organisation. As Collins and Lanz (2019) point out "data becomes an asset when, under the right circumstances, it is transformed into information that contains economic characteristics and facilitates actionable insights" (para.18).

Moving forward, confidence in, and reliability of, data are essential to underpin the increased deployment of advanced data analytics in the strategic procurement function, demanding an effective response, involving the cleansing of legacy data, and definition and strict (automated) quality control of newly introduced data. Only by grasping data as strategic asset allows the organisation to move forward in the successful deployment and exploitation of SPA.

7.2.4 Data-driven decision making

Gautam and Bhimavarapu (2022) suggest that any kind of business decision ranges somewhere in between intuitive and well-informed. Neither one of the extreme points in this continuum is applied in practice. This is in line with the reported working practices in the case study organisation; the nature of making decisions in the case study organisation was rated in the middle of intuitive and data-driven by participants in the in-depth interviews. At present, business expertise, personal experience and social relationships influence decision making to a large extent in the case study organisation. The low level of confidence and trust in data integrity hinders the acceptance of data-driven decision making (DDD), both at operational and managerial level. The aspiration for DDD is clearly supported and it exists partially in practice, because decisions need to be backed up by relevant data. Nevertheless, there is an overall tendency that organisations still struggle to transform to the “data-driven” enterprise, even though there is wide and cross-industry acknowledgement regarding the value of data analytics (Davenport & Bean, 2020).

The concept of DDD has been in evidence for at least three decades, but measurable business value has yet to be delivered in many areas of business operations. A study conducted by Harvard Business Review Analytics Services (2021), involving 271 procurement management members, found that not enough, or not relevant, data was collected. In addition, organisations have not yet built-up adequate capabilities to analyse and interpret the data. Unpredictable and dynamic events such as the Covid-19 pandemic pose a stress test to organisations and surface deficits in terms of data availability, integrity, and relevance. In the case study organisation, as an example, data needed for immediate decision making to perform business adaptions such as order cancellations or review of *force majeure* clauses and essential for survival, had to be extracted and processed manually.

DDD is understood as “the practice of basing decisions on the analysis of data rather than purely on intuition” (Provost & Fawcett, 2013, p.53). Elgendy et al. (2022) specify DDD as “systematic collection, analysis, examination, and interpretation of data, usually through the application of analytics or machine learning methods and techniques, to reach informed decisions" (p.349). In effect, DDD is a combination of data analysis- and intuition-based decision making based on expertise and experience (Provost & Fawcett, 2013). DDD entails the acceptance and willingness to support decision making by all members of the organisation, be it operational or managerial staff, through trust in data because data is at a high level of integrity. Contemporary research suggests that DDD, if applied properly, allows the achievement of enhanced productivity. Empirical evidence from a long-term study, lasting a decade, demonstrates revenue-based productivity gains could reach between 4% and 8%, predominately related to the application of predictive analysis at present (Brynjolfsson & McElheran, 2016). Furthermore, by using data-driven strategies and decision making, SPA could help to trigger the modernisation of processes in strategic procurement.

Organisations hope that the deployment of digital technology enables them to unlock the potential of advanced data analytics and finally achieve the associated benefits. Associated benefits of data commercialisation stem from speedy access to and utilisation of data, exploration of new data sources and the blending of various data in different patterns than before (Bieda, 2020). As pointed out in chapter 2, organisations that possess "analytical agility" (Bieda, 2020) or have an "analytical culture" (Handfield et al., 2019), meaning data-driven organisations, are successful in responding to a highly volatile business environment. According to Cosic et al. (2012) culture represents timely evolving values and behavioural patterns. Organisational norms, both implicit and explicit, form organisational culture.

Culture, then, that is understood to be data-affine, describes tacit and formalised behavioural patterns and organisational norms to enter, maintain, gather, analyse, and disseminate data in a systematic manner. It influences the way decisions are made (e.g., ad-hoc or fact-based), the proclivity for key performance indicators and quality measurement, the degree to which BA (Business Analytics) are enmeshed in daily business activities, the level of management for BA (Davenport, 2006) and receptivity to change (Hopkins et al., 2010). Such culture values transparency and knowledge sharing, and may counteract potentially biased decision making, and help dismantle information silos which inhibit the sharing of strategic information.

7.2.5 The limitations of process change in the aviation industry

Using data-driven strategies and decision making by the deployment of SPA could help in the modernisation of processes. SPA can bring benefits to the core processes of strategic procurement such as the development and execution of sourcing strategy, supplier, and contract management, as well as in leadership of, and communication with, direct and indirect reports. The digitalisation of contracts across the company can facilitate efficient management of contracts, including finding best practices of terms and conditions agreed upon, and accurate follow-ups of supplier adherence to the contract. Contract analytics is considered as being one of the areas where SPA allows an efficient review of a large number of contracts (e.g., in strategic procurement across all commodities) and enables harmonisation of the fragmented contract landscape, ensuring compliance to legal regulations and business policy, enhancement of contractual terms and conditions. The deployment of artificial intelligence to enable the application of smart contracting for self-execution and/or self-enforcement of contractual duties was also highlighted, and analytics-assisted risk management could strengthen the anticipation, instead of mitigation, of risks.

However, introducing technology to replicate legacy processes (rather than re-engineering them) often requires such an over-customisation of the software that it renders it impractical in its deployment. In addition, the attempt to incorporate every aspect of the procurement process and specific peculiarities of individual strategic procurement commodities may result in an “over-customisation”, either in the sense that numerous single-purpose specific and isolated tools are deployed, or technologies are designed in an overly complex way for an intuitive utilisation, or the application simply no longer works, and workarounds are being implemented.

On the other hand, adherence to processes, meaning the compliance to procedures that define the strategic procurement activities, is important for any business, e.g., to optimise corporate spend and prevent unauthorised expenditure. For a company in the aviation industry, it is mandatory and the elementary foundation of its business continuity. Strict process adherence of all functions is audited by internal revision boards and certified externally by aviation authorities such as EASA (European Union Aviation Safety Agency). Fundamental process change is hampered by concerns for product safety and airworthiness assurance, which constitute significant barriers to procedural change in this industry sector.

At present, realistic process change is limited in the main to acceleration and reduction of manual activities. In the case study organisation, ePROC strategic procurement, “a shared, single strategic space for buyers and suppliers across all (…) entities to perform all aspects of calls-for-tender- from the identification of potential suppliers to the selection of successful parties”, is used. In this application, extant processes are mapped and allow process adherence. However, interview partners reflected on the necessity to manually operate such as the manual upload and download of documents and the user-unfriendliness of the application. On the other hand, the introduction of new technology, aiming at a higher level of process automation whilst sticking to extant processes, has failed to date.

To progress in the endeavour to achieve greater digital maturity and automation, a revision and adaptation of processes is fundamental. Existing processes and procedures cannot easily be re-produced and amended in newly applied technologies. Applying new technology in a legacy process set-up invites failure. In the business environment of aircraft manufacturing this translates into the requirement for process evolution while ensuring compliance and approval by aviation authorities. Process defines the technology and not the technology the process, e.g., in an export control process, the process needs to be directly linked to what the digitalisation is aimed at. The determination which tasks are supported by technology needs to be documented in the procedural directive.

When adapting processes, efforts to truly simplify are needed. In the past, when processes were reviewed and adjusted, amongst others aiming at simplification, often another layer of complexity or a body or function for revision and assurance of compliance was introduced. The necessity to be compliant with defined and documented processes remains unchanged, and constitutes an on-going challenge to process simplification.

Another limiting factor which is not industry-specific is the conviction that, despite an increased level of automation along the procurement process, core activities such as negotiations with suppliers remain to be performed by humans, even when assisted by SPA or other digital technologies, and depending on specificities such as contract value, contract lifetime or complexity of work scope. Contract negotiations, regardless of whether as part of the selection process or during the contract life cycle, form an integral part of the strategic procurement portfolio, deliver optimised value for money for the company and can positively influence the quality of the business relationship.

One comment relating to the statements in the online-survey for the model validation, was “I struggle to think of a process where the supplier selection would be done by a machine". Indeed, the negotiation process is a “a complex emotional decision-making process”, which is claimed to be not manageable by artificial intelligence alone (Hindriks & Jonker, 2008, p.47). Hindriks and Jonker (2008) advocate a human-machine collaborative approach in order to combine strengths of humans (e.g., capturing the emotional and the contextual nature of negotiations) and machines (e.g., assessing alternative options and overcoming of lack of training and bias) in a complementary manner and balance respective weaknesses in the negotiation to achieve overall better results.

Even though it is expected that negotiations become more technology-driven to enable autonomous, beneficial, and efficient negotiations, even at large scale, meaning covering a large number of contracts simultaneously, machines are understood to complement humans’ negotiation capabilities and optimise results. This applies both quantitatively (e.g., number of managed contracts or achieved savings) and qualitatively (e.g., compliance with legal and business policy requirements or protection of contractually implied risk exposure). Elgendy et al. (2022) claim a proper balance is needed to develop appropriate alternatives.

7.3 Applying the model in practice – a guide for practitioners

Building upon the aspects discussed in the previous section, sub-section 7.3.1 sets out how to use the digital maturity model to approach digital transformation at corporate level. Then, sub-section 7.3.2 provides more specific guidance for the application of the developed digital maturity in a strategic procurement function in consideration of SPA implementation.

7.3.1 Applying the model at corporate level

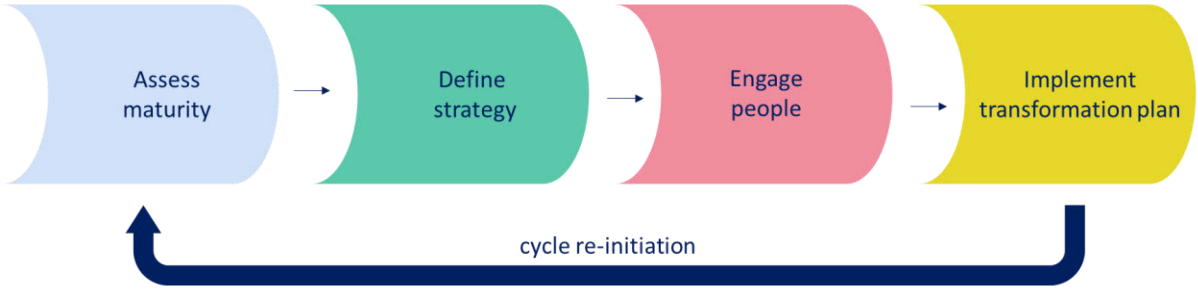
As previously stressed throughout this thesis, transformation occurs gradually and continuously rather than in a so-called "big bang" manner. Furthermore, instead of understanding transformation as a journey reaching an ultimate steady state, transformation needs to be grasped as a never-ending iterative cycle, not least because of constantly changing technologies. This stands valid for a complex organisation such as the case organisation. Hence, plotting and implementing a transformation is best performed in steps.

Belluantuono et al. (2021) adapt change management activities to the context of digital transformation, which includes: 1.) definition of strong leadership, 2.) analysis of Industry 4.0 environment to identify opportunities and threats, 3.) assessment of digital maturity, 4.) creation of awareness of the need for digital transformation, 5.) definition of a clear vision, a strategy and a roadmap, 6.) communication of the vision, strategy and roadmap, 7.) definition of a change management team, 8.) identification of short terms goals and pilot projects for digitalisation, 9.) identification and management of resistance to change, 10.) definition of required digital capabilities and skills, 11.) training and/or recruitment of people, 12.) collection and analysis of feedback and monitoring of the digital transformation process, 13.) celebration of success and implementation of corrective actions, and 14.) consolidation of change. In this thesis, a reduced number of steps is proposed, but they generally encompass and are in line with the steps identified by Belluantuono et al. (2021).

Each step needs to be clearly defined comprising an input-activity-output structure. Based on the extant literature and the insights gained from this research, four main steps are proposed: 1.) the assessment of the present state of digital maturity, 2.) the definition of a digital strategy, 3.) the engagement of people and 4.) the implementation of the transformation plan (see Figure 80).

Figure 80

Digital transformation steps



Transformation management follows, to a certain degree, good project management practices such as explicit definition, realistic planning in terms of time, resource and cost, adequate funding and organisational set-up including the appointment and authorisation of a transformation leader and team members, governance and management of progress, of changes and closure. The before mentioned aspects are of essence and pending on the fact whether transformation is performed in a project or steady-state organisation approach, boundaries to project management approaches may be sometimes interrelated and blurry. In some organisations, transformation will be managed purely as a one-off project, and the project team will be disbanded. In other organisations, such a team may remain in place over an extended period to manage transformation issues as they arise.

