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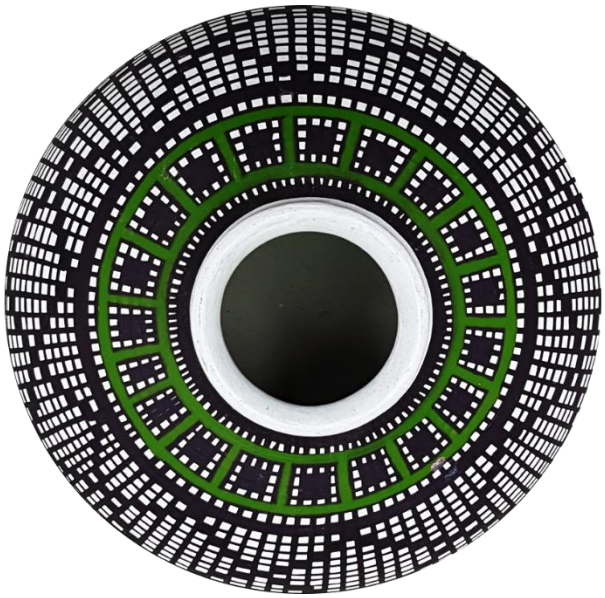

Study on up-take of emerging technologies in public procurement

DG GROW G.4, Req. No 146
Framework Contract DI/07624 - ABC IV Lot 3

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For more information about this paper, please contact:

European Commission

Directorate General for Internal Market, Industry, Entrepreneurship and SMEs

Email: GROW-G4@ec.europa.eu

Unit: G.4. – Innovative and Digital Procurement

Isabel Maria da Rosa – Policy Officer

Project Team

Sebastiaan van der Peijl, Deloitte; George O'Neill, Deloitte; Laura Doumbouya, Deloitte; Victoria Howlett Deloitte; João de Almeida, Independent Public Procurement Consultant.

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Table of Content

Table of Figures

Table of Tables

1 Introduction

This chapter introduces the purpose and structure of this document, and highlights the main focus and content of subsequent chapters.

1.1. Purpose of the document

As stipulated in the Technical Annex for the Specific Contract for the *Study on up-take of emerging technologies in public procurement* under Framework contract DI/07624 - ABC IV Lot 3, a Final Report is to be delivered as part of Task 4.

This document combines the main findings and results of the work conducted throughout the specific contract. It presents a stocktaking exercising assessing how emerging technologies are applied to the public procurement process worldwide. It combines both the findings of the longlist of initiatives developed as part of the "*1st Report: Compendium of projects using new technologies in public procurement across the globe*" and the case studies presented in the "*2nd Report: Detailed analysis (use-cases) of certain projects using new technologies in public procurement*".

Overall, this Final Report aims to provide ideas and inspiration for public organisations interested in applying emerging technologies to the public procurement process, eventually enhancing the digital transformation processes of public procurers in the European Union (EU).

1.2. Structure of the document

In line with its purpose, this report is structured as follows:

1. The first chapter **introduces** the report, its purpose and structure;
2. The second chapter presents an **executive summary** of the main findings of the study, including the development of the longlist of projects applying emerging technologies to public procurement, the 20 detailed case studies, and the lessons learnt from these case studies;
3. The third chapter provides a detailed description of theoretical **applications of emerging technologies to the public procurement process**, together with an overview of the real-life use-cases identified in **the longlist of initiatives**;
4. The fourth chapter introduces the 20 projects selected as case studies applying emerging technologies to public procurement. It presents **each case study** in turn, including the context in which the project was developed, its objectives and vision, the technological solution, results and future expectations, costs and requirements, risks and mitigation, challenges and lessons learnt;
5. The fifth chapter presents a **summary of the main findings of the cases studies**, identifying the overall impacts, costs, requirements and risks associated with each technology examined, as well as the key lessons that can be drawn;
6. The final chapter presents **conclusions of the study** and suggests **directions for future work**.

2 Executive summary

This chapter outlines the key findings of the study, including the longlist of emerging technology projects identified in the field of public procurement and the 20 in-depth case studies. To conclude, it summarises the lessons learnt and suggests directions for future work.

In OECD countries, public procurement accounts for 13% of gross domestic product (GDP) on average[1], spent in sectors delivering key public services such as healthcare and education. Given the volume of public procurement, it is crucial that this spending is well directed and that the procedures underlying it are effective. Emerging technologies can contribute to these goals and can be applied right along the public procurement process from the preparations during the pre-tendering phase, through publication of tenders and assessment of offers during the tendering phase, to contract management, reporting and evaluation during the post-tendering phase.

Over the course of this study, a **longlist of 96 initiatives** in which public organisations apply emerging technologies to their procurement processes and activities has been developed. The list provides concrete examples of the applications offered by Artificial Intelligence & Machine Learning (AI & ML; 27 projects), big data and data analytics (26 projects), blockchain (25 projects), robotic process automation (RPA; 6 projects), augmented and virtual reality (6 projects), internet of things (1 project), and robots and drones (1 project), in the context of public procurement. Initiatives led by public organisations within the EU are well represented within the longlist, providing 36 of the 96 projects.

Drawing on this longlist, **20 initiatives** were selected[2] for the development of **in-depth case studies**, providing further details on the technological solutions developed, their different impacts, costs, requirements and risks.

The following technologies and use-cases are covered by the case studies:

- **AI & ML** *(6 projects)* **–** demand prediction *(1 project)*, spend categorisation *(3 projects)*, chatbots *(2 projects)*;
- **Big data and data analytics** *(4 projects)* – business intelligence *(2 projects)*, price analysis *(2 projects)*;
- **Blockchain** *(5 projects)* – data backbone *(2 projects)*, transparency *(3 projects)*;
- **RPA** *(4 projects)* – automation of procurement processes *(4 projects)*;
- **3D printing** *(1 project)* – Printing of spare parts *(1 project)*.

The key findings of these case studies were in turn used to develop general lessons learnt aimed at other public organisations that seek to replicate initiatives and/or more broadly apply emerging technologies to their procurement function.

Regarding **impacts**, the highest quantifiable outcomes were delivered in the RPA projects, which appear to save the largest numbers of employee hours (up to 116 FTE over 3 years) through the automation of procurement processes. In a number of the other case studies, impacts have either not yet been directly measured by the project owners or may be difficult to quantify. This is the case, for example, for the big data projects which aim to improve decision-making: it is a challenge to measure the extent to which this has been achieved because the desired impacts can be wide-ranging and subject to many other variables. Overall, the blockchain and AI & ML projects analysed were smaller in scale compared to other projects and/or in earlier stages of their development[3]. As a consequence, they

[1] OECD. (2019). Productivity in public procurement. Available at: http://www.oecd.org/gov/public-procurement/publications/productivity-public-procurement.pdf

[2] These cases were chosen in order to ensure a wide geographical distribution of projects across the world, a focus on the technologies that public organisations have demonstrated the most interest in, a selection of well-developed, mature projects, and a variety of different use-cases across the public procurement process.

[3] According to the categorisation used in the longlist, projects could be either: deployed (fully developed and in operation), in development (a full-scale solution is being developed), pilot (a small-scale test case has been conducted), planned (use-case and

also appear as generating a smaller impact, with a maximum of 160 employee days per year (0.6 FTE per year) saved due to one of these projects.

Regarding **costs**, there is substantial variation across the case studies, both within and between the technology groups. All the technology groups (with the exception of AI & ML) feature at least one case study with costs over €1 million. In general, the costs of these projects are related to the scope and scale of the particular solution being developed, rather than any inherent cost of a particular technology. Consequently, the RPA and big data and data analytics cases tend to be more costly (from €250 000 to €4.1 million), reflecting the higher level of maturity and wider scope of these projects. However, it is worth noting that HHS Accelerate, a blockchain-driven initiative also drawing on AI & ML and RPA capabilities, while still in development, entails the largest financial investment (over €30 million) among the projects analysed.

In terms of **human resources,** more specifically the number of professionals involved in the projects, there is again substantial variation in the cases' requirements, both between and within technology groups. Significant differences appear across technologies in terms of the extent to which the work is outsourced. In the blockchain and AI & ML cases, a larger proportion (in some cases almost all) of the work seems to be outsourced, while the big data and data analytics projects, and to a lesser extent the RPA projects, seem to rely more on internal expertise and efforts. This may in part be explained by organisations' desire to maintain control and expertise regarding confidential data and data sources that is crucial to their operations. For the 3D printing case, a consortium is set up in order to access expertise across the value chain and to share the financial burden related to Research and Development (R&D) in the field of additive manufacturing.

As regards **other requirements** for the implementation of the case study projects, the most significant is the need for **data management** as an enabler of a number of emerging technologies. Data management practices are required to provide good quality training data for AI & ML projects, to ensure high quality data sources for big data and data analytics projects, and to deliver standardised data that RPA tools are able to process. Blockchain, on the other hand, was revealed as a possible enabler of data management, potentially providing the technological foundation for a trusted single source of data.

Finally, in terms of **risks**, a key recurring theme is the **uncertainty related to the realisation of the expected outcomes of the initiatives**. Indeed, there is usually limited previous experience for these types of projects to draw on in order to forecast their likely progression. The common approach to mitigate this risk is to implement an incremental project development approach, by, for example, first carrying out a pilot phase before moving on to a full-scale implementation.

Based on the information gathered in each case study, a series of general and technology-specific lessons for other public organisations interested in implementing emerging technologies was developed. These lessons are listed below.

goals determined but still in preparation), or a potential future implementation (interest displayed by public organisation but no concrete plans developed yet). All projects selected as case studies were in the pilot, in development, or deployed phases.

Table 1: Lessons for applying emerging technologies to public procurement

#	Technology	Lesson
1	All	Follow a gradual approach towards solution development and deployment
2	All	Develop a strategy to build-up internal support for the project
3	All	Build data management capabilities as a facilitator of emerging technology projects
4	All	Assess the appropriate approach to knowledge management
5	All	Ensure user feedback is incorporated into the solution design
6	AI & ML	Ensure access to high quality training data as a key determinant of success for AI & ML projects
7	Big data and data analytics	Involve subject matter experts in data analysis to ensure proper interpretation of results
8	Blockchain	Share knowledge of the potential applications of blockchain, which remain poorly understood
9	RPA	Thoroughly assess which processes are most suitable for automation
10	3D printing	Assess opportunities for collaboration with other stakeholders in the 3D printing value chain

Given these lessons, a promising area for **future work could include the development of guidance and recommendations on data management approaches**. Another impactful focus area would cover the production of supportive materials on **how project owners can best sell these types of projects internally**, including guidance on points to cover in a comprehensive cost-benefit analysis as part of the development of a convincing business case.

The case studies and longlist provide extensive information on different possible applications of emerging technologies to public procurement and can serve as an inspiration to public organisations. The longlist[4] remains open to additional entries and should serve as a repository of additional insightful projects as the digital transformation of public procurement continues.

[4] https://ec.europa.eu/growth/single-market/public-procurement/digital/emerging-technologies_en

3 Emerging technologies in public procurement around the world

This chapter provides a brief overview of public procurement processes. It presents theoretical applications of emerging technologies to these processes before summarising the characteristics of actual projects identified in which public organisations utilise these technologies.

3.1. The importance of public procurement and its general process

> Following the definition established in of Directive 2014/24/EU, public procurement refers to "acquisition by means of a public contract of works, supplies or services by one or more contracting authorities from economic operators chosen by those contracting authorities, whether or not the works, supplies or services are intended for a public purpose".

Source: European Parliament and European Council, 2014[5]

A significant share of government budgets – or tax payers' money – is allocated to public procurement every year. In fact, in OECD countries[6], this spending accounts for 13% of gross domestic product (GDP) on average[7] (or €6.5 trillion in 2016), spent in sectors delivering key public services such as healthcare, economic affairs and education. Given the volume of public procurement, it is crucial and expected[8] that operations are conducted following strict rules and principles ensuring their effectiveness, efficiency and compliance with shared ethical values.

Specific public procurement legislation allows for the implementation of public procurement principles into a regulatory framework that defines strict rules governing the operation of public procurement procedures. The UN Commission on International Trade Law (UNCITRAL) Model Law on Public Procurement seeks to provide enacting States with an effective legislative model to leverage modern purchasing techniques, achieve value for money and avoid unethical conduct of public procurement[9]. In the same vein, the WTO Agreement on Government Procurement (GPA) promotes mutual openness of government procurement markets among all WTO members who are parties to the GPA[10]. In the EU, public procurement procedures are regulated by three Directives[11] establishing rules on public purchases by national authorities in EU Member States.

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[5] European Parliament and European Council (2014), Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC OECD. (2018). Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0024&from=EN

[6] Including 35 member countries representing 59% of the world GPD.

[7] OECD. (2019). Productivity in public procurement. Available at: http://www.oecd.org/gov/public-procurement/publications/productivity-public-procurement.pdf

[8] Transparency International. (2018). Model Monitoring Agreement And Integrity Pact For Infrastructure. Available at: https://www.transparency.org/whatwedo/publication/model_monitoring_agreement_and_integrity_pact_for_infrastructure

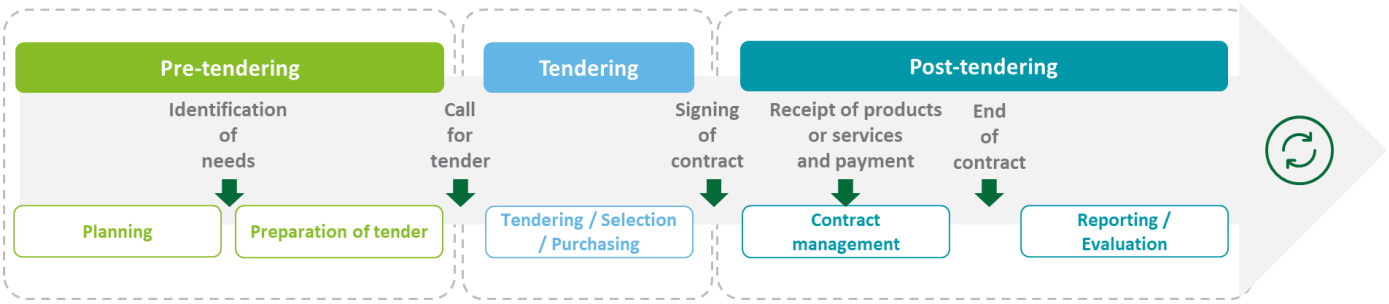
[9] UNCITRAL. (2019). UNCITRAL Model Law on Public Procurement (2011). Available at: http://www.uncitral.org/uncitral/en/uncitral_texts/procurement_infrastructure/2011Model.html

[10] WTO. (2019). Agreement on Government Procurement. Available at: https://www.wto.org/english/tratop_e/gproc_e/gp_gpa_e.htm

[11] Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC ; Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on procurement

As a result, the overall processes applied in public procurement all over the globe, at all levels of government, are fairly similar, which allows to characterise a 'typical' public procurement process, as shown in the figure below.

Figure 1: The typical public procurement process



During the **pre-tendering phase**, the following steps are followed:

1. **Planning**. Each public procurement procedure starts with a thorough planning in order to design a robust process to ensure the effectiveness of the delivery of the given products or services. Here the exact needs are identified, and the subject matter and the scope of the goods or services to be contracted are defined;
2. **Preparation of tender**. The tender is drafted. Beyond the choice of the tender procedure to follow, this includes tender specifications, selection/evaluation criteria, and contractual documents;

During the **tendering phase**, the following steps are followed:

3. **Tendering**. Following the notification and publishing of the tender, potential contractors may start submitting offers. After their reception, they will be opened and exclusion criteria will be applied.
4. **Selection and purchasing.** The evaluation committee evaluates all compliant tenders against the selection and evaluation criteria, and requests clarifications as relevant. The tendering phase closes upon the publishing of the award notice and the signature of the contract with the successful tenderer.

During the **post-tendering phase**, the following steps are followed:

5. **Contract management.** This phase involves managing the relationship with the contractor and monitoring the progress on the execution of the tasks, following up through coordination meetings and contractual reporting deliverables. Depending on the payment scheme foreseen in the contract, intermediary payments occur at given intervals or upon completion (of some extent) of the tasks.
6. **Reporting and monitoring**. At the end of the cycle, the contracting authority evaluates the contract and its execution, and monitors the outputs to create insightful data for subsequent procurement projects.

3.2. Use of emerging technologies for public procurement

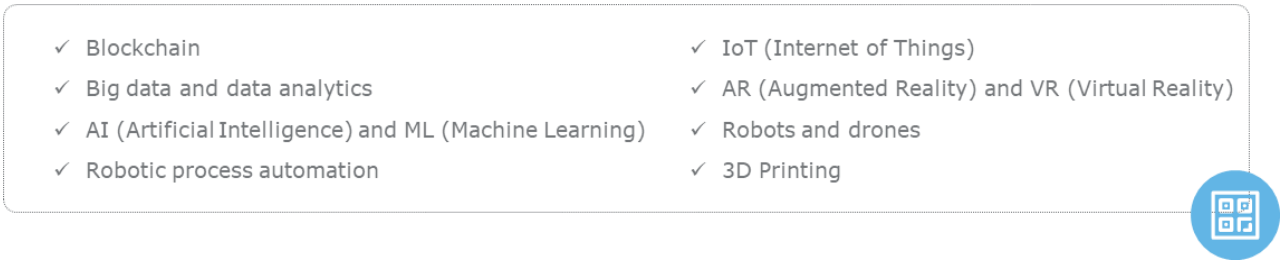
The optimisation of the public procurement process through digitalisation has a number of benefits. In this regard, 'emerging technologies' could potentially be applied throughout the public procurement process. As the label suggests, these technologies are not yet firmly established in the public procurement process. However, as presented in this chapter, they have the potential to transform this process in various ways and there is considerable scope as to how this could be achieved.

by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/EC and Directive 2009/81/EC on the coordination of procedures for the award of certain works contracts, supply contracts and service contracts by contracting authorities or entities in the fields of defence and security.

The purpose of this study is to take stock of the uptake of emerging technologies in public procurement processes around the globe. To this end, this study considers the emerging technologies listed in the figure below. While it is not an exhaustive list of technologies that could be applied to public procurement, those included fulfil the following two conditions:

1. Desk research revealed considerable scope for their **potential to transform public procurement**;
2. Most organisations engaging in public procurement have **not yet introduced** them into their processes, however interesting emerging use cases have been identified.

Figure 2 - List of technologies in the scope of this study



Source: Deloitte

Another technology that could play an important enabling role for public procurement, but which is not included here is **cloud computing**. Many of the technologies listed above could potentially be provided as a cloud solution – meaning that the public administration would buy access to the solution on the cloud, enabling it to use it without having to purchase the infrastructure and hardware that it runs on. Although, an important enabling technology, it is not included in the scope of the study, as it is considered that EU Member States are sufficiently familiar with this technology for it not to qualify as an 'emerging' technology.

A similar argument might also be used to justify the exclusion of **big data and data analytics** from the report. However, in this case the study team found enough innovative and interesting applications of this technology to procurement, to justify its inclusion in the study. In addition, the organisation and analysis of big data can be a necessary stepping stone before making use of sophisticated technologies such as Artificial Intelligence. This provides another rationale for documenting big data projects, as this can indicate where other technologies are likely to appear also at a later phase.

In some cases these technologies may not be used individually but instead together in order to improve the public procurement process. There are **clear links between several of these technologies**[12] that could make their joint deployment desirable. For example, the sensors on Internet of Things (IoT) products could provide one source of the big data processed through analytics. Meanwhile, Artificial Intelligence (AI) technologies in general are characterised by the need for enormous amounts of data in order for their applications to run effectively. Blockchain can also be seen as an enabler of several of these data-hungry applications, as it provides a way of ensuring that the data provided is reliable.

The next sections focus on each emerging technology in more detail. Based on findings emanating from desk research and interviews, it presents potential applications of these technologies within the procurement process.

[12] See for example here on the convergence of Blockchain and IoT: https://medium.com/procurement-tidbits/4-reasons-for-procurement-to-back-blockchain-7261b0633888

3.3. Emerging technologies in public procurement: applications in theory

In this section, potential applications of emerging technologies to public procurement are presented for all technologies in the scope of this study: blockchain, big data and data analytics, AI & ML, RPA, IoT, 3D printing, robots and drones, and AR & VR. The aim is to consider each technology from a 'theoretical' point of view in order to brainstorm and identify possibly use-cases. To do so, the definition and characteristics of each technology are presented, allowing for a discussion of the points of the procurement process at which they could be impactful.

In some cases, actual projects uncovered through desk research are already referenced in support of this. Section 3.4 on the other hand, will focus on the use-cases found 'in real life', thereby allowing a comparison of the theory and the practice.

3.3.1. Blockchain

Definition

Blockchain is a technology providing a distributed ledger. This means that instead of having one centralised database on which records are stored, this data is stored in a decentralised manner across all of the nodes of the blockchain network. Thus, each node of the blockchain stores all the information recorded in the ledger and forwards it on to all other nodes. Every user of the blockchain can see all previous transactions or changes made to the blockchain. Once a new record is added and approved on the blockchain, it is permanent and cannot be altered. Code can also be written onto the blockchain allowing for smart contracts – which automatically perform particular functions if certain conditions are fulfilled.

Source: Harvard Business Review, 2017[13]

Potential use-cases in public procurement

- A trusted, secure and transparent data backbone
- Ensuring transparency and reducing scope for corruption
- Automation through smart contracts

A trusted, secure and transparent data backbone

A key feature of blockchain technology is the security (based on its distributed nature and encryption) that creates transparency and trustworthiness of the data on the blockchain for all parties. Using blockchain technology for procurement would mean that "every agreement, every process, every task, and every payment would have a digital record and signature that could be identified, validated, stored, and shared".[14] This is what makes blockchain technology "a form of digital trust".[15] This key feature of blockchain technology can enable a number of important changes to the procurement process and associated impacts.

The blockchain as a shared ledger – representing the trusted, single source of truth – enables direct collaboration between individuals across departments and organisations, as well as machines and algorithms. Whereas in current processes and organisations, records are kept privately in separate systems often distributed over different departments, the blockchain would not only provide a single shared master ledger, but mean that transactions are also immediately reconcilable reducing efforts and potential errors. This would also reduce "the need for third-party intermediaries to verify or transfer ownership".[14] Hence, as different users can see when an action/transaction was

[13] Harvard Business Review article, January 2017, see https://hbr.org/2017/01/the-truth-about-blockchain
[14] Harvard Business Review, January-February 2017 issue, see: https://hbr.org/2017/01/the-truth-about-blockchain
[15] 4 Reasons for Procurement to Back Blockchain, Maltaverne (Aug 2018), see: https://medium.com/procurement-tidbits/4-reasons-for-procurement-to-back-blockchain-7261b0633888

logged and verify that no changes were made to it, there is scope to streamline operations, enable better cooperation between humans and machines and produce better insights.[14]

The latter is key when considering the list of emerging technologies that this study covers. In a world where the blockchain provides a trusted 'data backbone' deriving reliable insights from the analysis of this data becomes a key asset. As such, this opens the door for applications of big data, data analytics, business intelligence and artificial intelligence. Applying blockchain technology to the public procurement process can therefore be seen as an enabler for other emerging technologies.

Establishing a shared single source of data

Because of these features, blockchain has been proposed as the underlying technology for a database on which dispersed information from many different systems is brought together. The Global eGovernment Procurement Architecture project from the Asian Development Bank proposes the use of blockchain technology to bring together relevant data from all of the eGovernment Procurement systems from around the world in order to provide a single source of suppliers and an authenticated global online repository (e.g. for work experience certificates, bank guarantees).[16] This blockchain system would be built on top of existing eGovernment procurement systems from around the world, with new data from each individual system validated and then added to the overarching blockchain record.

In a similar way, the Public Services and Procurement Canada[17] has used blockchain technology to link their system holding information on suppliers with that of the Province of British Colombia. The blockchain technology linking the two systems is not used to transfer data from one to the other, but instead it provides a map of which organisations in the different administrations and regions hold what type of authoritative information on different suppliers. Likewise, the US Department of Health and Human Services uses blockchain technology to store and link "data from 100 000 contracts […] across five separate legacy contract writing systems". The added value of blockchain in this context is "full visibility into prices paid and terms and conditions", information which is used for "both planning and negotiating" [18].

Providing verified and authenticated information only once

A major way that blockchain could drive efficiencies during the tendering process is by ensuring that supporting documents required from suppliers during the procurement process need only by submitted once, and then verified against authoritative sources. By ensuring there is a common record of the verified information on suppliers that is accessible by different public buyers, administrative burden could be reduced. The above referenced example of the eGovernment Procurement Architecture project from the Asian Development Bank provides one example of this use-case - by enabling the sharing of work experiences that are stored once and authenticated, it would reduce the lengthy process which public procurers must go through to seek evidence and verification of the previous experience and achievements of suppliers. Similarly, the system trialed by the Japanese Ministry of Internal Affairs and Communication[19] aimed to allow public buyers to gather official documents such as tax payment certificates directly over the blockchain, removing the need for potential suppliers to submit them.

In another case, plans were announced to establish blockchain as the data backbone for another part of the procurement process. The Philippines national administration's Department of Budget and Management announced plans[20] to use blockchain to record stock levels as part of the Philippines Government Electronic Procurement System. The Head of the Department commented on the technology "we're going to use it for our warehousing" and

[16] Development of a Global e-Government Procurement Architecture using Blockchain Technology, Asian Development Bank (Oct 2018), see: https://www.adb.org/sites/default/files/project-documents/47192/47192-001-tacr-en_5.pdf
[17] Presentation by Laura Serghi, Public Services and Procurement Canada at Digital Transformation of Public Procurement Conference, October 2018, see: https://ec.europa.eu/docsroom/documents/32211
[18] Ledger Insights article, January 2019, see https://www.ledgerinsights.com/us-health-department-hhs-blockchain-procurement/
[19] Asian Nikkei Review article, June 2017, see https://asia.nikkei.com/Business/Biotechnology/Japan-looks-to-blockchains-for-more-secure-e-government-systems
[20] Bitpinas article, November 2018, see https://bitpinas.com/news/philippines-will-move-its-procurement-process-to-the-blockchain/

claimed that a blockchain system for doing this would be "secure and less expensive compared to a big data system".[21]

Ensuring transparency and reducing scope for corruption

In situations in which corruption is a concern, the transparent nature of records on blockchain is often seen as valuable. Explicit reference to this benefit is referenced in several projects identified through desk research. For example, one of the benefits of a ChileCompra pilot project on the use of blockchain in public purchases[22] was seen as reducing the potential for corruption. Part of the motivation of the project is that the security and transparency characteristics of blockchain provide a "guarantee that the documents in the purchase orders of the public sector have not been altered by particular interests"[23]. Similarly, for a blockchain project delivered in Yeongdeungpo-gu district in Seoul, South Korea[24], the value of the technology was partly derived from the fact that the data recorded on the blockchain "cannot be easily falsified". This was seen as enhancing the "trustworthiness and transparency" of the assessment of responses to tenders.

Automation through smart contracts

Another type of use-case enabled by blockchain is the further automation of parts of the procurement process. This possibility rests in particular on the ability to code smart contracts onto the blockchain. Smart contracts are automated programs that are stored and run on top of the blockchain so that the programme will "automatically execute when predetermined terms and conditions are met"[25].

Researchers at the University of London have published a proof of concept that proposes that tendering organisations "create a tender as a smart contract and place it on the blockchain".[26] This smart contract should include as well the "evaluation criteria stipulated in the tender specifications". They propose that these evaluation criteria could themselves be published as "evaluation code" on the blockchain. Once the request for tender is published on the blockchain, potential suppliers would be able to download it and publish their own offers in response as a smart contract on the blockchain. Then, when the deadline for submitting a bid is up, the smart contract would automatically stop accepting new bids. At this point, the tendering organisation downloads all received bids and runs the evaluation code against them. Following this, it announces the winner of the tender and publishes the results on the blockchain. At this point, this information will also be made available to citizens, who will be able to download the offers and the evaluation code and run this code themselves to confirm that the process was fair and run according to the declared criteria. The researchers claim that the advantage of this system is that it would "allow a citizen to evaluate the process with a single click" and thereby "increase government transparency and accountability".

Elsewhere, some have expressed scepticism over the potential for smart contracts to be used to automate the evaluation of bids for public procurement. Critics ask how could "acceptance criteria … be expressed or evaluated in lines of code"[27].

An example of smart contracts being used to enable automation of the public procurement process is a project carried out by the US General Services Administration. In this pilot project, smart contracts are used to automate the assessment of vendors' financial information compared against other companies. The smart contract automates the comparison of "financial ratios to the average of companies with the same NAICS code[28]", thereby allowing

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[21] GovInsider article, November 2018, see https://govinsider.asia/digital-gov/exclusive-philippines-announces-plans-for-blockchain-in-budget/
[22] Press release on ChileCompra website, July 2018, see https://www.chilecompra.cl/2018/07/chilecompra-inicia-proyecto-piloto-para-el-uso-de-la-herramienta-blockchain-en-compras-publicas/
[23] Bitfinance news article, July 2018, see http://bitfinance.news/en/idb-sponsors-public-purchases-in-chile-with-blockchain/
[24] Ledger Insights article, January 2019, see https://www.ledgerinsights.com/seoul-district-using-blockchain-for-public-procurement/
[25] IBM blog 2018, see https://www.ibm.com/blogs/blockchain/2018/07/what-are-smart-contracts-on-blockchain/
[26] Hardwick, Akram and Markantonakis, 2018, see https://arxiv.org/pdf/1805.05844.pdf
[27] Forbes article, February 2019, see https://www.forbes.com/sites/davidblack/2019/02/04/blockchain-smart-contracts-arent-smart-and-arent-contracts/#36cfbe1c1e6a
[28] North American Industry Classification System (NAICS)

"contracting officers to have quicker access to this financial analysis to make responsibility determinations" and "save a financial analyst 10 to 15 days when it comes to reviewing each proposal".[29] This solution has been designed to lessen the burden on industry and increase the accuracy in terms of the evaluation of […] contractors".[30]

3.3.2. Big data, data analytics and business intelligence

Definition

There are numerous definitions of big data – but commonly they refer to data sets which have reached a level of complexity such that normal methods are insufficient to analyse them. This complexity is commonly linked to the "Vs" – Volume (i.e. the amount of data), Variety (i.e. the data is in many different types – numeric, text, images, videos, etc. – and formats), Veracity (i.e. the trustworthiness of the data), Velocity (i.e. the speed at which new data is generated and moves around), Viability (i.e. the relevance and feasibility to be used), and the Value that data can bring based on the insights that can be gained from it.

Data analytics refers to the process of analysing data to describe events that have happened. It uses a range of statistical methods so as to "aggregate data in order to report a result, search for a pattern and find relationships between variables". Such methods can also be built and extrapolated upon in order to make predictions about the future.

Business intelligence systems can be understood as a subcategory of big data and data analytics providing "a system of tools for gathering, storing, analysing and providing access to data that helps organisations make better and faster business decisions"[31].

Source: Deloitte, 2016[32] & Forbes, 2018[33]

Potential use-cases in public procurement

- Support to decision making – analysis and evaluation
- Analysis of corruption
- Transparency through data visualisation

The amount of data available in the public sector is greater than ever before. Data is continuously being generated by machines and sensors (see also Section 3.3.5 "Internet of Things" below) while initiatives to bring together data sources (including using blockchain as an enabling technology as described previously) are creating growing opportunities to apply "analytics techniques to facilitate the creation of insights in data and content".[32]

Big data and data analytics could enable a range of improvements throughout the public procurement process, providing "a vastly superior guide to effective policy decisions and implementation compared to our current knowledge"[34]. Areas of application could include but are not limited to:

- Daily spend monitoring;
- Risk-based audit;
- Supporting system-wide policy decisions; and
- Supporting government accountability through, for example, watchdog portals[34]

[29] GCN article 2018, see https://gcn.com/articles/2018/11/15/gsa-blockchain-mas.aspx
[30] GCN article, 2017, see https://gcn.com/Articles/2017/09/21/GSA-looks-to-blockchain-for-procurement.aspx
[31] Singaporean Defence, Science and Technology Agency, Business Intelligence in government Procurement, see https://www.dsta.gov.sg/docs/default-source/dsta-about/business-intelligence-in-government-procurement.pdf?sfvrsn=2
[32] Big data analytics for policy making, Deloitte (2016) for the European Commission, see: https://joinup.ec.europa.eu/sites/default/files/document/2016-07/dg_digit_study_big_data_analytics_for_policy_making.pdf
[33] Forbes article, see https://www.forbes.com/sites/forbesagencycouncil/2018/08/01/do-you-know-the-difference-between-data-analytics-and-ai-machine-learning/#33ea56445878
[34] Fazekas and Saussier, Ch. 7 Colloquium, in Gustavo Piga and Tünde Tátrai (eds.), Law and Economics of Public Procurement Reforms

The use of big data and data analytics is also tightly entwined with that of Artificial Intelligence and Machine Learning. On the one hand, big data sets may require artificial intelligence tools to prepare and analyse them, because in some cases the job of "sifting through all of that data, parsing it…and analysing all of it" is simply "too much for human minds to tackle"[35]. On the other hand, the effective application of AI is entirely dependent upon data to the extent that "AI doesn't work without data. It consumes data in order to learn"[36].