1.) Assess contemporary state of digital maturity of the organisation

The assessment and understanding of the as-is status is an indispensable step in every transformation ambition. This step answers the question: “where do we stand in terms of digital maturity?” As advocated throughout this study, transformation takes place along a number of dimensions. The maturity model, developed in this thesis, in its descriptive functionality allows the practitioner to assess the change dimensions technology, process, people and structure. The assessment needs to be performed holistically, taking into the consideration these change dimensions, to disclose the contemporary status-quo incorporating technological, procedural, people-related and structural aspects.

An input to this step is a clear commitment and transparent communication by top management to trigger and perform a transformation. In one of the interviews with a respondent from the case study organisation, the management members commented that it was unclear what digital transformation meant and what it could potentially offer. Starting a transformation requires the creation of a common understanding of what digital transformation actually is and sharing this understanding throughout the organisation at every hierarchical level. If there is a specific focus on one function such as strategic procurement, which is not untypical in complex organisations, a very early engagement of impacted domains or functions is advised. A functional digital transformation strategy must be embedded in a wider transformation strategy at corporate level. The self-assessment can be performed based on a questionnaire, similar to the one used in this research. If the self-assessment involves a large number of respondents, other formats such as online surveys with Likert-scale statements could be chosen. When performing this assessment in a self-assessment approach, ideally the assessment is accompanied by an objective forum/body, either inter- or external to the organisation. Potentially, the results from a survey are further detailed by interviews with domain experts. The consultation of domain experts is important to ensure overall user-centricity in the transformation ambition, e.g., a central function managing processes and governance might not be the appropriate team to explore whether present technology and processes provide the solution needed, as this function is unlikely to use the currently deployed technology and processes.

An output of this transformation step is a documented and transparent analysis of the present maturity of the examined organisation. It lays the foundation for the formulation of the digital transformation strategy by identifying for technology updates, legacy process and/or business model re-design, organisational and individual capabilities and collaboration developments. It assists in identifying the boundaries and thus defining the possible target state of the organisation as regards the change dimensions technology, process, people and structure. Ideally, the development level of a data-affine culture is determined.

Zaoui and Souissi (2020) point out the necessity to iteratively repeat such evaluation throughout the transformation process to reflect on the achievements of such and potentially re-orientate. This serves as well to keep the stakeholders enrolled and expresses the requirement for an agile approach to the transformation.

2.) Define a digital strategy

The successful process of transformation entails the development of a vision and planning of strategy and implementation (Davis et al., 2010). Strategy is understood as structured and formal plan (Ismail et al., 2017). A digital strategy can be defined as “a business strategy, inspired by the capabilities of powerful, readily accessible digital technologies, intent on delivering unique, integrated business capabilities in ways that are responsive to constantly changing market conditions” (Sebastian et al., 2017, 198). In the context of a digital transformation, the formalised plan covers in an interrelated manner the change dimensions and navigates the organisation throughout the transition and are aligned with the overall business strategy. In addition, defining a strategic vision, envisaging the digital future infrastructure, is of use as an instrument to communicate ambitions to transformation stakeholders (Berghaus & Back, 2016). Strategy formulation and execution and adequate resource allocation are be driven, and committed to, by top-down management (Sebastian et al., 2017), yet involving cross-functional stakeholders. As Davis et al. (2010) put it “strategic transformation must be comprehensive and integrated systematically with purposeful action by the leader” (p.69). This includes as well appropriate resource allocation and capital expenditure commitment (Sebastian et al., 2017). Input for the performance of this transformation step is a detailed comprehension of the extant state of the organisation in each of the change dimensions.

Part of the strategy building process is the articulation of a target state of the future organisation. This requires a realistic and balanced consideration of organisational capabilities such as resource allocation and structural arrangements. The organisation adopts a holistic approach to identify the boundaries of what an organisation can deliver and is able to endure. The maturity model established in this research, in its prescriptive design, can support the clarification of such a targeted future state, and support the formulation of strategy by the explicit determination of features per change dimension and maturity stage. A comparison and assessment of the as-is and to-be digital maturity levels indicates the scale and content of what Heeks (2002) called the “design-actuality gap” that the organisation needs to bridge in each of the relevant areas.

A digital transformation programme calls for management at corporate level, incorporating all business functions, which ideally is not limited to a predominant focus, as may be the case when transforming and modernising the design of company products or services. With reference to the digital transformation of strategic procurement, there is a need for a comprehensive integrated strategy for the deployment of SPA, which is a part of a wider corporate digital transformation strategy.

The development of the digital transformation strategy incorporates, for example, in consideration of the technology dimension, the identification of major trends in technology adoption, emerging technology and value drivers. Handfield et. al. (2019) reflect on the definition of a future state of technology and a roadmap towards it as one of the effective methods of successful adoption of emerging technologies. The adoption of technologies requires a clear focus on overarching business enhancement, rather than the limited improvement of individual processes or solving individual problems. Advanced SPA are seen as a means of simplifying processes and achieving increased efficiencies. Strategic considerations, and the definition of an overall procurement technology architecture instead of implementing purpose-specific applications that exist as island-solutions, are key. The adoption of new technology supports the achievement of business strategy objectives. The strategy needs to set out how the organisation can create value in a highly competitive business environment and thus be sustainable in the future. The strategic procurement technology architecture is to be developed from a consistent corporate business and technology strategy and consist of interconnected and standardised applications, and have an integrative character. Connecting technologies and data is paramount. Individual, isolated applications, dedicated to performing a single job, possibly being used in only one single commodity, inhibit the exploitation of the benefits of the adopted new technology and restrict the desired contribution to increased efficiency. A comprehensive corporate technology strategy needs to encompass the organisation as a whole to avoid technological silos. Once the overarching strategy is formulated, the organisation sets out priorities in the achievement of the transition based on decision criteria such as return on investment (ROI) or direct benefit for the customer and/or employees.

Digital transformation is performed to create value, new opportunities and a competitive advantage for the organisation, allowing an enduring and sustainable future. However, central to any digital transformation is the strong emphasis on enhancing value for the customer and providing positive experiences for both customer and employees by, for example, simplification through new applications (Albukhitan, 2020). Output from this transformation step is an organisation-wide aligned digital transformation strategy, consistent with the overall business strategy and incorporating the identified change dimensions and an identified realistic target state. It is widely communicated throughout the organisation so that awareness of the necessity of the upcoming change is shared across the organisation.

3.) Engage people

People, both employees and business partners, are an integral part of an organisation's digital transformation and their support for change is indispensable for success. Thus, activities relating to the people change dimension of the developed maturity model, such as transformation resource planning, onboarding, change management of the company's workforce and transformation objectives, need to be accounted for when formulating the transformation strategy. Enrolling and engaging the members of the organisation, e.g., in implementing functional digital transformation strategies for strategic procurement, involves keeping them informed by communicating the vision, strategy, and implementation process in a transparent manner. Openness to change and the development of a mindset that supports organisational transformation are key. Management needs to acknowledge that humans are reluctant to change and cope appropriately with it. It is required to accept that employees are resistant to change as natural human behaviour and to adequately manage the resistance, e.g., involving and empowering employees into the change process and celebrating achievements (Bellantuono et al., 2021).

The comprehension and exploitation of already existing and available internal knowledge and capabilities are essential. Management needs to create a climate in which people are willing and encouraged to share their capabilities in a transparent manner. Business experts need to be listened to, their needs are to be understood and the pain points, for which a solution is required, are identified and addressed. For example, in the deployment of SPA, business domain knowledge needs to be taken into consideration. The introduction of new technology is to implement solutions that solve existing problems. Encouraging an organisation-wide collaboration over top-down decision making is favourable. Successful transformation requires an adequate level of resource at the right place. A climate where people are constantly overloaded because of too many digital pilots and projects in addition to their regular jobs needs to be avoided. Otherwise, an atmosphere is created where involved people stop being enthusiastic about contributing to change and ultimately stop contributing.

In other words, it needs to be ensured, when implementing new technology, that customer centricity and user-friendliness is given priority. Otherwise, employees might stop supporting change and resistance to the introduction to new technology can grow. Taking the case study organisation as an example; when new applications are not compatible with existing processes, employees are likely to reject the use of the new technology as process adherence is mandatory and subject to audits, but utilisation of technology is not. This can result in business and transformation leaders losing credibility and consequently employees feeling demotivated and becoming disengaged.

To foster people engagement, the creation of a working environment free from the imposition of negative KPIs such as quality performance indicators is fundamental. Because of potentially negative repercussions in the organisation when mistakes happen, employees could try to hide mistakes which could lead to incompliant or even illegal behaviour.

Employees need to have the time to invest in digital capability development and the accessibility to learning solutions, allowing continuous learning. For example, strategic procurement staff should acquire analytics skills, but not everybody needs to become an expert. A reflection of one of the interviewees from the case study organisation was that powerful tools, currently deployed in the case study organisation, such as Skywise or Qlik Sense, are used as a “better than Excel” option, because only rudimentary spreadsheet capabilities exist among members of the strategic procurement community. Seemingly, technology is there, but adequate skills to master it are yet to be developed. Capabilities and skills need to be progressed in order to seize the benefits that new technology applications offer. A clear understanding of skills and capabilities, e.g., adjustment of existing job profiles or additional job profiles, is required.

The enablement of transparent and regular organisation-wide communication is paramount for the engagement of employees to keep them engaged and avoid the development of silos. True and cross-functional collaboration needs to become standard business practice. The protection of data to secure an advantage through information, perceived as vital to retain power and control, hinders the optimal utilisation of capabilities and in consequence impacts the company's efficiency and effectiveness. Kane points out the significance of this change dimension by asserting people are "the real key to transformation" (Kane, 2019, p.44).

Similar principles apply to the fundamental involvement of business partners such as suppliers. It is necessary to make suppliers part of this transformation, not least because the new collaboration technology, adjusted processes and organisational structure have an impact on external partnerships and might disrupt business relationship. Furthermore, external partners, including suppliers, can be a fruitful source in assisting the organisation's transformation, e.g., business model adjustments in order to establish new sourcing approaches, such as innovation sourcing, as presented in the literature review, in chapter 2, of this thesis.

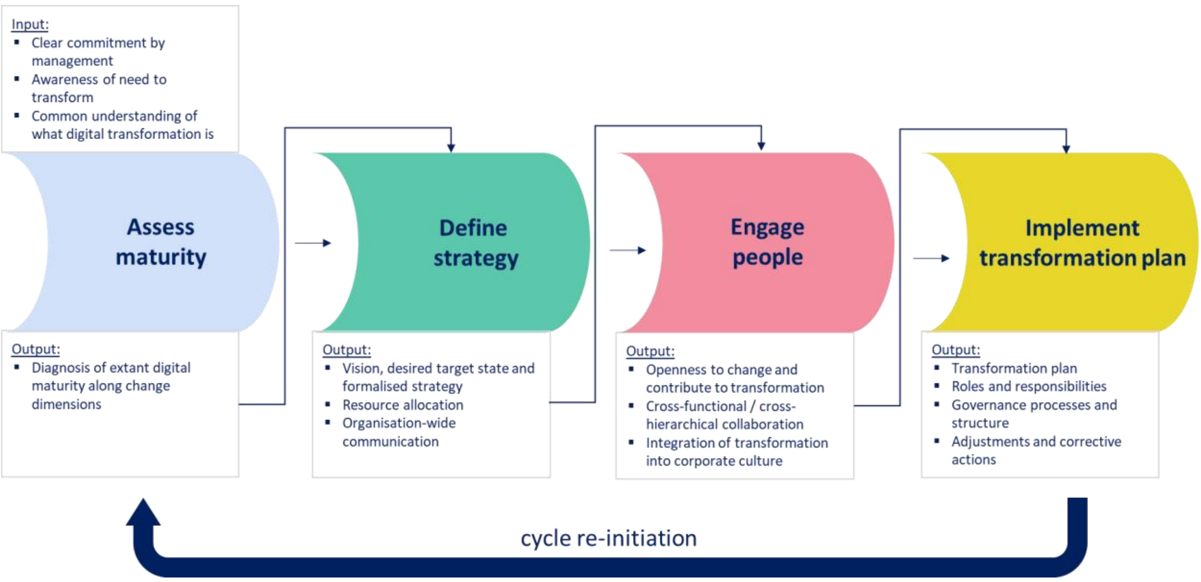
4.) Implement the transformation plan

Strategy implementation is defined as "the communication, interpretation, adoption, and enactment of strategic plans" (Nobles, 1999, p.120). In the context of this thesis, implementation relates to the translation of the organisation's formulated digital strategy into a concrete implementation roadmap, including the specification of a course of actions, definition of roles and responsibilities (Davis et al., 2010), and setting of specific, measurable, attainable, relevant, and time-bound (SMART) objectives (Bjerke & Renger, 2017).

Strategic targets are translated into operational objectives and activities. In order to allow the measurement of progress in the realisation of the transformation and compare actual results with planned results, proper governance, monitoring the achievements in terms of content, time, cost and qualities, needs to be put in place. In the context of this research, governance is understood as "a framework that combines processes, roles and accountabilities" (Biesenthal & Wilden, 2014, p.1299), and includes decision making and performance monitoring models. Overall, it aims at the delivery of transformation-related operationalised objectives and strategic targets. It entails the management of appropriate organisational structures and procedures, e.g., steering committees and rules for escalation. During implementation, the digital strategy is continuously reviewed and adjusted if needed. A vigilant implementation encompasses potential strategy modifications including a reorientation and corrections of transformation plans and actions. The transformation implementation is to be clearly distinguished from strategy formulation. Even when there is a sophisticated digital transformation strategy, poor implementation leads to failure of a high percentage of transformation projects (Correani et al., 2020), and implementation must, therefore, be performed with care, management commitment and employee engagement.

Figure 81

Digital transformation steps including in- and out-put details



In summary, organisations that engage in a transformation must actively manage such change in order to achieve the overall transformation targets. An analysis of extant literature indicates that only 30% of change initiatives deliver the expected results (Bellantuono et al., 2021). Handfield et al. (2019) deem change management as the salient feature of competitiveness for organisations in a transformation. Overall, change management can be viewed as “the process of continually renewing an organization's direction, structure, and capabilities to serve the ever-changing needs of external and internal customers” (Moran & Brightman, 2000, p.66). The term does not include defining the transformation content or ambition itself (Lauer, 2021).

7.3.2 Applying the model at strategic procurement function level

Following the presentation of digital transformation steps in the wider context of changes at corporate level, this sub-section describes how to apply the developed maturity model in a strategic procurement organisation. The set of activities includes 1.) familiarisation with the digital maturity model, 2.) assessment of present digital maturity, 3.) identification of target state, 4.) development and implementation of action roadmap and 5.) review and relaunch.

1.) Familiarisation with the digital maturity model

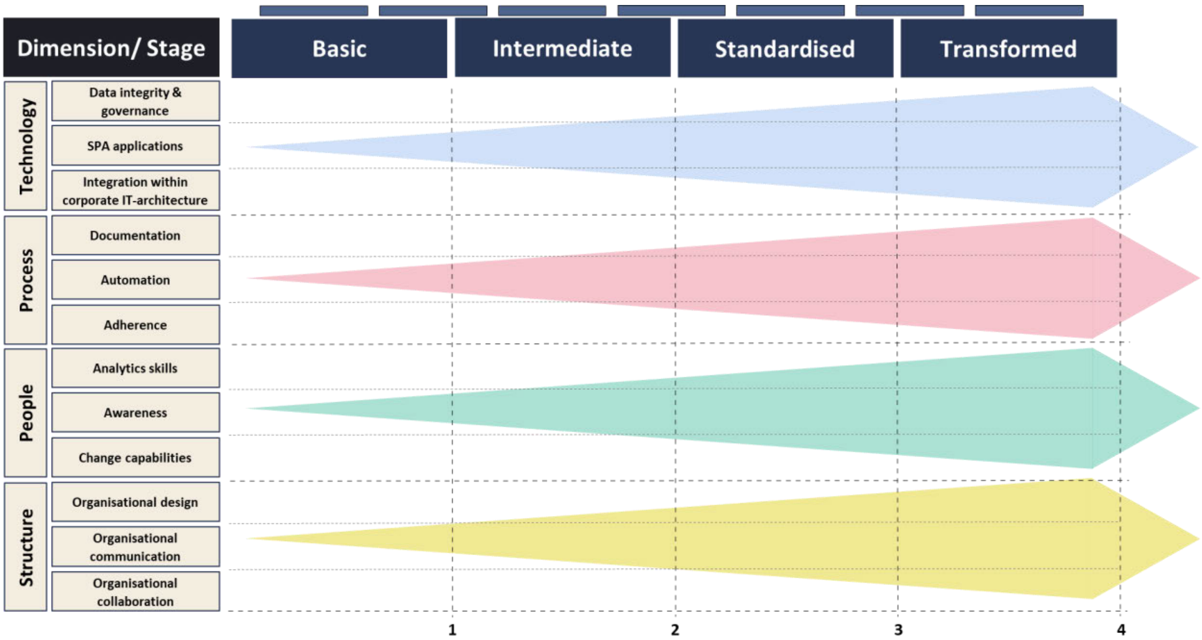
Despite the contemporary popularity and advanced understanding of digital maturity models in the field of academic research, such an appreciation may not exist in the corporate environment. Therefore, before starting the actual project or change initiative, a presentation of the purpose and working mechanisms of the maturity model can develop a shared awareness and knowledge level among the organisation’s stakeholders. Furthermore, such presentation or project brief incorporates design principles, detailing and explaining the dimensions, stages and descriptive features for further understanding of the model.

2.) Assess present digital maturity (“as-is” mapping)

Following the above familiarisation activity, the extant position of the organisation needs to be mapped, meaning the assessment of the current level of digital maturity per change dimension. This step starts with a customisation of the basic model design to accommodate the specific features of the organisation (e.g., process requirements, sourcing models, industry etc.). This allows the matching of the model to specifics of the organisation. Sub-dimensions can be added for each individual change dimension. Barry et al. (2023) argue that breaking down dimensions into sub-dimensions allows a higher level of granularity and thus strengthens the assessment. Here, three sub-dimensions, derived as an example from the case study organisation, are added per change dimension (see Figure 82).

Figure 82

Digital maturity model, enhanced with sub-dimensions



The self-assessment can be performed in different ways. If a large population in the organisation is to be addressed, a survey including a rating similar to the maturity stages with statements to be commented upon can be set up (see Table 25). This survey can be enriched by a number of open questions to further explore topics, for example existing pain points, and the envisaged future value of the organisation. The survey can be set-up with an online application such as Google Forms for easy accessibility, regardless of the participant's location, and automated data consolidation.

Table 25

Example questionnaire for "as-is" mapping

Dimension	***Sub-dimension***	***Statement***	***1*** *(poor)*	***2*** *(average)*	***3*** *(good)*	***4*** *(advanced)*
Technology	Data integrity	Please rate the quality of data to support your decision making?				
		Please rate the availability of data to support my decision making?				
	SPA applications	Please name currently deployed SPA applications and state their purpose:				
		For the SPA that you currently use, how do you rate the information provided for: "What has happened?" (1) "Why it has happened?" (2) "What will happen?" (3) "What should you do?" (4)				
	Integration within IT-architecture	Please rate the integration of SPA in the corporate IT architecture?				
		Please rate the accessibility to a common organisation-wide data platform?				
Process	Documentation	Please rate the existence and comprehensibility of process documentation?				
		Please rate the level and speed of process adaptivity?				
	Automation	Please rate the level of automated processes?				
		Please name processes that are automated at present:				
	Adherence	Please rate the actual level of process adherence/ compliance?				
		If you don't adhere to documented processes, it is due to (Please complete the sentence.)				
People	Analytics skills	Please rate your skills to operate currently deployed SPA?				
		Please rate the availability and purpose for your job of offered SPA training?				
	Awareness	Please rate the preparedness of the organisation for the future?				
		Please rate the quality of communication relating to organisational change?				
	Change capabilities	Please rate the success of past change initiatives?				
		Please rate the openness of the organisation towards digital change?				

Structure	Organisational design	Please rate the existing organisational structure decision making?				
		How do you rate your organisation's contribution to corporate objectives?				
	Organisational communication	How do you rate the transparency of information in your organisation?				
		How do you rate the flow of information between functions?				
	Organisational collaboration	How do you rate collaboration in general in your organisation?				
		How do you rate currently deployed technology to support collaboration?				
		Please name the top three existing qualities of your organisation for the achievement of corporate objectives?	1. 2. 3.			
		Please name the top three existing pain points that hinder you in the performance of your job:	1. 2. 3.			

In addition, expert and/ or executive interviews based on a pre-defined interview guide can be performed to achieve a deeper understanding of the present state of the organisation.

An illustration of the model including sub-dimensions (see Figure 82) is part of the survey and the interview guide. All respondents are asked to mark the presently perceived digital maturity per sub-dimension in the organisation on the figure depicting the model. This will provide a clearly identified and differentiated picture of existing digital maturity, as perceived by strategic procurement staff. Alternatively, if operationally feasible, a two-day workshop could be organised to assess the extant maturity.

3.) Identify target state

This step starts with a review of the "as-is" mapping. How does the perceived maturity of different change dimensions vary? Are they all more or less at the same stage of maturity or are there significant differences? Were the results expected or are there some surprises? What are the least and most mature change dimensions? How did people comment on the perception of value contribution and existing pain points?

The identification of a target future maturity state could be the subject of a workshop with a dedicated group of people including domain and transformation experts and a moderator. The advantages of a workshop approach include focus on the topic and fostering team culture. Furthermore, commitment by the workshop participants including management can be achieved to actively engage in the change process.

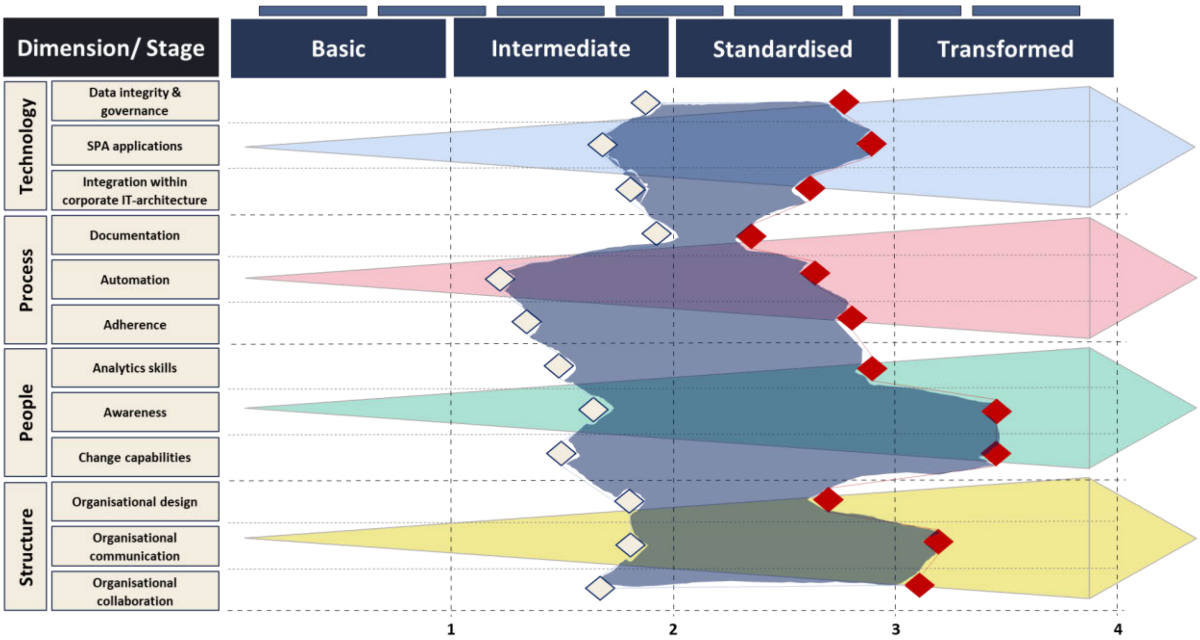
In order to identify a meaningful target state per change dimension and for the organisation overall, a series of additional questions need to be addressed. These include: what is the purpose of the organisation? what are main activities and deliverables towards the (internal) customer? what are (business) priorities and what are areas of development? More specifically, what maturity stage should be targeted for each sub-dimension, given the function's purpose and customer expectations.

In general, successive stages in the maturity model must be achieved before moving on to the next stage. For example, whilst an organisation might target the transformed stage for technology, it must pursue the actions necessary to achieve the previous stages (intermediate, standardised etc.) first. There are unlikely to be any short cuts to a transformed organisation.

The pace at which dimensions, and their sub-dimensions, progress in their maturity will vary. However, they are likely to be highly interrelated, and thus judgements must be made regarding what is desirable and realistically achievable for each sub-dimension over agreed future timescales. In making these judgements, wider future changes in the business and technology environments need to be considered. The above activities will provide a clear profile of the "as-is" position and the future target state at dimension and subdimension levels. Furthermore, the gap between as-is and target position is clearly identified and described. As presented in Figure 83, the illustration of as-is and target position in the model supports the visualisation.