The applications of big data to public procurement are currently limited by the lack of "large structured and high quality datasets"[37]. However, governments are tackling this challenge. The Norwegian Agency for Public Management and eGovernment (DIFI) has set up a Digital Procurement Program[38] through which it is currently working on the linking and storage of different data sets in a single place. The program has the ultimate aim of improving and streamlining public procurement by moving to a fully digitised procurement process. However, as a first step towards this, the program is working on first ensuring that all data from transactions between suppliers and public buyers is captured. The proposed system for achieving this makes use of the Peppol eDelivery network – which provides a set of common business processes and technical standards that can be used to link eProcurement platforms. DIFI is ensuring that all invoices are sent both to the buying organisation and to DIFI itself, which stores them for future analysis. The precise use to which this data will be put has not yet been determined, however, it could include categorisation of different types of procurement spending, and input into the states' budget making process.

Analysis and evaluation - support to decision making

In other cases, the preparation of the requisite data sets has progressed far enough to enable the provision of insights into procurement activities and support to decision making. The State of New York, for example, analysed its data on historical purchases to shift its sourcing strategy to "increase volume from fewer suppliers"[39].

In many big data and data analytics projects, the primary aim is holistic analysis and visibility over the procurement process in order to identify areas and actions for improvement. In other instances, a more specific use-case was identified for the analysis – namely the assessment and analysis of procurement prices. The MEDIAAN platform[40] in Belgium, for example, brings together a range of "applications, databases, and other instruments related to pricing of public procurement contracts". The historical data on tenders collected on this platform is then used to support "pricing analysis, pricing assessment, and pricing review" by public buyers.

At this point business intelligence systems of varying sophistication have been integrated into eProcurement systems around the world. A World Bank report identifies business intelligence modules in national eProcurement systems in Bulgaria, Georgia, Macedonia, Ukraine, Albania, and Turkey. This software is used for "monitoring and statistical review of the trends in public procurement".[41] Another advanced business intelligence system is also in place in Belarus. Under the new system implemented with support from the EBRD, the open contracting data standard was implemented across 3 different eprocurement platforms used in Belarus in order to provide a single data source for procurement analytics and reporting. Business intelligence technology is used to transform the standardised raw data into meaningful and useful information with visual graphics used to display this information.

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[35] Maryville University blog post, see https://online.maryville.edu/blog/big-data-is-too-big-without-ai/
[36] Hackernoon article, October 2018, see https://hackernoon.com/ai-and-big-data-two-major-parts-of-the-digital-future-2f9c7c5e813a
[37] Fazekas and Saussier, Ch. 7 Colloquium, in Gustavo Piga and Tünde Tátrai (eds.), Law and Economics of Public Procurement Reforms
[38] Details of the program were shared with the study team during an interview with a DIFI employee
[39] Data Smart City Solutions article, May 2017, see https://datasmart.ash.harvard.edu/news/article/ten-great-ways-data-can-make-government-better-1041
[40] Coninck, Viaene, Leysen and van der Auwera, June 2017, Barometer Innovative Public Procurement in Belgium, p.9, see https://www.vlerick.com/~/media/corporate-marketing/our-expertise/pdf/20170927BarometerInnovativePublicProcurementpdf.pdf
[41] World Bank Report, 2015, e-Procurement forum: enhancing public spending, Annex II "Summary of presentations submitted", see https://collaboration.worldbank.org/content/usergenerated/asi/cloud/attachments/sites/collaboration-for-development/en/groups/e-procurement/documents/jcr:content/content/primary/blog/enhancing_publicspe-Y88Z/Enhancing-Public-Spending-Vienna-ANNEX-II-Summary-of-Presentations-Submitted..pdf

Identification of corruption

Detecting and preventing corruption is a priority for public authorities both inside and outside of Europe with, for example, a national campaign[42,43] in Portugal to raise awareness of the costs associated with bid-rigging and enabling officials to identify collusive behaviour. Two European projects, Red Flags and Digiwhist, are using big data and data analytics with the aim to reduce corruption. In the case of Digiwhist, the project performed "systematic collection, structuring, analysis, and broad dissemination of information on public procurement"[44]. The project brought together 25 different data sources[45] on public procurement, and used this information to develop indicators of public sector corruption. The Red Flags project[46], aimed to "enhance the transparency of public procurements in Hungary and support the fight against corrupt procurements". The project has developed an algorithm through which procurement documents are run. It flags "risky procurements" and sends them to users that have signed up for alerts.

Outside of the EU, similar projects are also being pursued. The South Korean Bid-rigging Indicator Analysis System (BRIAS), implemented by the Korea Fair Trade Commission "carries out quantitative analysis of bidding information"[47] in order to "detect signs of bid-rigging" as an "automated system for the detection of red flags in public procurement". Since 2012, BRIAS has been used to assess "20,000 to 30,000 biddings per year". In 2012 "the system generated 200 hits that warranted an additional look" and "three cases initially identified by BRIAS have led to findings of guilt"[48].

Finally, the Ukrainian ProZorro platform[49,50] provides an ex-ante data-driven monitoring system. The system was developed together with the EBRD. It monitors risks of corruption in real time, using algorithms to flag high risk cases based on risk indicators and drawing on data based on the open contracting data standard. In practice, an automated risk-indicator engine scans all active electronic tenders for non-compliance and irregularities, following which risky transactions are selected for further monitoring. The system presents real-time results for the entire procurement system.

Transparency through data visualisation

One method to ensure that the information provide through the analysis of big data is properly understood and can be acted upon is through data visualisation techniques. Data visualisation involves the "presentation of data of almost any type in a graphical format that makes it easy to understand and interpret"[51]. The US Treasury's Datalab[52] project provides one example of this as a "platform designed to help generate public understanding of government spending through interactive data visualizations and analyses"[53]. This portal provides information on federal spending and in 2017 providing "insights, accountability and oversight into $3.98 trillion of government spending"[54]. Features include "a browseable map of 2000 federal agency accounts" as well as the ability to "intuitively browse agency awards to specific contractors".

[42] Combate ao Conluio na Contratação Pública, see http://www.concorrencia.pt/CombateAoConluionacontratacaopublica/
[43] The campaign is not included in the study longlist of initiatives as it does not make use of emerging technologies
[44] Digiwhist website, see http://digiwhist.eu/about-digiwhist/
[45] Digiwhist Methods Paper, see http://digiwhist.eu/publications/d2-8-methods-paper/
[46] Redflags website, see https://www.redflags.eu/
[47] Korea Fair Trade Commission, Current Status of Operation of Bid Rigging Indicator Analysis System, http://www.ftc.go.kr/www/cmm/fms/FileDown.do?atchFileId=FILE_000000000079626&fileSn=0
[48] OECD Country Case: Korea's Bid Rigging Indicator Analysis System (BRIAS), 2016, see https://www.oecd.org/governance/procurement/toolbox/search/korea-bid-rigging-indicator-analysis-system-brias.pdf
[49] ProZorro website, https://ProZorro.gov.ua/en
[50] Details shared during interview with EBRD
[51] Datamotion article, June 2017, see https://www.datamation.com/big-data/big-data-visualization.html
[52] Datalab website, see https://datalab.usaspending.gov/index.html
[53] Fedscoop article, April 2018, see https://www.fedscoop.com/federal-spending-data-visualizations-data-lab/
[54] Data Coalition press release, April 2018, see https://www.datacoalition.org/press-releases/treasury-launches-data-lab-on-revamped-usaspending-gov/

3.3.3. Artificial Intelligence and Machine Learning

Definition

A broad and commonly used definition of Artificial Intelligence (AI) is as a technology that is able to perform "tasks commonly associated with intelligent beings [...] dedicated to solving cognitive problems […] such as learning, problem solving, and pattern recognition". It is also defined as "a system's ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation".

Machine learning is a way of achieving artificial intelligence based on the "ability to learn without being explicitly programmed" by "training an algorithm so that it can learn" and "feeding huge amounts of data to the algorithm and allowing the algorithm to adjust itself and improve".[55] AI machine learning can therefore be considered as a set of models and tools providing "core capabilities of AI such as natural language processing, speech and image recognition and reasoning" such that a machine "analyses data, makes assumptions, learns and provides predictions at a scale and depth of detail impossible for individual human analysts".

Source: Business Horizons, 2019[56] & Forbes, 2018[57]

Potential use-cases in public procurement

- Analysis and evaluation – procurement data, government spending and stakeholder sentiments
  - Quality of information uploaded to eProcurement platforms
  - Sentiment analysis of users
- Categorisation of government spending
- Identification of corruption
- Contract preparation and management
- Chatbots
- Further automation of procurement tasks

Analysis and evaluation – procurement data, government spending and stakeholder sentiments

The ability of artificial intelligence/machine learning tools to process large amounts of data and perform sophisticated data analysis enables them to "automatically extract meaningful patterns from large datasets for decision making"[58] and pick up trends and anomalies that were not previously detected. In a procurement context, AI tools can be applied to identify "patterns in the large volumes of data generated through purchasing and then [forecast] future trends"[59]. In addition they can be applied to other types of data and used to ensure correct and accurate information is uploaded to procurement platforms, or even to monitor the reactions and behaviours of users and stakeholsers.

In addition, these tools can be used to support procurement decisions made by procurement officers. The Performance Information Procurement System (PIPS) was used by Utah Division of Facilities Construction Management[60] and draws on artificial intelligence capabilities. The system was designed and tested in response to

[55] The Difference Between Artificial Intelligence, Machine Learning, and Deep Learning, (McClelland 2017), see: https://medium.com/iotforall/the-difference-between-artificial-intelligence-machine-learning-and-deep-learning-3aa67bff5991
[56] Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence, Elsevier Business Horizons January-February issue 2019, (Kaplan & Haenlein, 2018), see: https://www.sciencedirect.com/science/article/pii/S0007681318301393?via%3Dihub
[57] The Key Definitions Of Artificial Intelligence (AI) That Explain Its Importance, Forbes, (Marr 2018), see: https://www.forbes.com/sites/bernardmarr/2018/02/14/the-key-definitions-of-artificial-intelligence-ai-that-explain-its-importance/#4ae9c7df4f5d
[58] Becominghuman.ai article, June 2018, see https://becominghuman.ai/the-benefits-of-ai-in-data-analytics-2eef978292d0
[59] Chartered Institute of Procurement and Supply, 2019, see https://www.cips.org/en/supply-management/opinion/2018/november/how-to-survive-the-public-sector-shift-to-ai/
[60] Forbes article, May 2018, see https://www.forbes.com/sites/forbestechcouncil/2018/03/22/ai-can-help-procurement-reach-the-high-hanging-fruit/#7b57f18e7167

a chronic problem in the state of construction projects going over budget. One driver of this problem was thought to be "subjective bias in procurement". With this in mind, an AI system was seen as a solution to provide a more "objective buyer". This system was tested on "the procurement of the $2.96 million Bridgerland Academic Training Center" with the criteria used incorporating information on both price and performance[61]. The results of this trial were seen as a success, with the construction project being delivered "on time, on budget, [and with] high quality"[62].

Quality of information uploaded to eProcurement platforms

Artificial Intelligence can also be used to monitor the tendering documents and information prepared by the public buyer for clarity and language quality. As part of an e-procurement platform solution, an AI assistant can provide "a semantics check on requirements and other text in the procurement material" in order to "decrease the risk of bidders misunderstanding the tender material… reducing the bidder risk" and thus "lowering the total cost of the bid".[63] Both the Italian central purchasing body, Consip, and the Ukrainian eprocurement body, ProZorro, are exploring uses of AI in relation to this.

Consip is developing a project, "Mepa watch" in which natural language processing tools are used in order to monitor the information uploaded onto its platform by procurement officers. In this way it is able to detect whether the correct information is being put onto its system, for example whether the correct codes are being used for products

Sentiment analysis of users

Other AI applications can be used to assess user approval of a public procurement platform. Consip is experimenting with AI to better understand how the users of its platform view it. The organisation is piloting the use of a machine learning platform enabling sentiment analysis of both buyers and suppliers using its platform. The pilot project draws on data from twitter to provide quick feedback on how users react to developments such as the publication of new tenders. It categorises relevant tweets as either positive, neutral or negative.

Categorisation of government spending

One analytic task that AI tools are performing on public procurement data is the categorisation of different types of spending across organisations in order to provide visibility and understanding of how administrations are allocating their budget. This type of application is observed in the Finnish Explore State Spending Project[64]. In this project, the central procurement unit of the Finnish Government, Hansel Oy, publishes information on levels of government procurement across 57 different public buyers across 13 administrative branches. In order to categorise the different types of procurement (e.g. ICT procurement, business premises, route projects, administrative services, etc.) made across all of these administrative branches and organisations, an AI tool is used.

In a similar type of application, the Australian New South Wales Data Analytics Centre is building "a machine learning neural network to categorise how the NSW Government's $30 billion annual procurement budget is allocated each year"[65]. Under the proof of concept currently underway the aim is "to validate what [the NSW Government is] spending money on, and then confirm whether it's getting value for money." The overall aim of the project is to "[help] the people who are working to reform procurement".

The Ukrainian Government has also been working on a range of potential AI applications for its public procurement platform, ProZorro. One such machine learning application draws on natural language processing to automatically

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[61] Kashiwagi, 2015, Case study: Best value procurement/performance Information Procurement System Development, see https://www.aiaseattle.org/wp-content/uploads/2015/01/Case-Study-Best-Value-Procurement-Performance-Information-Procurement-System-Development.pdf

[62] Kashiwagi and Byfield, 2002, Testing of Minimization of Subjectivity in Best Value Procurement by Using Artificial Intelligence Systems in State of Utah Procurement, see https://ascelibrary.org/doi/pdf/10.1061/%28ASCE%290733-9364%282002%29128%3A6%28496%29

[63] The Reuse Company press release, January 2019, see https://www.reusecompany.com/news/516-a-successful-swedish-procurement-conference-2019

[64] Tutkihankintoja website (Explore State Spending), see https://tutkihankintoja.fi/about-service?lang=en

[65] Microsoft press release, June 2018, see https://news.microsoft.com/en-au/features/nsw-government-signs-agreement-with-microsoft-to-globalise-data-science-capability/

suggest the common procurement vocabulary (CPV) codes that should be input on its platform on the basis of product names.[66]

Identification of corruption

Artificial intelligence can also be used to identify corrupt behaviour in procurement. Corruption is an expensive problem for governments around the world, with an estimated worldwide annual cost for bribery alone of "about $1.5 to $2 trillion"[67]. Given the scale of the issue, it is therefore unsurprising that both administrations and citizens – taking advantage of new open data policies - are investigating the potential of artificial intelligence in this regard. Here again, the value of AI tools is to "reveal patterns too complex for humans to see without mechanical assistance" and "process large amounts of data" so that people can "focus on details".[68]

The Singaporean Agency for Science, Technology and Research, for example, has developed an AI system that will "analyse HR and finance data, procurement requests, tender approvals and workflows to pick up patterns" with the aim of "identify[ing] potentially corrupt or negligent officials before the cases escalate in public". This tool can perform analysis such as "correlate[ing] names of individuals and employees of the company – say family members –… against names of suppliers".[69]

The Brazilian Labcontas project[70,71,72], is similarly enabling automated checks of public tenders posing a risk of potential corruption. The Labcontas project, brought together 96 databases with information relevant to the work of the Brazilian Federal Audit Court (TCU). Following this, three automated tools were developed that facilitate the work of the Court. The "ALICE" tool, for example, performs a daily check of all bids from federal agencies. The results of this daily analysis are sent to TCU auditors by email, with the system flagging any abnormalities about the bids. Meanwhile, the "MONICA" tool provides a visualisation of public purchasing data, such as the suppliers that are most contracted and the types of service most used, and finally the "SOFIA" tool analyses the reports developed by auditors. It points out errors and suggests correlations and reference sources.

Another project focussed on corruption is the Ukrainian DoZorro initiative, which has developed AI software which "learns to identify tenders with a high risk of corruption". The beta test results of this software tool were that "26% more tenders with unfounded selection of the winner were identified, 37% more tenders with groundless disqualification, 298% more with participants' conspiracy".[73] Spanish researchers[74], meanwhile, have developed a neural network designed to provide an "early warning system" predicting public corruption. The tool uses data on economic and political factors such as economic growth and the length of time a political party has stayed in power, together with data on actual corruption cases to predict the risk of corruption in Spanish provinces.

Contract preparation and management

The preparation and management of contracts was repeatedly referred to in the strategic interviews conducted in the course of the study as an area of public procurement in which there is room for improvement. AI is seen as one of the technologies that could deliver this improvement. AI could be used in this area to ensure, for example, that

[66] OECD Observatory of Public Sector Innovation, 2018, see https://oecd-opsi.org/innovations/eprocurement-system-ProZorro/
[67] IMF Staff Discussion Note "Corruption :
[68] Oxford Insights article, July 2018, see https://www.oxfordinsights.com/insights/aiforanticorruption
[69] GovInsider Article, May 2016, see https://govinsider.asia/security/exclusive-singapore-trialling-ai-to-predict-procurement-fraud/
[70] Panorama Publico article, March 2018, see https://panoramapublico.com/2018/03/26/big-data-e-gestao-publica/
[71] Atricon article, September 2018, see http://www.atricon.org.br/imprensa/destaque/tcu-usa-tecnologia-para-combater-fraudes/
[72] Globo article, March 2018, see https://g1.globo.com/economia/tecnologia/noticia/como-as-robos-alice-sofia-e-monica-ajudam-o-tcu-a-cacar-irregularidades-em-licitacoes.ghtml
[73] Transparency International Ukraine press release, November 2018, https://ti-ukraine.org/en/news/DoZorro-artificial-intelligence-to-find-violations-in-ProZorro-how-it-works/
[74] López-Iturriaga and Pastor-Sanz, November 2017, Predicting Public Corruption with Neural Networks: An Analysis of Spanish Provinces, see https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3075828

"organizations maintain consistency in the terms and usage in all of their contracts"[75] and to speed up manual tasks from "identification of requirements, to creation and approval of critical contracts, to their eventual renewal".[76]

With the advance of AI technologies comes the hope that they could take over "the function of drafting contracts from lawyers". With the current state of technology, AI tools are able to "produce standard form contracts as long as there is a precedent provided to the contract generator, and to create simple, un-complicated contracts". It is thought that currently the development of systems that can "draft advanced contracts" would be costly and "require an extensive beta testing with a large number of users"[77]. The HHS Accelerate project, managed by the US Federal Department of Health and Human Services, has made some headway on this use-case. It draws on its extensive database of previous procurement contracts to make recommendations to public procurement officers on standard clauses that they should include in public procurement contracts that they are drafting.

Chatbots

Procurement procedures can often be complex and difficult to navigate, with information on the necessary steps to take not immediately accessible. This can be a challenge both on the side of buyers and suppliers, Chatbots provide one example of an AI-enabled tool that can be used to face this issue. Such tools "offer a conversational experience using artificial intelligence and natural language processing to mimic conversations"[78]. In the procurement process they can deal with user questions, thus freeing up time for employees to focus on other tasks. In practice, this technology can range in sophistication, as follows:

- **FAQ Chatbot** – which "can understand questions" from users and provide them with "the most relevant answer";
- **Virtual Assistant** – which as well as responding to questions can "perform basic actions, such as looking up personal information"; to a
- **Virtual Agent** – which can "completely replace an employee" and handle the most complex dialogs, processes and security protocols".

There are existing examples of chatbots which have been developed to respond to queries from employees of public sector buyers, and those for which the target audience is potential suppliers. In El Paso City, Texas, for example, a chatbot – Ask Laura[79] – was developed to help with "customer service" type enquiries from potential suppliers. The chatbot is able to provide "immediate information on topics that include how to register as a vendor with the city; how to do business with special programs; where to find bids and other FAQs". In another example, the US Airforce is working with IBM to develop a tool that "could navigate the 1,897-page Federal Acquisition Regulation, helping potential government vendors actually bid for military contracts".[80]

On the other hand, the San Franciscan Government Digital Assistant, PAIGE (Procurement Answers and Information Guided Experience), has been developed with an internal public sector employee audience in mind. This chatbot is built on top of a "natural language processing engine" and is able to answer "about 1000 questions" related to IT procurement. The project was developed in response to "scattered and threadbare" institutional knowledge about the procurement process, which was seen as "confusing, especially for employees in smaller agencies that don't buy a lot of technology".[81]

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[75] AI Business article, October 2018, see https://aibusiness.com/procurement-powered-ai-opportunities-risks-challenges/
[76] Harvard Business Review article, February 2018, see https://hbr.org/2018/02/how-ai-is-changing-contracts
[77] Ng, 2017, TTLF Working Paper: The Art of Contract Drafting in the Age of Artificial Intelligence: A Comparative Study Based on US, UK and Austrian Law, see https://www-cdn.law.stanford.edu/wp-content/uploads/2017/02/Irene-Ng-TTLF-Working-PAper-26-Art-of-Contract-Drafting.pdf
[78] Deloitte, Chatbots point of view, see https://www2.deloitte.com/content/dam/Deloitte/nl/Documents/deloitte-analytics/deloitte-nl-chatbots-moving-beyond-the-hype.pdf
[79] GovTech article, December 2017, see http://www.govtech.com/dc/Meet-El-Pasos-Chatbot-Ask-Laura-Shes-a-Real-Game-Changer.html
[80] RT article, March 2016, see https://www.rt.com/usa/336177-usaf-watson-computer-procurement/
[81] Statescoop article, march 2018, see https://statescoop.com/san-francisco-procurement-chatbot/

Further automation of procurement tasks

Many of the use-cases described above describe examples in which artificial intelligence is used to automate various stages of the procurement process, from user support to contract preparation. There is considerable speculation about the potential of artificial intelligence to automate yet further aspects of procurement, for example, supplier management and efficiency monitoring,[82], and increase the efficiency of staff working in public procurement in a myriad of ways. One example of planned further automation of the procurement process is observed in Finland, where the State Treasury has declared plans to use Artificial Intelligence to automate invoice processing. Finland already has a high level of eInvoicing but officials believe that with the aid of AI technology they will achieve "one-hundred per cent eInvoicing". AI can make eInvoicing more palatable by "further eliminating administrative burdens" and is expected to lead to "substantial costs savings for the public administration".[83]

[82] Future of sourcing article, January 2018, see https://futureofsourcing.com/will-machine-learning-save-procurement-millions-a-year

[83] Finland is using AI in attempt to achieve one-hundred per cent eInvoicing, European Commission (October 2018), see https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/2018/06/13/Finland+is+using+AI+in+attempt+to+achieve+one-hundred+per+cent+eInvoicing

3.3.4. Robotic process automation

Definition

Robotic process automation (RPA) technologies are software programmes that are able to perform repetitive, rules-based tasks. They are able to automate many of the basic, routine processes that are currently done manually. Typically, these are clerical tasks which involve the transfer of information between applications. Such tasks could include filling in forms, copying and pasting, scraping data from the web, and extracting structured data from documents. Robotic process automation is not to be confused with Artificial Intelligence. Although both technologies can be applied in order to automate tasks, robotic process automation is a less complex technology. It simply replicates actions that users previously performed in an application.

Source: Deloitte, 2017[84]

Potential use-cases in public procurement

- Automation using RPA
  - Gathering and verifying information about suppliers
  - Invoice processing

Automation using Robotic Process Automation

There are a wide variety of tasks that could be automated in public procurement using RPA. The tasks most suited for automation in this context are "routine processes performed manually that lack the scale or value to warrant automation via IT transformation, but for which macros and other such desktop automation tools are too limited to effectively address". RPA therefore represents a sort of midway point, enabling automation up to a certain point for basic tasks, which can be just sub-processes, and doesn't have to be (and typically isn't) "applied to an end-to-end process"[85]. Indeed, this quality has led to the observation that RPA "could be the perfect way for procurement organisations" to digitalise without "burn[ing] their fingers in attempting to do something that they don't fully understand".[86]

Given the potential wide range of application, a basic checklist that can be run through to consider whether a task is suitable for robotic process automation could include that:

- they are rules-driven processes, requiring no human judgement;
- they are repetitive in nature;
- they can be performed out of hours;
- they involve data manipulation, such as calculations and data migration;
- they are data intensive;
- they are electronically triggered;
- they have a high error rate; and
- they involve reconciliations[87,88]

[84] Deloitte, 2017, The new machinery of government Robotic Process Automation in the Public Sector https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/Innovation/deloitte-uk-innovation-the-new-machinery-of-govt.pdf

[85] Deloitte, 2017, The new machinery of government Robotic Process Automation in the Public Sector https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/Innovation/deloitte-uk-innovation-the-new-machinery-of-govt.pdf

[86] GEP article, December 2018, see https://www.gep.com/blog/robotic-process-automation-in-procurement

[87] Deloitte, 2017, The new machinery of government Robotic Process Automation in the Public Sector https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/Innovation/deloitte-uk-innovation-the-new-machinery-of-govt.pdf

[88] Process involving confirming accounting records by comparing balances of transactions

Gathering and verifying information about suppliers

The US General Services Administration has been investigating the potential application of RPA to their processes. An early test case they selected was to see if RPA could run a "validation of whether or not a vendor was eligible to do business with the government". The tool was able to "pull a DUNS number from an offer, go to the website, run validation, print PDF results" and furthermore was able to do this task, which would have taken an employee "about 15 minutes" in "10 seconds". In a second test, the RPA tools was even able to "pull information from vendor offers on websites and populate them into a pre-negotiation memo"[89]. The mTender digital procurement service platform implemented in Moldova also implements robotic process automation in order to perform tasks including eligibility checks on suppliers.

Meanwhile, in Finland, Palkeet, the Finnish Government Shared Services Centre for Finance is applying robotic process automation in a widespread manner across "payroll, procurement, finance, accounting, data processing and invoicing"[90] tasks. The project aims at saving "6 million [euros] and up to 116 FTE (full-time equivalent) of manual work until 2020". Palkeet has applied RPA to its management of its supplier register, using the tool to "create and supplement vendor data"[91].

Invoice processing

Another task to which RPA technology was put in the Palkeet example includes the verification of invoices. Between June and November 2017, an RPA tool was used to process "247,965 invoices". Out of these invoices "59% were correct regarding the number verification and the rest were transferred…for further processing"[92]. In order to achieve these results, Palkeet worked with a private partner to "build its own scalable robot environment and center of excellence".

[89] Federal News Network article, March 2019, see https://federalnewsnetwork.com/technology-main/2018/03/how-gsa-turned-an-automation-project-into-a-acquisition-time-saver/

[90] Norian press release, see https://www.norian.eu/palkeet-expand-highly-successful-software-robotics-cooperation-norian/

[91] Palkeet presentation, November 2017, "Handi and RPA", http://nssc-forum.com/onewebmedia/NSSCF_Palkeet_RPA_17112017.pdf

[92] Palkeet presentation, November 2017, "Handi and RPA", http://nssc-forum.com/onewebmedia/NSSCF_Palkeet_RPA_17112017.pdf

3.3.5. Internet of Things

Definition

The Internet of Things (IoT) can be defined as technologies that enable devices and locations to generate information and which also connect those devices and locations to enable data analysis and potentially action. IoT involves physical objects making use of the Internet backbone in order to communicate data about their condition, position, or other attributes.

Source: Deloitte, 2018[93]

Potential use-cases in public procurement

- Asset tracking
- Forecasting, inventory and automated ordering

IoT is connected with huge opportunities and values across sectors and industries, projected to grow to an $8.9 trillion market by 2020[94], with the number of connected IoT devices reaching almost 31 billion.[95] A part of this value is attributable to IoT's impact on procurement and related processes with one of the major advantages of IoT described as "gaining supply chain visibility". IoT indeed has great potential to provide data and improve operations right across the supply chain.

Asset tracking

Despite this potential, there is limited evidence of IoT technology being used by public procurement authorities to transform their operations. In the area of asset tracking, one case is observed of in the military sector of a supplier making available sensor equipment for the "US Department of Defense (DoD), NATO, and Federal Government agencies" in order to track information on "equipment, materiel and supplies"[96]. A recent Pentagon audit highlighted "inaccuracies with its internal asset tracking databases". It is claimed that the new sensors would be effective for "tracking and managing… valuable inventory with the potential to save taxpayers hundreds of millions of dollars".

Forecasting, inventory and automated ordering

IoT can enable the tracking of inventory levels and support forecasting in order to ensure an organisation has enough stock to reach demand as well as automated ordering when stocks run low. [97,98] No cases were observed of this potential IoT use case in the context of public procurement, however.

[93] The Internet of Things: A technical primer, Deloitte 2018, see: https://www2.deloitte.com/insights/us/en/focus/internet-of-things/technical-primer.html?icid=dcom_promo_featured|us;en#endnote-sup-3
[94] Forbes article, December 2017, see https://www.forbes.com/sites/louiscolumbus/2017/12/10/2017-roundup-of-internet-of-things-forecasts/#2d8ea3ba1480
[95] Statista 2019, see https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/
[96] BusinessWire article, November 2018, see https://www.businesswire.com/news/home/20181127005160/en/Savi-Introduces-New-Sensors-IoT-Asset-Tracking
[97] Farnell article, see https://nl.farnell.com/amazon-a-prime-example-of-an-iot-implementation
[98] Forbes article, January 2017, see https://www.forbes.com/sites/michelleevans1/2017/01/24/5-ways-the-internet-of-things-will-influence-commerce/#748756b44a0f

3.3.6. 3D printing

Definition

3D printing – or additive manufacturing – refers to a process whereby 3D objects can be printed from digital data. This process starts with a digital 3D model of the object, and this object is then manufactured, in general by laying down layer after layer of a material on top of each other. 3D printers can manufacture objects from a number of materials, including plastics and metals.

Source: Deloitte, 2017[99]

Potential use-cases in public procurement

- Production of prototypes
- Production of supplies

3D Printing provides an alternative to traditional manufacturing methods. It operates according to a "layer-by-layer additive process", adding layers of material, one on top of the other, until the physical object is created[100]". Compared to traditional manufacturing it has different strengths and advantages as illustrated in the table below:

Table 2: Benefits of 3D printing and traditional manufacturing

Benefits of 3D printing	Benefits of traditional manufacturing
Design complexity ✓ Can produce intricate designs, that are difficult or impossible via traditional methods	**Mass Production** ✓ Well-suited for high volume production
Speed to market ✓ Little to no tooling required, saving time during design and development	**Choice of materials** ✓ Can use a wide variety of materials (3D printing predominantly uses polymers, metals, ceramics and composites
Waste reduction ✓ Uses less extraneous material	**Manufacturing large parts** ✓ Better suited to this than 3D printing, which is limited by envelope size

Source: Deloitte, 2019[101]

Given these contrasting benefits, it may be necessary to temper the 'exuberance' that has led some to declare 3D printing as "the next great disruptive technology" and instead consider where and how this technology will grow and complement the manufacturing value chain.[102]

Production of prototypes

Since its conception in the 1980s, the technology has been used for "prototyping and modelling applications" and "this purpose still accounts for the largest share of the 3D technology market"[103] with its advantages in this regard including "[reduced] prototype development time and [shortened] review cycles". The US Department of Defence has for example used the technology to "produce prototype aircrew masks, nuts and bolts, miscellaneous repair

[99] https://www2.deloitte.com/content/dam/Deloitte/ca/Documents/insights-and-issues/ca-en-insights-issues-disruptive-manufacturing.pdf

[100] Deloitte article 2019, see https://www2.deloitte.com/insights/us/en/focus/3d-opportunity/the-3d-opportunity-primer-the-basics-of-additive-manufacturing.html

[101] Table developed from information in Deloitte article, 2019, https://www2.deloitte.com/insights/us/en/focus/3d-opportunity/the-3d-opportunity-primer-the-basics-of-additive-manufacturing.html

[102] Deloitte article 2019, see https://www2.deloitte.com/insights/us/en/focus/3d-opportunity/the-3d-opportunity-primer-the-basics-of-additive-manufacturing.html

[103] European Parliament report on three dimensional printing, see http://www.europarl.europa.eu/doceo/document/A-8-2018-0223_EN.html?redirect

items like radio caps and oil reservoir plugs, antennas and electronic components, casting cores of engine parts, vehicle valve stem covers, custom combat drones, and brackets for mounting flashlights to mine detection sensors"[104].