Figure 83

Exemplary as-is mapping vs. (theoretical) target maturity



Note. White diamonds symbolise the "as-is" state, red diamonds symbolise the target state per sub-dimension.

4.) Develop and implement action plan and roadmap

In line with beforementioned principles of enhancing maturity (see 7.3.1), the development of an action plan and roadmap towards advanced maturity is in line with corporate objectives and strategies. To develop an action plan, priorities per subdimensions and dimensions are formulated, timeframes for the achievement of the determined actions agreed and milestones defined. Potential "quick wins" are identified. Short-term (one year) and mid-term (one-three years) objectives are incorporated into a five-year roadmap. Concrete actions per sub-dimension are defined. The output is a comprehensive and integrated action plan and roadmap towards target maturity taking into account the requirement of achieving stages successively and observing dependencies.

Roles, responsibilities and accountabilities for the achievement of the objectives are defined. Vital for the implementation is the evaluation and allocation of required human, financial and knowledge resources. In accordance with the implementation of an adequate governance, a clear definition of roles and processes is set out and put in place.

5.) Review and relaunch

In line with agreed governance structures, the progress in achieving objectives is monitored and corrective actions agreed. Regular reviews consider the appropriateness and reinforcement of the agreed objectives and target state. An adjustment of target state and objectives may become necessary, depending on progress to date and possible changes in the external environment.

The review process will encompass all relevant documents for the achievement of the objectives, such as development schedules, deliverables, resource estimates and organisation charts. It is important that lessons learnt are captured and documented and fed into future re-planning and resource and cost estimates.

7.4 Chapter summary

In this chapter, emerging themes in the deployment of SPA in the aviation industry were discussed. Section 7.2 examines a number of critical factors in the deployment of SPA or, when considered in a wider sense, factors critical to advance digital maturity in an organisation.

First of all, the deployment of SPA needs to be performed as a strategic initiative integrated in an overall digital transformation strategy - triggered, steered and transparently communicated by management. Secondly, contemporary deployment of SPA is understood to be at a rather low maturity level and limited to descriptive exploitation and to a limited number of activities along the procurement process. Overall, transformation of strategic procurement seems slow and behind its ambition to become a digitally leading function. However, the future and expanded application of SPA including predictive analytics is considered valuable. Thirdly, the consideration of data as a strategic asset and its management as a core activity supports the improvement of data integrity and accessibility. Such improvement also requires the development of individual and organisational capabilities. Improved data integrity results in an enhanced trust in data which helps foster a data-affine mindset and paves the way toward DDD. DDD is clearly advocated but organisations grapple to capitalise in terms of increased productivity. DDD is associated with enabling the modernisation of the strategic procurement process which is a prerequisite in the adoption of new technology. In particular, in the aviation industry, the re-engineering of processes is problematic and arduous due to the mandatory adherence to processes imposed by internal and external auditing bodies. In addition, the significance of the human factor was highlighted, meaning that certain strategic procurement activities such as contract negotiation cannot be totally replaced, but nevertheless can be complemented, by machines.

Section 7.3 proposes a guide for practitioners. Section 7.3.1 sets out the steps to digitally transform at corporate level, considering the nature of transformation as a dynamic and iterative cycle. Four main steps for digital transformation are put forward:1.) assess maturity, 2.) define strategy, 3.) engage people and 4.) implement transformation plan. This section provided guidance for each step, gleaned from the existing literature and the interview feedback, and identified in general terms the required inputs and expected outputs at each stage. It emphasises the significance of management commitment and the necessity to actively manage the fundamental change, both at organisational and individual level, which is central to achieving successful transformation. In line with the principles set out in section 7.3.1, section 7.3.2 offers practical guidance in the application of the digital maturity model specifically in a strategic procurement function. The section outlines the steps as 1.) familiarisation with the digital maturity model, 2.) assess present digital maturity, 3.) identify target state, 4.) develop and implement action plan and roadmap and 5.) review and relaunch.

The final chapter now concludes this thesis with a detailed response to the research objectives and reflection on contribution to knowledge and practice.

CHAPTER 8: CONCLUSION

8.1 Introduction

The aim of this research study was to provide a digital maturity model for the deployment of advanced analytics in strategic procurement. It addresses the digital maturity of the strategic procurement function in the context of an OEM, competing in a duopoly, from the aviation industry. The Covid-19 pandemic brought a number of supply chain disruptions, and the industry is also confronted with extant and emerging competitors and challenging business dynamics. These include requirements to become a “green” and innovative industry. In summary, the aviation industry is required to navigate through volatile, uncertain and accelerating business conditions. Digitally transforming by enhancing digital maturity is recognised to be vital in coping with these challenges. A key enabler to enhance digital maturity and ultimately transform successfully into a digitally mature organisation is by successful exploitation of advanced data analytics.

Strategic procurement plays a critical role in the prosperity of the company by the external sourcing of an equivalent of two-thirds of the company’s revenues (Airbus, 2023b, para.2). The development of strategic procurement into a digitally mature function is essential to accomplish overall business objectives and is part of the requirement to transform at corporate level. Specifically, the application of advanced data analytics in the corporate function of strategic procurement is seen as an essential component of a transition towards a new value proposition.

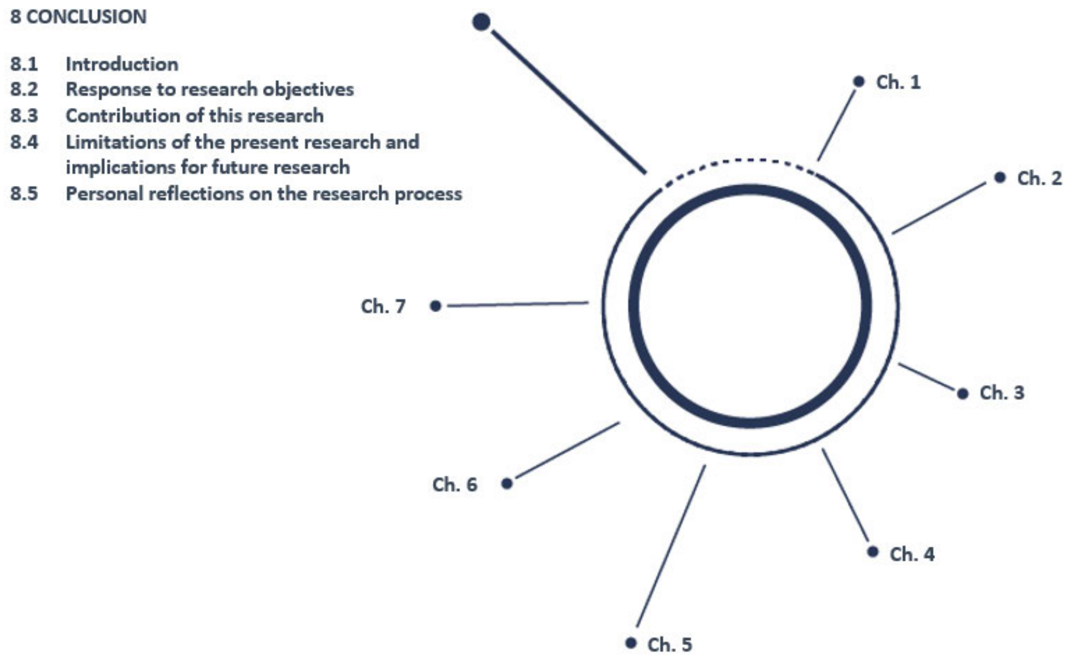
From a methodological point of view, this research was based on an interpretive research paradigm, which is often associated with qualitative research. An inductive approach was used to develop and apply the new model. The thesis centred on a single-case study and is positioned as a revelatory case where the phenomenon has just become accessible to research. It aims at extending theoretical knowledge in the under researched area of digital maturity in strategic procurement organisations (see 4.5.1).

As a result of this research study, a digital maturity model containing four change dimensions and four maturity stages was developed. Furthermore, a guide for practitioners, utilising the model and considering digital transformation overall, was designed.

In this chapter (see Figure 84), conclusions of this study are presented.

Figure 84

Structure of chapter 8 in the context of this thesis



Following this brief introduction, a detailed response to the ROs 1-3 is provided in section 8.2 after which the contribution of this study to knowledge and practice is set out in section 8.3. The subsequent section 8.4 points out existing limitations of this research and provides recommendations for future research. The thesis concludes with a reflection on the research process.

8.2 Response to research objectives

In the introductory chapter of this thesis three ROs were set out. This research was initiated by the personal desire to understand the mechanism and progress of digitalisation in the strategic procurement function of the case study organisation in comparison with other business functions such as operations (i.e., the production of the aircraft). Whilst enrolling into the PhD programme and reviewing academic publication literature, it became apparent that gaps exist in academic knowledge relating to the application of advanced data analytics and particularly the digital transformation of strategic procurement.

Publications, mainly from practitioners, but also the few available scholarly works on the subject, concluded that strategic procurement functions in most companies are located at an early phase in their digital maturity development. This gave rise to the following ROs which are addressed, in summary, below.

RO1: To review and analyse the extant literature relating to the deployment of advanced data analytics in the strategic procurement process in the aviation industry.

The aviation industry is characterised by a high future demand for commercial aircraft, particularly from Asia (see section 1.2). The demand forecast for the next 15-20 years does not change fundamentally when comparing pre- and post-pandemic figures. While still in recovery in the face of the Covid-19 impacts, aircraft manufacturers face a demanding clientele that expect an innovative, economic and safe aircraft. Further challenges include intense competition for market share between extant rivals, the market entry of emerging competitors, high-cost pressures and a complex and fragile value chain. To this, one can add the enormous pressure from the general public and politicians to decarbonise the product, its manufacturing, and its operations and become an emission-free industry by 2050. The aviation industry and its stakeholders are asked to proactively manage some very significant present and impending trends and transitions.

Strategic procurement (see 2.3.1 and 2.3.2), defined as the fundamental integration of purchasing and supply chain into the strategy, decision making and operation of the enterprise, performs the following key activities: 1.) definition of procurement strategy and policy, 2.) market assessment, 3.) identification and assessment of potential suppliers, 3.) supplier selection and negotiation of contracts, and 4.) supplier relationship management. Extant strategic procurement functions are viewed as playing a pivotal role in the achievement of corporate objectives by developing and managing a global, competitive and reliable supplier base. In practice, it is pointed out, strategic procurement has not yet become, but is compelled to evolve into, a value-chain minded function, adopting new technologies, developing the skills of procurement staff, and accelerating processes to deliver the value that the function claims to offer.

Not introducing new digital technologies is associated with competitive disadvantages. Technology is understood as the key enabler and pacemaker of transformation (see 2.2.1). Nevertheless, academic and practitioner authors consent that digital transformation is a key undertaking and must encompass business models, processes, organisational and individual capabilities and organisational structures.

Big data and advanced data analytics (see 2.2.3 and 2.3.4) are considered important technological enablers in a digital transformation. In the aviation industry, and in strategic procurement, the aspiration to exploit advanced data analytics is well documented. The term big data is defined as an abundant form of structured and unstructured data and permanently produced and compiled by various sources. The so-called “10-V” taxonomy identifies 10 characteristics of big data: Volume, Velocity, Variety, Veracity, Value, Volatility, Validity, Visualisation, Virality, Viscosity.

Advanced data analytics are categorised into descriptive, predictive or prescriptive. This categorisation represents a transitional path towards maturity in the application of advanced data analytics technology. A mature level of advanced data analytics is associated with an advanced level of digital maturity in the organisation in general, and contributes to the achievement of corporate transformational objectives. Traditional companies face a higher level of challenges in relation to implementation because IT infrastructure, data inventories, organisational structures and decision making were built and developed prior the digitalisation era.

Digital Procurement (see 2.3.4), interchangeably used with the term Procurement 4.0, itself derived from the term Industry 4.0, captures the deployment of advanced digitalisation and automation, both internally and externally interfacing with supply chain partners. Contributions stemming predominately from practitioner literature emphasise the potential of a digital procurement function. But they attest to a rather slow engagement in digital transformation and a low level of digital maturity.

Only one digital maturity model for strategic procurement could be identified in the literature during this study. Kleemann and Glas (2020) provided the “4.0 Readiness model” and concluded, in line with other authors, that most companies are at an early phase in the evolution to procurement 4.0. Consensus exits that a digitally mature strategic procurement function quickly adopts new technology, but also transforms the procurement business model, develops people, re-designs processes and adjusts organisational structures.

The numerous publications relating to the application of advanced analytics in procurement cover the discipline of SCM in general and underline the potential value of advanced data analytics in the area due to the high number of internal and external interfaces, and the respective exposure to large amounts of data. SCA is defined as the process of applying advanced analytics techniques in combination with SCM theory to datasets whose volume, velocity or variety require information technology tools from the big data technology stack; leveraging supply chain professionals with the ability to continually sense and respond to SCM relevant problems by providing accurate and timely business insights (see 2.4). Objectives for application include the measurement of performance, identification of cost reductions, improvement of supplier management, enhancement of manufacturing efficiencies and optimisation of delivery. In line with the overall perception of advanced data analytics, impacts on organisational aspects are to be further researched, capabilities at organisational and individual level are yet to be developed and a capitalisation of SCA benefits remains pending.

Only a very limited body of literature is available in the explicit area of strategic procurement. At present, strategic procurement analytics are used to visualise and manage spend. Furthermore, the application of analytics technology assists in the generation of business insights and supports decision making. Authors synthesise knowledge about potential benefits when applying analytics, such as leveraging supplier negotiations, developing meaningful sourcing strategies (e.g., consolidation of tail-end spends), automation of operational procurement process steps and achieving financial savings. Areas of particular interest include contract analytics, e.g., monitoring contractual compliance, group-wide harmonisation of terms and conditions. Further potential fields of application are risk management and prevention of fraud. The application of SPA accelerates procurement processes and reduces manual, still performed transactional work, and frees up capacity to allow focus on strategic tasks.

Even though abundant academic research exists for the studied technological concepts such as digitalisation, digital transformation, digital maturity, digital maturity models and advanced data analytics, unambiguous and academically agreed definitions do not exist for most of these concepts. Most procurement organisations are only beginning to explore the power of analytics through early steps to cleanse and categorise data, e.g., spend volumes per commodity, and adopting a more rigorous procure-to-pay process that embodies a disciplined data governance approach. Some literature suggests that the full potential of advanced data analytics has not been explored during the last three decades. Major transformational projects involving enormous investment in effort and resources have not yielded the expected results.

RO2: To evaluate the use of advanced data analytics in the procurement process (using an aviation industry company as a case study) focusing on the type of applications used and their operational implications for individuals and organisational structures.

Numerous purpose-specific applications exist in the organisation, and in strategic procurement in particular. Applications specifically for strategic procurement, such as Qlik and P360, focus on the consolidation of data from different sources and on the visualisation of past business transactions in the form of interactive customisable dashboards. Spend analysis, supplier performance monitoring, and risk management are typical areas of utilisation. Newly implemented tools are cloud-based platforms. To some extent, the large number of applications is found to be overpowering by the members of the strategic procurement function, even though training is available.

In addition, there are examples where technology deployed or planned for deployment does not support existing procurement processes, to which adherence is compulsory. For some applications, access rights are limited to a determined pool of users. These circumstances result in technology being perceived as not working properly and not supporting the need of the targeted user population. A low level of acceptance among users and a biased reluctance to apply new tools are the consequential behaviour. The individual technologies often exist in isolation, e.g., at commodity-level, with a lack of harmonisation and integration in the organisation's overall technology and process architecture even though integration is declared a priority by central functions, such as Procurement Governance. It was found that the current commodity patchwork landscape of advanced data analytics applications hinders the exploitation of SPA. For several years, an ongoing and major project within the organisation has been the integration of the different ERP-systems within the company. The overall target is the harmonisation of independently operating ERP systems in different countries and respective processes. It will allow access to a common database by relevant stakeholders such as strategic procurement members, regardless of their location. Furthermore, commodity-specific applications, in the form of manually maintained databases are used to satisfy reporting requests by the management. Data collection involves establishing contact with knowledgeable stakeholders from within or other functions and manual retrieval. Data processing usually involves manual manipulation of spreadsheet applications. Strategic procurement members have knowledge of additional applications deployed at corporate or procurement domain level, such as Skywise, a successfully deployed corporate data platform, but only rarely use them. Collaboration platforms exist such as ePROC, that allow the exchange of information and collaboration with the supplier in a call-for-tender, but with manual data up- and downloads of documents, e.g., contract templates.

SPA is viewed as unambiguously beneficial by the strategic procurement members. There are aspirations to fully capitalise the value of data and advanced data analytics and use SPA for forecasting and simulation purposes. In conclusion, the full power of SPA technology has not been “unleashed”. Overall, the present utilisation of SPA focuses on the visualisation and “dashboarding” of past transactions and contract analytics to a very limited extent. SPA is assessed to be advantageous throughout the strategic procurement process, as presented in Table 20. The potential areas of application range from leveraging internal and external data for strategy development, call-for-tender, and contract and claim management, to risk management and early technology and supplier trend recognition. Almost unexplored, but presumed beneficial, are the fields of smart contracting, SPA-augmented negotiations, and application of SPA technology that allows E2E transparency throughout the entire supply chain. This would involve suppliers that deliver directly to the case study organisation, but also at multiple sub-tier levels.

To date, the introduction of SPA has not yet produced any fundamental procedural change in the case study organisation, in neither an addition nor an elimination of process steps or activities. A direct correlation between the deployment of SPA technology and the evolution of legacy processes could not be determined. Overall, the benefits are not seen to include the complete removal of sub-processes (sometimes called “disintermediation”), or greater flexibility in the process itself. The impacts of SPA on processes are assumed to relate to enhanced speed of performing the procurement process including decision making, improved efficiencies, and substantially less manual work in data collection and processing. It was foreseen that increased automation and SPA potentially ameliorate some of the heavy validation processes that are performed at multiple functional and hierarchical levels at present. In addition, SPA could support the identification of process deficiencies. A successful implementation of SPA is closely linked to process change but is not seen as influential enough to cause it. Process adaptations in the case study organisation resulted from business requirements and not because of digitalisation.

Strategic procurement members feel more or less adequately skilled to operate currently available SPA technology. Training courses in the form of e-learnings are existent and accessible by all users. The high number of applications implemented for specific and occasionally performed activities in the procurement processes and the requirement to be familiar with them at any time overwhelms strategic procurement members and leads to notable demotivation. In addition, a full understanding of all analytics applications seems difficult to achieve. In general, strategic procurement members are open to using SPA technology, but expect user-friendly design, conditions for intuitive usage, and applications centred around the needs of the targeted audience. Broad consensus exists in the understanding that basic analytics skills, limited to an understanding of data extraction, processing and visualisation, should be part of the job profile for any strategic procurement role. Hitherto, using SPA has not had impacts on the job profile itself and is not expected to produce fundamental changes. SPA is attributed to potentially eliminating highly transactional and data gathering activities, and to allow re-prioritisation of strategic procurement objectives. Advantages to date of using SPA are the inclusion of more information from different data sources in the decision process and building capabilities and confidence to make well-informed decisions. When using SPA, a transition from experience- to data-based knowledge was witnessed. It was noted that certain roles could be become more open for a broader base of potential recruits as SPA potentially reduces the need for a technical background.

A strong appetite to use data analytics and consequently achieve a data-driven procurement management exists in the case study organisation. However, trust in the data and technology must be established as indispensable prerequisites. The addition of new roles, such as data analysts, in a central team was viewed as potentially beneficial. It was reaffirmed that an indispensable prerequisite to adding value would be a thorough understanding of the business domain. Only then was bringing in such analytics experts perceived positively. Roles like so-called “digital ambassadors” or “digital champions” within the organisation support the implementation and foster acceptance of new technologies, such as of Google Workspace. The introduction of SPA and a commonly available and accessible database was seen to improve coordination between people, but, to date, with still considerable scope for further enhancement. Resource-intensive MFT exchanges still play a vital role in the case study organisation. At present, data is not freely shared between strategic procurement functions or other corporate functions. SPA is considered an enabler that increases transparency by granting easy access to the same data for everybody. Even though the significance of the continuing interaction between humans was emphasised, there was strong support for the role SPA can play in the demolition of functional silos, both within the procurement function and the organisation as a whole.

The implementation of SPA has not yet triggered modifications of organisational structures in the company. Digital procurement is assumed to flatten management hierarchies, facilitating agility and an optimised structure. For example, agile procurement teams could be solely dedicated to performing big call-for-tenders. Alternative organisational structures include purpose-driven networks, meaning an architecture built less around “boxes”. Once a network had achieved its purpose, it would be disbanded, and nodes would be re-shuffled to serve a different mission. On the other hand, the present strategic procurement structure, built around commodities, was seen as appropriate, but that the currently centralised functions, which manage digitalisation initiatives, should be integrated in, or added to, the commodity structure, supporting it in a decentralised manner. It was also pointed out overall that the transition into a digital procurement function is corroborated by, but not attributed exclusively to, the utilisation of SPA.

Reliability of data was seen to be linked to empowerment. Full exploitation of SPA and associated transparency would lead to much more autonomous working. In general, however, concepts such as empowerment and self-organising structures are in the very early stages of development within the strategic procurement function. Pilot projects demonstrated continued incompatibility with existing processes that demand rigid adherence and managerial validation. Overall, utilisation of SPA could boost the overall performance function and generate value and thus contribute to corporate performance. Among respondents, two-thirds expect to see the strategic procurement function evolving into a truly digital procurement function during the next decade.

In this thesis, the acronym of SPA was introduced, being a development of the SCA concept and acronym, and defined as the process of applying advanced analytics techniques in combination with strategic procurement theory to leverage procurement data to derive accurate, timely and meaningful business insights, apply data-driven decision making and manage procurement-related business processes with enhanced effectiveness and efficiency.

RO3: To develop and assess the application of a new model for the digital transformation of strategic procurement in the aviation industry

In the academic literature, only a limited number of contributions on the subject of SPA could be identified. In this study, a digital maturity model focusing the deployment of SPA in the context of a global aircraft manufacturer was provided (see Figure 75).

The PCF proposed in chapter 3 was reviewed and advanced into a new digital maturity model for the deployment of SPA in strategic procurement in chapter 6. The understanding of digital transformation as a multidimensional, cross-functional, and organisation-wide phenomenon is embedded in the presented maturity model. It exhibitsfour change dimensions, namely “technology”, “process”, “people”, and “structure”. The digital maturity model discerns the four change dimensions as dependent and highly interlinked, but potentially divergent in the achievement of maturity. Each of the dimensions plays a vital role in a successful digital transformation. Technology is understood as the enabler and pacemaker of the digital transformation. In this research, the technology dimension relates to the impact of implemented SPA. Advanced data analytics are generally accepted as being one of the key enablers for organisations to build their capabilities to adapt quickly and navigate through volatile business circumstances successfully. Touched upon as an issue in the literature review, the findings from the case study analysis confirmed the position expressed by extant academic research and practitioner publications that poor data quality and data integrity issues hinder the exploitation of advanced data analytics. In the case study organisation, at organisational and individual level, the value of data as a strategic asset is yet to be appreciated. Moreover, data integrity was perceived as a paramount prerequisite to benefit from analytics technology.

Processes are considered a vital change dimension which allows simplification, automation and the effective deployment of the technology for its designed purpose and to solve a user’s problem. Introduction of SPA in a legacy process set-up restricts desired optimisation and efficiencies increases.

The people change dimension in the presented digital maturity model is viewed as a key parameter fully acknowledging that without engagement of the organisational members and enablement by management, digital transformation will fail. It incorporates the level of mastering analytics technology and empowerment (resulting from the increased trust and data-driven decision making). Structure, as the fourth dimension, reflects on the level of organisational arrangements such as hierarchical structures and coordination

The developed digital maturity model incorporates four maturity stages, namely “basic”, “intermediate”, “standardised”, and “transformed”. The inclusion of maturity status allows the determination of the current position of the organisation in its transition to a digital strategic procurement function. In the maturity model, principal features of each maturity stage per change dimension were compiled (see Figures 71-74).

By advancing all four dimensions, the strategic procurement function matures digitally and ultimately becomes a digitally mature function. It can be assumed that the advancement as per change dimension is homogenous in neither speed nor extent, but highly interrelated. Nevertheless, a similar pace in progressing the individual dimensions is necessary.

Beyond an assessment of the as-is status of digital maturity in the strategic procurement function, the model subsequently offers the possibility to identify the gap between the status-quo and envisaged target state. It can support the development of main themes in a digital transformation and recommendations for each change dimension can be concluded.

The maturity model, developed in this thesis, is specific to strategic procurement in the aviation industry and takes into consideration specific peculiarities such as the uncompromisable obligation to process adherence. This imposes high barriers to truly re-engineer, simplify and automate processes around strategic sourcing activities. Furthermore, in the case study organisation, technology seems to be available, but deployed SPA is only exploited to a very limited extend because of missing interconnectivity, limited process modernisation and missing in-depth knowledge of the technology by people.