Production of supplies

Another use of 3D printing would be to employ it to change how supplies and replacement parts are produced. Nederlandse Spoorwegen, the Dutch Railway has been experimenting with this type of application, "[selecting] and [re-engineering] a few parts, which were then 3D printed by [the supplier] to the specifications provided". The benefits of the system have been to "avoid long lead times by 3D printing parts on demand", leading ultimately to the organisation spending "less money and space on keeping spare parts in stock" [105].

Similarly, the German railway company, Deutsche Bahn has explored a similar use case, using 3D printing to produce "spare parts for older vehicles or systems in the infrastructure sector"[106]. The items printed included such things as "ventilation grilles, headrests, coat hooks or cable boxes". It was used for items required in small quantities, where traditional methods would have been "ineffective". Deutsche Bahn does not, however, have its own 3D printer. It instead "works together with service providers from the industry".

[104] Wilbanks and Vadiee, 2017, Beyond prototyping: 3D printing in government contracts, see http://www.smithpachter.com/files/Wilbanks%20Vadiee%20-%20Beyond%20Prototyping%203DP%20in%20Government%20Contracts%20%28Feb%202017%29.pdf
[105] 3D print article, September 2018, see https://3dprint.com/224413/dutch-railways-dimanex/
[106] Deutsche Bahn article, see https://www.deutschebahn.com/en/Digitalization/DB_Digital/productworld/3dprint-1214672

3.3.7. Robots and Drones

Definition

For our purposes, robots refer to autonomous devices that are programmed to perform certain tasks with little or no human intervention. These could be repetitive, manual tasks or more complex tasks depending on the sophistication of the robot. The automation of tasks within a digital environment is excluded from this definition as it has separately been covered in the robotic process automation category. Drones are a subcategory of robots – aircraft that are able to operate autonomously, without a human pilot on-board.

Source: Deloitte, 2017[107]

Potential use-cases in public porcurement

- Delivery of materials and supplies
- Monitoring of project progress

Delivery of materials and supplies

Drones currently have only a marginal position in the procurement field as a whole, with even enthusiasts admitting that the "technology hasn't taken off as quickly as…expected". When they do gain a hold, however, they could have impacts on areas including delivery and monitoring of project progress or infrastructure condition. On this latter it is thought that drones could for example be used "for monitoring the health of oil and gas pipelines or railroad tracks" – repairs and replacements would then be procured if this monitoring suggested it was needed.

Monitoring of project progress

In the Philippines' Project DIME, drones are indeed used for monitoring purposes – to assess "the status and speed of implementation of government projects, especially those with high value"[108]. Under this project, run by the Department of Budget and Management, the selected projects will be monitored in order to "compare fund use vis-à-vis physical accomplishment"[109]. The aim is to "ensure that every peso allocated to government programs and projects will be used efficiently and effectively". The program is seen as particularly useful for "far-flung areas wherein in-person physical inspection would prove difficult"[108].

[107] https://www2.deloitte.com/content/dam/Deloitte/us/Documents/manufacturing/us-manufacturing-autonomous-robots-supply-chain-innovation.pdf

[108] Philippines Department of Budget and Management press release, March 2018, see https://www.dbm.gov.ph/index.php/secretary-s-corner/press-releases/list-of-press-releases/709-project-dime-dbm-dost-launch-monitoring-of-gov-t-projects-using-digital-data-imaging-tech

[109] Philippines news agency article, November 2018, see http://www.pna.gov.ph/articles/1054731

3.3.8. Augmented Reality and Virtual Reality

Definition

Augmented reality refers to technologies through which users are able to see and interact with the real world while digital content is added to it. These technologies "superimpose images on a user's view of the real world". Meanwhile virtual reality, goes a step beyond this, "[creating] a digital environment that replaces the user's real-world environment".

Source: Deloitte, 2018[110,111]

Potential use-cases in public procurement

- Visualising goods and services
- Aiding evaluation

There is variation in opinion over future trends for the Augmented Reality and Virtual Reality markets, which as of 2017, had a combined global market valued at $14.1 billion[112]. The applications of these two technologies range from enabling consumers to try a product before they buy it (for example the Dulux Visualiser allowed consumers to test out a shade of paint for their room before buying it using their smartphone camera)[113], to "enabling medical professionals to interact with patients".

Potential uses by the public sector of this technology are also wide-ranging, ranging from creating immersive experiences in museums to the visualisation of data to support decision making. The technology could be used, for example to display "how new roads, bridges and public transit will affect auto traffic"[114]. .

Visualisation of goods and services

There is considerable speculation about the use of these technologies as a way to allow procurers to see or visualise[115,116,117] the goods they would buy. Being able to see and interact with these goods could greatly enhance the way that procurement authorities approach the tendering process. While "ordering resources for an organisation has long meant identifying a product in a catalogue, and often not knowing if it's appropriate until the day it arrives", these new technologies could enable more informed decisions[118].

A step earlier in the procurement process, AR and VR technologies could play an important role in helping public authorities decide what they should procure. A relevant project[119] in this respect is being looked into by the Flemish Agency for Nature and Forestry together with the Department for Mobility and Public Works. They are concerned that "citizens do not always feel timely and sufficiently informed about public projects of spatial or urban planning". This can result in resistance and delays when authorities attempt to implement their plans. These Flemish authorities

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[110] Deloitte article, 2018, see https://www2.deloitte.com/uk/en/pages/consumer-business/articles/what-is-augmented-reality.html
[111] Deloitte report, 2018, see https://www2.deloitte.com/content/dam/insights/us/articles/4426_Digital-reality-primer/DI_Digital%20Reality_Primer.pdf
[112] Medium article, 2017, see https://medium.com/vr-first/a-summary-of-augmented-reality-and-virtual-reality-market-size-predictions-4b51ea5e2509
[113] Forbes article, 2018, see https://www.forbes.com/sites/bernardmarr/2018/07/30/9-powerful-real-world-applications-of-augmented-reality-ar-today/#a00bf052fe95
[114] Deloitte article, 2018, see https://www2.deloitte.com/insights/us/en/industry/public-sector/augmented-virtual-reality-government-services.html
[115] Waxdigital article, July 2017, see https://www.waxdigital.com/blog/emerging-technology-change-procurement/
[116] ITProportal article, April 2017, see https://www.itproportal.com/features/from-virtual-stockrooms-to-procurement-advisors-how-businesses-can-apply-ai-and-ar/
[117] https://www.smartbygep.com/blog/impact-virtual-and-augmented-reality-procurement
[118] ITProportal article, April 2017, see https://www.itproportal.com/features/from-virtual-stockrooms-to-procurement-advisors-how-businesses-can-apply-ai-and-ar/
[119] Flemish Programme for Innovation Procurement, see http://www.innovatieveoverheidsopdrachten.be/en/projects/public-spatial-planning-projects-augmented-and-virtual-reality

are now looking into how augmented and virtual reality can be used to enable citizens to "experience [proposed] projects in a virtual way" so that "feedback from the public can be collected and lead to useful input and timely adjustments". In another project[120] drawing on AR technologies, Helsinki City Council planners made use of AR tablets to evaluate proposed building plans for a hotel. Finally, the Norwegian Directorate of Public Construction and Property has also made use of AR & VR technologies as part of their Digibygg pilot project[121] – using this technology in the post-tendering phase in order to visualise the building (a utility station) it was constructing.

Aiding evaluation

More generally, these technologies could be used to support exchanges whenever data and information is being presented. For example, AR glasses support discussions between different teams within an organisation, used to visualise "cost and contract data"[122] when team member discuss a particular asset.

[120] Guardian article, see https://www.theguardian.com/local-government-network/2012/may/18/augmented-reality-planning-applications
[121] Bygg.no article, see http://www.bygg.no/article/1381510?image=dp-image121202-1381521
[122] AcquireProcure article, November 2016, https://acquireprocure.com/future-procurement/augmented-reality-procurement-new-way-visualise-data/

3.4. Emerging technologies in public procurement in practice: overview of the longlist

Over the course of the study, a longlist of projects utilising emerging technologies in the field of public procurement has been built up. The full longlist is available on the study webpage[123] and provides a reference point for public organisations interested in applying these technologies to their procurement functions. The longlist provides examples of public procurement projects applying all technologies discussed in this report: AI & ML, big data and data analytics, blockchain, RPA, IoT, 3D printing, robots and drones, and AR & VR. The following section presents the methodology through which the longlist was developed together with an overview of the characteristics of the projects identified.

A first iteration of the longlist was developed by screening 68 countries[124] spread over six continents through extensive web-search. Multinational organisations such as the World Bank, Regional Development Banks, the United Nations and the OECD were also included in the searches. While this method allowed for the identification of some 45 initiatives, it relied only on public information available online.

As in any domain, another effective way to identify attempts to innovate was to speak with experts in the field. Eleven strategic interviews were therefore conducted with key stakeholders and leveraged to further complement the longlist as summarised in Table 3. In addition, members of the Commission's Multi-Stakeholder Expert Group on eProcurement (EXEP) as well as European Commission policy officers were contacted to gather details of any emerging technology projects they were familiar with. As a result, an additional 51 cases were integrated into the longlist. In total, **96 projects were included in the longlist**.

Table 3: Organisations and geographical expertise of interviewees

Organisations represented by interviewees	Geographical expertise
Asian Development Bank	Asia
Agency for Public Management and eGovernment (DIFI)	Norway
Consip	Italy
Corvinus University of Budapest	Hungary
European Bank for Reconstruction and Development (EBRD)	Europe and International
Hansel Oy	Finland
Public Services and Procurement Canada	Canada
World Bank[125]	International

Source: Deloitte

[123] https://ec.europa.eu/growth/single-market/public-procurement/digital/emerging-technologies_en
[124] Argentina, Armenia, Australia, Brazil, Canada, Chile, China, Colombia, Ecuador, Egypt, EU-28, Georgia, Hong Kong, India, Israel, Japan, Kenya, Liechtenstein, Malaysia, Mauritius, Mexico, New Zealand, Nigeria, Norway, Paraguay, Peru, Philippines, Qatar, Russia, Saudi Arabia, Singapore, South Africa, South Korea, Switzerland, Taiwan, Tanzania, Turkey, Ukraine, United Arab Emirates, United States of America, Uruguay.
[125] Three separate experts from the World Bank were interviewed. All other organisations on the list were represented by one interviewee.

3.4.1. Geographical distribution of projects in the longlist

Projects have been identified from all over the world leveraging one (or a combination) of the eight emerging technologies investigated as part of this study to facilitate one or multiple phases of the public tendering process. The region from which most projects come from is the EU (36 projects), followed by North America (19 projects), other European countries (16 projects), Asia (12 projects), South America (5 projects), Oceania (2 projects), and the Middle East (1 project). 5 projects were also identified which were run by Multinational organisations. The countries or multinational organisations in which projects have been identified are the following:

Table 4: List of countries in which emerging technology projects were identified

Region	Number of projects	Country[126] (number of projects in country)
Asia	12	China (1), Japan (1), Philippines (2), Singapore (1), South Korea (5), Taiwan (1), Turkey (1),
Europe (EU)	36	Austria (1), Belgium (5), Bulgaria (1), EU (2) Finland (5), Germany (1), Italy (4), Latvia (1), Malta (1), Netherlands (2), Portugal (1), Romania (1), Slovenia (2), Spain (3), Sweden (1), UK (3), Group of Southern European Countries (1), Nordic Council (1)
Europe (non-EU)	16	Albania (1), Armenia (1), Belarus (1), Georgia (1), Moldova (1), Norway (5), Russia (1), Ukraine (5),
Middle East	1	United Arab Emirates (1)
Multinational organisation	5	Asian Development Bank (1), NATO (1), United Nations (1), World Bank (2)
North America	19	Canada (5), Mexico (1), USA (13)
Oceania	2	Australia (2)
South America	5	Brazil (2), Chile (1), Colombia (1), Costa Rica (1)

Source: Deloitte

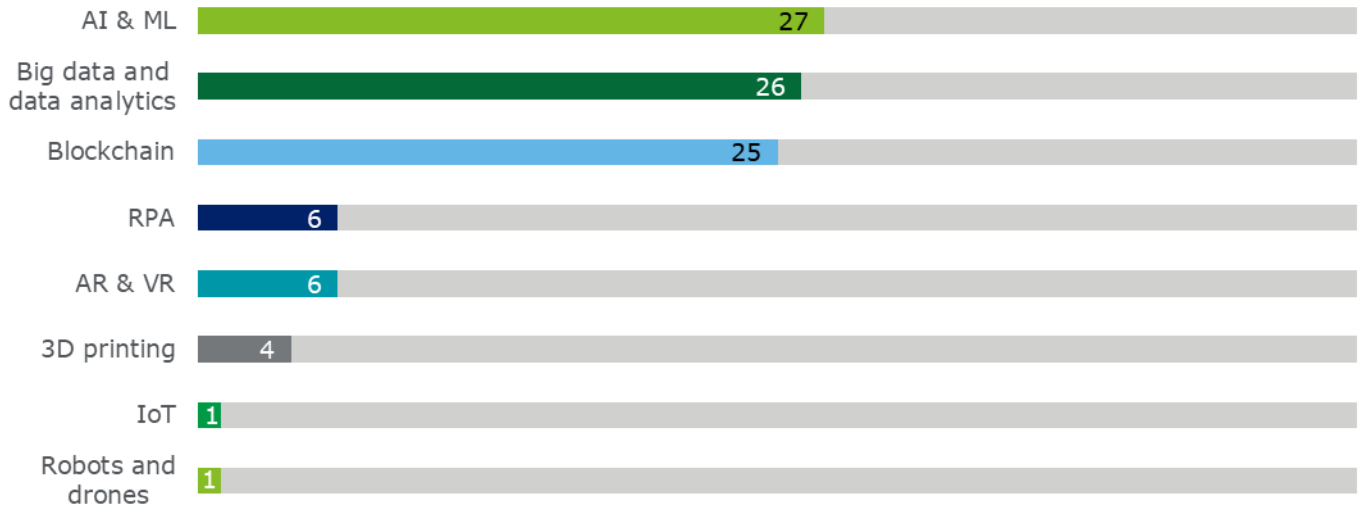
3.4.2. Distribution of technologies in the longlist

The number of cases identified per technology differs greatly. As Figure 3**Error! Reference source not found.** clearly illustrates, **AI & ML, big data and data analytics, and blockchain appear to be the top-three technologies** used to further optimise the procurement processes of public administrations around the world. Far

[126] Also included under this category are projects set up by one of the European Institutions (labelled under "EU") or supported by a group of countries such as the Group of Southern European Countries, or the Countries of the Nordic Council

fewer cases are found of RPA (6 cases), AR & VR (6 cases) and 3D printing (4 cases). And just 1 case each is found for IoT and robots & drones.

Figure 3: Longlist of initiatives by emerging technology



Source: Deloitte

3.4.3. Level of development of identified projects

The above graphs provide a first indication of the level of interest public buyers are taking in these different technologies globally. Moreover, it is worth considering the extent to which these projects have actually been developed. Of the 96 cases identified in the longlist:

- **7%** (or 7 cases) are **potential future implementations**, i.e. where actual trial of the idea in practice is plausible, however, limited to speculation;
- **23%** (or 22 cases) are **planned initiatives**, i.e. where a clear use-case and scope have been defined, and there is a firm intention to trial it (in the near future);

Both these categories of cases (29) will be of relatively limited value for evaluating the actual impacts of the technologies on the procurement process (e.g. efficiency gains, cost savings, increased transparency, etc.), for identifying any lessons learnt or best practices and for issuing recommendations in view of their potential future uptake. However, these initiatives allow to complement the knowledge-base on the (theoretical) applications of these technologies, thereby possibly providing insightful inspiration material for public authorities interested to find innovative ways to solve public procurement challenges at various stages of the procurement process.

In addition, the longlist includes a series of more advanced cases (67). Of the total number of cases included in the longlist:

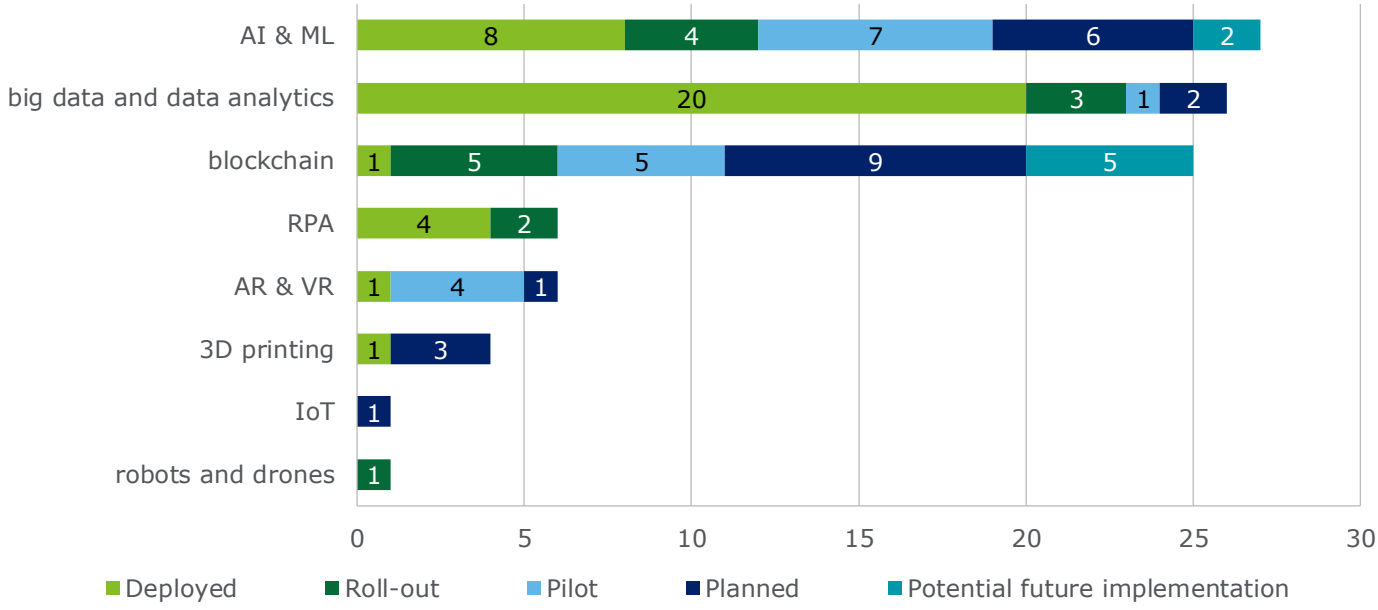
- **18%** (or 17 cases) are **pilot projects**, i.e. where a small-scale trial is/was conducted to test the feasibility (e.g. technical, financial, etc.) and overall value-added of the initiative;
- **16%** (or 15 cases) are being **rolled out**;
- **36%** (or 35 cases) are **deployed**, i.e. the initiative has been implemented, adopted and integrated into the procurement process.

These latter categories of cases are expected to provide (more) concrete findings and conclusions relating to actual experimentations, which could further be aggregated into key trends, best practices and recommendations on the uptake of emerging technologies in public procurement processes.

When applying this categorisation on the initiatives sorted by technology, on the one hand, it appears that **Big Data and Data Analytics** is not only one of the most popular technologies in terms of number of projects in the area,

but also the **domain in which public authorities have the most advanced experience**. 20 out of the 26 identified big data and data analytics projects (77%) have been fully deployed. Of the other technologies, RPA also stands out as having a high proportion of fully deployed projects (4 out of a total of six projects identified) although this is on the basis of a much smaller number of identified projects. AI & ML accounts for most of the remainder of the fully deployed solutions (8 of the 27 AI & ML projects are fully deployed). Meanwhile, there is just one fully deployed blockchain project. **Blockchain** stands out as the technology with a **great number of potential use cases which have yet to be tested in practice**, with 14 initiatives in the pure ideation and planning phases as illustrated in Figure 4 below.

Figure 4: Longlist of initiatives by stages of development



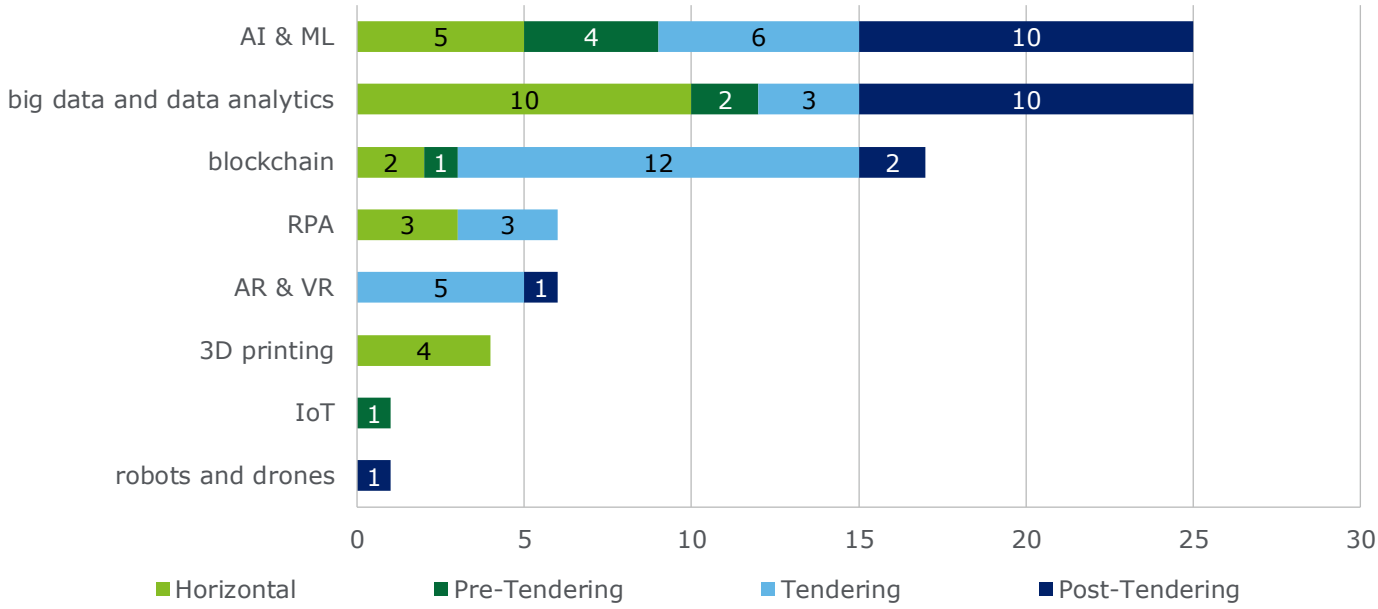
Source: Deloitte

3.4.4. Initiatives by public procurement phase and use case

The initiatives gathered in the longlist may also be mapped in function of their application to the public procurement process, which can be **horizontal** (i.e. possibly leveraged throughout the entire procurement cycle) or occur more specifically in the **pre-tendering, tendering and/or post-tendering phase(s)**. In some cases, the exact phase of application was not specified due to limited information available.

Cases of Artificial Intelligence and Machine Learning as well as big data and analytics were found to facilitate each phase of the public procurement process. Blockchain was found to predominantly focus on the tendering phase. The only case of Internet of Things was found in the pre-tendering phases, while the only Robots and drones case was applied in the post-tendering phase. Meanwhile, Robotic Process Automation and AR & VR cases were found in both the tendering and post-tendering phases. Most 3D Printing cases were judged to have a horizontal application to public procurement, but in a slightly different sense to the other technologies. This technology has the potential to change what is procured, rather than how – and this will therefore have repercussions right along the procurement process.

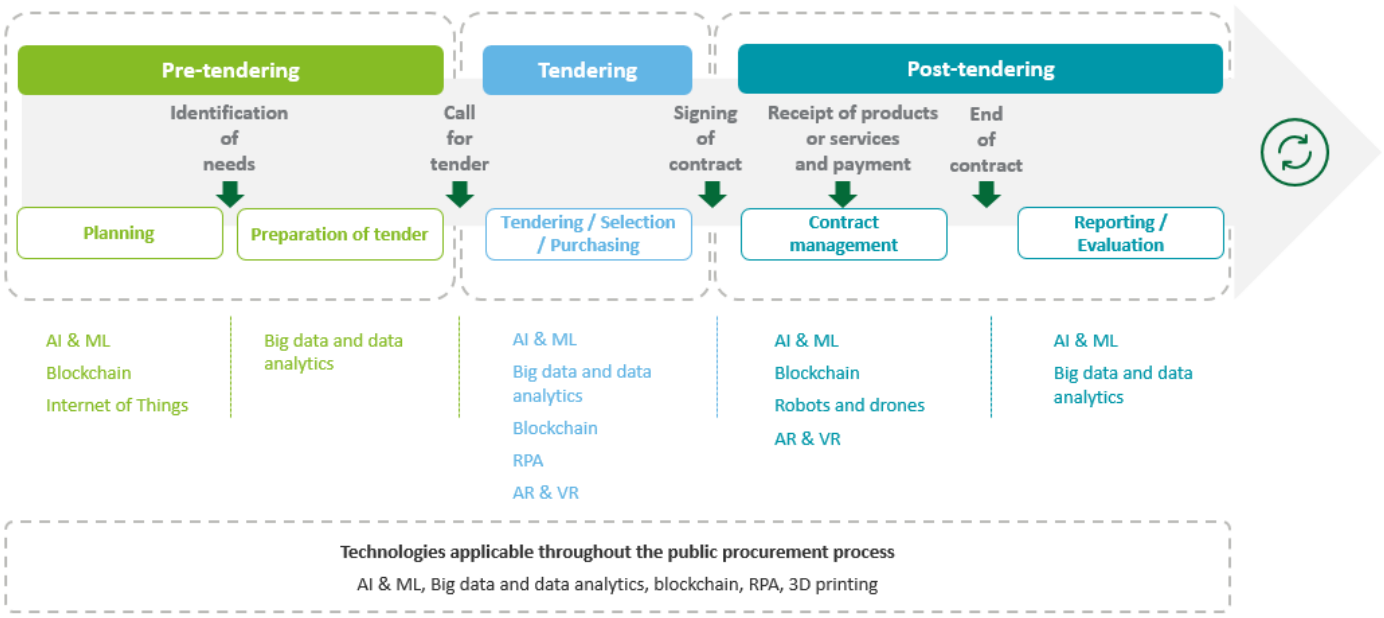
Figure 5: Longlist of initiatives by public procurement phase[127]



Source: Deloitte

Based on the projects identified in the longlist, the emerging technologies discussed can therefore be mapped against the public procurement process as shown in Figure 6.

Figure 6: The longlisted projects across the public procurement process



A final attribute based on which the longlist may be categorised is the **type of use cases of the initiatives**. While this list may not be exhaustive, 11 general use cases for technologies have been identified, as depicted in the table below. As many as five usage types have been highlighted for AI & ML, and four each for big data and data analytics,

[127] Total cases do not add to 96 as for 8 blockchain projects and 2 AI & ML projects the procurement phase is unknown. These projects are not included in the figure.

and blockchain). Other technologies (RPA, AR & VR, 3D Printing, IoT, robots and drones) offer more focussed applications.

Table 5: Longlist initiatives by general use case[128]

	AI & ML	Big data and data analytics	Blockchain	RPA	AR & VR	3D Printing	IoT	Robots & Drones
Analysis and evaluation	9	14	2					
Analysis and evaluation – risk of corruption	5	6						
Automation	2		3	6				
Categorisation	4							
Chatbot	5							
Data backbone		2	11					
Monitoring of project progress								1
Production of supplies						4		
Asset tracking							1	
Transparency			3					
Visualisation		4			6			

Source: Deloitte

[128] 6 Blockchain and 2 AI projects were left out of this figure as their use-case could not be determined from the information available. 7 of these projects fell under the "potential future implementation" category in terms of project maturity, while 1 is in the "planning" phase.

4 Selection of case studies on emerging technologies

After presenting the criteria used to select the 20 most interesting projects, this chapter offers the in-depth case studies developed as part of the second report.

4.1. Selection of the 20 most interesting use cases

Alongside taking stock of any developments related to the uptake of the eight emerging technologies in public procurement processes around the globe, this report develops 20 initiatives as case studies. In view of the scope of this study as well as the insights provided in the previous sections, the following attributes/criteria were considered for the selection of the 20 cases:

- **the geographical coverage** of the initiative, i.e. a majority of the cases should be from outside the EU, including cases from South Korea, South America and the USA;
- **the interest of public authorities** for certain technologies, i.e. mainly Big Data and Data Analytics, Blockchain, Artificial Intelligence and Machine Learning, based on the data collected to date;
- **the coverage of each public procurement phase** and **main use cases** i.e. collectively, the 20 case studies provide a solid overview of main applications;
- **the maturity of the initiatives** i.e. when possible, the most mature initiatives will be preferred in order to allow for a more extensive cost, benefit and impact assessment.

On the basis of these criteria, the projects listed below in Table 6 have been selected as case studies. The full case studies are presented in Section 4.3 to 4.7. Each case study is numbered (Case 1 to Case 20) and these numbers are used to reference the case studies throughout the rest of this report.

Table 6: List of selected case studies

#	Country	Project Name	Lead organisation	Maturity	**Use case.** Description
			Artificial intelligence and machine learning		
1	Republic of Korea	AI product management	Public Procurement Service	Pilot completed	**Demand prediction**. PPS implemented a pilot project in which a deep learning solution was used to predict annual government demand for products. This deep learning solution drew on data (10.53 million data items) from the PPS' Product Management System.
2	Finland	Explore state spending – Categorisation of public spending	Hansel Oy	Pilot completed	**Spend categorisation**. Hansel Oy piloted a machine learning solution to categorise eInvoicing data according to the United Nations Standard Products and Services Code (UNSPSC). This data is uploaded to an open data portal – Explore State Spending – to provide spending transparency.
3	Ukraine	CPV Code Prediction	ProZorro; uData	Pilot completed.	**Spend categorisation**. A data science consultancy (uData) developed a machine learning solution for ProZorro, the State organisation behind Ukraine's hybrid e-Procurement system, that predicts the correct Common Procurement Vocabulary (CPV) code for a product.
4	Australia	Categorisation Artificial Intelligence Technology (CAITY)	NSW Procurement	Deployed	**Spend categorisation**. NSW Procurement has developed an AI tool – CAITY – that automatically categorises spend data according to the NSW all of government procurement taxonomy. The organisation previously manually categorised 2 million procurement transactions every quarter. The solution was trained on data from the previous manual categorisation process.
5	UK	Procurement Information Provider	YPO	Deployed	**Chatbot**. YPO provides framework contracts through which public sector buyers buy products and services. YPO integrated a chatbot onto its webpage which can direct users to relevant parts of the website to find relevant framework contracts.
6	USA	Ask Laura	El Paso City Council	Deployed	**Chatbot**. The El Paso City Council Purchasing and Strategic Souring department (PSS) operates a call service for potential vendors, with staff dealing with questions on doing business with the Council that are often repetitive and basic. PSS integrated a chatbot – Ask Laura – on its webpage to deal with these inquiries.

Big data and data analytics					
7	Belgium	MEDIAAN project	Flemish Department of Mobility and Public Works	Deployed	**Price analysis**. The Department of Mobility and Public Works lacked the tools to enable analysis of historical prices for goods and services. To address this it developed the MEDIAAN platform, which provides a searchable database of historical prices and a range of applications for cost engineering and analysis.
8	Belarus	Open Contracting Data Standard (OCDS) Transformation and Analytics	Ministry of Antimonopoly Regulation and Trade; EBRD	Deployed	**Business intelligence**. Belarus had several digital public procurement platforms, however the information generated through them and stored was not standardised, making analysis challenging. Under the solution implemented with the EBRD, data is extracted from existing public procurement platforms and transformed to the Open Contracting Data Standard (OCDS). A business intelligence module is run on top of this data.
9	Slovenia	Skrinja Business Intelligence	Ministry of Public Administration (MPA)	In development	**Business intelligence**. The IT directorate of MPA is developing a data warehouse and business intelligence system to be provided as a horizontal service on the Government Cloud till 2022 in order to promote data-driven decision making in public administration. Public procurement data will be uploaded analysed using the new system to support decision making and transparency purposes.
10	Brazil	Public Procurement Price Panel	Federal Ministry of Economy	Deployed	**Price analysis**. In Brazil, it is mandatory by law to conduct price research as a preparatory task before launching a procurement procedure. The Federal Ministry of Economy developed a price panel to provide visibility on historical prices paid. Users are able to search according to filters including material name, goods and service code, and material description.
Blockchain					
11	USA	HHS Accelerate	Department of Health and Human Services	In development	**Data backbone**. HHS has multiple legacy systems for contract writing and other procurement functions. Through HHS Accelerate, HHS has developed a data lake running on blockchain that operates on top of legacy systems. Data is pulled from existing contract-writing systems, tagged on the blockchain and stored. On top of this data lake, containerised microservices, drawing on robotic process automation and machine learning technology, have been developed which automate procurement functions at every phase.
12	Belgium	Smart procurement tool	Digipolis	In development	**Transparency**. Digipolis, the IT agency for Antwerp, is developing a blockchain-based application together with its partner for the project, BallistiX, which will allow for the publication of a quotation request and submission and opening of quotations. The use of blockchain guarantees the reliability of each step of the procurement process, as they will be recorded in a transparent manner.

13	Republic of Korea	Blockchain-based Proposal Evaluation System	Yeongdeungpo-gu District Office	Deployed	**Transparency**. Yeongdeungpo-gu District Office had a largely paper-based tendering system. As a consequence its tendering processes were not transparent and not seen as trustworthy by other stakeholders. In particular, the evaluation of vendors' bids for public contracts was often contested by losing vendors. Yeongdeungpo-gu District Office set up a digital tendering platform coupled with a blockchain record on which to store individual scores by members of the evaluation committee for vendor bids for public contracts.
14	Mexico	Blockchain HACKMX	National Digital Strategy Coordinator, State Gov of Jalisco, IBM, University of Guadalajara, C-Minds	Pilot completed	**Transparency**. One project within HACKMX was developed with the State of Jalisco. It aimed to create traceable, immutable, transparent and reliable processes. The developed proof of concept stored data from the following procurement phases on the blockchain: 1. Request to procure an item; 2. Direction of request to procurement specialist; 3. Assignment of procurement specialist; 4. Publication of contract notice. The solution was developed on Hyperledge Fabric and integrated (within a test environment) with the State's central procurement platform 'SEPAF System'.
15	Japan	Blockchain feasibility study	Ministry of Internal Affairs and Communication	Pilot completed	**Data backbone**. MIC wanted to understand whether blockchain could be used to improve the security and auditability of public procurement processes as well as increasing the availability and re-use of data. The organisation decided to assess whether it could store information on the results of supplier qualifications on the blockchain. Public organisations would be able to access information and documents on the blockchain related to past qualifications for the company in question. MIC launched a feasibility study in which it developed and tested a hyperledger fabric blockchain solution for this purpose.
Robotic process automation					
16	Portugal	Purchasing management platform	Institute of Oncology of Lisbon (IPO)	In development	**Automation of procurement processes**. IPO is developing an all-in-one purchasing management platform, integrated with the systems of external entities (e.g. Vortal eProcurement platform). The solution is based on a 3 layer approach: Presentation layer (user interface layer, with RPA integrated to automate certain procedures); Logic layer (for the execution of business processes); and Data layer (drawing on blockchain technology, ensuring that information is immutable and auditable).
17	USA	TRUMAN - Automation of vendor	Federal Acquisition Service (FAS),	Deployed	**Automation of tendering processes**. The Federal Acquisition Service (FAS) negotiates central contracts (Multiple Award Schedules) through which public organisations can purchase products and services. Vendors apply for a schedule contract, submitting a large application package with

		application assessment	General Services Administration		details of the company, offer and documentation. FAS has utilised RPA technology in order to automate the initial stages of the award process for a Multiple Awards Schedule.
18	Finland	Intelligent Automation	Palkeet	Deployed	**Automation of procurement processes**. In the course of providing human resources and financial services to Government organisations, Palkeet employees must conduct many tedious manual processes. To tackle this, Palkeet has rolled out RPA technology, with 26 bots now automating 70 processes. Processes automated include processing purchase invoices and maintaining the supplier register.
19	USA	Automated responsibility determination	Internal Revenue Service	Deployed	**Automation of tendering processes.** Responsibility determination is a process that must be performed before any new contract is awarded to ensure the vendor is compliant with federal law. The contracting officer must search for information and red flags on vendors available on public websites. The IRS Procurement Office deployed RPA technology to automate the responsibility determination process.
			3D printing		
20	Germany	Additive manufacturing at Deutsche Bahn	Deutsche Bahn	Deployed	**Production of supplies.** To tackle long waiting times associated with replacement of spare-parts, and to increase its negotiating power over their pricing, Deutsche Bahn started experimenting with additive manufacturing in 2015, sharing in the establishment of the Mobility goes Additive Network in September 2016. Since then, Deutsche Bahn has identified over 120 use cases for 3D printing, and printed more than 7000 components, resulted in important cost-savings.

4.2. The case studies against the selection criteria

The selected case studies fulfil the stated criteria outline in the previous section in terms of geographical distribution, coverage of technologies, maturity of the projects, and coverage of different procurement phases and use-cases.

In terms of **geographical distribution**, the case studies selected cover regions right across the world:

- 8 from the EU;
- 2 from Europe (non-EU);
- 1 from South America;
- 5 from North America;
- 3 from Asia;
- 1 from Oceania.

In terms of **coverage of technologies**, the selection ensures a good coverage of the emerging technologies that are most popular with public authorities (according to the number of projects identified in the longlist): AI & ML, big data and data analytics, blockchain):

- 6 AI & ML projects;
- 4 big data and data analytics projects;
- 5 blockchain projects;
- 4 RPA projects;
- 1 3D printing project.

Regarding, the **maturity of the projects** selected, all have at least completed a pilot phase, and the majority have a fully deployed solution:

- 11 deployed;
- 4 in development;
- 5 with completed pilots.

Regarding the **coverage of projects right across the procurement process**, there are projects focussed on each of the major procurement phases (pre-tendering, tendering, post-tendering) as well as a number with a horizontal application:

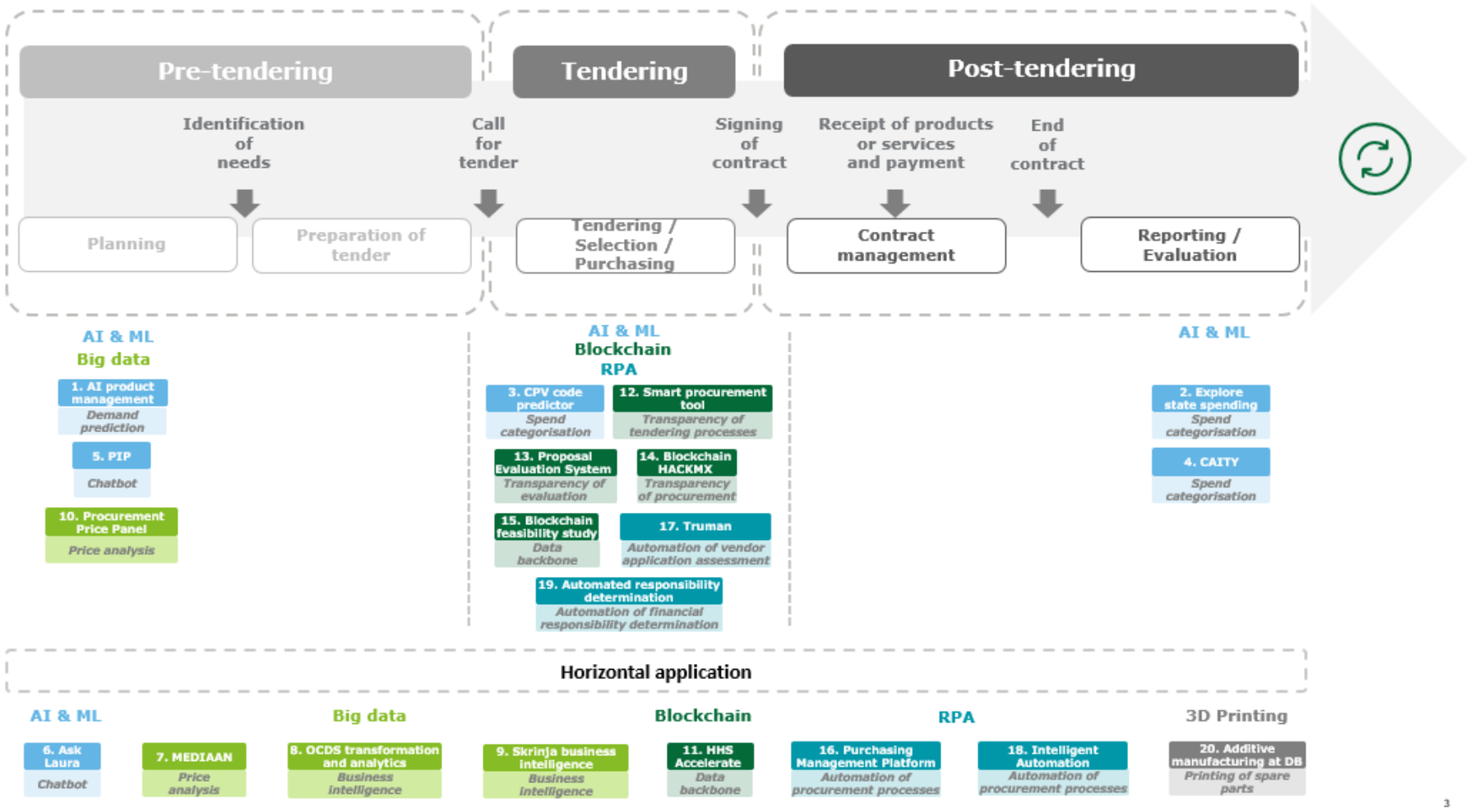
- 8 projects have a horizontal application across procurement;
- 3 projects are focussed in the pre-tendering phase;
- 7 projects are focussed in the tendering phase;
- 2 projects are focussed in the post-tendering phase.

The projects also **cover 7 out of the 11 general use-cases** presented in Table 5. The only general use-cases not covered are "analysis and evaluation – risk of corruption" (as a number of general analysis and evaluation projects are presented, and this subcategory was not seen as sufficiently different), "asset tracking" (as there were no sufficiently mature IoT projects), "monitoring of project progress" (as there was a lack of mature robots and drones projects), and "visualisation" (as other use-cases were believed to be of greater interest). The selection covers the following general use-cases:

- 5 projects focussed on analysis and evaluation;
- 4 projects focussed on automation;
- 3 projects focussed on categorisation;
- 2 projects providing chatbots;
- 2 projects providing a data backbone;
- 1 project focussed on production of supplies;
- 3 projects focussed on providing transparency.

A visualisation of the case studies, their primary technologies, specific use cases and application within the procurement process is provided in Figure 7 below. The case studies are presented in full in the following sections.

Figure 7: The case studies across the public procurement process



4.3. AI & ML case studies

The following section presents **six case studies** in which public administrations make use of artificial intelligence and machine learning as a primary technology to transform or improve their public procurement processes and functions:

Case study 1: AI Product Management

Lead Organisation: Public Procurement Service

Location: Republic of Korea

Technologies: AI & ML

Level of government: National

Problem Statement: Central public organisations establish their own annual Material Requirement Planning (MRP) using PPS's Product Management System. PPS collects these MRPs from the system and report them to the Ministry of Economy and Finance (MOEF). However, PPS found out that the plans were increasingly inaccurate in recent years. Administrative inefficiencies were generated as a result of forecasting demand for unnecessary items and conversely failing to predict the level of demand for other items.

Description: PPS implemented a pilot project in which a deep learning solution and the Process Innovation method (PI) were used to predict annual government demand for products. The scope of the pilot project was restricted to just five types of goods purchased across four public organisations. By utilising historical purchasing data (10.53 million data items) drawn from the Product Management System, PPS established improvements with the deep learning solution and Process Innovation (PI) to enhance the efficiency of administrative work and increase the accuracy of predictions. The deep learning solution was developed by an external IT consultancy, drawing on historical purchasing data (10.53 million data items) from the Product Management System. PI was used to revise the existing, relevant policies, and the deep learning was used to detect trends and patterns in the data, reducing the reliance on analysts being able to manually identify key variables in order to specify an accurate statistical model.

Lessons learnt: Large and standardised datasets of historical public purchasing behaviour are a necessity for projects of this nature. Even with the large dataset available from the PPS Product Management System, the available data was insufficient for some categories of goods.

Cost: < €100 000

Impact: Limited. Only a pilot project. Overall accuracy of the deep learning solution was not better than the manual solution previously used.

Future expectations: PPS believes that with additional data, and using more advanced algorithms, the accuracy of the deep learning solution can be improved. It will make a decision on whether to integrate deep learning capabilities when its Product Management System is upgraded in 2020.

Human resources: IT consultancy (2 full time data scientists; 1 part-time process integration consultant); PPS (3 staff members contributing to interpretation of results).

Risks: Limited – sensitive data encoded to limit privacy risks; government security standards complied with.

Other requirements: Standardised historical purchasing data from across the government; internal expertise related to procurement policies and data.

Project timeline: 3 month project (2017)

Project status: Pilot completed

Email: Sangwoon Park
oonpark@korea.kr

Website: https://www.pps.go.kr/eng/index.do

Context and problem statement

The **Public Procurement Service (PPS) is the central procurement agency for the Government of the Republic of Korea**. It is responsible for:

1. Negotiating and providing contracts for goods, services, and construction for other government and public entities;
2. Operating the Korean eProcurement platform – KONEPS;
3. Stockpile management; and
4. Goods and property management.

As part of its work on goods and property management, PPS maintains a Product Management System. This system is used to monitor and store data related to the life cycle of goods purchased by the government, from acquisition to disposal. All goods, with the exception of consumables, are marked with RFID tags, allowing for the tracking of these goods and stocktaking.

Central public organisations use the data within the Product Management System for their annual Material Requirement Plannings (MRPs). Drawing on the historical data of the purchase and use of products, they predict the overall demand for additional or replacement products for the next year.

The prediction for the next year is based on a statement of budget items prepared in the previous year and a property survey made at the end of the year. A large number of variables can potentially influence the demand for different goods. Over time, **PPS has noted a decrease in the accuracy of the predictions made, and a widening gap between expected and actual demand for products.** Over the last five years, the predictions made were off by between 160 and 200%.

Objectives and vision

PPS aims to **increase the accuracy of its purchase planning**, thus creating budgets that more closely reflect governmental needs and minimising unplanned government spending. It aims to **explore whether an AI and PI-based model can deliver more accurate predictions** of government demand for new or replacement products.

Technological solution and implementation

PPS piloted a **deep learning solution to predict demand for products for public agencies** for the coming year based on data on previous purchases. Deep learning is a sub-category of machine learning which draws on artificial neural networks and algorithms which are inspired by the structure of the human brain[129].

As it was a pilot project, the scope was limited to predicting the demand for five goods purchased across four public organisations.

In order to train the deep learning solution, historical data from the Product Management System was shared amounting to **10.53 million data units**, covering the period between 2003 and 2016. The content of the data shared include details on:

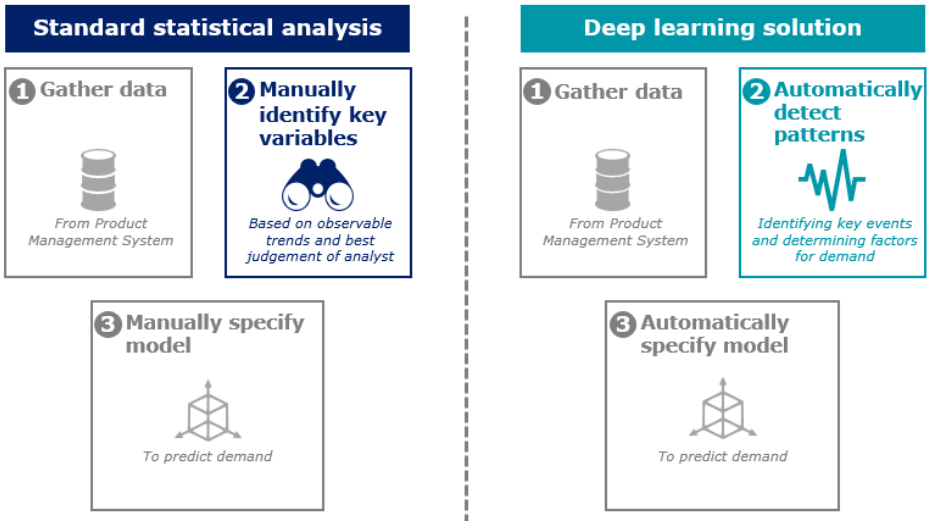
- Annual acquisition of major products;
- Annual disposal of major products;
- Acquisition plans

[129] See Forbes article "What is deep learning AI? A simple guide with 8 practical examples", available at https://www.forbes.com/sites/bernardmarr/2018/10/01/what-is-deep-learning-ai-a-simple-guide-with-8-practical-examples/

The organisation outsourced the development and implementation of this deep learning solution to an external IT consultancy. It shared **encrypted data from its Product Management System** with this consultancy via a secure connection.

The **deep learning solution was used to reduce the reliance on manual identification of the key variables used to specify the model**. By providing it with historical data on the purchasing patterns of public organisations, the deep learning tool was able to automatically identify key events and factors (e.g. internal reorganisation) that influence an organisation's demand for particular goods and on the basis of this predict purchasing behaviour for the coming year. Figure 8 below shows how this deep learning approach differs from the previously used standard statistical modelling approach.

Figure 8: Comparison of standard statistical and deep learning approach



Development of the project

PPS has pursued a **gradual approach for the development of this deep learning solution**. It initially contracted the IT consultancy in 2017 to conduct a study on current issues for the Product Management System and propose ideas for improvements. The duration of the pilot project was approximately 3 months. Some of the recommendations of the study were to improve the accuracy of the annual Material Requirement Planning through a deep learning approach and to increase accuracy and the convenience of the prediction by improving the existing policies and systems. The model used to improve policies to increase the prediction accuracy was implemented in 2018. But the deep learning-based model to improve the prediction accuracy was not implemented until 2019.

Results and future expectations

The results of the pilot project were mixed, with the demand for some categories of goods predicted with a high degree of accuracy, while for certain others the prediction was far less accurate. In general, the deep learning solution performed better for goods which featured regular and frequent purchasing patterns for which there was therefore plenty of data available. For goods, which were purchased less frequently (i.e. every 5 to 10 years), there are fewer data points to draw upon (the data set available only goes back slightly over 10 years, and the good may have only been purchased once in this time). This relative lack of data explains the relatively low accuracy of the prediction generated. **Overall, manual prediction by persons in charge of demand prediction was found to be more accurate than the deep learning solution.**

PPS believes that with additional data, and using more advanced algorithms, the accuracy of the deep learning solution can be improved. The Product Management System is due to be upgraded in 2020, however as of yet a decision has not been made as to whether to integrate deep learning technology within this

upgraded system in a further attempt to increase demand forecast accuracy. Currently, however PPS is experimenting with alternative process innovation methods to increase the accuracy of this forecast, and it is possible that they will choose to adopt this approach towards improving the accuracy of their predictions of demand. An example of the changes the organisation has adopted using the PI approach is the organisation of the concepts of life cycle period, usage period, quantity and reasonable quantity and connection of them with the product management system. Following this, policies and process were updated to enable the product management system to predict demand for the next year.

Costs and requirements

Costs	Human resources	Other
• Total costs of **<€100 000**	• **Inhouse team:** 3 employees providing support for interpretation of results; • **IT consultancy:** 2 full-time data scientists; 1 part-time process integration consultant.	• Large and standardised database of historical purchasing behaviour • Support from internal stakeholders to enable access to budget for pilot project

The **overall cost of the pilot project comes to less than €100 000**. This budget is accounted for by the fees for the IT consultancy. No additional investment was made by PPS in infrastructure.

In terms of the human resources invested in the project, this came both internally from PPS and from the consultancy. The **project team from the IT Consultancy consisted of 3 profiles**:

- 2 data scientists, full-time
- 1 Process Integration consultant, part-time

Meanwhile, the **contribution from PPS also consisted of 3 employees** – who were responsible for helping **interpret the results of the analysis** – for example identifying purchase patterns and trends stemming from government policies, or identifying where actual purchases are being mistaking for product transfers between public agencies. Internal expertise related to procurement policies and data is needed to interpret the results of the deep learning analysis, and is an essential requirement for the project.

Another **central requirement for the project related to the availability of a large catalogue of standardised historical data on government purchases**. PPS implements a Master Data Management (MDM) plan which ensures that end-users in government agencies record their purchase referring to standard product cataloguing codes. The data on these purchases across the South Korean Government and its agencies is stored in the Product Management System. A similar standardised system for the recording of historical government purchases is a requirement for demand prediction projects such as this. Even with this extensive and standardised data source to draw upon, a constraint of the project was the lack of sufficient data to use to predict the demand for certain categories of goods which are infrequently purchased. For such categories of goods, several decades' worth of purchasing data would be required in order to produce an accurate prediction. However, only slightly over ten years of data was available.

A final requirement for the project entailed **winning support from internal stakeholders** for the deep learning project. Through discussions, PPS generated interested from top management as well as understanding of the goals and approach from working level officials, and won the necessary support for the pilot project.

Risk and mitigation

The **risks associated with this pilot project are limited**. To ensure that they were minimised, PPS refrained from using any private sector data, encoded all sensitive data, and ensured compliance with general government security standards.

Challenges and lessons learnt

The main challenges of the project related to winning internal support for the project and the need to provide sufficient data for the deep learning solution, and the need to improve the algorithms of the deep learning solution.

In order to win **internal support for the project**, it was necessary to have detailed discussions with both top management and staff to convince them of the value of the approach and generate interest and understanding.

A need for general improvements in the algorithms of the deep learning solution was also identified. Although they are an improvement on the alternative statistical regression model, manual estimates by persons responsible for demand predictions remained more accurate than the deep learning algorithms.

Regarding the **sufficiency of the data provided**, PPS had a large database of standardised historical purchasing data stemming from their Product Management System. Even with this large dataset, however, the accuracy of the deep learning solution was low for some categories of infrequently purchased items. The main lesson that can be taken from the project is therefore that a very large and standardised dataset of historical purchasing behaviour is a necessity before embarking on any similar project.

Case study 2: Explore State Spending – Categorisation of public spending

Lead Organisation: Hansel Oy

Location: Finland

Technologies: AI & ML

Level of government: National

Problem Statement: Hansel Oy, the central purchasing body for the Finnish Government, was given access to eInvoicing data from the state eInvoicing system. It planned to upload this data to an open data portal – Explore State Spending – however, it was not categorised according to any standardised procurement taxonomy and so was not easily examinable.

Description: Hansel Oy piloted a machine learning solution to automatically categorise state eInvoicing data according to the United Nations Standard Products and Services Code (UNSPSC) procurement taxonomy. An IT consultancy developed the categorisation algorithm and integrated it with Hansel Oy's IT environment – specifically the Qlik Business Intelligence solution. Due to a lack of machine training data, the overall accuracy of the categorisation solution is only 51%. So far, the organisation has not made the investment to fully develop and start using it as this would require a considerable investment in providing the necessary training data.

Lessons learnt: The key takeaway from the project is the importance of ensuring adequate machine training data is available for the categorisation algorithm (roughly 1000 rows per category). Hansel Oy also experienced some difficulties with the integration with the Qlik BI solution and believes it may have been better off investigating open source solutions.

Cost: €89 265

Impact: Limited. Solution never put into full production. Achieved 51% accuracy of categorisation.

Future expectations: Hansel Oy believes that it could improve the accuracy of the algorithm if additional training data is provided. However, this would necessitate a substantial investment, and it has not yet decided whether it is willing to do this.

Human resources: IT consultancy, 2-7 person team (not FTE: project manager, data scientists, Qlik experts); Hansel Oy, 4 staff members (3 analysts and a technology manager)

Risks: Privacy concerns related to publishing eInvoicing data on Explore State Spending portal (although not directly linked to AI categorisation).

Other requirements: Access to machine-readable eInvoicing data. Access to pre-categorised training data.

Project timeline: 2016 - present

Project status: Pilot project completed, full deployment on hold

Email: analyysipalvelut@hansel.fi

Website: https://www.tutkihankintoja.fi/?lang=en

Context and problem statement

Hansel Oy is the **central purchasing body for the Finnish Government**. Its tasks include establishing and managing framework contracts, running requests for tenders for goods and services, and providing advice to public organisations on procurement matters.

In 2016, Hansel Oy gained **access to data from the state eInvoicing system**. The system contains eInvoicing data from central government ministries and agencies – with about 1 million new eInvoices registered in the system each year. The aim was to use this data for several purposes, including **providing transparency to citizens and economic operators regarding state spending**, and to conduct spend analysis for their public clients. To achieve the transparency goals, a new open data website on which to post the data - Tutkihankintoja.fi, ("Explore State Spending") - was created.

One issue, however is that the **data is categorised according to a book-keeping accounts taxonomy instead of any standard procurement classification**, such as the United Nations Standard Products and Services Code (UNSPSC) – which would be both more easily navigable by citizens, and, better suited to other forms of procurement analysis. While the re-categorisation of data was crucial to ensure its usability, such a task would have been extremely time consuming and arduous if performed manually. Hansel Oy had therefore to come up with an alternative re-categorisation method.

Objectives and vision

Hansel Oy aimed to **deploy a machine learning solution to re-categorise the state eInvoicing data according to the UNSPSC procurement taxonomy**. The objective of this re-categorisation project is to produce data that is both more accessible and more easily analysable, fitting into the wider objectives of Hansel Oy to:

- Ensure transparency regarding state spending, by sharing the re-categorised data on a new open data portal - Tutkihankintoja.fi, the "Explore State Spending" website;
- Produce insights into state spending, by facilitating spend analysis of the public eInvoicing data.

Technological solution and implementation

The organisation decided to p**urchase from the market a machine learning solution that could automatically categorise the eInvoicing data** according to the UNSPSC. It initially requested a proof of concept from several companies (see more details below), before contracting an IT consultancy to develop this solution.

The consultancy developed the CAEN categorisation algorithm for this purpose, which has natural language processing capabilities enabling it to assign a procurement category to the different rows of invoicing data, based on an analysis of the textual data. This algorithm is based on tools available in the Azure machine learning studio.

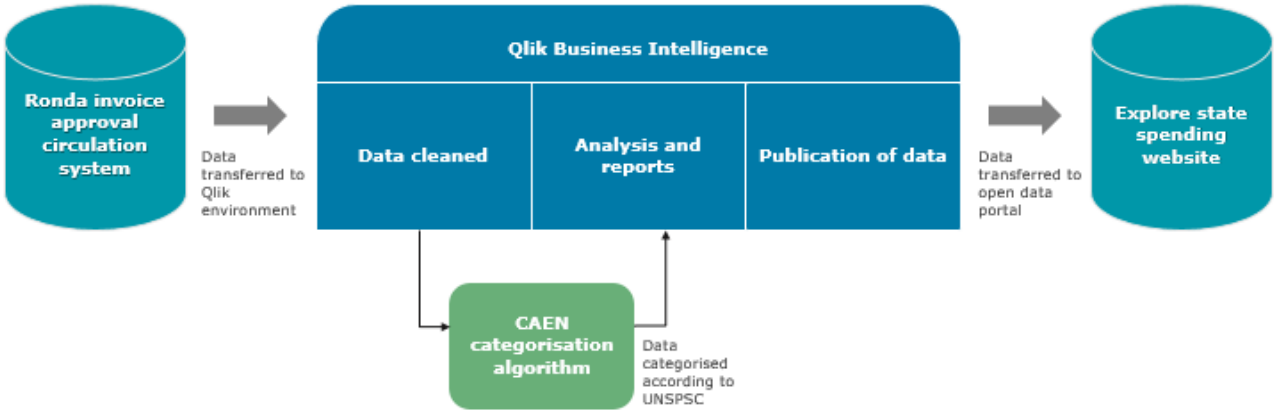
As a machine learning algorithm, it must be "trained" – a process whereby it is fed with pre-categorised data, so that it can learn the correct classifications for different textual data. **This training data was provided via two different sources**:

- **1000 rows** – manually classified by Hansel Oy experts
- **300 000 rows** – created by mapping products from framework contracts against the UNSPSC. They then linked supplier reporting data for these framework contracts with eInvoicing data to link the book-keeping account codes with the UNSPSC codes.

Under the planned solution, data would be extracted from the central state invoicing system and uploaded onto Hansel Oy's Qlik Business Intelligence (BI) system. On this system, the data would be cleaned and then run through the "CAEN" categorisation algorithm, which was integrated with the Qlik solution. Then the re-categorised data is returned to the Qlik system, where it can be viewed and analysed as necessary by Hansel Oy employees. Following this, the data would be uploaded to the "Explore State Spending" portal, where it can be viewed by citizens.

The overall system architecture is illustrated below:

Figure 9: System for categorisation and publication of state invoice data



The IT consultancy which developed this system also developed an application in Qlik which would allow users to manually classify data and send it to the categorisation algorithm in order to train it further. The project team, however, experienced difficulties in developing a user-friendly tool for this purpose in Qlik. In general, it felt that the software was not well-suited to this type of use – continuously receiving and processing large amounts of text data.

Implementation of the project

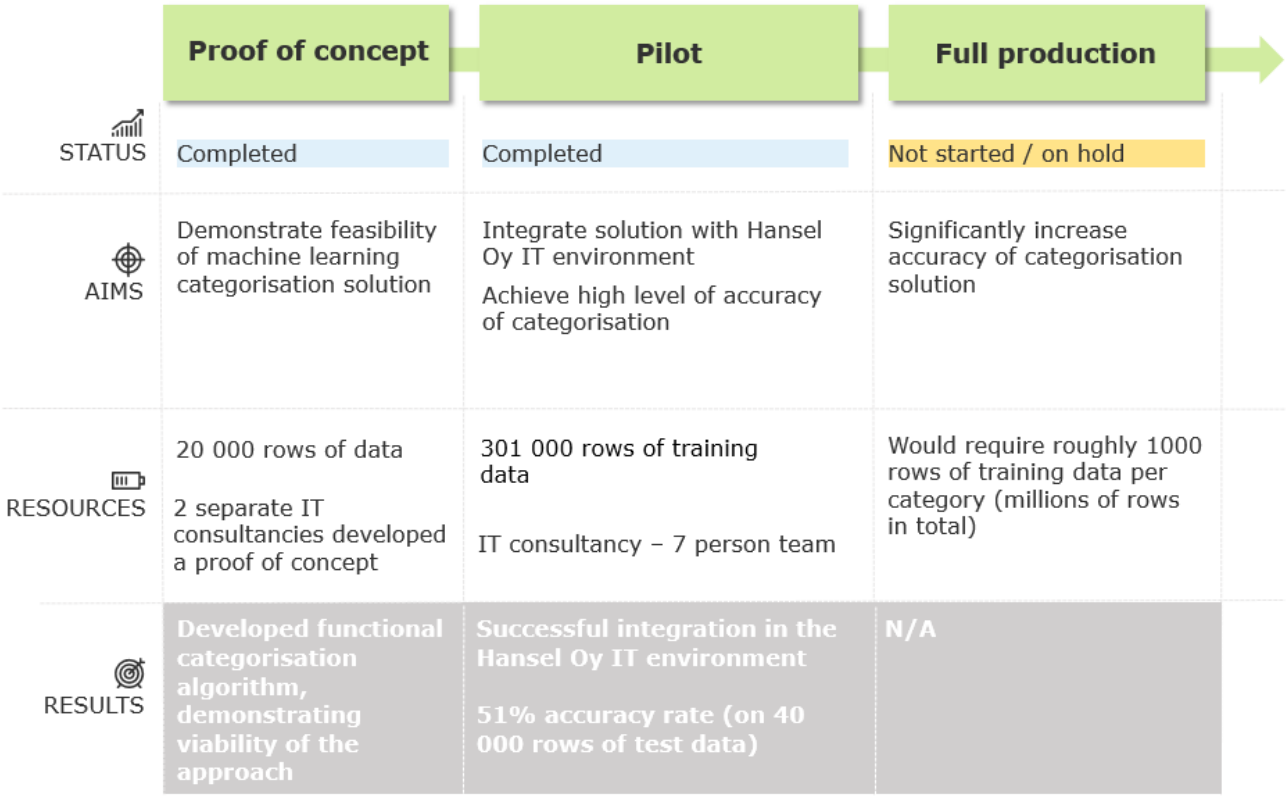
First, Hansel Oy **contacted several other organisations with previous experience in attempting such categorisation projects** (e.g. SKI, the Danish central purchasing body). However, they found that the solution used by these organisations was too expensive. As a result, they approached several Finnish companies to see if they would be willing to develop a proof of concept for a machine learning categorisation solution.