The practical relevance and utility of the maturity model was evidenced by an online survey. It was confirmed by the respondents that the developed maturity model incorporating maturity dimensions, stages and respective principal features is appropriate to perform and repeat meaningful assessments of the current digital maturity.

In the development of the presented digital maturity model, it is fully acknowledged that successful digital transformation embraces the transition of corporate culture into a “data-affine” or data-driven culture. However, this aspect was not considered in the design of this digital maturity model as initiatives to effect a cultural change in the case study organisation were not carried out at time of investigation.

8.3 Contribution of this research

8.3.1 Contribution to knowledge

The literature review reveals an abundant number of academic publications in regards to digital transformation, digital maturity models and advanced data analytics (see 2.2.1-2.2.4). However, in the academic literature on digital transformation and the digital maturity of strategic procurement, a significant knowledge gap was identified (see 1.4, 2.3.4 & 2.4). The need for further research was articulated by academia, for example by Schild (2017) and Scholz (2016) that called for additional investigation into the impacts that advanced data analytics have on economic organisations and organisational structures. Research publications specifically concerning advanced data analytics in the strategic procurement function are few and far between. No model for the assessment and development of strategic procurement into a digitally mature function was identified. Only Kleeman and Glas (2020) provided, with the “4.0-readiness” model, an initial scholarly approach to the subject.

The main contribution of this research is the development of a new maturity model for the deployment of advanced data analytics in strategic procurement in the context of a global aircraft manufacturer. The presented maturity model addresses the implications of deployed advanced data analytics at the individual and organisational level, in particular within the strategic procurement function. The model is one of the few designed to explore the status of extant digital maturity and provide guidance for the strategic procurement function. The model provides a descriptive functionality and in addition, can be used to identify a targeted future state. Hence, it offers possibilities for a prescriptive use and to derive practical recommendations.

In the present thesis, the term of strategic procurement analytics (SPA) was introduced and defined. The research provides a detailed picture of the contemporary use of SPA, expected benefits and possible future fields of application. In this context, data integrity, in particular, was determined a concern in the present application of this technology and vital for building trust and acceptance of data-driven decision making.

This research extends existing academic knowledge in the provision of a domain-specific digital maturity model. Kıyıklık et al. (2022) confirms limitations in the existing body of literature with coverage of the airline industry. In chapter one of this thesis, it was articulated that the aviation industry encompasses the air transport sector including airline sector and the aircraft manufacturing sector. While a digital maturity model for airlines and airports (Kıyıklık et al., 2022) was proposed, a maturity model for an aircraft manufacturer could not be identified during this study. Therefore, the developed model responds to the critique from De Bruin et al. (2005) that domain-specific issues and complexity were previously not addressed adequately. Additionally, the developed model can serve as a starting point to be applied to other manufacturing companies from the aviation industry.

Overall, a comprehensive and consolidated view of the current digital maturity of a complex strategic procurement function is provided. The study benefits from the insights on individual experiences provided by domain-experts and thus underlines the validity of the model. Hereby, it answers a shortcoming of other models to inappropriately reflect the requirement of users expressed by Buckle (2017).

Furthermore, this research contributes to knowledge by examining each change dimension in the context of SPA deployment in the unique and complex context of the case study organisation. It underpins the understanding that transformation and advancement of digital maturity requires a holistic approach, not confined to the application of the latest data analytics technology.

In addition, this study contributes to scholarly work in the field of the contemporary strategic procurement function. It reflects on the current ambiguous perception and requirements of strategic procurement as a corporate function in the digital era. This research supports the call, echoed in the interview findings, for the necessary evolution of strategic procurement. The study elaborates on aspects in the modernisation of the procurement “business model” and creation of new value propositions. These emphasise the adoption of innovation sourcing as a new procurement paradigm, entailing the development of procurement as hub or a centric node in a procurement network that connects suppliers, partners and even competitors in a business environment where company's boundaries dissolve.

8.3.2 Contribution to practice

The findings of this research indicate that strategic procurement in the case study organisation is perceived to be at an intermediate stage on its path towards digital maturity (see Figure 76 in 6.3). Despite years of advocating the benefits of using advanced data analytics and digital transformation in academic and practitioners' literature, advancement has happened only at a slow pace (see 2.3.4). The enhancement of digital maturity means the adoption of new technologies, modernisation of processes, the expansion of analytical skills and introduction of new collaboration and empowerment models. In general, strategic procurement makes moderate progress to advance and transform the "business model" to assist the company to respond to market dynamics, e.g., emerging competition (see 1.2.3) and megatrends such as sustainability and innovation (see 1.2.4). Despite repeated claims that procurement could be in a leading position in a transformation, it has so far not assumed this role. Undisputedly, strategic procurement is a function that uses factual data for decision making. Nevertheless, it is not perceived as a data-driven function, nor is it generally seen as applying data-driven decision making (see 7.2.3 and 7.2.4).

Within the context of the above scenario, this thesis provides a model that allows organisations to assess and enhance digital maturity. The application of the developed maturity model allows the assessment of the current digital state of the organisation. Moreover, the model could potentially support the comparison of strategic procurement organisations either with an external organisation or in a scenario where a corporate group comprises a number of business units each with an independent procurement organisation. Thus, the model could support a wider benchmarking and harmonisation initiative. Furthermore, the digital maturity model can be used for the definition of a desired digital target state and the identification of the gap between present and future status. The model can be applied to develop paths per change dimension towards an enhanced maturity. A guide for progressing digital transformation, highlighting specific points of attention was provided (see 7.3.1). In addition, an exemplary application of the model for the assessment of current status, identification of target state and development of a roadmap was outlined (see 7.3.2).

Furthermore, the model assumes an understanding of digital transformation and maturity as multidimensional. As regards application in practice, the digital maturity model implies that technology introduction is not an isolated element of change. To become a digitally mature organisation requires the integration of the further change dimensions, as proposed in the presented model: the adaptation of processes and the acquisition of analytics skills at individual level and change capabilities at organisational level. In addition, it requires an objective assessment as to whether extant organisational structures, decision making and collaboration practices fit the requirements of current business dynamics.

This research aims at a critical revision of the contemporary state and role of strategic procurement by procurement executives. It is hoped that the findings will encourage management to embrace transformation as an iterative and strategic activity and either initiate or re-initiate change programmes or set-up permanent transformation teams in the organisation. This research potentially contributes to an improvement of change management processes by highlighting the need for a systematic and integrative approach.

Finally, the thesis highlights the significance of data as a strategic asset (see 7.2.3). Underpinning the value of data in this thesis assists procurement organisation in enhancing data integrity as a strategic priority, hence fostering trust in the data, improving decision making processes and exploiting the benefits of advanced data analytics.

8.4 Limitations of the present research and implication for further research

This research made contributions to knowledge and practice, but also has certain limitations. This research adopted a qualitative approach investigating one organisation only, meaning a single-case study was undertaken, based on in-depth interviews with 15 participants from the strategic procurement community. As demonstrated in section 4.6.2, this relatively small sample size is appropriate to achieve the point of data saturation, meaning additional interview partners would not have resulted in a richer and more complete set of data, hence altering the findings of the research. The research design allowed the development of new insights into the phenomenon under study, however statistical generalisability, meaning the determination of patterns and an accurate quantification in a large population, cannot be claimed. In general, the results of this research cannot be widely transferred to other settings and other populations. However, the developed model could be transferred to other contexts in its basic design, incorporating maturity dimensions and stages. It then should be adjusted and attuned to the specifics of such contexts, e.g., other industries or different corporate functions

The setting of this research is one in a duopoly competing global aircraft manufacturers. Hence, the research was undertaken in a unique industry and organisational context. The complex context contains a highly fragmented technology landscape and mandatory compliance to rigid processes. Highly professional domain experts and a formal hierarchy structure, focused on procurement commodities, form the people-related and structural arrangements in the case study organisation. The results from the case study analysis are based on interviews as the primary form of data gathering procedure performed between April and August 2021. Thus, the research presents a “snapshot” at a single point in time. Moreover, the case study phase was performed mainly under the influence of the Covid-19 crisis, a time of extreme volatility and uncertainty. The aircraft industry including airlines, aircraft manufacturers and suppliers has recovered and is still recovering from a substantial loss of business. Taking the results of this research, future research could establish the longitudinal impacts of deployed SPA.

Another possible limitation of this study relates to the role of the researcher as a member of the case study organisation. Even though, as pointed out by Golafshani (2003), the engagement of the researcher in qualitative research is crucial, analysis and findings could be biased and lead the researcher in a preconceived direction. As addressed in chapter 4.8, the researcher's own role in the research was critically scrutinised and a reflective approach adopted throughout the study.

An aspect to be additionally researched via the digital maturity model from this thesis could be the examination of the gap between the claim and reality of digital maturity put forward by Forrester (2019). In that study, it was concluded that the majority of survey participants who were asked for an assessment of digital maturity in their respective organisation overestimated the level of maturity. Further studies could also examine the development of strategic procurement into a digitally mature procurement function.

Academic research and practitioner literature highlighted a number of multiple digital maturity models with a varying number of change dimensions and differences in what these change dimensions measure (see Table 2 in 2.2.2). Nevertheless, more research is warranted, involving rigorous testing of which change dimensions are the most relevant and how the individual dimensions are interrelated in order to achieve a superior level of digital maturity. Such studies could look also to encompass the procurement function as it operates in other industry sectors.

In this thesis, the model did not examine the correlation between advanced digital maturity and enhanced business performance. It was not a research objective of this thesis. This is a weakness of existing digital maturity models, identified by Berghaus and Back (2016), which could profitably be addressed in further investigations. Measurable business performance improvement, and hence evidenced value creation, requires further research, both at organisational level and in particular at strategic procurement level as a supporting company function. At the same time, the aspect of data-affine culture and the development of a data-driven organisation was only touched upon in this research. The existing research gap in this field and the application of findings in practice need to be pursued. In academic publications, company culture is particularly emphasised as “there is evidence that culture is the number one hurdle to digital transformation” (Teichert, 2019, p.1674).

8.5 Personal reflections on the research process

Belonging to the case study organisation facilitated access to information and interview participants. Most people, regardless of their hierarchical level, were willing to support me in my research even though confronted with an enormous workload and being in the middle of a pandemic causing uncertainty and concerns over health issues and professional futures. Nevertheless, colleagues got engaged, trusted and opened up to me. This was helpful in “uncovering” their experiences and feelings and enriched this research. I understand and talk “their language”, meaning a mix of specific case study organisation terminology and contexts. In addition, I shared with all of the participants the fact that English is not my mother-tongue, nor theirs.

Being a part of the strategic procurement function of the case organisation, I am a domain expert, both in the aviation industry and in strategic procurement and master my job-related activities in an organisation and process landscape with enormous complexity and compliance requirements. I understood internal documentation without having to invest a lot of resource for familiarisation. I possessed the same maturity of understanding in relation to organisational aspects as my interview partners. At the same time, I was always aware of the risk of being biased.

When embarking on this research, I had to revive and strengthen scholarly working and writing capabilities. Not having studied and worked academically in more than a decade was demanding in the beginning. The literature review comprised the analysis of more than 450 journals, books and other available documentation. The precise definition of a relevant thesis topic and building the PCF required an intensive thinking process and took place in iterations. The acquisition of skills relating to research methodology, such as research design and paradigm comprehension and assessment, followed by the application of appropriate methods for this research, presented in chapter 4, was challenging.

I am proud of this accomplishment and my personal development during this thesis. During the study, I acquired content-related and methodical capabilities that assist me in improving my professional contributions. I approach topics and contribute to projects in the organisation in an academic-knowledge-based and methodological manner which overall corresponds to my personal value of continuous improvement. In addition, I developed skills with which I am able to build a bridge between academic research and practical business management, and actually transfer theory-based knowledge into strategic and operational work. This is something I always envisaged for myself.

The hardest part for me was to keep the momentum of performing the different steps in the process of research and regaining momentum once I lost it due to other priorities. My research journey took longer than I originally expected, but as one of the (inspiring) lecturers of the University Gloucestershire said in the first module back in Mainz in 2017: “Life comes in between”. And indeed, professional and personal life came in between the completion of this thesis and me. I started to wonder whether the subject and the results of my study would become outdated and no longer be of relevance. Currently, however, I strongly believe the opposite. As long as there is no unified understanding of digital maturity and practice is still struggling to turn applied advanced data analytics into measurable value, there is potential, appetite and moreover necessity for further research in maturing enterprises towards a data-driven organisation.