Two companies **developed proofs of concept for Hansel Oy**. Each company was provided with a demo set of data (10 000 rows) and given the challenge of developing a solution that could categorise it in as much detail as possible according to the UNSBSC classification, in one month time.

Both companies, successfully developed a proof of concept. On the basis of these results, Hansel Oy **tendered for a full-scale version that could be piloted within its IT environment**. One of the companies that developed the proof of concept won this tender, and it developed the full-scale version in 6 months.

As of **January 2017, the pilot phase of the project was completed**. During this phase, the algorithm was developed and refined, trained, and integrated with the Qlik environment. At the end of this procedure, the algorithm was tested on 40 000 rows of test data, which it could assign to 20 000 different UNSPSC classes. It achieved an overall accuracy rate of 51% in its categorisation.

Figure 10: Phases of development of the categorisation solution



Results and future expectations

The pilot version of the categorisation algorithm has been successfully developed, integrated and tested within Hansel Oy's IT environment. As stated above, the **overall accuracy rate achieved by the algorithm is 51%.** This differs, however, according to the type of spending that must be categorised. For certain areas, such as spending on ICT equipment, the accuracy rate achieved was between 70 and 80%. However, for others areas it is far lower.

The organisation has not yet chosen to roll out a production level version of the solution (i.e. a fully functioning solution that is used in the organisation's normal operations). This is in large part due to restrictions related to training data. **In order to increase the output of the algorithm to an acceptable level of accuracy, it must be fed with many more rows of training data**. This data must be classified beforehand according to the UNSPSC scheme, which is an extremely time consuming manual process. To give a sense of the scale of this task, Hansel Oy estimates that for each UNSPSC category, roughly 1000 rows of training data is required. There are many thousands of UNSPSC categories. As a consequence, several million pre-categorised rows are required as training data.

Given this constraint, **the organisation has not yet chosen to make the investment that would be necessary to roll-out a more accurate, production version of the pilot**. It is also assessing whether it could develop in-house an alternative version of the categorisation algorithm, as new staff members have since joined the organisation with the necessary AI skillset. It is felt, in particular, that a revised solution, which is not integrated with the Qlik Business Intelligence system, may be preferable and worth developing.

Despite the AI categorisation solution not having been implemented, the explore state spending website has been set up and is kept up to date with the spending (eInvoice) data from central government agencies and ministries. This data is not, however, categorised according to the UNSPSC schema. Instead it is categorised

according to the existing schema recorded within the original eInvoice data. Although this is not the preferred way to present the data, it nonetheless ensures a level of transparency is maintained towards citizens and businesses regarding state spending.

Costs and requirements

Costs	Human resources	Other
€89 265 (divided into €79 265 for the pilot, and €10 000 for the 2 proofs of concept)	**Pilot project:** • **IT consultancy:** 7 person team (not full time) – manager, data scientist, Qlik experts) • Hansely Oy: 3 analysts, technology manager	**Data**: access to eInvoicing data in machine readable form **Training data**: 301 000 rows of pre-categorised data

The entire price of the project, from the proof of concept stage to the end of the pilot was **€89 265**. An initial €10 000 (€5,000 each) was paid to the two companies that developed a Proof of Concept for the categorisation solution. Following this, the cost of the pilot came to €79 265, which was divided into:

- €15 361 for the categorisation algorithm
- €47 380 for the integration with the Qlik infrastructure and the teaching interface
- €12 523 for maintenance and service desk services
- €4 000 for set up by the contractor

In terms of requirements, these can be broken down into **2 main types: human resources, and data**. The human resources for the projects were drawn both from the IT consultancy and in-house. **From the consultancy, a total of 7 profiles contributed over the 6 month duration** of the project. The total number of people from the company working on the project at any one moment ranged between 2 and 7. The contributors had the following profiles: Project manager; Senior data scientist; Junior data scientist; Qlik manager; Qlik back end developer; 2 Qlik front end developers.

Contributions from Hansel Oy were also required to develop the pilot. These contributions primarily came from 3 analysts - who dealt with communication with the supplier, preparation and provision of data, workshop style development sessions – and a technology manager who dealt with the issues related to the Hansel Oy's cloud infrastructure. At the start of the project there were also some contributions to meetings from the CFO and the CTO (who initially led the project).

The **other main requirement (and main barrier) for the development of the project was the provisions of categorised training data** for the AI algorithm. Insufficient training data was available to reach the desired level of accuracy. In order, to scale up the solution to a more accurate, full-production solution, several million more rows of training data would be required.

Another fundamental requirement of the project was the access to the detailed invoicing data in a machine readable and analysable format. Hansel Oy's access to the central government eInvoicing system ensured that this data was available, but it was nonetheless necessary to conduct further cleaning of the data, within the Qlik system, before it was put through the categorisation algorithm.

Risk and mitigation

As the solution has only reached a pilot version the risks so far have been limited. Those privacy and security risks that exist are more connected to the wider open data "Explore State Spending" project, than to the machine categorisation algorithm itself. Because the data on this website is publicly available it is necessary to remove and anonymise some of it in order to ensure that it is compliant with the GDPR. Details that are removed from the original eInvoicing data include data items such as consultant names (i.e. on a consultant invoice), phone numbers, car registration, etc).

When starting up this project, the other **main risk related to the lack of experience and expertise with machine learning technology and implementations within the organisation**. It was because of these concerns that a **gradual roll-out approach** was pursued – going first to the market to get several possible approaches to the problem via the proofs of concept, then tendering the pilot version, and only then considering whether to put the solution into full production.

Challenges and lessons learnt

There are a number of points that Hansel Oy has taken from the project and learnt from. One of the main aspects that it would like to revise is the **integration of the categorisation solution with the Qlik Business Intelligence system** to develop an interface through which users could manually classify data to be used to train the algorithm. This integration proved to be difficult, expensive, and did not deliver much additional value.

Another general lesson that could be drawn from Hansel Oy's experience relates to the **importance of training data**. Providing an adequate amount of training data for a machine learning algorithm to perform at the desired level can necessitate a substantial investment. The level of this required investment should be estimated and incorporated into the budgeting process at the beginning of the project.

A final lesson to take from the project relates to whether to outsource the development of AI solutions or develop them internally. Hansel Oy chose to outsource the work, but later considered that the better route may have been to develop the solution itself. Organisations should carefully assess, based on the human resources available to them, which is the better route before starting the project.

Case study 3: CPV Code Prediction

Lead Organisation: ProZorro; uData

Location: Ukraine

Technologies: AI & ML

Level of government: National

Problem Statement: Goods and services are often classified under the wrong Common Procurement Vocabulary (CPV) code when public authorities open a call for tender. This results in fewer interested vendors identifying and bidding for the tender, lower competition, and ultimately lower value for public authorities.

Description: A data science consultancy (uData) developed a **machine learning solution** for ProZorro, the State organisation behind Ukraine's hybrid e-Procurement system, that **predicts the correct CPV code** for a product. The algorithm developed does this based on textual input including the description and title of the product. The output of the algorithm is a number of different CPV codes, together with a probability for each one that it is correct. If restricted to just providing one CPV code for a good or service, it can **predict the first four digits of the CPV code with an accuracy of 70%**.

The solution was developed using machine learning **building blocks available on the Amazon stack.** It was trained with data on previous tenders held by ProZorro, which had already been classified with a CPV code. The solution was, in fact, developed by trainees of a training programme run by uData (uData School). The solution has been delivered to ProZorro but is not yet in use.

Lessons learnt: With sufficient training data, a reasonably accurate CPV code prediction algorithm can be developed by a team of junior-to-middle ML engineers (i.e. trainees within the uData School training programme.

Cost: approx. €7 000 - 10 000 for equivalent projects (developed free as part of the uData consultancy's training programme)

Impact: Limited. Solution has not yet been integrated into any front-end e-procurement platforms (i.e. the platforms where public authorities upload calls for tender to be bid for by vendors).

Future expectations: The tool is available for integration into a front-end eProcurement platform. uData itself plans to integrate the tool into other broader offerings that it is developing – for example a service that updates private companies on new tenders of interest to them on the basis of a description of the items and services they provide.

Human resources: 4-6 weeks for equivalent project with full time team of 2 machine learning engineers

Risks: Limited – project drew on open data and open source technology**.**

Other requirements: Training data – uData was able to draw on ProZorro's open data set on 4 million public tenders (comprising 15 gigabytes of data).

Project timeline: 6 weeks

Project status: Solution developed but not implemented

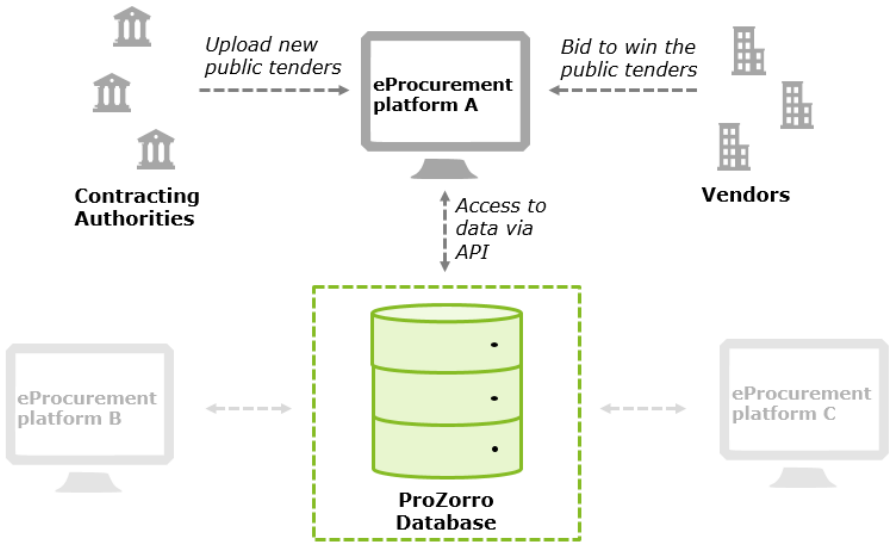
E-mail: bdm@udata.tech

Website: https://prozorro.gov.ua/

Context and problem statement

Prozorro is Ukraine's award winning[130], **hybrid eProcurement system**. Operational since 2016, it combines a **state-owned open source database** which holds data on all public tenders over a certain value, with **privately operated "marketplaces**". These marketplaces are the front-end platforms on which public organisations upload and update tenders, and private companies bid for them. Currently, there are 18 different platforms provided by different private suppliers. In addition, the state also provides a web portal through which the data is accessible.

Figure 11: ProZorro eProcurement ecosystem



A **State-owned enterprise, "Prozorro", has been established**, which is responsible for the development and maintenance of the database and the web portal. This organisation also develops tools and features which can be integrated into the private eprocurement platforms operating on top of the database. For example, the organisation has developed a business intelligence module enabling the monitoring and analysis of the tender data.

A common feature of the eProcurement marketplaces supported by Prozorro is that **when public organisations upload new tenders, they must include the Common Procurement Vocabulary (CPV) code** for the good or service they want supplied. A CPV code provides a classification for the good or service which is standardised across the EU. It can consist of up to 8 digits, however in practice it is rare to use more than 4. The use of CPV codes helps both public and private bodies when searching for different types of tenders, or analysing the associated data.

One common issue when uploading a tender is misclassification of the good or service – with the employee of the contracting authority **assigning it the wrong CPV code**. This can happen for a number of reasons, whether through a typo or a misunderstanding of the rules, or simply because the procurement officer did not make the extra effort to find the correct code. Overall, misclassification of items according to the CPV code can make it harder for competitive businesses to find relevant tenders resulting in higher prices and

[130] World Procurement Award 2016, see https://worldprocurementawards.com/hall-of-fame/; Open Government Award 2016, see https://www.opengovawards.org/2016Results

less efficient outcomes. ProZorro would therefore like to find ways to limit the proportion of these misclassifications.

Objectives and vision

ProZorro aimed to find an artificial intelligence solution that would automatically predict the correct CPV code based on information about the item, such as the name and written description. The objectives of implementing such a solution are to:

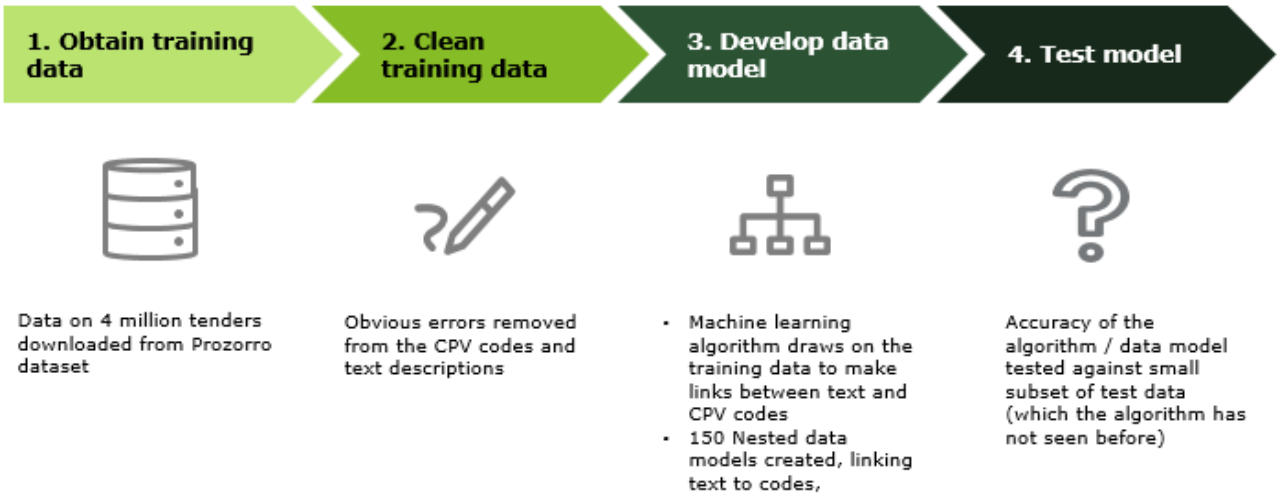
- **Save procurement officers time and effort** in looking up the correct CPV code when uploading new tenders to ProZorro-based eProcurement platforms;
- **Increase the proportion** of tenders that are classified **with the correct CPV code**; and therefore
- Ensure that a **greater number of vendors are able to identify and bid for relevant tenders**; and ultimately
- Promote a **greater level of competition** for public tenders resulting in **better value public procurement**.

Technological solution and implementation

The AI CPV solution that has been developed predicts the first four digits of the CPV code of an item on the basis of text input of the tender title, tender description, item description and item unit. **The tool provides the user with a number of potentially correct CPV codes, providing an estimate of the likelihood of each one being correct**. On the basis of this, the user can select the option that seems to be correct.

In order to develop this AI tool, Prozorro approached **uData, a data science consultancy** specialised in data mining and analysis, and machine learning. uData created this solution through the following steps.

Figure 12: Steps towards developing the machine learning solution



The **first step - obtaining data -** is a necessary step for training an AI machine learning solution. In this case, this step posed little problem. The Prozorro dataset contains 15 gigabytes of data on 4 million tenders, including the tender title, description of the item procured, item unit, and the CPV code that was assigned to it. This dataset therefore provides many rows of data linking the desired input (i.e. the description) to the desired output (the CPV code), making it an appropriate training dataset. The data is accessible via API directly from the ProZorro database.

The **second step – cleaning the data** – is necessary especially for as diverse and large a dataset as that of Prozorro. The underlying source of the data is classifications provided manually when contracting agents

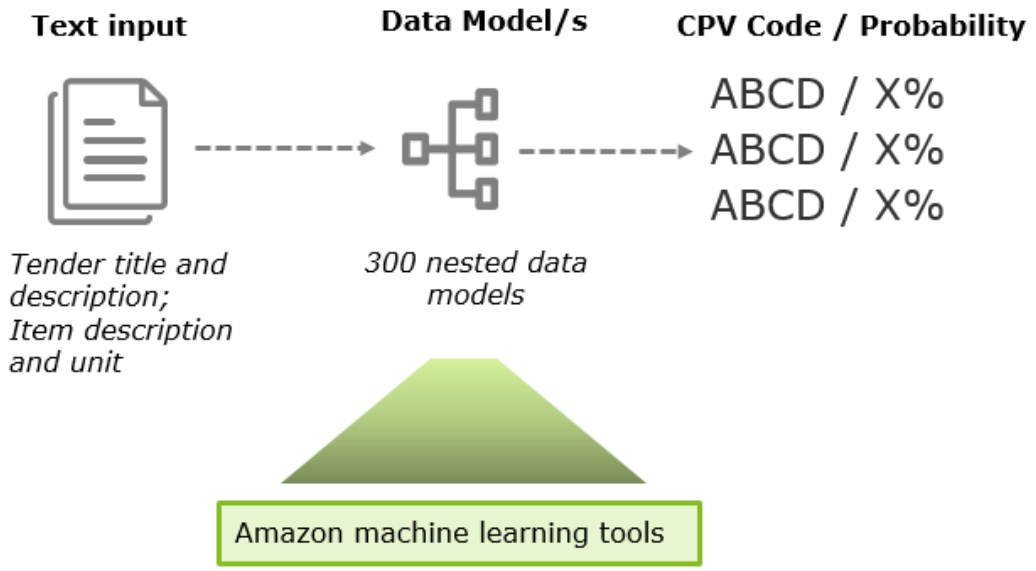
put together tenders. As already discussed, CPV codes can often be misclassified during this process – meaning that the code recorded in the Prozorro dataset would also be wrong. The uData team spent 2 weeks cleaning this data, both making sure that the more obvious CPV coding errors (e.g. blanks or coded with four zeros) were removed, and cleaning the descriptions of the tendered item.

The **next step, the development of the data model**, is what links the input description to the outcome CPV code. uData drew upon the machine learning tools and building blocks available in the Amazon stack to create this data model – which is a neural network that can predict a numeric value (the CPV code) on the basis of text (the tender title, tender description, item description and item unit). The underlying data (the CPV code) is hierarchical. The first two digits of the CPV code define the general category of the good, then the next digit specifies the category further, and so on.

The **data model created is therefore also hierarchical, it has 3 layers**, with 300 nested data models within it, each used to predict a different category as you go further along the CPV code digits:

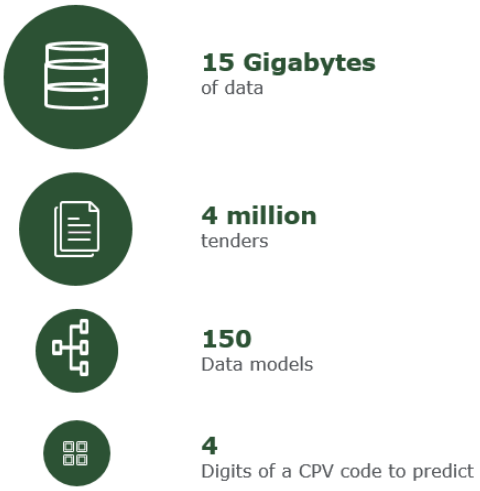
- **1 model**: is used to predict the first 2 digits of the CPV code;
- **50 models:** are used to predict the third digit of the CPV code (the model used depends on the predicted value of the first two digits);
- **250 models:** are used to predict the fourth digit of the CPV code (the model used depends on the predicted value of the first two digits).

Figure 13: CPV prediction solution



The **final step**, once this data model is produced, is to **test it to see how accurate its predictions are**. uData used a subset of the Prozorro data to do this, holding back roughly 5% of the data for this purpose. In order to do get the most accurate prediction the Levenstein metric was used. Once the accuracy of the algorithm reached an acceptable level, according to this test data, the team delivered the Python code representing the solution to Prozorro, so that it could be implemented on any of the Prozorro-based eProcurement platforms.

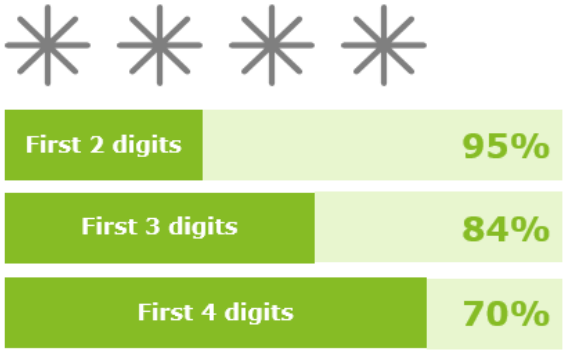
Figure 14: The solution in numbers



Results and future expectations

In April 2019, uData delivered the code for the machine learning categorisation solution to ProZorro. The solution provides a number of possible CPV codes (with their probabilities) on the basis of text input. If looking at just the top prediction of the solution, the **overall accuracy of solution for the first four digits of the CPV code was 70%.** If restricted to just predicting the first few numbers of the CPV code (providing the broad categories to which the items belong) the tool was more accurate. It can predict the first three digits of the CPV code with an accuracy of 84% and the first two digits with an accuracy of 95%.

Figure 15: Accuracy of CPV code prediction tool



The code prediction solution has **not yet been integrated into any of the front-end eProcurement platforms** and so is not in use. However, it is available and could be immediately implemented whenever one of the private providers of these platforms decides to do so.

uData itself has plans to integrate the tool into other broader offerings that it is developing – for example a service that updates private companies on new tenders of interest to them on the basis of a description of the items and services they provide. The service would convert the input description into probable CPV codes and search for and update the users regarding new tenders on the basis of these codes.

Costs and requirements

uData developed the solution as part of a training program "uData School" that they run for aspiring mathematicians. As such they did not charge ProZorro for the tool, and it took slightly longer and involved more machine learning engineers than would normally be the case. The consultancy estimates that under normal circumstances, the development of an equivalent solution would **cost €7 000 – 10 000**. 90% of this cost would cover human resources, while the remaining budget would be allocated to over cloud servers and infrastructure.

Similarly, uData estimates that a project team consisting of **2 mid-level machine learning engineers** could develop an equivalent solution in **4 to 6 weeks full-time**.

Figure 16: Costs and requirements of developing the CPV prediction solution

As with all machine learning solutions, the **availability of appropriate training data is a crucial success factor** for the projects. In the instance, the availability of the open ProZorro dataset of 4 million public tenders, provided a more than adequate level of training data. Each tender was already provided a CPV code by the contracting authority. Although in some instances the incorrect code may have been provided, the sheer amount of the available data means that there are enough correct classifications that the machine learning solution can build up an accurate model linking text descriptions to CPV codes.

Risk and mitigation

For this project, the **risks were very limited**. The training data set used is already open data, freely accessible over the ProZorro API, so there are no issues related to privacy and security. The project drew on largely on open-source scripts and tools, so there is little associated risk of lock-in. Finally, as the project was conducted as a free training project, there were no risks to ProZorro related to overrunning on costs.

Challenges and lessons learnt

The project results demonstrate that with **sufficient training data** reasonably accurate CPV code predictions can be generated. Even with large and complete datasets, however, there can be challenges in terms of ensuring the dataset is clean – this can require a substantial time investment.

The prediction solution was also successfully developed in this case by trainees within uData's training programme – uData School. This suggests also that the **development of such solutions is relatively straight-forward** and does not require a huge amount of experience. Of course, the project did not require any integration with existing IT system or legacy solutions – which may also have meant that the task was more straightforward and feasible for less experienced workers.

Case study 4: Categorisation Artificial Intelligence Technology (CAITY)

Lead Organisation: New South Wales Procurement, Department of Analytics

Location: New South Wales, Australia

Technologies: AI & ML

Level of government: Regional

Problem Statement: NSW Procurement is required to manually categorise 2 million procurement transactions every quarter according to the NSW all of government procurement taxonomy. This is a necessary task in order to provide insight into government spending, however it is a time-consuming and tedious process, using up 160 employee days every year.

Description: New South Wales (NSW) Procurement, with support from the Data Analytics Centre, has developed a machine learning tool – CAITY – that automatically categorises different types of procurement spending based on data extracted from general ledger data. The solution was developed using python-based machine learning tools provided on the Microsoft Azure public cloud. The previous manual classification process had an accuracy rate of about 70%. After being trained on over 45 million rows of pre-classified data, CAITY is able to categorise procurement spend with an accuracy of over 90%.

Lessons learnt: High quality and accurate training data is crucial for the success of a machine learning categorisation project. Even with large quantities of pre-categorised data, the project faced challenges as this data was not validated.

Cost: approximately €185 000 (AUS $300 000)

Impact: Mid-range. Saves 160 employee days / year; Increased accuracy of categorisation from roughly 70% to over 90%

Future expectations: Currently, there are no efforts to expand or build upon the tool. Several other government agencies have expressed some interest in making use of the tool, however, NSW Procurement is not actively promoting the tool across the government.

Human resources: Proof of Concept - 2 full time employees, 8 weeks. Full scale: 1 additional full time employee, 8 months; 10-20% of existing full time employee's time on permanent basis

Risks: Privacy/security concerns over storing data on external server; surpassing expected project budget; expectation management of media and external stakeholders

Other requirements: Training data - 45 million rows of pre-categorised data

Project timeline: Aug 2017 - present

Project status: Fully deployed solution

Email: analytics@treasury.nsw.gov.au; dac@customerservice.nsw.gov.au

Website: https://buy.nsw.gov.au/ict/

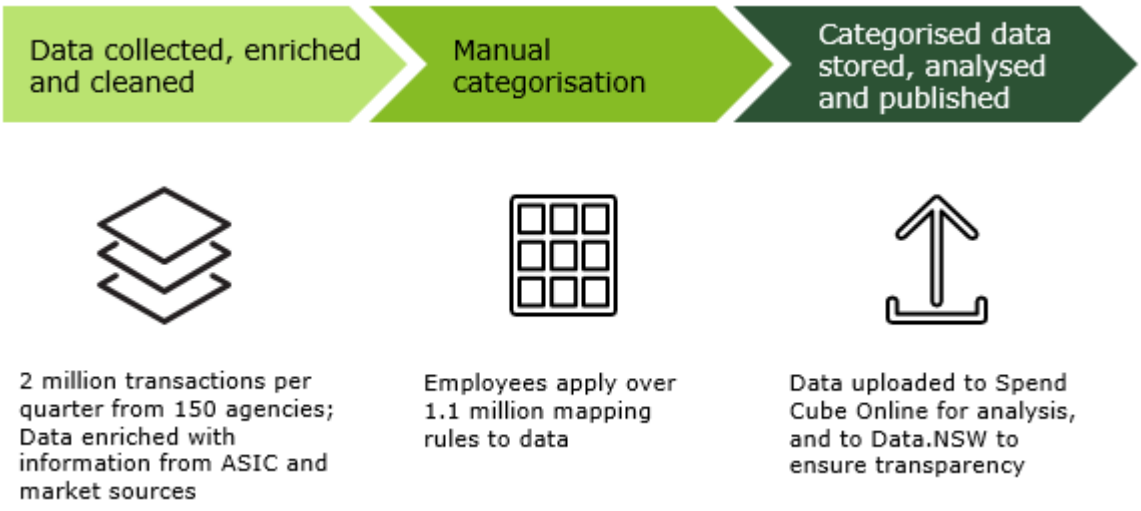
Context and problem statement

NSW Procurement is an office within the NSW Department of Finance, Services & Innovation. It provides **support to NSW government agencies in their procurement activities, providing procurement services and solutions**. As part of its activities, it maintains an analytics team which is responsible for analysing public procurement data from across the State. The tasks of the analytics team include the collection of procurement data, providing analytics platforms (e.g. category-specific dashboards), and leveraging the data to support agencies and clusters to develop insights and solutions to their procurement challenges.

More specifically, the following set of activities are conducted by the analytics team in order to provide a base of analysable data which procurement teams can explore and derive insights from:

- **Collection of data:** The analytics team collects general leger data on spending from over 150 NSW government agencies.
- **Enrichment of data:** The analytics team combines the collected data with additional data purchased on the market and from sources such as the Australian Securities and Investments Commission (ASIC) to provide a more complete picture of procurement across the state and the vendors that are supplying goods and services.
- **Cleaning and categorisation of data** – The analytics team cleans the extracted data, ensuring that a common format is used and that there are no obvious errors. It then manually categorises each item of spending according to the NSW all of government procurement taxonomy (a categorisation scheme based on and similar to UNSPSC.
- **Visualisation of data and publication of data**: The analytics team uploads the data to the "Spend Cube Online" platform, a business intelligence cloud solution which enables visualization and analysis of spend data. The data is also published on the open data website – Data.NSW.

Figure 17: NSW Procurement treatment of spend data: manual categorisation



Of these tasks, the manual spend data categorisation is a particularly time-consuming and arduous task. It is done on a quarterly basis, with over 2 million transactions requiring categorisation each quarter. The data is collected from state government agencies in general ledger form. This general ledger data provides a categorisation of each item of spending, however, this existing categorisation scheme is not the standardised taxonomy used for procurement analysis. It is therefore necessary to re-categorise it.

In order to perform this categorisation, NSW Procurement maintain a set of over 1.1 million mapping rules which match information on the supplier and the general ledger classification to the desired procurement classification. In order to reclassify the data, employees must manually go over each entry in the dataset,

applying the relevant rule. Under this process, mis-categorisations and mistakes often creep into the categorised data due to human error. The team has estimated that the correct classification was provided only 70% of the time under the manual procedure. The categorisation work takes 160 working days per year (40 per quarter). Work must also be done to update the mapping table with additional rules each time a new supplier is added.

In order to support its analytic work, the team has been looking into a range of emerging technologies, from AI and machine learning applications supported advance analytics solutions, to new dashboards and open data approaches. It identified the categorisation of the data as a promising area for automation through the application of emerging technologies, due to the time consuming and repetitive nature of the task.

Objectives and vision

The unit **aimed to develop and make use of a machine learning tool to carry out the quarterly categorisation of procurement data** from government agencies across the State. The two objectives that it was hoped could be achieved through the use of such a tool were:

- **Efficiency and time saved** – decrease the staff time spent on categorisation of procurement data;
- **Accuracy** - accurately classify at least 90% of acquisitions based on general ledger data.

Achieving these goals was considered to be worth an investment in trialling a new technology – machine learning - that the analytics team did not have prior experience with. They therefore went ahead with first contracting a partner to develop the categorisation solution and then implementing, as described in the section below.

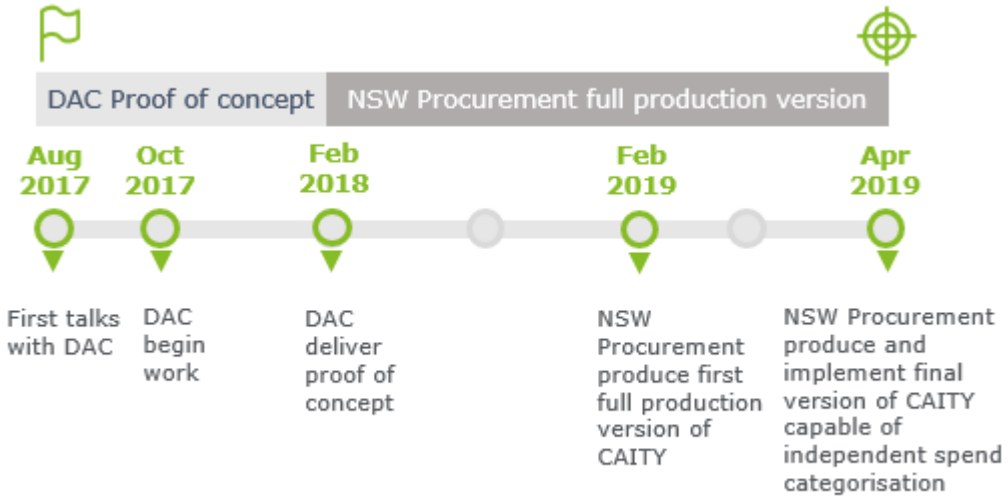
Technological solution and implementation

The machine learning tool that was created in order to fulfil these objectives is known as Categorisation AI TechnologY (CAITY). CAITY was developed in two phases:

- **Development of proof of concept** – A categorisation model was developed by the Data Analytics Centre and tested against a random sample;
- **Development of full production version –** The proof of concept was scaled up and developed by the NSW Procurement analytics team into a full production version.

The first phase commenced in August 2017, with the second phase following it in Feb 2018, according to the timeline presented in the figure below.

Figure 18: Timeline for the development of CAITY



The following sub-sections describe each phase in more detail.

Proof of concept

The **proof of concept of CAITY was developed by the Data Analytics Centre** (DAC), following their engagement by NSW Procurement on the project in August 2017. The DAC is a NSW State body with a mission to build world-class capabilities in data analytics and help the NSW Government to get the most out of its data. It supports and collaborates with Government agencies and helps provide data-oriented solutions to their problems.

DAC delivered the proof of concept in February 2018. In order to develop it, they **drew upon python-based machine learning tools provided on the Microsoft Azure public cloud** that enable natural language processing. The team developed a machine learning algorithm that could automatically categorise spend data based on information on:

- the supplier name;
- the supplier classification and Australian Business Number;
- the general ledger categorisation; and
- the general ledger description of the item.

DAC was **given access to 45 million previous categorisations (from the previous manual process) to use as training data for the machine learning algorithm**. It made use of 20 million rows of this data – following this, no further improvements to the accuracy of the algorithm were returned through the use of additional training data. This data was stored on an Azure server. In order to address privacy concerns associated with storing this data on an external server, it was anonymised. On the basis of this training data, the DAC was able to get the proof of concept algorithm to provide procurement classifications with over 90% accuracy.

An additional interesting finding by the DAC when they developed their proof of concept, was that they could forcibly reclassify spend that had previously been categorised as "other". Several hundred million transactions were classified as "other" in the data they were provided with. It was demonstrated that a large proportion of this could potentially be reclassified – which could have implications for various government targets (e.g. percent of various types of spending going to indigenous or regional vendors).

The proof of concept algorithm demonstrated that a machine learning tool could perform the spend categorisation task with a high degree of accuracy. On the basis of the results provided by DAC, NSW procurement decided to develop a full scale version of the algorithm and integrate it into their procedures and systems, as described in the following section.

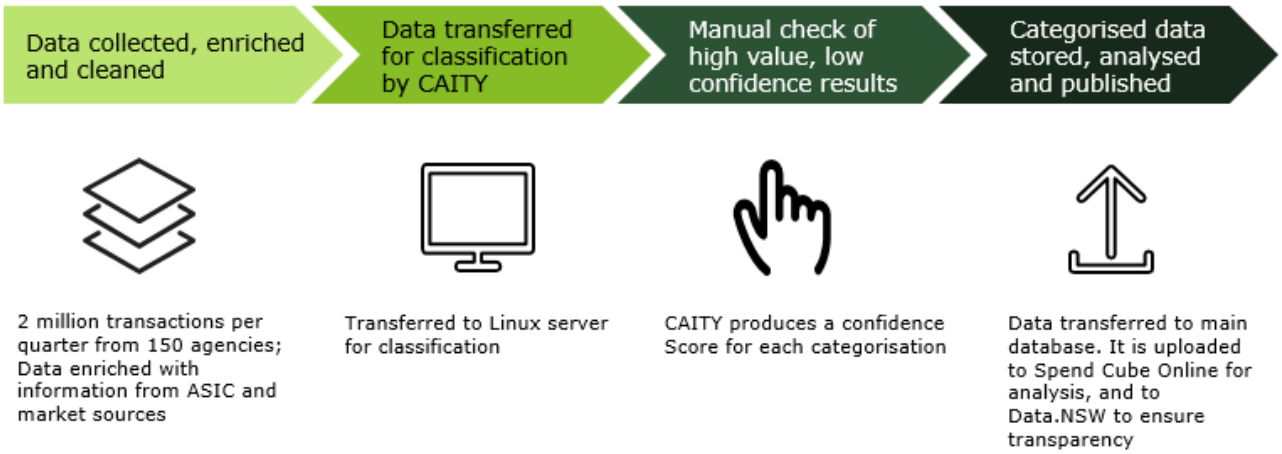
Full production version

Following the successful proof of concept, **the analytics team in NSW Procurement developed a full production version of CAITY that can operate independently in performing their quarterly spend categorisation**. Changes that were implemented to scale up the proof of concept included:

- **Migration of the code** from an Azure server to local Linux server – This was done for cost-saving reasons. The team opted to shift to using a local unused Linux server in place of the Azure server, which they had to pay for.
- **Optimisation of the code** – This resulted ultimately in a reduction of the time taken for the categorisation from 4 or 5 days to a couple of hours. The accuracy of the categorisation was maintained at over 90%.
- **Transfer of data** – A system was developed through which the general ledger data is transferred from the main database to the Linux server for categorisation by CAITY, and is then transferred back to the main database.

Along with a predicted categorisation, CAITY provides a confidence score for the categorisation. This means that for high value and low confidence categorisations a manual check (and if necessary, reclassification) can be done. The automated classification procedure as supported by CAITY is presented in the figure below.

Figure 19: NSW Procurement treatment of spend data: automated classification



Initially the project team experienced **some challenges in achieving the desired level of accuracy** (over 90%) for the automated categorisation solution. In addition, the algorithm achieved lower levels of accuracy for categorisations of acquisitions from new vendors. This **issue with the new vendors was resolved by enriching the training data with data from other sources**. Specifically, data bought from the market providing a classification of the type of vendor (ANZ classification and SIC classification) was added. This provided the algorithm with sufficient additional information about the new vendor that it was able to make a more accurate classification.

The machine learning application has been used by NSW procurement since April 2019, and the new automated procedure has now fully replaced the old manual process. The results of this implementation are addressed in the next section.

Results and future expectations

The CAITY project has been a success for the NSW Procurement team as measured by the two main KPIs established:

- **Accuracy**: The tool categorises the spend data with an accuracy of roughly 90%. The estimated accuracy, based on test samples, of the previous manual classification procedure was about 70% - with misclassifications made due to human errors. The tool has therefore resulted in an approximately 20 percentage point increase in the accuracy of spend categorisation.
- **Efficiency**: The tool saves 160 FTE days/year by removing the need to conduct the manual classification each quarter. This allows staff to spend time on higher value data analysis tasks rather than tedious data categorisation.

NSW Procurement has since also won awards for its work on CAITY, winning the CIPS Australasia award for Technology Innovation. As it currently stands there are no efforts to expand or build upon the tool. Several other government agencies have expressed some interest in making use of the tool themselves. However, NSW Procurement is not actively promoting the spread of the tool across the government.

Costs and Requirements

Costs	Human resources	Other
≈ **€185 000** (AUS$ 300 000)	**Proof of Concept**: 2 full time employees, 8 weeks **Full scale**: 1 additional full time employee, 8 months; 10-20% of existing full time employee's time on permanent basis	**Training data**: 45 million rows of pre-categorised data

In terms of **finances**, the total investment in the project by NSW Procurement has been about **AUS$ 300 000** (€185 000). This is split between the following:

- DAC proof of concept
- Scale-up by NSW procurement of the proof of concept – approximately AUS$ 150 000 (€92 000).
- Maintenance costs (updated training data etc)

In terms of **human resources**, the proof of concept took 2 full-time DAC employees 8 weeks to develop. Following this, for their scale up effort, NSW procurement employed an additional full-time employee for 8 months. This employee had a data scientist profile, and experience in programming in python. For the maintenance effort, a technical specialist who already works for the unit now spends 10 to 20 percent of his time on tasks related to CAITY.

Another key requirement for the project was the **availability of training data**. NSW procurement had the large advantage of having a huge database of categorised data, resulting from the established manual classification procedure. This data was also cleaned and validated at an earlier stage (according to existing processes within the unit) as well as enriched with data from other sources (for example with the "Australian business number" of the supplier) before being used to train CAITY.

The CAITY project therefore delivered on its main objectives of increased accuracy and efficiency of spend categorisation on the basis of a relatively limited investment in terms of money and human resources. The following section, will consider other risks that were associated with the project and how they were mitigated.

Risk and mitigation

There were a limited number of risks associated with the project, including in the area of privacy and security, budget, and expectation management.

In terms of **privacy and security**, there were some concerns during the proof of concept stage, when the data was being stored on an external Azure server. Azure had previously been awarded a security certification by the government, which enabled the storage of this government data on its servers. Some of the general ledger data included personal data, such as names of individuals. This data was therefore anonymised before being transferred to the Azure server. Following the move to the local Linux server which is a part of the NSW Procurement IT system, the privacy concerns associated with external servers were alleviated.

The NSW Procurement team also had some **concerns that the machine learning solution could be too expensive** at the start of the project – if so they would have preferred to continue with the manual classification system. It was able to alleviate these concerns through conversations with DAC, which provided assurances that the development of the tool would not be overly expensive. In addition, the gradualist approach towards the project – developing first the proof of concept and only later the full scale version – enabled the team to make an educated estimate of the likely cost.

Finally, one unexpected risk involved **expectation management** following mistaken reports in the media that the use of the CAITY tool could result in savings to the NSW government budget of 1 percent. As the CAITY tool cannot directly produce these type of savings, DAC and the Ministry had to correct these claims circulating in the media.

Challenges and lessons learnt

The CAITY project demonstrated the importance of having **good quality training data**. The data available to the development team was pre-categorised but not validated (i.e. no human had gone through it to check that the classifications were correct). This meant that it is less reliable, and a greater quantity of it is required in order to create an accurate categorisation solution. The project team was fortunate to have a large enough quantity of this pre-categorised data that they could draw upon that they could overcome this issue.

Another challenge involved the low level of accuracy initially output for the categorisation of new vendors. This issue was solved by **enriching the training data with additional information** – bought from the market - on the type of vendor. This allowed the solution to assess the type of vendor providing a solution (even when it was a new vendor and no previous data was available on it) and make an accurate categorisation of the type of item procured on the basis of that.

Case study 5: Procurement Information Provider (PIP)

Lead Organisation: YPO

Location: United Kingdom (UK)

Technologies: AI & ML

Level of government: Regional

Problem Statement: YPO provides framework contracts through which its clients (public sector buyers) can access and buy products and services. However, clients found it difficult to navigate the YPO website and identify the framework contracts that match their needs.

Description: YPO integrated a chatbot solution onto their webpage – the Procurement Information Provider (PIP). The chatbot is able to interpret written user queries and direct them to relevant parts of the YPO website. PIP was developed using the Microsoft Azure bot framework. This framework enables organisations to build and tailor a chatbot to their needs. The initial version of PIP was developed in 3 months (May – July 2018). Since this time it has been regularly updated and improved on the basis of user feedback.

Lessons learnt: Chatbot technology can be relatively easy and inexpensive to implement as a tool to help users identify the public procurement services that match their needs. Given the relatively limited knowledge and expertise available on the implementation of chatbot technology it is nonetheless advisable to approach such projects gradually, first attempting a small-scale implementation before moving on to more ambitious efforts. Some focus is also needed to ensure that the tool is maintained and kept up to date to ensure the proper functioning of the technology.

Cost: Approximately €5,780 (£5,000), entirely accounted for by YPO staff time. The Microsoft Azure bot framework was provided for free.

Impact: Mid-range. Increased traffic to frameworks section of YPO website; Customer support now available on a 24/7 basis: YPO positioned as a digitally innovative organisation.

Future expectations: YPO will continue to investigate how PIP can be used to improve their customer service and ensure their clients can access the information they need.

Human resources: Chatbot developed and maintained by internal YPO staff. Required programming and customer user journey expertise.

Risks: Some risk of the chatbot behaving in unexpected and unwanted ways (e.g. learning profanities from uses and repeating them in later user-interactions).

Other requirements: Development and maintenance of the question and answer knowledge base that the chatbot draws upon.

Project timeline: July 2018 – present.

Project status: Fully deployed solution - but additional functionality is still being developed.

Email: paul.smith@ypo.co.uk

Website: https://www.ypo.co.uk/news-and-events/news/ypo-unveils-first-public-sector-procurement-chatbot

Context and problem statement

YPO is the United Kingdom's (UK) largest public sector buying organisation. YPO has a wide range of public sector clients from schools to local authorities, charities, emergency services, as well as some private sector clients such as nurseries and care homes. It supplies these clients with the products and services they need to perform their missions.

YPO originates from Yorkshire and is 100% publically owned by a consortium of 13 local authorities, with all profits made by YPO returned to their public sector customers, delivering value for money. The organisation has been running for 45 years and currently has around 500 people in its employ. In 2018, YPO's turnover reached £840 million.

The organisation is split into two main parts. The core business is the wholesale business that purchases different products and stocks them in warehouses to be sold to its clients, mostly to schools. The second focus of the organisation is offering ready-made and ready to go framework contracts, through which YPO's customers can access the services and/ or the products that they require. The framework services and products provided are on offer across a wide range of sectors such as emergency services, food and catering, furniture, health and social care, technology and communications and fleet and highways. In total, YPO currently has around 30, 000 products and 100 frameworks in its inventory for clients.

YPO receives a large volume of inquiries from its customers in regards to the services and products it can provide. Clients often do not find it straightforward or obvious to navigate the YPO website and identify the offerings that correspond to their needs. In particular, it can be difficult for clients to determine the framework contract, product or service that matches their needs, or to know which key words to use in their search of the website. YPO identified that the most challenging area for clients related to the identification of which framework contract could be used to source the product or service they require.

Objectives and vision

The overall objective of the project was to **ensure that YPO's resources and offerings could be identified and accessed efficiently** by its users and **provide an improved online customer experience**. To achieve this, YPO envisioned the use of chatbot technology, in line with its wider strategy to digitally transform its operations and become a digital leader in the public procurement sector.

In addition, YPO aims to take on interesting challenges to develop its technological competences, even if the products or processes it tests are not implemented in the long term. It maintains an Innovation Stream through which it tests new technologies. It views the integration of new technologies as a reputational issue, and wants to be seen as innovative and as a driver of technological trends in the market. YPO was interested in experimenting with and testing chatbot technology in order to build internal skills in this area. This feeds into YPO's strategy and vision to lead digital progress in public procurement.

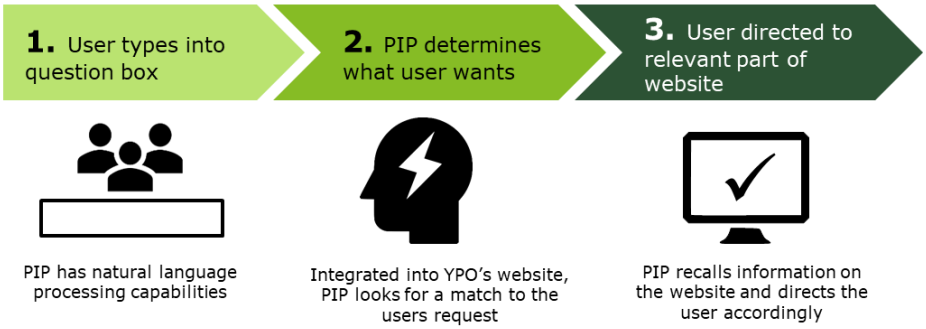
Technological solution and implementation

Main features of the solution

The Procurement Information Provider (PIP) is the chatbot solution that has been integrated onto YPO's website. It provides a text box in which users can input questions, and responds to these questions by directing users to relevant parts of the YPO website. PIP communicates in simple terms with the user and can respond with simple phrases such as 'thank you'. It is also able to ask for clarification ("what do you mean") if it does not understand the input from the user. The chatbot functions by recalling information from existing areas of the website drawing on neuro-linguistic language programming capabilities to interpret text input from the user. There is a tracking system of the user journey allowing employees to monitor how the chatbot responds to different questions. When PIP is unable to respond to a user's request, alerts are sent to internal employees via email or the back-end web platform.

Overall, PIP remains in its infancy and interacts only in a limited capacity with the user. Further development of the bot is required to improve its capabilities when it does not understand what is being asked. While it can ask for clarifications it would benefit from further development enabling it to pose a chain of questions to clarify what the user requires.

Figure 20: Procurement Information Provider process



Software and application

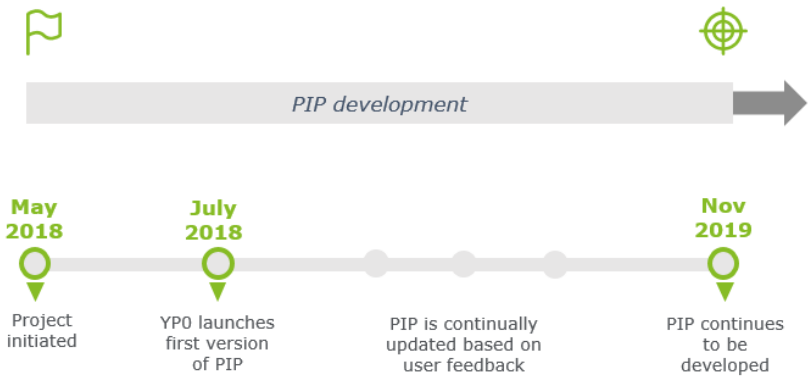
PIP runs on Microsoft's Azure Bot framework. This framework allows organisations to develop a bot as a webservice according to their needs. Organisations are able to plan, build, test, publish, and connect their bot to the communication channels used by their customers. In YPO's case, the chatbot webservice was integrated in the YPO website. Microsoft's bot framework allows its users to develop further the artificial intelligence (AI) capabilities of their chatbot. This idea has been explored by YPO but at present has not been taken forward.

Implementation

At the start of the project, discussions were held by the team members of the Innovation Stream of the Digital Board on where to use a chatbot within YPO. The Digital Board is responsible for digital transformation across YPO. One area identified as a promising target for a chatbot was the internal IT service desk, which has to deal with many repetitive questions on logistics and the business. The process required to deal with these questions was not especially tailored and therefore it was seen as an easy target for a chatbot.

In line with YPO's goals to improve its customer online experience, however, improving the discoverability of frameworks on the YPO website was finally selected as a "minimum viable product" to develop as a first chatbot implementation by YPO. This use-case was also seen as a relatively straight-forward one to be addressed by chatbot technology. YPO's internal IT eCommerce team were responsible for PIP's initial development and implementation. With the chatbot framework already provided by Microsoft, it was relatively simple to build and tailor a chatbot to YPO's needs, and it took just 3 months for the team to build and deliver PIP.

Figure 21: Timeline for the development of PIP

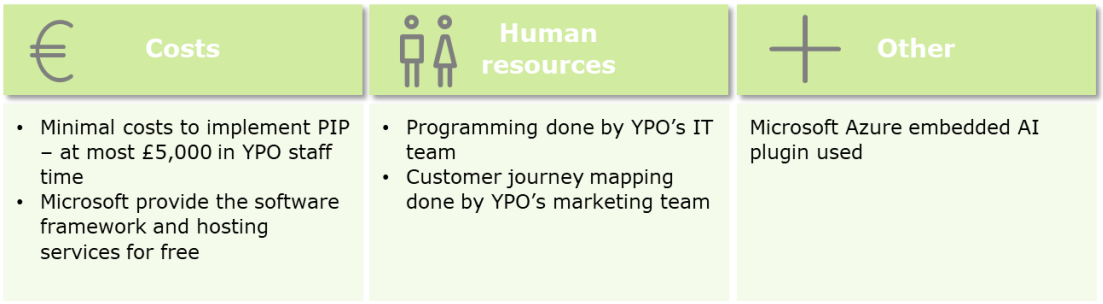


Results and future expectations

PIP has enabled YPO to improve the discoverability of frameworks and increase traffic to those frameworks. PIP has enabled YPO to provide customer support on a 24/7 basis, whereas it was previously restricted to operational hours. The amount of spend by customers on framework contracts at YPO has also been increasing, reaching £1 billion last year. However, it is not clear what share of the growth can be linked to PIP. In general, the return on investment from PIP has outstripped YPO's expectations at its launch. At this point in time they were not expecting to see a return on investment for the first two years.

Another important result from YPO's investment in PIP has been the strengthened perception of the organisation as innovative. This has opened up a new branding opportunity for YPO in relation to digital transformation. PIP has helped promote a revitalised view of public sector procurement in the technology age. A project such as this helps to present the procurement process as more open and appealing, in contrast to the stereotypical image of it as arduous and boring.

Costs and requirements



The **overall cost of the project so far has been roughly €5,780 (£5,000)**. This is accounted for entirely by internal employee time. This time was spent initially on development using the Microsoft Azure embedded AI plugin and the training of PIP. Following this, a small amount of time from developers is also required for the maintenance and up-keep of the chatbot, including updating questions and answers. The bot framework was provided by Microsoft for free.

The **technical skills required to implement this project** consisted of:

- **Programming skills** – already covered within YPO's IT team; and
- **Customer journey mapping** – already covered by (and implemented by) YPO's marketing team.

The skills required to implement the project were therefore already available internally, and there was no need to outsource any part of the work.

Risk and mitigation

Risks associated with this project are minimal. There are no security or privacy risks as PIP is directing its users to information that is not sensitive and already publicly available on the website. There is a small risk related to the technology's language learning capabilities. The chatbot could learn profanities input by users and repeat the language again in later interactions. However, so far in its implementation YPO has not experienced this with PIP.

Challenges and lessons learnt

One of the main challenges of this project is related to the **early stage of development of chatbot technology**. Adoption of the technology is generally low and there is a limited amount of expertise easily available on the best use and implementation of chatbots. One consequence of this is that it is best to initially invest in a smaller project and develop it further based on the successes and challenges experienced as well as on feedback from users. This limits the potential risk of losing a large upfront investment if the project is unsuccessful, and enables the organisation to update the chatbot and tailor its responses to its users' needs. Another lesson that should be taken from YPO's experience is that to have an effective chatbot, it is crucial to maintain the bot regularly and keep it up to date to ensure the proper functioning of the technology.

Overall, the YPO project has demonstrated that chatbot technology can be inexpensive to integrate into a procurement organisation's websites to improve user experience.

Case study 6: Ask Laura

Lead Organisation: El Paso City Council

Location: El Paso, Texas, United States

Technologies: AI & ML

Level of government: Local

Problem Statement: The El Paso City Council Purchasing and Strategic Souring department (PSS) operates a call service for potential vendors, with staff dealing with questions that are often repetitive and basic in nature. Following internal restructuring, the volume of these calls increased, as vendors did not understand well the new organisation. PSS wanted to find a way to reduce the employee time spent on this task.

Description: PSS department integrated a chatbot solution – Ask Laura – on their webpage. The (proprietary) solution implements natural language processing capabilities drawn from open source algorithms to interpret and deal with questions. The Ask Laura chatbot consists of an avatar and text input box providing a user interface, a knowledge base (of FAQs) and an analytics platform enabling the council team to monitor and respond to user behaviour. Following the successful implementation of the Ask Laura chatbot on the PSS webpage, the City Council have replicated the approach on other department websites.

Lessons learnt: Chatbots can be implemented at a relatively low cost with a return on investment possible within a couple of years. Some resources must be dedicated to maintain the knowledge base to ensure that the chatbot is effective.

Cost: Initial implementation cost and first year annual subscription of €18 060 ($20, 000), followed by €9 090 ($10, 140) annual subscription.

Impact: Mid-range. Total "cost-avoidance" of €19,850 ($22, 217) until end 2019. Customer support services extended and available outside of operational hours.

Future expectations: Going forward, the PSS department plans to further replicate the bot and expand the software's use across other government departments.

Human resources: 3 staff from technology vendor (1 project manager; 1 analytics expert, 1 developer. Takes 4-5 days to integrate and tailor.
2 internal employees – IT team work on maintenance of knowledge

Risks: No major risks associated with the project. There is a risk that is the chatbot will not function optimally if it is not updated regularly with new questions and answers (based on analytics report provided by vendor).

Other requirements: Experts within the City Council were consulted on the subject matter of the questions and answers for the knowledge base of Ask Laura.

Project timeline: Jan 2017 – present

Project status: Fully deployed

Email:
vendormanagement@elpasotexas.gov;
GomezV1@elpasotexas.gov

Website: https://www.elpasotexas.gov/ask-laura

Context and problem statement

The city of El Paso is in the top 10 biggest cities and towns of the Texas State. The El Paso City Council provides a government service to the city's inhabitants. Its mission is to 'deliver exceptional services to support a high quality of life and place for our community'. The purchasing and strategic sourcing department (PSS) of the El Paso City Council is responsible for 'purchasing and e-sourcing matters for supplier and services necessary for the efficient operation of all the City departments' and is also responsible for 'monitoring annual contracts, contract administration, issuing and approving purchase orders'. The department has approximately **4,000 registered vendors** and an average of **43,000 visits on its website annually**. The total spend for the PSS department so far for 2019 is $269 million, with $181 million spent locally and $88 million spent non-locally.

PSS provides a call service for vendors to ensure that they understand how to do business with the City Council and can have their inquiries answered in a timely manner. Following an internal restructuring within the Council, with the public procurement and construction sections being merged, the call service experienced an increase in the amount of the calls from vendors who wanted to clarify how these changes affected their interactions and business with the Council. It was estimated that staff were spending 5-6 hours a week answering basic and repetitive frequently asked questions.

Objectives and vision

The main objectives of this project were to increase process efficiencies in delivering customer support via the website in order to **save employees time** and ensure that **vendors receive a timely and personalised response** to their inquiries. The PSS department at the EL Paso City Council spearheaded this project and envisioned the use of a chatbot with its own personalised avatar to achieve these objectives.

Technological solution and implementation

Main features of the solution

El Paso City Council **deployed a chatbot known as "Ask Laura"** (referred to as a virtual information officer (VIO) by the Council) in order to meet its goals of saving employee time while ensuring a timely service for vendors.

The chatbot is **integrated into the City Council's website** and offers personalised assistance to users of the website. Users type in a question in the bot's question box to which Ask Laura responds with a written answer and also audio voiceover. Users are also able to search using tags and categories tool, and Ask Laura is able to deal with and respond to questions in both English and Spanish, helping it to better service El Paso's bilingual population**.** Figure 22 below shows how Ask Laura appears on El Paso City Council's website.

Figure 22: Ask Laura avatar

If a user requests information which can be found on the website, the chatbot provides a visual of the relevant page with its explanation and a link. If the chatbot does not understand the user input, it is able ask for additional information and clarifications, or make suggestions as to what the user may have been looking for. The user is also able to record whether their question has been properly answered.

Infrastructure, software and application

The Ask Laura chatbot is **integrated as lines of javascript directly on the El Paso City Council's web application** (the council website). The underlying technology was developed by the French company, Cantoche, who tailored the chatbot to the Council's needs, and delivered it according to a Software as a Service (SaaS) model.

The chatbot is able to respond to user enquiries thanks to its **natural language processing capabilities**, which have been developed drawing on open source code. This code enables the chatbot to:

- tag the user input according to the part of speech it represents (e.g. article, verb, noun),
- check whether there are any errors (e.g. spelling mistakes in the input),
- search for any synonyms of the text input
- identify the intent of the user and direct it towards the required content

The **Ask Laura chatbot consists of the following components:**

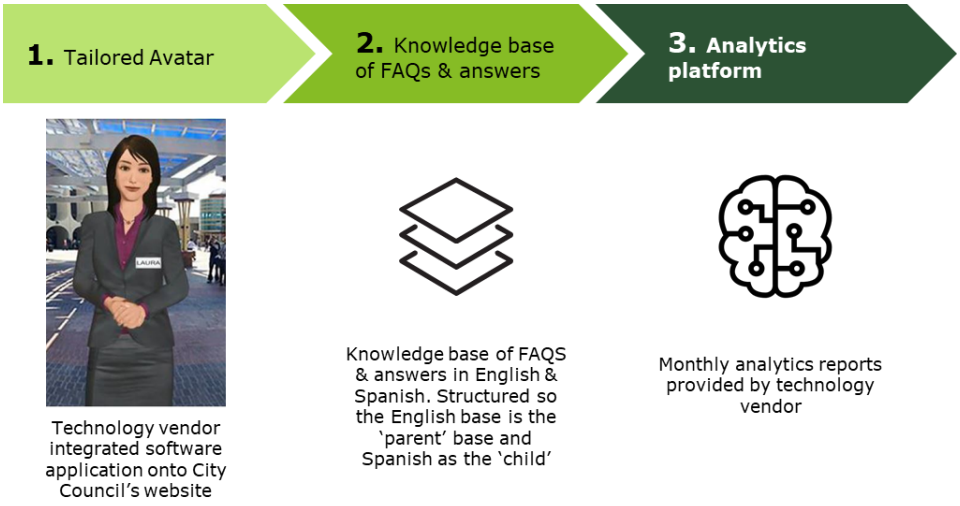
- **Avatar and question input box** – Which is integrated on the council website, and provides the user interface for both questions and answers from Ask Laura;
- **Knowledge base –** The back-end platform where the questions that Ask Laura can respond to and the answers it can provide are stored and updated;
- **Analytics platform** – Enabling the council to monitor how the chatbot is being used and make any necessary adjustments or reaction.

The **Ask Laura avatar is provided to ensure a human and customer-orientated image** is maintained by the chatbot. The avatar appears as a woman on the council website with its gestures and lip movement synced with the messages it is conveying. This synchronisation of the gestures with the messages depends on AI technology developed by Cantoche which interprets the intent and meaning of the messages.

The **Ask Laura knowledge base** provides a store of all the questions that the chatbot can respond to matched with the answers it can provide. There are currently approximately 300 questions and answers in the knowledge base, which is maintained and updated as necessary by the Council employees.

The **Ask Laura analytics platform** provides dashboard on which Council employees can monitor the way in which the chatbot is being used. This can provide useful insight into the type of information that vendors are looking for and enable the Council to identify where the chatbot is not providing adequate answers and update the knowledge base accordingly. Other analytics provided include when the chatbot is being used most. The Council has direct view of the analytics platform, however in addition the technology vendor (Cantoche) provides a monthly analytics report summarising the main trends.

Figure 23: Components of the Ask Laura chatbot



Implementation

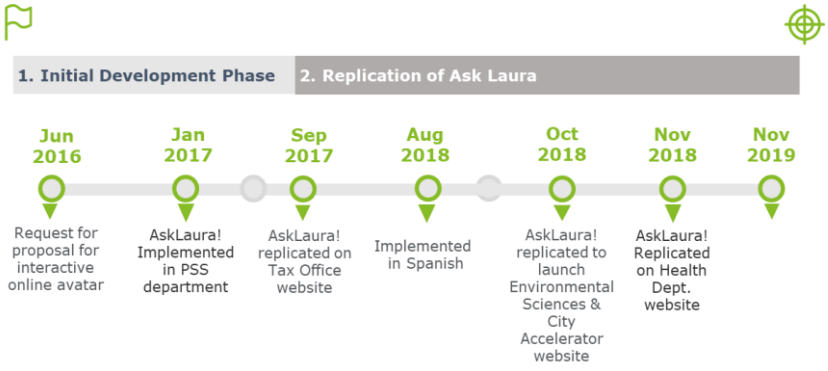
The Ask Laura chatbot solution was **integrated with the City Council's website by the technology vendor, Cantoche**. From the side of the Council, the requirements were to provide a comprehensive list of the questions and answers it wanted the chatbot to be able to deal with. Although the Council provided the primary input for this list, Cantoche also provided input and advice on how to properly phrase and separate the questions. It is important that the different questions deal with distinctly different areas and intentions in order for the chatbot to be able to distinguish effectively between them. These questions and answers were uploaded to the Ask Laura knowledge base. The maintenance of this knowledge base is now the responsibility of the Council.

Following the development of the English knowledge base, **an additional Spanish knowledge base was also developed**, enabling the chatbot to deal with Spanish questions. This Spanish knowledge base is linked to the English one, so that if the English one is updated, the Spanish knowledge base is automatically marked that it should also be updated.

Since its initial installation on PSS department website, **Ask Laura has been replicated in other El Paso City Council Department webpages**, including the Tax department and the Environmental Sciences and City Accelerator department. PSS maintains overall responsibility and ownership of the Ask Laura project and the deployment of the chatbot across different departments.

The timeline according to which the Ask Laura chatbot was developed, deployed, and replicated across the El Paso City Council Department webpages is shown in Figure 17 below.

Figure 24: Ask Laura timeline



Results and future expectations

Ask Laura is viewed as a success by the Council as demonstrated by its replication across a number of other departments across the City Council, with a view to expanding the use of the software further.

The project has resulted in a reduction in the staff hours spent replying to customer FAQs and therefore freed staff to focus on other work projects within the department. It has allowed the department to extend customer support outside of operational hours. In its first year of operation, PSS' Ask Laura chatbot was used 1500 times.