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X. APPENDICES

10.1 Research questionnaire

UNIVERSITY OF GLOUCESTERSHIRE
at Cheltenham and Gloucester

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February 2021

RESEARCH QUESTIONNAIRE FORM

Research on application of Strategic Procurement Analytics (SPA)

GENERAL INFORMATION

1. What is your role in Strategic Procurement?

____

2. In which Procurement Commodity do you work?

Aerostructure	☐	Equipment/Systems	☐
Cabin	☐	Material & Parts	☐

3. Which of the following activities do you mostly perform in your job?
(Instructions: Please tick the relevant boxes. If the boxes do not fit to the activities that you perform in your current role or are not exhaustive, please proceed to next question.)

Define Procurement Commodity Strategy

Translate corporate strategic goals into commodity targets and criteria	☐
Perform market and supplier intelligence and issue the commodity strategy recommendations	☐
Aggregate commodities recommendations and get management approval	☐
Set priorities within commodities and launch development action plans	☐

Select and Contract Supplier

Prepare Call for Tender (CFT)	☐
Prepare CFT Pack	☐
Perform CFT and contracting	☐
Select supplier	☐
Adhere to Ethics & Compliance rules	☐
Anticipate and mitigate risks	☐

Manage Suppliers Contracts and Supplier

Implement contractual relationship with a supplier (e.g. population master data)	☐
Monitor and manage contract execution (fulfilment of supplier obligation). Monitor supplier performance for all contractual requirements (e.g. delivery, compliance with quality requirements, legal requirements such as export control)	☐
Instigate supplier development activities (in cases of non-performance)	☐
Manage claims	☐
Amend contracts	☐
Manage Contract Expiry, evaluate, prepare and send new tendering decision	☐
Close and terminate contract	☐
Adhere to Ethics & Compliance rules	☐
Anticipate and mitigate contractual risks	☐

4. What are your key activities?
(Instructions: Please complete only in case choices of question 3 do not fit to the activities you perform in your current role or are not exhaustive.)

5. How long have you been working in Strategic Procurement (in years)?

6. What are the main objectives of Strategic Procurement?

7. What do you think is the perception of Strategic Procurement by other company stakeholders?

STRATEGY

8. Is there a corporate digital transformation (or technology) strategy?
If so, what are its key elements?

9. On a scale from 1 to 5, where do you perceive Airbus as a whole to be?

1 (early stage of digital transform.)	2	3	4	5 (fully digitally transformed)
☐	☐	☐	☐	☐

10. On a scale from 1 to 5, where do you perceive Strategic Procurement to be?

1 (early stage of digital transform.)	2	3	4	5 (fully digitally transformed)
☐	☐	☐	☐	☐

11. What do you perceive as the 5 most critical elements (game changers) of digital transformation for Strategic Procurement?

DATA

12. On a scale from 1 to 5, how do you perceive the quality of data to support your decision-making?

1 (poor)	2	3	4	5 (advanced)
☐	☐	☐	☐	☐

13. On a scale from 1 to 5, how do you perceive the availability of data to support your decision-making?

1 (poor)	2	3	4	5 (advanced)
☐	☐	☐	☐	☐

14. How do you obtain data for the decision-making process?

15. On a scale from 1 to 5, how do you take decisions?

1 (intuitive)	2	3	4	5 (data-driven)
☐	☐	☐	☐	☐

16. On a scale from 1 to 5, how do you perceive management takes decisions?

1 (intuitive)	2	3	4	5 (data-driven)
☐	☐	☐	☐	☐

17. In order to prepare and make relevant decisions, is data immediately available and easily accessible?

18. In general, is the data obtained accurate?

19. Is there a Chief Data Officer at Airbus?

20. Is there a data management governance and/or strategy at commodity level?
If so, what are its main aspects?

21. Are you aware of roles related to data governance (Data Officer, Data Custodian, Lead Data Architect)?
    For which topics do you contact them? What are the key activities of those roles?

22. What are the major barriers to establishing data governance management?

TECHNOLOGY

23. Does your commodity use Procurement Analytics applications to support procurement objectives and/or commodity strategy? Which ones?

24. Do your think the application of Procurement Analytics adds any value?
    If yes, do you agree with the following results of the utilization of Procurement Analytics?
    Can you please establish a ranking in the importance of the benefits listed below?
    (Instructions: Please tick the relevant box. Furthermore, please use the third box to establish your ranking, starting with 1 being most important.)

		yes	no	Ranking
1.	Better terms	☐	☐	
2.	Reduced supply disruption	☐	☐	
3.	Improved supplier performance	☐	☐	
4.	Facilitated supplier collaboration	☐	☐	
5.	Reduced working capital	☐	☐	
6.	Reduced transactional activity	☐	☐	
7.	Reduced risk	☐	☐	
8.	Work on higher value activities	☐	☐	
9.	Improved category strategy	☐	☐	
10.	Improved purchasing power	☐	☐	
11.	Lower prices	☐	☐	
12.	Improved visibility on potential suppliers	☐	☐	
13.	Improved visibility on technology/innovation developments	☐	☐	
14.	Improved adherence to compliance rules	☐	☐	
15.	Better contribution to sustainability initiatives	☐	☐	

Do you see any other benefits?
If you do not think that Procurement Analytics is beneficial, can you detail your answer?

25. Do you use Procurement Analytics? Can you name the applications?
    How frequent do you use them? For what purpose?

26. For the Procurement Analytics that you currently use, do they provide you with information to ...

	yes	no
... understand: "WHAT HAS happened?"	☐	☐
... understand: "WHY IT HAS happened?"	☐	☐
... forecast / to predict "WHAT WILL happen?"	☐	☐
... make a decision: "WHAT SHOULD I do?"	☐	☐

27. Are you aware of Procurement Analytics that are not applied in your commodity / in the company that you think could be beneficial? Which?

28. How well are the Procurement Analytics integrated in the Airbus overall technology and process landscape?

29. In order to add value to your job, what does Procurement Analytics need to do for you?

30. Do you use real-time data?

31. Are the Procurement Analytics available as mobile apps? Does it matter to you?

PROCESSES

32. For which of the following activities of the Strategic Procurement process do you use Procurement Analytics <u>currently</u>? (*Please tick first box.)*
For which activities (currently used and also not currently used) would the use of Procurement Analytics be most beneficial? *Please tick second box.)*

	Currently used	Most beneficial
Translate corporate strategic goals into commodity targets and criteria	☐	☐
Perform market and supplier intelligence and issue the commodity strategy recommendations	☐	☐
Aggregate commodities recommendations and get management approval	☐	☐
Set priorities within commodities and launch development action plans	☐	☐
Prepare CFT	☐	☐
Prepare CFT pack	☐	☐
Perform CFT and contracting	☐	☐
Select supplier	☐	☐
Adhere to Ethics & Compliance rules	☐	☐

Anticipate and Mitigate Risks	☐	☐
Implement contractual relationship with a supplier (e.g. population master data)	☐	☐
Monitor and manage contract execution (fulfilment of supplier obligation). Monitor supplier performance for all contractual requirements (e.g. delivery, compliance with quality requirements, legal requirements such as export control)	☐	☐
Instigate supplier development activities (in cases of non-performance)	☐	☐
Manage claims	☐	☐
Amend contracts	☐	☐
Manage Contract Expiry, evaluate, prepare and send new tendering decision	☐	☐
Close and terminate contract	☐	☐
Adhere to Ethics & Compliance rules	☐	☐
Anticipate and mitigate contractual risks	☐	☐

Can you detail your answer please?

33. Do you think that Procurement Analytics can have an impact on other megatrends such as sustainability?

34. Have you witnessed any changes of procurement processes following the implementation of Procurement Analytics? If yes, which ones?

35. Do you think processes will change/ will be redefined following the implementation of Procurement Analytics? Which? How (Rigidity vs. Flexibility)?

36. Do you think Procurement Analytics will make processes more efficient? How?

37. Will there be additional processes, or will there be processes as well that will be abundant?

38. What are the main constraints with regards to processes that you consider could be improved by the implementation of Procurement Analytics?

PEOPLE

39. Have you engaged/participated in a digitalisation/analytics project? If yes, how were the project members selected? Who was the chairperson or sponsor of the project?

40. Have you attended training to use Procurement Analytics? What and in which training form (e-learning/classroom etc.)?

41. Do you feel adequately skilled to operate Procurement Analytics technology?
42. Do you think that that the application of Procurement Analytics technology changes the job profile for your role you currently perform?

43. Do you think that Strategic Procurement members should have or should acquire analytical skills?

44. What do you consider to be the necessary hard and soft skills to benefit from the application of Procurement Analytics?

45. Did the utilization of Procurement Analytics change your way of working?

46. If Procurement Analytics is not used, how do you think your way of working would change?

47. What impact has the implementation of Procurement Analytics had on the coordination between people (intra-/cross-functional)?

48. Do you think additional roles are needed within Strategic Procurement? What would that be (e.g. data analysts etc.)?

49. Question removed

50. What is digital leadership for you?

STRUCTURE

51. Do you think that the implementation of Procurement Analytics will have impacts on the organisational structure? Which?
(Hierarchical structures vs. Agile, self-organizing structures/ Formalized departments vs. Boundless teams/Goal-based management vs. Self-monitoring)

52. What would be the optimum kind of organizational structure to take advantage of data-driven decision making?

53. Where do you see Strategic Procurement in the overall organisation in 10 years from now?
(Instructions: Please mark the scenario that you feel is most likely.)

New value proposition because of evolution to a truly Digital Procurement, supported by Artificial Intelligence	☐
No change compared to today's position	☐
Less important than today	☐
Dissolved because of technological advancement and integrated into business	☐

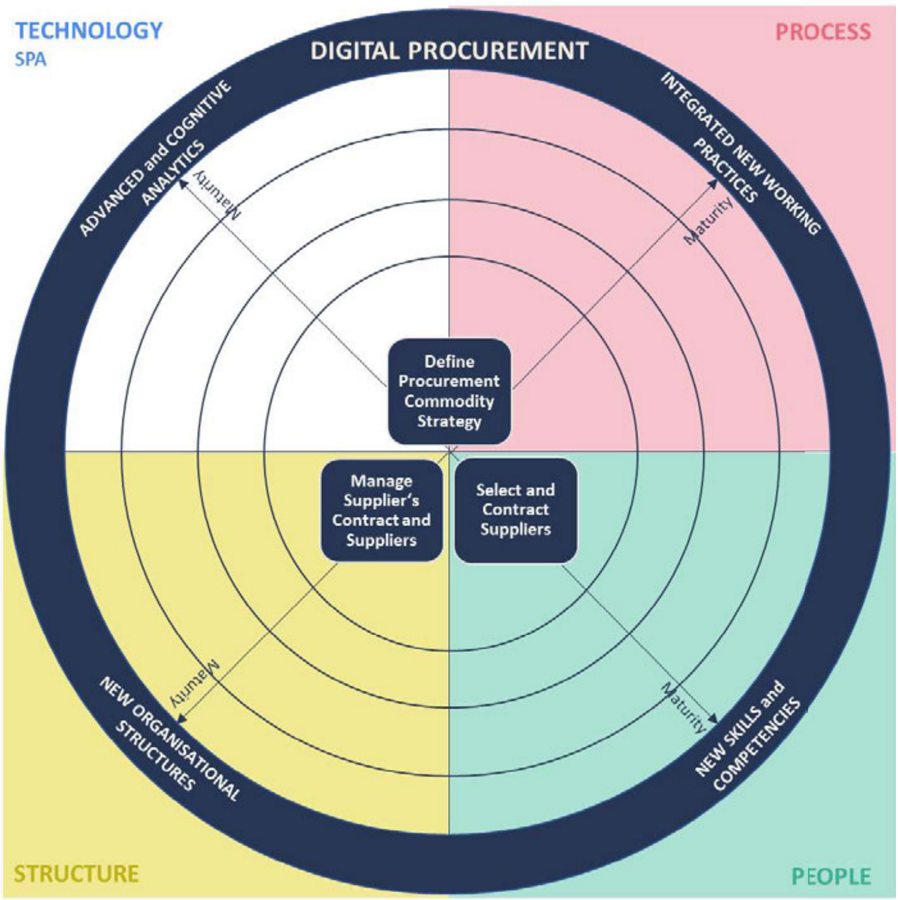
CULTURE

54. What do you think a data-affine culture looks like? Can you detail your answer?

55. Do you think Strategic Procurement has a data-affine culture today?

56. What do you see as key elements of a truly "Digital Procurement" function?

57. Please mark the current positioning (maturity) of Strategic Procurement on the conceptual framework in each of the four dimensions (Technology, Process, People, and Structure).