The **primary metric used by PSS to measure the impact of the Ask Laura chatbot is cost avoidance**. This measures the savings the department has made because requests and questions that would have had to be dealt with by an employee were instead dealt with by Ask Laura. **The total "cost avoidance" that the project has generated up until the end of 2019 is €19,850** ($22, 217). This figure is calculated by:

- the number of times the chatbot has been used; multiplied by
- the time it takes on average for an employee to deal with a call from a vendor (2.5 minutes); multiplied by
- the wage of the employee who would have had to respond to this call.

The actual and projected yearly cost avoidance figures for the Ask Laura project from 2017 to 2023 are presented in the table below.

Table 7: Actual and projected annual cost avoidance

Year	Cost Avoidance	Cost	Return on Investment $	Cumulative Cost Avoidance	Return on Investment %
FY 17	$ 19.651,43	$ 20.140,00	$ 488,57	$ 488,57	-2%
FY 18	$ 21. 575,57	$ 10.140,00	$ 11.432,57	$ 10.944,00	36%
FY 19	$ 21.413,66	$ 10.140,00	$ 11.373,66	$ 22.217,65	55%
FY 20	$23.507,91	$ 10.140,00	$ 13.367,91	$ 35.585,57	70%
FY 21	$ 25.806,98	$ 10.140,00	$ 15.666,98	$ 51.252,55	84%
FY 22	$ 28.330,91	$ 10.140,00	$ 18.190,91	$ 69.553,46	98%
FY 23	$ 31.101,67	$ 10.140,00	$20.961,67	$ 90.405,13	112%

Costs and requirements

Costs	Human resources	Other
• $20, 140.00 implementation cost including first year's subscription • $10, 140.00 yearly subscription fee thereafter • $700.00 per videos, which are training videos	• Software vendor installed and set up Ask Laura: 1 Project Manger, 1 Developer & 1 analytics expert. It took approx. 4- 5 days. • Monthly analytics report provided by vendor • Ad- hoc assistance from vendor when needed • 2 colleagues part-time at the City Council maintain & update FAQs monthly	Knowledge base of FAQS and answers needs to be maintained and updated

The implementation cost of Ask Laura and annual subscription fee for the first year was €18 060 ($20 140). Following the first year, an annual subscription fee of €9 090 ($10 140) is paid, which covers maintenance costs, system upgrades, software assistance and troubleshooting. There are unlimited questions and answers built into the contract with the vendor, and therefore the software has been replicated and integrated into other departments' webpages of the El Paso City Council without any additional costs. Additionally, included in the contract is the possibility to create training videos. There is an additional cost associated with each training video on top of the annual subscription (approximately $ 700 dollars per video).

In terms of human resources for the project, the technology vendor (Cantoche) provided 1 project manager, 1 analytics expert and 1 developer to implement Ask Laura; this process took around 4-5 days. Cantoche also provided training to designated staff members at the El Paso City Council including system administrator training and end-user training.

The Procurement Office's IT staff are largely responsible for the Ask Laura Platform but had to get help from internal subject matter experts to complete the knowledge base of FAQs and answers. There is not a huge time commitment required for the bot, mostly the time spent on the bot is in relation to maintenance activities such as updating the FAQs and answers in the knowledge base.

Risk and mitigation

This is a **relatively low risk project** as the technology is straight forward to integrate on a web application and simple to maintain. For this project, there was no need to integrate the chatbot with any other existing IT systems, which would have increased the complexity and risks of the project. The project also **avoids any privacy risks as the chatbot only provides information that is already made publicly available** by the El Paso City Council.

Challenges and lessons learnt

This project did not face any significant challenges or obstacles. The overall lesson learnt from this project is that implementing a chatbot is a relatively straightforward project. The software can be implemented for a relatively small cost and it is effective enough to deliver a return on investment within a couple of years. Some focus and resources are required to maintain the knowledge base of FAQs on which the chatbot operates, as it is only able to provide accurate answers on the basis of this information.

4.4. Big data and data analytics case studies

The following section presents **four case studies** in which public administrations make use of big data and data analytics as a primary technology to transform or improve their public procurement processes and functions:

Case study 7: MEDIAAN

Lead Organisation: Cost Engineering Unit, Department of Mobility and Public Works

Location: Flanders, Belgium

Technologies: Big data and data analytics

Level of government: Regional

Problem Statement: The Department of Mobility and Public Works managed and tracked its procurement contracts using a digital system, however it lacked the tools to enable visibility of historical prices for goods and services. The Department was therefore not making full use of its data to guide its procurement decisions.

Description: The MEDIAAN platform provides a searchable database of historical prices together with a range of applications for cost engineering and analysis. The primary data source is the Department's eDelta contract management system, which contains price data on contracts going back to 2001. This data is supplemented from other sources, including information on rules and parameters that effect prices stemming from Belgian legislation. Tools and capabilities developed include a price revision applications, semi-automatic estimation of prices, and calculation of different unit and hourly rates. All tools and the underlying data is viewable via a user-friendly interface. MEDIAAN is currently only accessible for Department users, however there are plans to expand this to other users in the Flemish Government, as well as extending the range of tools available and the data on which these tools are based.

Lessons learnt: It is crucial for organisations to own their own (price) data; the database and applications should be kept separate to ensure flexibility and enable updates and changes to the interface and tools; a gradual approach is recommended to ensure the project is targeted at user needs.

Cost: €4.1 million (2014-2019). Expected annual costs of €300 000 – 400 000 going forward

Impact: High. 500 – 600 users of the platform across the Department; more accurate price estimates for projects; time saved on manual benchmarking.

Future expectations: Going forward, there are plans to expand and develop MEDIAAN across multiple dimensions – in terms of tools, data, and users

Human resources: 6 person FTE team: project coordinator, application manager; cost engineer; oracle database specialist; 2 x Oracle APEX Programmer.

Risks: Sensitive data that should only be accessed by authorised users; privacy concerns regarding data stored on individuals; use of proprietary technology implies some risk of lock-in

Other requirements: Ownership of historical pricing data (extracted from eDelta contract management system)

Project timeline: 2009 – present (the project was formalised in 2014)

Project status: Fully deployed solution

Email: mediaan@mow.vlaanderen.be

Website: https://mediaan.login.kanooh.be/mediaan

Context and problem statement

The Department of Mobility and Public Works within the Flemish Ministry of Mobility and Public Works is responsible for the creation and implementation of policies related to mobility and road safety, as well overseeing and managing investments in transport and port infrastructure in the region. Within the Department, the Cost Engineering team provides support and consultative services on cost engineering and price analysis services on investments. The team also performs cost audits on existing projects and programmes.

Since 2001, the Department **made use of the eDelta contract management system to manage and track their procurement contracts**. This meant that there was an existing pool of data related to the prices paid historically by the Department for a range of goods. The Cost Engineering Unit within the Department conducted cost audits and provided price analysis services on the basis of this data, however there was **no single platform on which historical pricing data could be reviewed and examined**. The Cost Engineering Unit drew on the data from the eDelta contract management system to extract reports in xls and pdf formats, providing some visibility into historical unit rates for standardised work elements of road construction and civil works. However, such reports are not easily searchable and analysable. As a result, in 2009, the Cost Engineering Unit began informal efforts to establish a searchable database of pricing data together with analytic tools.

Objectives and vision

Through the MEDIAAN project, the Cost Engineering Unit **aimed to promote the use of data in the preparation, negotiation and execution of public contracts**. Proper exploitation of the available historical price data was expected to enable users (department employees involved in contracting) to:

- better estimate the costs associated with new projects; and
- better negotiate with suppliers the prices of particular goods and services based on a fuller knowledge of historical prices agreed upon.

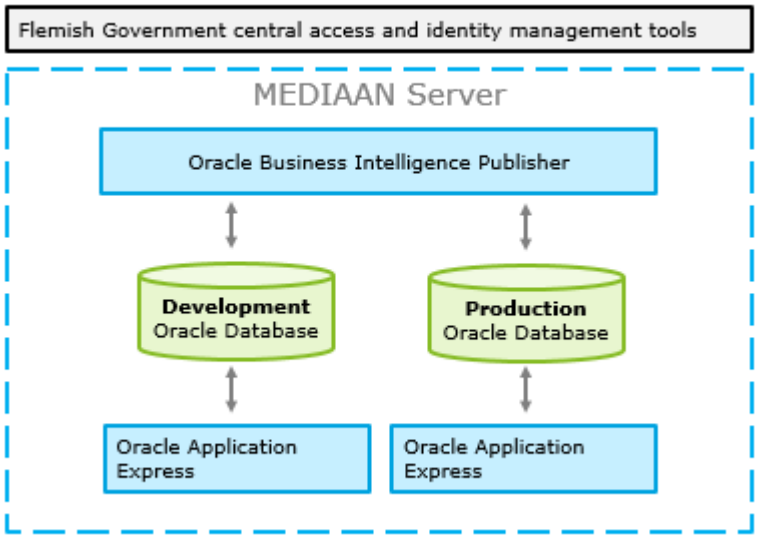
Ultimately, the objective was therefore to enable the Department to get better value for money in their outsourcing contracts. The vision for how to achieve this was the creation of a platform with a user friendly interface for the exploration and analysis of historical pricing data on infrastructure projects. On top of this platform, a series of tools related to cost engineering and other cost aspects of the construction, maintenance and reparation of public infrastructure, would be built.

Technological solution and implementation

The MEDIAAN project has been built out according to the vision described above. The implemented solution consists of:

- **An Oracle database** containing data on historical costs of infrastructure projects, as well as other supplementary data including on price revision parameters rules according to Belgian legislation;
- **Applications** (built in oracle Application Express) for the analysis of the data, providing a user-friendly interface for Department staff
- **Software** (Oracle Business Intelligence Publisher) enabling the extraction of static reports on the data in the database

Figure 25: MEDIAAN server



A crucial feature of the implemented solution is that **the database and the applications built on top of it are kept separate**. This key advantage associated with this is that it limits the costs associated with changing the functionalities of the system. Large costs are associated with the development of the database, and direct changes to the structure of this database would be costly and difficult. Under the solution developed, however, applications on top of this database can be added and transformed relatively easily. A related advantage is also that it is easier to switch the provider of the application software (i.e. switching away from Oracle).

As is standard practice, the team maintains two separate identical databases for development and production. This allows for the development of new functionalities without risking shutting down the production database and inconveniencing users.

The applications and functionalities that have been created drawing on the core database are presented below.

Functionalities of the platform

The MEDIAAN project has steadily built out a range of applications and tools relevant to cost engineering and cost aspects of infrastructure projects, drawing on the department's historical pricing data and other sources. Access and use of these tools is controlled via the central access and identity management tools - Digital Access Management Flanders (ACM) - provided by the Flemish regional administration. The applications now include the following:

- **Interface to the unit rate database –** This searchable database provides information on the historical costs and prices on both standardised and non-standardised aspects of infrastructure projects. About 7.6 million unit rate prices coming from 105 000 bids on over 15 000 projects can analysed. Users are able to explore the data using a keyword search, and are also able to view and analyse the data across a number of different dimensions, for example producing charts illustrating how prices change for a particular product relative to the year or quantity ordered.
- **Price revision application –** this application complements the price database, and allows users to search for information related to price revision parameters, parameter values and price revision formulas. According to Belgian legislation, contracts must include provisions on how prices in contracts will change if certain costs, such as labour costs, change. The application provides information on those variables and values that should be used in order to revise and index prices.

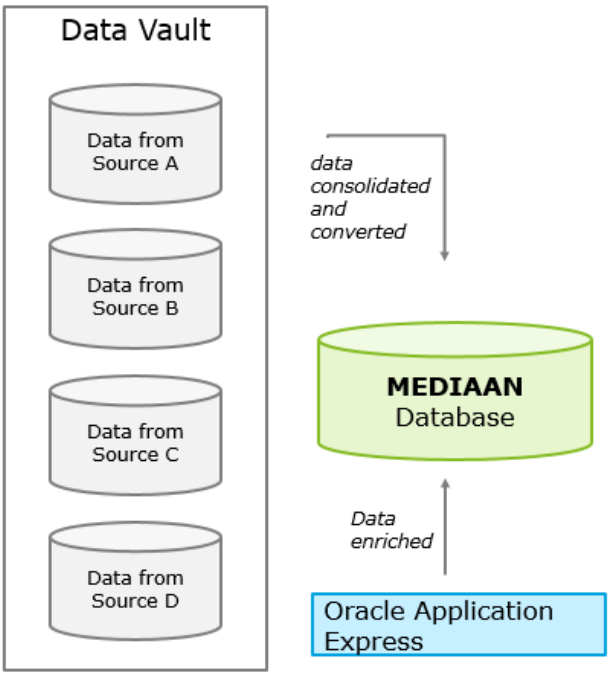
- **Semi-automatic estimation of prices –** Based on the data from the price database, this tool can be used to provide an estimate of the cost for a public work, based on a work breakdown structure that must be completed in another application – either the eDelta contract management system or Microsoft Excel.
- **Calculation of hourly rate of manual labour –** this tool enables a calculation of the hourly rates for different types of manual labour. It draws on the rules and rates laid out in Belgian legislation as well as in collective labour agreements.
- **Calculation of unit rates for construction equipment –** this tool enables the calculation of unit rates for the operation of different types of construction equipment. It draws on data from the European Structure of Construction Equipment (EUROLISTE) as well as the Register of Construction Equipment (BGL) – which provide standard rates for such equipment.
- **Cost engineering library –** The library contains information in a variety of different forms and formats – data, literature, manuals – on cost engineering and price analysis.

Data, software and infrastructure

The key **data underlying the MEDIAAN platform is extracted from the Department of Mobility and Public Work's eDelta contract management system** – with information on 7.6 million unit rate prices. However, as specified for a number of the applications described above, this departmental contract data has also been complemented and expanded upon with data stemming from other sources, including standardised lists and rules laid down in Belgian legislation.

Data from the different internal and external data sources and providers is first stored in a data vault, in their original structures. From here, the data is consolidated, converted into one uniform structure and uploaded to the Oracle database serving the MEDIAAN platform. The Cost Engineering Unit is also able to enrich the data from other sources, using Oracle Application Express. The entire process is shown in Figure 26 below.

Figure 26: Provision and preparation of data for MEDIAAN

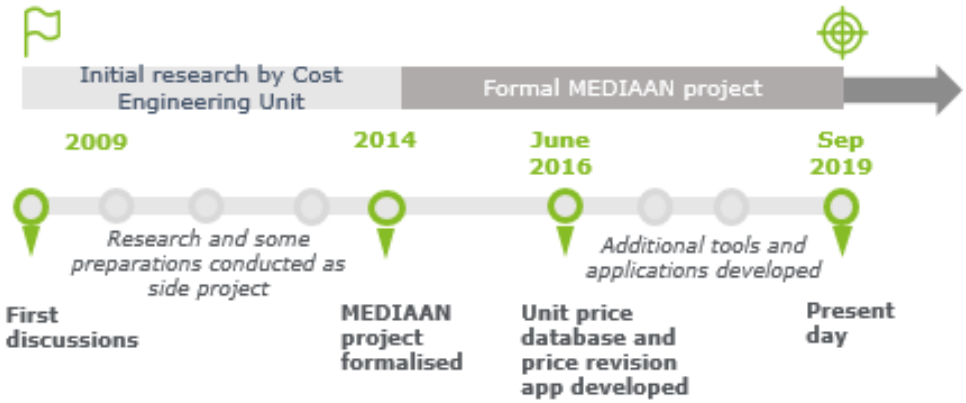


Implementation of the project

Work towards the development of tools now incorporated in the MEDIAAN platform began in 2009 as an individual initiative from the Cost Engineering team, drawing on its experience performing cost

audits of projects. As a first step, they developed the unit rate database in order to demonstrate the value that this sort of data could have. Together with this the team developed the price revision application. These developments were successful, and **in 2013, the MEDIAAN program was formalised**, gaining official support and funding from the Department for its goals of providing cost engineering and price analysis tools. Since then the additional applications described have been developed.

Figure 27: Development of the MEDIAAN Programme

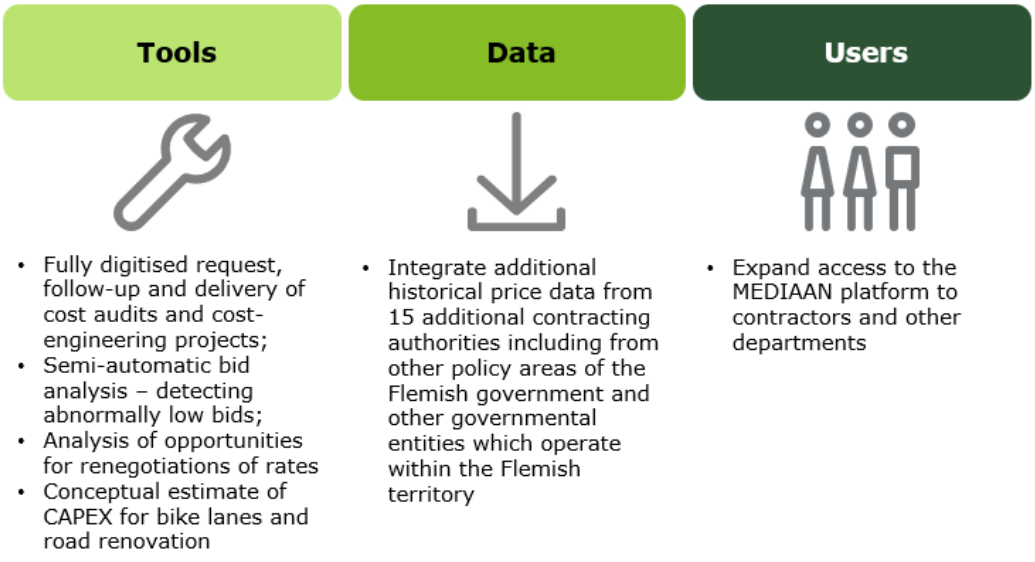


Results and future expectations

The **impact of the MEDIAAN platform is not directly measured**, making it difficult to estimate. One measure is provided by the uptake of the MEDIAAN applications within the Department, with **500 to 600 users now making use of these tools.** User satisfaction with MEDIAAN is high, as judged by user feedback during a more general annual evaluation exercise of the Department's work. The project team believes that the primary impact of the platform is in the accuracy of the price estimates it can generate, which is far higher than would otherwise be possible. Another benefit is also time saved for employees, who can use the available applications rather than conducting time-consuming manual benchmarking exercises. Overall, the project contributes to better planned and more successful public works programs and projects.

Going forward, there are plans to expand and develop MEDIAAN across multiple dimensions – in terms of tools, data, and users – as shown in Figure 28 below.

Figure 28: Future plans for the development of MEDIAAN



Costs and requirements

Costs	Human resources	Other
≈ **€4.1 million** (2014-2019) • €0.7 million for hardware and licenses • €2 million on freelancers working on the project • €1.4 million on inhouse staff	• MEDIAAN team consists of 6 FTE workers with the following profiles: project coordinator, application manager; cost engineer; oracle database specialist; 2 x Oracle APEX Programmer.	**Data**: historical data in the eDelta contract management system

The total budget of MEDIAAN from 2014 to 2019 has been **€4.1 million**, split between hardware and licenses (€0.7 million), spending on freelancers (€2 million) and salaries for in-house staff (€1.4 million). Going forward beyond 2019, the yearly budget for the platform is expected to be €300 000 to 400 000.

This **spending on human resources** has been necessary to attract and retain the appropriate profiles (as listed above). In order to promote the use of MEDIAAN, the team has also conducted trainings and promotional activities. Going forward, in order to expand the project the **main additional requirements are for human resources to communicate and share the results and capabilities of the platform, and to perform additional data processing and content creation** (i.e. concepts for new applications).

Another key requirement for the success of the project was the **ownership of the historical price data contained within the eDelta contract management system**. This ownership of the data ensure that the project team has immediate and unconditional access to the data and was not tied down to any other third party. The importance of clear ownership of the data was brought home during recent efforts to expand the MEDIAAN programme to include data from local authorities. These authorities, however, used a private contract management system and the supplier of this system did not want to cooperate with these efforts. As the contracts with this service provider did not define who owned the data saved and created with the software, it has not been possible to force the supplier to collaborate. The efforts to incorporate this local authority data into the MEDIAAN platform therefore eventually had to be abandoned. Clear and unambiguous ownership of price data is therefore a crucial enabler of projects such as MEDIAAN and should not be overlooked.

Risk and mitigation

Risks that were confronted during the project related predominantly to **privacy and security concerns**. Given the sensitive nature of some of the data (which could provide a competitive advantage to private sector suppliers) it was necessary to ensure that it is only made available to the appropriate public sector users within the Department of Mobility and Public Works.

In order to meet this challenge, the team was able to **draw upon user authentication tools - Digital Access Management Flanders – provided centrally by the Flemish Government**. The MEDIAAN team therefore only needed to implement this solution, rather than starting from scratch. Using these tools, the team is also able to determine exactly which tools and content specific users are able to access, depending on the type of user group they fall into. As an additional safeguard against misuse of the platform, a monitoring tool is used to scan user behaviour and identify risks. MEDIAAN also limits the type of data stored in their database so as to reduce privacy concerns. Only minimal information on individuals is stored in order to ensure GDPR compliance.

As the project makes use of proprietary technology, there is also **some risk of lock-in** should the department want to change providers at a later stage. This risk has however been minimised as far as possible through the use of commonly used open standard data formats, and designing the system so that it can operate on different kinds of hardware (with sufficient memory and storage capacity) and on different operating systems. The separation of the database and applications into separate layers, also reduces the chance of lock-in.

A formal risk analysis was conducted together with a Quality Manager responsible for the MEDIAAN project – identifying the risks mentioned above. Appropriate mitigation steps, as listed, have therefore been taken to limit them.

Challenges and lessons learnt

The MEDIAAN project has been a significant success for the Department and lessons can be learnt by considering the reasons for this success. One of the key lessons learnt is the **importance of an organisation owning its own data**. Their ownership of the historical pricing data within the eDelta contract management system allowed the team to develop the unit-rate database that underlies the MEDIAAN platform's functionalities. Where ownership of the historical data is not provided, it will be necessary to find a way to cooperate with and incentivise different types of private or public organisations to gain access to the necessary data.

Another lesson relates to the importance of ensuring that the **database and applications be kept separate**. The database lies at the core of the project, and any changes to it would be expensive and difficult. Keeping the application layer separate from the data allows flexibility in updating and changing the applications and their interfaces with limited costs. It would also facilitate a switch of technology provider (from Oracle Application Express) if deemed desirable.

The MEDIAAN project started as an individual initiative from the Cost Engineering team, and initially found it challenging to build up support for and awareness of the project. However, this also meant that the team took a **gradual approach**, developing the platform in an iterative manner, rather than aiming for the perfect solution straight away. The focus was on addressing practical issues the team faced and developing a solution that could improve and support their work. This iterative and practical approach can provide a model approach for other organisations.

Case study 8: Open Contracting Data Standard Transformation and Analytics

Lead Organisation: Ministry of Antimonopoly Regulation and Trade; European Bank for Reconstruction and Development (EBRD)

Location: Belarus

Technologies: Big data and data analytics

Level of government: National

Problem Statement: Belarus had several digital public procurement platforms, however the information generated through them and stored was not standardised, making analysis challenging and hindering data-driven decision making. The presence of multiple non-standardised digital procurement platforms led to issues with data duplication and data quality. In addition, the approach to public procurement reporting was not automated, and was neither efficient nor reliable.

Description: Data is extracted from the existing public procurement platforms, which continue to operate, and transformed to the Open Contracting Data Standard (OCDS). This data is consolidated in a single database, and a business intelligence module is run on top of it, accessing the data via an Application Programme Interface (API). This provides government procurement policy makers with a tool to analyse and visualise procurement trends. The data is also made accessible via an open data portal, ensuring transparency of public spending.

Lessons learnt: 1. The underlying quality of the data is a key determinant of success – impacting the costs of the data transformation and the accuracy of the public procurement statistics generated; 2. Projects should be designed in several phases, giving time for the government to make changes on the basis of the initial business intelligence tools developed; 3. To ensure take-up and proper use of the developed tools, a budget for training and outreach should be included.

Cost: €200 000 – 250 000 (main factor impacting cost of equivalent projects is the quality of the underlying data)

Impact: High. Enables public procurement policy makers to take data-driven decisions; Provides for the automated generation of public procurement reports; Ensures transparency of public spending.

Future expectations: Going forward, the impact of the project could be increased by allocating resources and budget to training and outreach programmes to promote the use of the business intelligence tools.

Human resources: Project implemented by EBRD and 3 IT/consulting contractors, providing expertise in business intelligence software, web applications, and data analysis.

Risks: Gaining adequate access to public procurement data and systems required for the project, together with the expertise to understand these systems. Potential for political blocks to the project.

Other requirements: The project requires existing digital procurement platforms from which to extract and then transform data. Similar project can be implemented building on a wide range (in terms of quality and type) of such procurement platforms.

Project timeline: Nov 2017 – Nov 2018

Project status: Fully deployed

Email: NiewiadE@ebrd.com

Website: EBRD – Public Procurement Reporting Module for the National eProcurement System

Context and problem statement

As of 2016, The Republic of Belarus was negotiating its accession to the World Trade Organisation (WTO) as a priority. One element of this is the adoption of the WTO's Agreement on Government Procurement (GPA) – which aims to open Government procurement markets to signatory countries. In order to comply with the GPA, Belarus requested support from the European Bank for Reconstruction and Development's (EBRD) GPA Technical Cooperation Facility to help modernise its public procurement system.

The Republic of Belarus has several existing, well-functioning electronic public procurement solutions that deliver semi-automated processes. However, these solutions are spread across several different systems and organisations:

- A **public procurement marketplace** operated by the National Centre of Marketing
- A **public procurement marketplace** operated by the Belarusian Universal Commodity Exchange
- A **publication centre** for procurement information (purchases made) operated by the National Centre of Marketing. This publication centre publishes procurement data generated through both of the marketplaces mentioned above.

A separate organisation, the Ministry of Antimonopoly Regulation and Trade has responsibility for state policy on the public procurement of goods and services. Despite the presence of the eProcurement systems described above, the Ministry faced a number of challenges related to them **and did not systematically make use of procurement data to inform its public procurement policies**. The problems experienced included:

- Information on procurement procedures and contracts was difficult to retrieve;
- Public procurement data had no standardised structure, making analysis challenging;
- Lack of availability of transactional data;
- Approach to procurement reporting was inefficient, unreliable and time-consuming;
- Inconsistent data quality and duplicate data entries, driven also by the high costs of maintaining software, servers and hardware for multiple data repositories.

Objectives and vision

Working with the EBRD GPA Technical Cooperation Facility, the Ministry of Antimonopoly Regulation and Trade aimed to modernise its public procurement system, ensuring it can **draw on the data stored within its national eProcurement marketplaces to drive improved public procurement policies and decisions**. It aimed to:

- Provide improved public procurement statistics to guide decision making;
- Generate automated public procurement reports;
- Provide transparency on public spending for citizens.

The EBRD-developed vision to achieve these objectives contains two primary points:

- Implementation of an **open contracting data standard (OCDS) transformation** on existing eProcurement data;
- Deployment of an **OCDS-based set of business intelligence and reporting tools** to enable analysis of public procurement data, and ensure transparency towards citizens and businesses.

Technological solution and implementation

The developed solution **extracts data from the existing eProcurement systems and converts it to the OCDS standard** while allowing the legacy solutions to continue running unaffected. Once the data has been converted to the OCDS it is consolidated in one database. **Two reporting modules** – one for public

authorities and one for the general public – have been set up, which **access this data directly through an API**. These modules allow users to analyse the eProcurement data and view it through a number of different angles and filters. The overall result is a publicly accessible contract register together with the business intelligence tools to dig into and analyse the contract data.

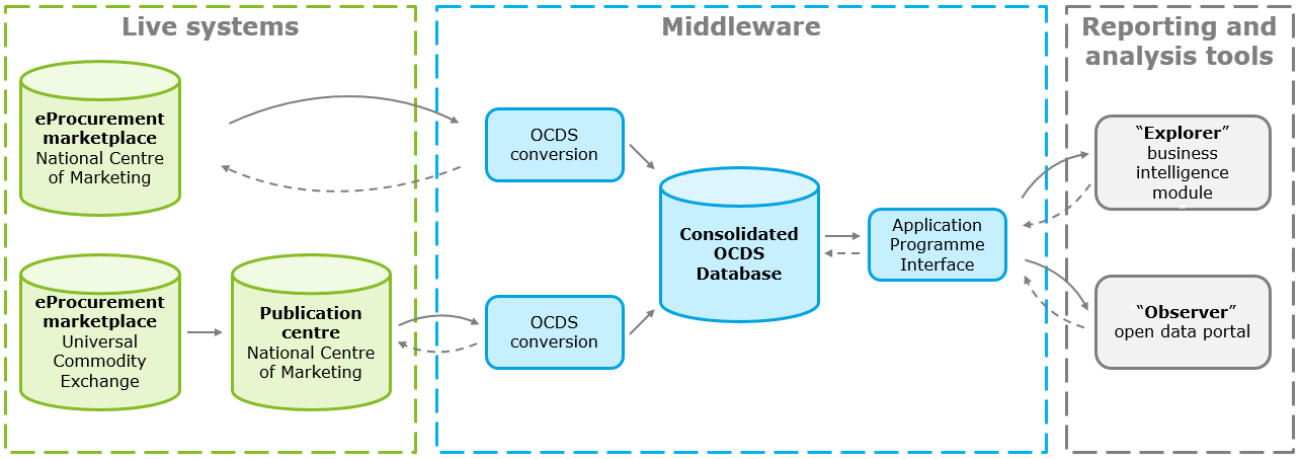
Data extraction and transformation

The data drawn upon is extracted in the following ways:

- Directly from the **eProcurement system of the National Centre of Marketing**
- Data from the **eProcurement system of the Belarus Universal Commodity Exchange** is sent for publication to the Publication centre for procurement data of the National Centre of Marketing. The data is extracted from the publication centre.
    - Direct extraction from the Belarus Universal Commodity Exchange eProcurement system would have been preferable, however the project team was not granted direct access to this data.

Middleware is used to extract this data, convert it to the OCDS and store it in a consolidated database. This process is shown in Figure 29: OCDS Transformation and Analytics

Figure 29: OCDS Transformation and Analytics



Development of the data extraction and transformation solution

The process of developing this data extraction and transformation system has a number of steps. First, there is a **systems exploration stage**. During this stage, the project team describes the processes by which the eProcurement systems operate, it conducts a **technical analysis of these business processes** and models them using business process modelling notation (bpmn). Following this, an **analysis of the system database** is conducted in order to understand how it operates, to assess the quality and consistency of the data, and to judge how best to extract the data. Following this, a **business analysis** is conducted in order to map the data in the database onto the OCDS standard.

Once these analytical phases are complete, the project team develops the APIs through which the data is extracted from the live eProcurement systems and those through which the data is made available for the business intelligence tools also developed.

Data analytics and transparency tools

The EBRD provides a **pre-defined set of dashboards which provide different analytical angles through which the OCDS data can be viewed**. These dashboards provide a breakdown between different

stages, processes and markets. Aspects such as the number of complaints and challenges, purchases made by a particular public entity, or the number of successful procurement procedures completed can be measured. The data to be examined at different levels of detail, ranging from an overview of the functioning of the procurement system, to data on individual public procurers or tenderers.

Drawing on these dashboards, two separate data analytics tools have been provided. The first, "**Explorer", is built for public procurement analysts** within the Ministry of Antimonopoly Regulation and Trade as well as other public administrations, and is intended to support their decision-making. The Ministry makes use of Qlik Business Intelligence software in order to view the "Explorer" data. The standard set of dashboards provided by the EBRD was tailored according to the needs of the Ministry and according to the nature and quality of the data available. The Ministry is able to further develop its own aspects to measure and visualise according to their priorities. Using the "Explorer" tool, automated reports on public procurement in Belarus can also be generated.

The other data analytics tool developed, **the "Observer" module, is targeted at the general public** – citizens, businesses, and civil society – and is intended to **ensure transparency of public procurement spending**. The Observer tool is made available online and allows users to view the procurement data according to a number of pre-defined indicators, including aspects such as the percentage of competitive procedures and the breakdown of types of goods being procured. In addition, the online reporting system set up, provides measures of public procurement spending over the last week, and extracts facts from the systems which are presented as "stories" regarding aspects such as the percent of tenders won by international suppliers, and the focus of public spending in particular regions.