58. What do you think are success factors per dimension to move toward the outer circle (Digital Procurement)?

59. What do you think are core values of a digital Strategic Procurement function?

10.2 Interview brief

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February 2021

INTERVIEW BRIEF

Research on application of Strategic Procurement Analytics (SPA)

Research Background

The fact that data is seen as a key element of digital transformation underlines its significance. Procurement is in a unique position as the interface between external suppliers and internal stakeholders, and seems to be predestined to benefit from a high level of connectivity between partners, and exposure to abundant data from internal and external sources. The development of analytics capabilities in Procurement is relatively new, and a model to assess the overall digital maturity is not yet available.

Purpose of the research

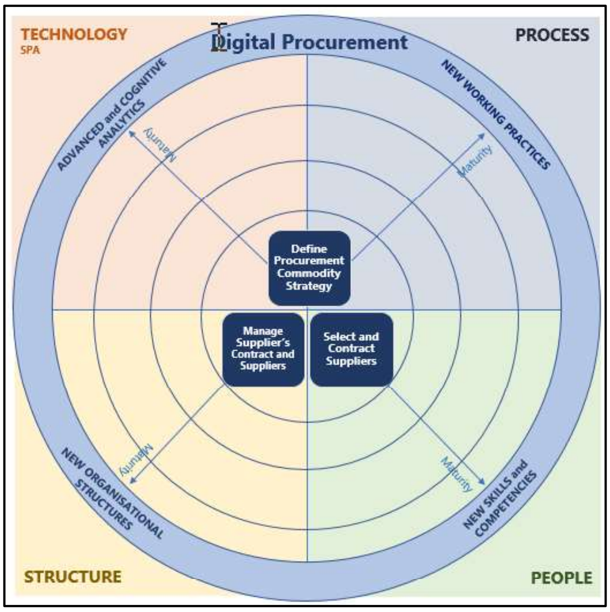
This research study investigates the application of advanced data analytics in the domain of strategic procurement and its implications for processes, people, and organisational structures.

The aim of this research is

- to evaluate the use of advanced data analytics in the strategic procurement process,
- to develop a conceptual framework for the digital transformation of strategic procurement in the aviation industry.

Methodology

Central to the study is a preliminary conceptual framework that highlights the positioning of strategic procurement in the wider transitioning to digital procurement.



Expected benefits and risks

This research investigates the application of advanced data analytics as a key enabler of digital transformation and the development of the required capabilities to adapt quickly, and navigate through volatile business circumstances successfully. The results of this research aim to improve how strategic procurement can achieve such transformation to become a truly digital function.

There are no foreseen risks associated with the involvement in the study.

Your Involvement

You have been invited to take part in this research, but participation is entirely voluntary. If you choose to participate, you will be required to sign a consent form.

Taking part in the research will involve talking to the researcher from the University of Gloucestershire for approximately an hour and a half, at a time and location that is convenient to you. All information will remain strictly confidential, and all names will be anonymised.

Audio Recording of Interviews

With your permission, the researcher would like to audio record the interview for better data capture.

Confidentiality

The information that you provide is anonymous. The information will be stored using study numbers on a password-protected computer within a locked space. Your name will not be stored with your interview data. No information about any single individual will be made available to any other person. Only group information will be given in any reports of the study, with no indication of any participant's identity. When the research is completed and reported, all recording data will be destroyed, and all the transcripts will be stored securely for a period of 10 years to allow for checking the accuracy of the information if necessary during that period.

Results

The results of this research will be part of the doctoral thesis. The research will also be published in the form of academic papers in management journals and presented at academic conferences to disseminate the research findings.

Researcher and supervisors

Dr. Martin Wynn and Professor Kamal Bechkoum (University of Gloucestershire, UK) are the principal supervisors for the study who will oversee the work of the researcher. Andrea Altundag is the researcher on the project and will be conducting the research for her doctoral thesis.

Further information

If you have any questions about this research, or require further information, please contact the study researcher at the email address indicated above.

Thank you for your interest and participation!

10.3 Consent form

UNIVERSITY OF GLOUCESTERSHIRE
at Cheltenham and Gloucester

Contact
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February 2021

RESEARCH CONSENT FORM

Research on application of Strategic Procurement Analytics (SPA)

Please complete this form to provide consent to take part in the research after reading the Interview Brief and tick YES or NO	**YES**	**NO**
1. The research INTERVIEW BRIEF has been provided to me.	☐	☐
2. I have read and understood the research project information sheet.	☐	☐
3. I have asked questions about the research project (or been given an opportunity to).	☐	☐
4. I am taking part in this research voluntarily and have not been forced by my employer or the researcher to take part in this study.	☐	☐
5. I understand taking part in this study could mean my responses could be quoted in the researcher's thesis or related work.	☐	☐
6. I agree to take part in the project and understand that taking part in the project will include completing the attached questionnaire.	☐	☐
7. I understand that I can withdraw from the study at any time, before the data is analysed without reason.	☐	☐

Please enter your name		13.02.2021
Participant Name	Signature	Date

10.4 Online survey

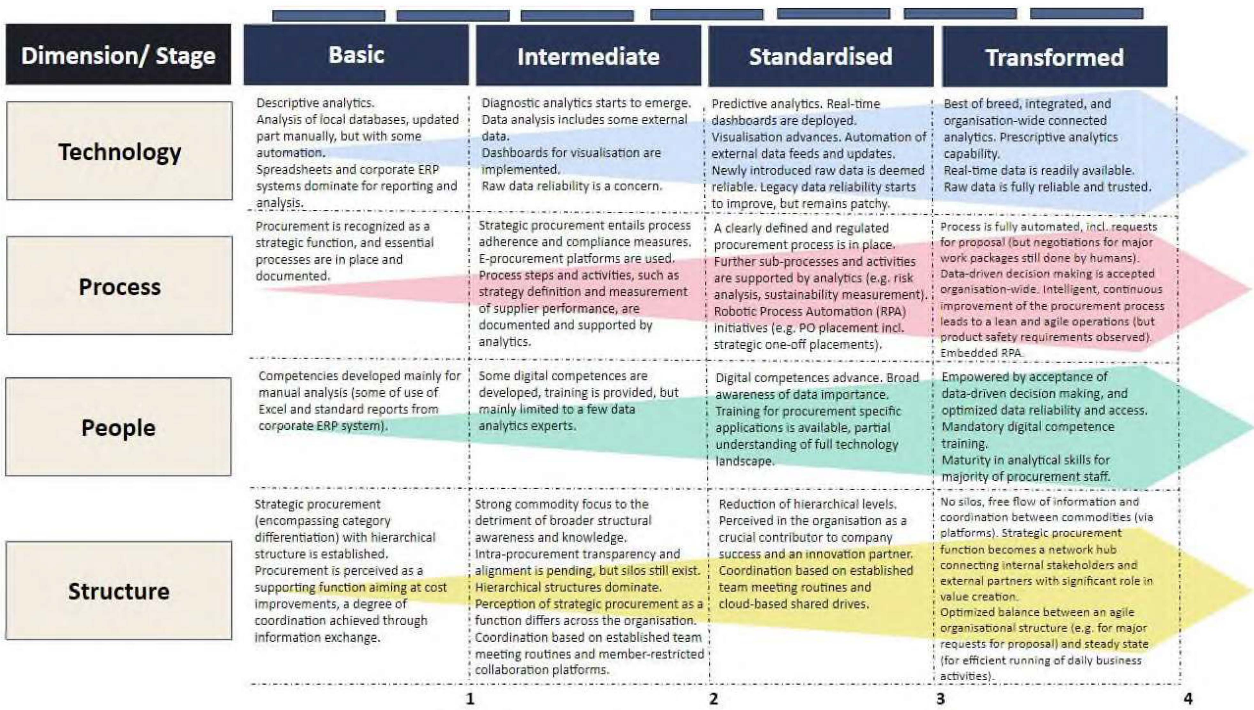
Model Assessment Survey

Dear participant,
Thank you again for your support of my PhD thesis. This online survey aims at assessing the developed model for digital transformation, focusing on the deployment of strategic procurement analytics (SPA).
I kindly ask you to

- take a look at the image "Maturity model for deployment of SPA",
- read below mentioned statements (numbered 1-7) and indicate for each statement whether you strongly agree, agree, be neutral, disagree or strongly disagree,
- please indicate the level of maturity (statement number 8) in the strategic procurement in which you work.

* Indicates required question

Maturity model for deployment of SPA including key characteristics
(for better readability of key characteristics per dimension/stage, please use link)



Dimension/ Stage	Basic	Intermediate	Standardised	Transformed
Technology	Descriptive analytics. Analysis of local databases, updated part manually, but with some automation. Spreadsheets and corporate ERP systems dominate for reporting and analysis.	Diagnostic analytics starts to emerge. Data analysis includes some external data. Dashboards for visualisation are implemented. Raw data reliability is a concern.	Predictive analytics. Real-time dashboards are deployed. Visualisation advances. Automation of external data feeds and updates. Newly introduced raw data is deemed reliable. Legacy data reliability starts to improve, but remains patchy.	Best of breed, integrated, and organisation-wide connected analytics. Prescriptive analytics capability. Real-time data is readily available. Raw data is fully reliable and trusted.
Process	Procurement is recognized as a strategic function, and essential processes are in place and documented.	Strategic procurement entails process adherence and compliance measures. E-procurement platforms are used. Process steps and activities, such as strategy definition and measurement of supplier performance, are documented and supported by analytics.	A clearly defined and regulated procurement process is in place. Further sub-processes and activities are supported by analytics (e.g. risk analysis, sustainability measurement). Robotic Process Automation (RPA) initiatives (e.g. PO placement incl. strategic one-off placements).	Process is fully automated, incl. requests for proposal (but negotiations for major work packages still done by humans). Data-driven decision making is accepted organisation-wide. Intelligent, continuous improvement of the procurement process leads to a lean and agile operations (but product safety requirements observed). Embedded RPA.
People	Competencies developed mainly for manual analysis (some of use of Excel and standard reports from corporate ERP system).	Some digital competences are developed, training is provided, but mainly limited to a few data analytics experts.	Digital competences advance. Broad awareness of data importance. Training for procurement specific applications is available, partial understanding of full technology landscape.	Empowered by acceptance of data-driven decision making, and optimized data reliability and access. Mandatory digital competence training. Maturity in analytical skills for majority of procurement staff.
Structure	Strategic procurement (encompassing category differentiation) with hierarchical structure is established. Procurement is perceived as a supporting function aiming at cost improvements, a degree of coordination achieved through information exchange.	Strong commodity focus to the detriment of broader structural awareness and knowledge. Intra-procurement transparency and alignment is pending, but silos still exist. Hierarchical structures dominate. Perception of strategic procurement as a function differs across the organisation. Coordination based on established team meeting routines and member-restricted collaboration platforms.	Reduction of hierarchical levels. Perceived in the organisation as a crucial contributor to company success and an innovation partner. Coordination based on established team meeting routines and cloud-based shared drives.	No silos, free flow of information and coordination between commodities (via platforms). Strategic procurement function becomes a network hub connecting internal stakeholders and external partners with significant role in value creation. Optimized balance between an agile organisational structure (e.g. for major requests for proposal) and steady state (for efficient running of daily business activities).
	1	2	3	4

1. 1. Overall, the model supports the realistic assessment of the current level of digital maturity in strategic procurement.

Mark only one oval.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

2. Please add comment if you (strongly) disagree.

____

3. 2. The four dimensions of change (technology-process-people-structure) are appropriate for the model and allow for a comprehensive assessment of the level of maturity in strategic procurement. *

Mark only one oval.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

4. Please add comment if you (strongly) disagree.

____

5. 3. The descriptors for the four stages of maturity in the model are appropriate, balanced and allow a realistic assessment of the different dimensions of change. *

Mark only one oval.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

6. Please add comment if you (strongly) disagree.

____

7. 4. The model can be used in practice as a guide to progress the deployment of advanced analytics in strategic procurement. *

Mark only one oval.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

8. Please add comment if you (strongly) disagree.

____

9. 5. The model supports the development of data-driven decision making. *

Mark only one oval.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

10. Please add comment if you (strongly) disagree.

____

11. 6. The model, if used effectively, can trigger and support an improvement in data quality. *

Mark only one oval.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

12. Please add comment if you (strongly) disagree.

____

13. 7. The model can be used periodically to assess the level of digital maturity and act as the basis for action planning in the different change dimensions. *

Mark only one oval.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

14. Please add comment if you (strongly) disagree.

____

15. 8. Can you please again look at the model and assess where the strategic procurement function is for each dimension of maturity.

Mark only one oval per row.

	Basic	Intermediate	Standardised	Transformed
Technology				
Process				
People				
Structure				