Figure 30: Data analytics and transparency tools

	Explorer	Observer
Purpose	Enable data-driven decision-making	Ensure transparency of public spending
Data	Accesses consolidated OCDS database via an API	Accesses consolidated OCDS database via an API
Audience	Public procurement analysts and policy makers	Citizens, businesses, civil society

Development of the data analytics and transparency tools

The EBRD provided support to the Belarus public authorities for the development of the business intelligence tools. This includes not just technical support in relation to the digital tools being used, but support regarding the methodologies to use to calculate the measures of the various procurement procedures. This is done to ensure the proper alignment of the procurement processes followed and the indicators used to measure them.

Following the initial development and delivery of the business intelligence tools, the Ministry had previously unmatched visibility over the eProcurement processes being implemented. On the basis of this it chose to update some of its eProcurement processes. This meant, however, that the business intelligence tools required updating themselves in order to match the revised procedures, delaying the project somewhat.

Results and future expectations

As a result of the project, Belarus now has a **national-level public procurement data analytical infrastructure**. This system enables a previously impossible level of vision over procurement spending within the country, and enables various types of big data analysis.

In terms of the goals set for the project, the OCDS-based analytical system:

- **Provides transparency on public spending** – through the online "Observer" tool
- **Enables the automated generation of public procurement reports** – through the "Explorer" analytical tool
- **Provides support for public administration regarding public procurement decisions** – Government employees are able to use the "Explorer" tool to analyse public procurement data and guide their procurement decisions.
    - Evidence that policy makers are making use of the Business Intelligence tools they now have to guide their decisions came with the passing of new legislation on how to deal with procurement complaints. The new system provided evidence regarding the inefficiencies of the existing review and complaints process for public procurement procedures. The new law reforming these procedures was passed as a result of having access to this data.

Going forward, the impact of the project could be increased by allocating resources and budget to training and outreach programmes to promote the use of the business intelligence tools not just within the Ministry of Antimonopoly Regulation and Trade, but in agencies and departments across the Government. The tools and spending data now available, could be used to guide decision-making not just for public procurement specialists but for policy makers across different policy fields.

Costs and requirements

Costs	Human resources	Other
• Total costs **of €200 000 – 250 000.** Large majority of costs are on human resources. Costs are split between: o Data extraction and transformation: ≈ **€100 000;** o "Explorer" BI tool: €60 000 – 80 000; o "Observer" transparency tool: ≈ €60 000	• Project led by EBRD with **support from 3 IT/consulting contractors** with expertise in: o Business intelligence software; o Web applications; o Data analysis	• Underlying **digital procurement systems and databases**; • Access to eprocurement systems and databases, as well as internal expertise to explain how they are set up.

The OCDS data transformation and analytical solution was developed for a total cost of between **€200 000 – €250 000**. The large majority of these costs are focussed on the human resources required to first analyse the existing processes and systems, and then develop the tailored data extraction, transformation, and analytical tools needed. Any licenses that are required, are relatively cheap. For example, the cost of a Qlik licence is roughly 10€ per month per user.

The **breakdown of costs** is roughly as follows:

- **Development of data extraction and transformation** – roughly **€100 000**. The main variables affecting this cost are related to the quality of the underlying eProcurement systems and databases. For this case an additional cost was created by the need to consolidate data from several databases. The costs of equivalent projects in other countries could therefore vary considerably depending on the underlying systems and data.
- **Development of the "Explorer" Business intelligence tool** – **€60 000 – €80 000**. The main factors influencing the cost are the underlying quality of the data, and the number of dashboards to be developed.
- **Development of the "Observer" spending transparency tool** – roughly **€60 000**. The main variable affecting the cost of this development is again the data quality.

In terms of the **human resources required for the project**, the EBRD worked **with 3 separate consulting and technology firms** in order to develop the system. Each of these firms provided expertise in different areas, with one with specialist knowledge on the use of **Qlik and business intelligence software**, one with expertise in **web applications**, and the other with expertise in **data analysis**.

Other key requirements to perform the project include the **existence of digital procurement systems** in the first place. However, similar projects can be performed with a wide variety of different types and standards of such eProcurement systems. As mentioned in the costs section above, however, systems with poorly organised databases and poor data quality will require considerably more time and expense in order to perform the necessary data transformation and set up functioning data analytics tools. A final key requirement in order to perform such a project is to **have access to people and experts who can explain how the existing databases are set up and what the various data refer to**.

Risk and mitigation

At the start of the project, one of the risks identified relates directly to the point above – **access to the experts who could accurately describe the current state of the existing eProcurement systems** and databases. It was not known whether this would be provided, or whether for example the team risked being provided out-of-data information on the systems.

Another major risk faced by the project concerned gaining **access to the eProcurement systems and data** that was required. With several different public organisations owning the systems and data required, there was a risk of political blocks, with organisations refusing to cooperate with the project. This risk did partially materialise, with the Belarus Universal Commodity Exchange refusing to directly send its data for the OCDS transformation. This led to the need for the data to be extracted via a different source – the Public Procurement Publication Centre, with which the commodity exchange already shared its data.

Challenges and lessons learnt

The main challenges for the project were related to getting the **necessary support from the people and organisations** in order to access the necessary systems and data. The assessment of the legacy systems and data transformation is the most challenging phase, and the completion of this task requires internal support and expertise regarding procurement processes and data.

Lessons that can be taken from the project include:

- **The underlying quality of the data is key** – bad quality data will drive costs up and reduce the accuracy of the business intelligence tools developed.
- **Plan the project in several phases, providing time for feedback from the Government** – Following the initial development of the business intelligence tools, the Ministry decided to change some of its digital procurement processes, on the basis of the evidence that these tools provided. These changes affected the underlying data, meant the business intelligence tools had to be themselves updated, and therefore delayed the project.

- **Budget for training and outreach should be included** – in order to ensure the new tools are understood and used.

Case study 9: Skrinja – Business intelligence project

Lead Organisation: Ministry of Public Administration (MPA)

Location: Slovenia

Technologies: Big data

Level of government: National

Problem Statement: The data held by MPA is fragmented and siloed with the result that it is not drawn upon systematically as a resource to support decision making and the automation of reporting obligations is hindered.

Description: MPA's mission is the improvement of public administration across the Slovenian Government. Among other things, it leads regarding Government-wide public procurement policy. Following a successful big data pilot which demonstrated the value of a data-driven approach, MPA has set up the Skrinja project – establishing an independent ecosystem of business analytics services for all public administration bodies, which consists of local data warehouses divided by domain common reference data sources with business intelligence tools built on top. The project will bring together data from across the public administration. Salaries from the Slovenian public sector and public procurement data from Tenders Electronic Daily (TED) and the Slovenian electronic public procurement portal will be among the first data sources uploaded to Skrinja. These two sources cover ¾ of the Slovenian national budget. Before doing this, the project team will conduct user requirements interviews with the public procurement data owners, develop a data model on the basis of this, and ensure that only relevant data is uploaded. For the "salaries in Slovenian public sector" this process has already been conducted in 2018.

Lessons learnt: Limited as the project is still in development. A challenge was the lack of other public authorities with experience with business intelligence tools that the Skrinja team could learn from. This was partially overcome by drawing on expertise and experience from the private sector (both through the preceding pilot project and the contracted consultancy).

Cost: €1 000 000 (€500 000 on licenses; €500 000 on human resources and consulting)

Impact: Limited. Project still in development.

Future expectations: The data warehouse and business intelligence functionality will be operational in Summer 2020. The project team is optimistic that users from the analytical level all the way to high level managerial or political positions will use the developed tools to support their decision making and fulfil transparency objectives.

Human resources: In-house team of 4 full-time and 10 part time employees supported by contracted IT consultancy.

Risks: Privacy/security risks due to the confidential nature of the data. Limited uptake by users across the Ministry.

Other requirements: Collaboration between IT and non-IT users (data owners); availability of data sources.

Project timeline: Sep 2017 - present

Project status: In development

Email: karmen.kern-pipan@gov.si

Website: https://www.gov.si/en/state-authorities/ministries/ministry-of-public-administration/

Context and problem statement

The **Slovenian Ministry of Public Administration (MPA)** is responsible for organising and ensuring the proper functioning of public administration in Slovenia. It aims to increase the quality of public administration and reduce the level of administrative burden experienced. **Specific responsibilities of the Ministry include public procurement,** ensuring transparency and integrity in the public sector, governing the central information and communication system, developing common information solutions and support to local self-government.

In carrying out duties related to these competences, MPA encountered difficulties related to unlinked and siloed data sources across the organisation. This fragmented approach has resulted in:

- Difficulties for staff to perform the necessary analyses to support data driven decision making;
- Time wasted on manual efforts to fulfil reporting requirements (as automation not possible based on the fragmented data);
- Long response times for questions from journalists and politicians (as data could not be easily accessed).

The Ministry therefore **determined to conduct a big data pilot** by using and trying out the tools already available in the Slovenian Government cloud to determine whether a data-driven approach could produce efficient and satisfying results. The project collected and combined data on public salaries, human resources, public procurement and other data, and was a success, familiarising policy officers and data owners across MPA with the possibilities and effectiveness of a big data approach.

Big data pilot

Aim: To explore the possibilities of big data approach for improving decision-making process across MPA and to contribute towards the development of a data-driven public administration in Slovenia.

Timeline: April 2016 - February 2017.

Approach: Using and trying out big data tools already available in the Slovenian Government Cloud, the project analysed data from sources across the Ministry (MPA) to identify possible benefits. This was done in an open and exploratory manner, with key aspects of the pilot including:

- **Data sources:** Data on employee time management, human resources, finances, salaries and public procurement was identified and provided by various organisational units (data owners) of the Ministry.
- **Tools:** Data was stored and processed on 2 servers and working stations provided for the project. Statistical analysis was conducted using Power BI and R, while text mining was performed using Python and RStudio.
- **Support from private sector consultants** – EMC Dell was a partner for the pilot and provided 5 data scientists on voluntary basis to conduct the necessary statistical analysis.
- **Involvement of data owners –** The active involvement of these data owners was required first to identify and make available the data that could be used for the project. It was also crucial for the interpretation of the results of the statistical analysis.

Results: In the field of HR, the pilot identified five clusters of employees, differentiated by their performance levels and behaviour (e.g. lunches taken, working time). The analysis could be used to tailor management approaches towards these different employee clusters. More generally, the pilot familiarised different departments within the Ministry with the possibilities of a data-driven approach and laid out the foundations for future work in this area.

Following this pilot project, departments throughout the ministry became more interested in implementing data- driven approaches, with public procurement and human resources highlighted as areas in which this approach could be impactful.

Objectives and vision

Building on the results of the pilot project, **MPA aimed to transform itself into a data-driven administration** by adopting data analytics and visualisation tools to:

- Improve decision making;
- Improve policy planning;
- Reduce repetitive tasks and focus on substantive analysis
- Increase transparency

In order to fulfill these goals, the Ministry aimed to develop and deploy a business intelligence tool that would support both analytics and reporting functionalities and would be made available to users throughout public administration. The first selected domain policy areas and associated data sources on which to test and implement business intelligence functionalities have been human resources (public administration employee salary data) and public procurements (contract and tendering data).

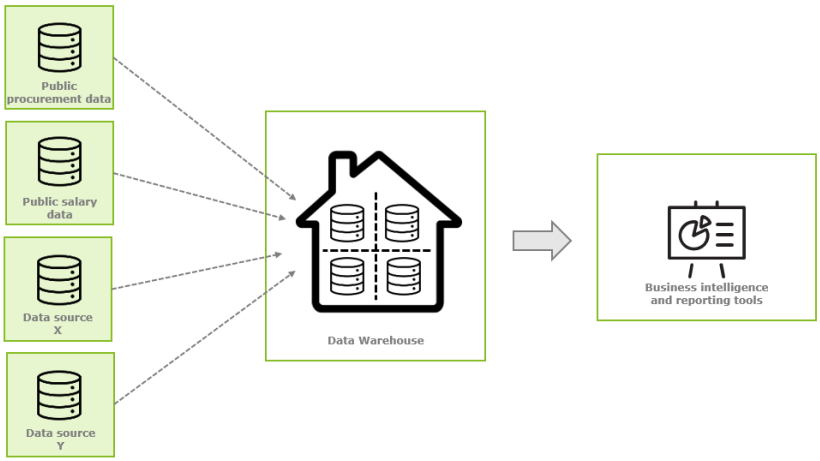
Technological solution and implementation

The Skrinja project is developing two key components to support the transformation of the MPA into a data driven administration:

- **Data warehouse**: *Oracle database.* This will provide a central repository in which data from public administration bodies will be stored in a standardised format. The data held by different bodies will be separated in local data warehouses to ensure that only data owners can view their data and authorise others to use business intelligence tools on this data. This will ensure that confidential data is not shared with unauthorised users and minimise the possibility of misinterpretation of more complex analyses. The data warehouse has privacy built in by design, as only pseudonymised personal data can be stored.
- **Business intelligence functionality**: *Based on Power BI*. Enabling the visualisation and analysis of the data stored in the data warehouse. This tool will also enable the Ministry to meet its reporting obligations, generating automated reports. Additionally, some of the modules will be made public, thus fulfilling transparency goals, and enabling citizens, businesses, and civil society to view public spending data as well as other aspects.

Figure 31 below provides a visualisation of these components.

Figure 31: Components of the Skrinja project



The aim is to make these tools available horizontally across the Ministry. However, initially in order to test the components, data related to just two areas is being uploaded to the data warehouse. This data is public salary data from organisations across the public sector and public procurement data, shared by the Directorate of Public Procurement within the MPA.

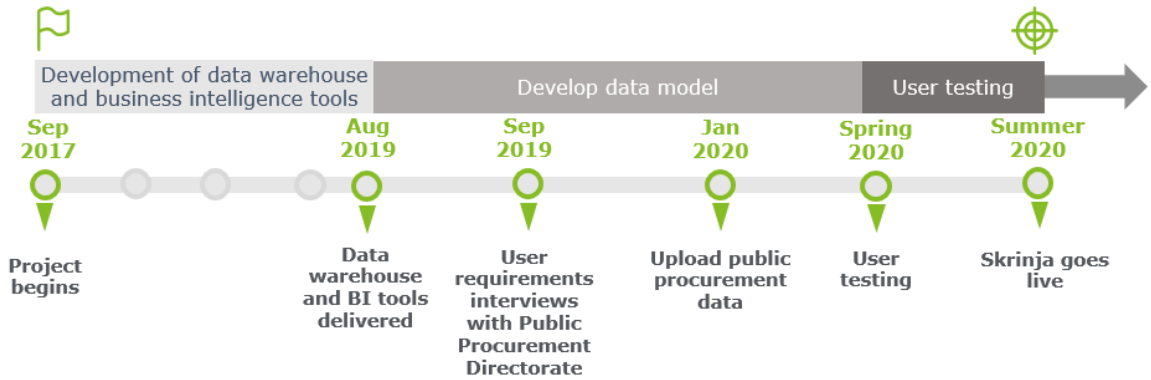
The public procurement data to be used comes from two sources:

- **Tenders Electronic Daily (TED)** – for those tenders which are above the threshold where publication throughout the EU become obligatory;
- **Slovenian electronic public procurement portal** – for those tenders falling below the thresholds for EU wide publication.

Before data is uploaded to the data warehouse and analysed using business intelligence tools**, a number of steps must be followed to ensure that the data uploaded is properly matched with user requirements**. In the case of the public procurement data, the primary users come from the Public Procurement Directorate. The technical team developing the tools conducts interviews with these users, documents what they need to do with the data (e.g. calculations that must be performed) and elaborates on user requirements in detail. On the basis of this information they design a data model that will be used. Once the data is modeled, the tools are put through a user testing phase, before being put into production.

This process of adding domain data sources to the business intelligence ecosystem is conducted separately for each source. For now public salaries data and public procurement data have been added to local data warehouses. The timeline for completion of these phases is detailed in Figure 32 below.

Figure 32: Skrinja timeline



Results and future expectations

As shown in the timeline above, **the Skrinja project is still in development**. The first data source (public salaries) to be used by the business intelligence service is now in testing phase. Therefore, there are currently no concrete results to be presented.

The outcome of the preceding big data pilot, however, revealed both the need and an interest in the type of data tools provided by Skrinja, and so the project team is optimistic that users from the analytical level all the way to high level managerial or political positions will use the developed tools to support their decision making, and that they will also be used to fulfill transparency objectives.

Costs and requirements

Costs	Human resources	Other
• Total costs **of €1 000 000** split between: o Human resources and consulting: **€500 000;** o Licenses and hardware: **€500 000**.	• **Inhouse team** of 4 full-time staff and 4 part-time staff (potentially to be increased in the future); • Supported by contracted **IT consultancy**.	• Digital procurement data sources to draw upon; • Servers to support the data processing requirements; • Collaboration between IT and non-IT employees

The total costs of the project come to approximately 1 million euros. This is divided into the following main components:

- **Human resources and consulting** – €500 000. To develop the data warehouse, business intelligence module, and develop the data model and upload and test the necessary data;
- **Licenses and hardware** - €1 500 000. Including for Power BI, Oracle database, servers, etc.

The project depends on **digital records of public procurement tenders**. However in terms of the format in which this data is provided, the requirements are not too demanding. The project team will conduct a data transformation on the data resources provided to them, ensuring that they are uploaded to the data warehouse according to a common standard.

Other key requirements for the project, which emerged clearly from the preceding pilot project, was the need for **close cooperation between non-IT and IT employees in order to develop the tools**. Input from non-IT data owners is required as they are the ones with knowledge and expertise on the domain data and data sources. This knowledge is essential first for designing well adapted tools and second to enable interpretation of the results of data analysis. In order to ensure that these non-IT staff are more familiar and adept with data analysis approaches, the Ministry established a training programme for public servants together with the University of Maribor and the University of Ljubljana, which has so far had over 200 participants.

In terms of the human resources directed toward the project, there is an in-house team of 4 full-time employees supported by an additional 4 part-time employees. This in-house team may also grow further going forward. A private sector IT consultancy has also been contacted to work on the project, developing the data warehouse and business intelligence tools.

Risk and mitigation

The main risk the project team was concerned about while planning the development and deployment of Skrinja tools was not that the envisaged functionality would not be provided but rather that **the uptake by users across Public Administration would be limited**. This limited uptake could be a result of either a lack of awareness of potential users or due to the facts that tools have not been properly tailored to their

needs. In order to reduce this risk, the team ensured the close involvement in the project of non-IT users across the Ministry in order to have their input and to properly understand their requirements.

Another general risk that the team developing the Skrinja project had to deal with were **privacy risks associated with the personal and confidential data to be uploaded to the data warehouse**. For the public procurement data this was less of a concern, as in general the data uploaded had been already made public, either through the TED portal or the Slovenian electronic public procurement portal. However, in other areas, such as the public salary data, this is not the case, and steps had to be taken to ensure privacy by design and provide guarantees that unauthorised users are not given access to this data. As a general policy, in order to address this risk, the data warehouse will be divided into sections, with data owners (i.e. different departments from within the ministry) only able to access and analyse the data that they have provided.

Challenges and lessons learnt

In line with the main risks described above, **the primary challenge of the project is to provide support to data driven decision making** – ranging from technical-level users within units or departments in the Ministry (and broader Slovenian public administration) for analytic or reporting purposes, to high level Ministerial or managerial users who need an overview or supportive data to support policy discussions and decisions.

Other challenges include ensuring privacy concerns are addressed by guaranteeing that only authorised users will be able to access data stored within the data warehouse, and ensuring that the level of data analysis skills within the Ministry are at a sufficient level such that the business intelligence tools can be properly used and their output understood.

A final challenge that the team had to confront relates to the **lack of experience of similar projects in other public administrations across Europe which they could draw upon and use to improve their approach**. The team did not find another EU country implementing business intelligence tools. In order to overcome this, the team drew on and learnt from private sector experience, including from EMC Dell during the pilot project, as well as from the contractors working on the project.

Case study 10: Public Procurement Price Panel

Lead Organisation: Department of Logistics, Standards and Systems of the Secretariat of Management – Federal Ministry of Economy

Location: Brasilia, Brazil

Technologies: Big data and data analytics

Level of government: National

Problem Statement: In Brazil, it is mandatory by law to conduct price research as a preparatory task in view of launching a procurement procedure, however, it is hard to operationalise this task. The traditionally used method of comparing and taking the average of three cost estimates is inefficient, time-consuming, untransparent, non-exhaustive and non-representative, thus leading to incorrect estimates and failing to fulfil its objective.

Description: The solution consists of a Business Intelligence application (developed using Qlik Sense) that allows for crossing and homogenising data from several sources. Given the variety of parameters written differently, but with the same semantic and conceptual meaning, it is possible to simply and quickly unify such information to increase the scope of analysis for market price researching.

Lessons learnt: Engage qualified solution users as early as possible at the design stage to avoid future rework and redesign which increases investment costs and may lead to a low level of user's satisfaction.

Cost: Total investment of €675 264 split between initial investment of €225.088 (75% on acquisition of technological solution; 25% on consultancy services) and follow-up investment of €450 176 to acquire additional licenses to expand the user base.

Impact: High. Average length of price research reduced from 6 weeks down to 6 minutes; increased reliability and transparency of price estimations.

Future expectations: Looking ahead, there are plans to potentially cross-check the price data used with electronic Invoicing data. These prices have the potential to feed into the Panel's price base and allow research to be even more accurate.

Human resources: Mainly consisting of in-house ICT Experts from the Federal Ministry of Economy complemented by very limited support from external ICT Consultants.

Risks: In the event of a discontinuity of Qlik technology, there would be the need for replacing for a similar tool in a domain where, so far, no open-source tool has been identified that can meet the expected dynamics of the product with the proper quality.

Other requirements: Assessment of the extent (size and time) to which the existing capacity of the infrastructure is able to support the cross-checking of mass data simultaneously undertaken by all federal contracting agencies

Project timeline: Nov 2016 – April 2017 (six months)

Project status: Completed, in operation since April 2017

Email: everton.santos@planejamento.gov.br

Website: http://www.planejamento.gov.br/

Context and problem statement

The legal requirement for undertaking price research as a preparatory task in view of launching a procurement procedure dates back to the nineties. In fact, Article 15, § 1, of Law No. 8.666/93 (PPL)[131] already provided that "*Price registration shall be preceded by extensive market research*" and introduced a new method consisting in comparing with "*similar contracts entered into by other public entities*". However, the problem has always been how to operationalise this legal command: **where to find the prices applied?** The case-law of the Federal Court of Accounts (TCU - Brazil)[132] states that "*the prices collected should be searched under similar conditions, requested in the bidding procedure and refer to an object comprised in the subject matter of a contract that is identical to that of the bidding*". Furthermore, the reference price should reflect the market price, taking into account all factors that influence the formation of costs (e.g. specification of the good or service; quantity purchased; geographic scope of the market to be researched - municipal, state, national or international); performance requirements; levels of service required; delivery times; warranty and post-sale support; logistics costs related to the place of sale and purchase and procurement method used (more or less competitive). In several cases[133] The Federal Court of Auditors held that "*The award of the lowest bid or the lowest amount offered does not guarantee compliance with the principle of selection of the most advantageous proposal if the price research was not done according to the best technique possible, following the parameters defined in Normative Instruction No. 3 of June 27, 2014*".[134] (updated by IN 3/2017).

For a long time **the custom was to take the average of "three budgets**", consulting suppliers. But this method has **serious risks of producing skewed estimates** as companies have no interest to disclose, prior to bidding, their effective bid to conduct the business. Suppliers know that the budget will serve as the basis for judging disputes and tend to overestimate it in anticipation of higher profits (TCU Judgment 299/2011-Plenary). It has been 24 years of waiting, since the promulgation of the PPL, but from April 2017, finally the command of article 15 of the law became technically viable. An example of this can be read in the Master's research of Lacerda (2012)[135], who evaluated 2011 e-auctions for purchasing "*white A4 paper*" based on data from Compras.net[136]. Unit prices per ream ranged from R$ 6.80 to R$ 15.82 i.e. more than 130% dispersion. In one of the trading sessions covered by this study, the estimated price was R$ 45.95 per pack. Almost triple the highest price practised. How to evaluate the most advantageous proposal in this case? And what is the effect of an inflated estimate on prices paid? Lacerda's research concluded that overrated prices tend to generate more expensive proposals. The traditional price estimating technique, through asking for "three cost estimates", therefore led to losses by resulting in unreasonable proposal prices. It also is inefficient and time-consuming and may represent up to 45% of the total time dedicated to the preparation of the procurement procedure (Casagrande; Cestari; Motta, 2009)[137].

Table 8: Difference in estimated and actual costs

Year	Estimated Value (EUR)[138]	Actual contracted (EUR)	Difference
2015	220.811.000.000	20.933.200.000	10 X
2016	130.551.000.000	19.807.700.000	6 X
2017	99.939.000.000	9.903.860.000	10 X

Source: Secretariat of Management – Federal Ministry of Economy

[131] Still today considered the Public Procurement Law of the country.
[132] https://portal.tcu.gov.br/english/
[133] Judgments of the Federal Court of Auditors 2829/2015, 1785/2013, 299/2011 and 2463/2008.
[134] Updated by Normative Instruction No. 3 of April 20, 2017
[135] Lacerda, Luiz Carlos Neiva, Uma análise da variabilidade dos preços adjudicados em pregões eletrônicos na administração pública federal / Luiz Carlos Neiva Lacerda. 2012
[136] The Federal Government Procurement portal at https://www.comprasgovernamentais.gov.br/
[137] CASAGRANDE, Maria L.; CESTARI, Angeliki N.; MOTTA, Ana Paula P. D. Preços referenciais: economia, rapidez e qualidade nas compras governamentais. In: II CONGRESSO CONSAD DE GESTÃO PÚBLICA. Brasília-DF, 2009.
[138] 1,00 R$ = 0,22509 EUR (indicative exchange rate BRL/EUR on 25.10.2019)

The **Secretariat of Management is the unit of the Ministry of Economy** that coordinates and supports the implementation of programs and projects designed to **modernise the public management function**.

In the field of public procurement, the unit has been **challenged to find innovative solutions supporting the market research** needed to be conducted by contracting entities in the preparation of their procurement procedures. In particular, the lack of a Price Panel – in the form of a dashboard where actual prices of concrete purchased goods and services[139] can be consulted - was not allowing public procurers to carry out a reliable and timely research on the prices practised by contractors when selling to the Government. Thus, the price estimation process – which is a mandatory step the contracting entity must follow to launch any procurement procedure – was solely based on the direct consultation with potential suppliers. In addition to not being representative of a market trend nor exhaustive, this method was only able to deliver price estimates that were very far from reality and so not reflecting what is going on with real and actual contracts or transactions. Furthermore, such manual price estimation process usually took around 45 days to be completed and involved several interactions between the contracting agencies and potential suppliers in a non-structured and non-transparent way. The process was very time consuming and not reliable since no accurate indication about the actual (historic) prices could be obtained.

As a result, the **unit proposed the use of big data, data analytics and business intelligence tools in view of making a Price Panel available for all, contracting entities and the public at large**.

Under these circumstances, with so many variables influencing prices and their research, public procurers needed technological tools to help the undertaking of real-time price research based on actual contracts entered into by contracting entities in several geographies.

[139] The provisions of the Normative Instruction do not apply to engineering works and services, referred to in Decree No. 7983, of April 8, 2013. For engineering works and services, contracted and performed with resources from the Union budgets Decree No. 7983 has its own rule for the elaboration of using among other tools such as SINAPI and SICRO, and therefore does not apply to the standard under study. SINAPI is the National System of Research of Costs and Indexes of Civil Construction maintained by Caixa Econômica Federal - CEF, according to CEF engineering technical definitions and price research conducted by the Brazilian Institute of Geography and Statistics – IBGE. SICRO is the System of Referential Costs of Works whose maintenance and disclosure National Department of Transport Infrastructure – DNIT.

Normative Instruction No. 3 of April 20, 2017

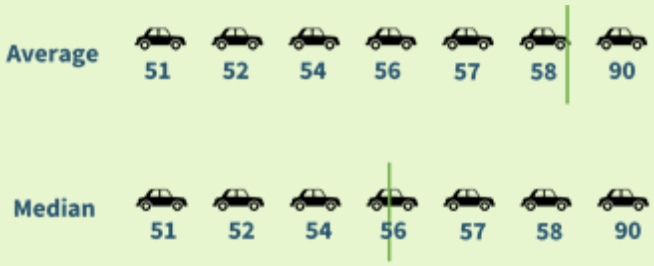
Article 1 This Normative Instruction provides for the administrative procedure of price research for the acquisition of goods and services.

Art. 2 The price survey will be carried out using the following Parameters:

*I - **Price Panel**, **available at the website http://paineldeprecos.planejection.gov.br**;*
II - similar contracts entered into by other public entities, in execution or concluded in the 180th (one hundred and eighty) days prior to the price survey date;
III - research published in specialized media, specialized electronic websites or broad domain, provided it contains the date and time of access; or
IV - research with suppliers, as long as the dates of the research do not differ in more than 180 (one hundred and eighty) days.

*Paragraph 1. The parameters provided for in the clauses of this article may be used combined or not, and **priority should be given to those provided for in items I (Price Panel) and II** and in the administrative process the methodology used to obtain the reference price.*

*Paragraph 2. The following shall be used as a methodology for obtaining the reference price for contracting, **the average, the median or the lowest of the values obtained in the price survey**, provided that the calculation relates to a set of three or more prices from one or more parameters adopted in this article, disregarding the unenforceable values and the excessively high.*



Source: Secretariat of Management – Federal Ministry of Economy

Objectives and vision

The purpose of the project was two-fold, on one hand **to enable public buyers to improve their knowledge of the market** in which they operate and, on the other, **to comply with the legal and policy requirement for researching prices**.

The following specific objectives should also be highlighted:

- Provide accessible and user-friendly data and information about prices in public markets;
- Make the prices paid by public contracting entities more transparent - enabling a comparison between the prices different contracting entities pay for the same items from suppliers across the country under the same legal and policy rules;
- Stimulate the participation of citizens (taxpayers) and non-governmental organisations in the scrutiny of the economic performance of public markets
- Set the prices for purchases within the Food Acquisition Program (PAA)[140]

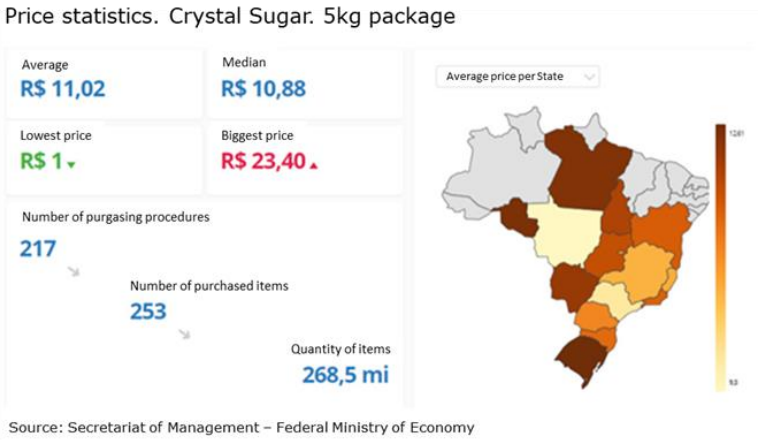
[140] The Food Acquisition Program (PAA), created by art. 19 of Law No. 10,696, of July 2, 2003, has two basic purposes: promoting access to food and encouraging family farming. In order to achieve these two objectives, the program purchases food produced by family farming through a non-bidding procedure and is intended to benefit people in

Technological solution and implementation

The Price Panel, developed by the Department of Logistics, Standards and Systems of the Secretariat of Management – Federal Ministry of Economy, provides user-friendly data and public procurement information generated in the Integrated Management System of General Services - SIASG[141] and on Compras.net.

The example below (Figure 33) summarizes the type of statistical information available through the price panel and the intuitive way it is presented. The density of the information can be adjusted through filters available to the user, and it should be noted that the application is full of help points - available by sliding the mouse and through the hyperlinks that direct to the tutorial tools eg application manual, videos and sources of price literature in public markets. The availability of the "average" and "median" as the most prominent visible figures on the screen show the importance that has been given to the objective of providing an efficient tool to undertake price market research as a necessary step to estimate contract price in a realistic and reliable way.

Figure 33: Example price statistics



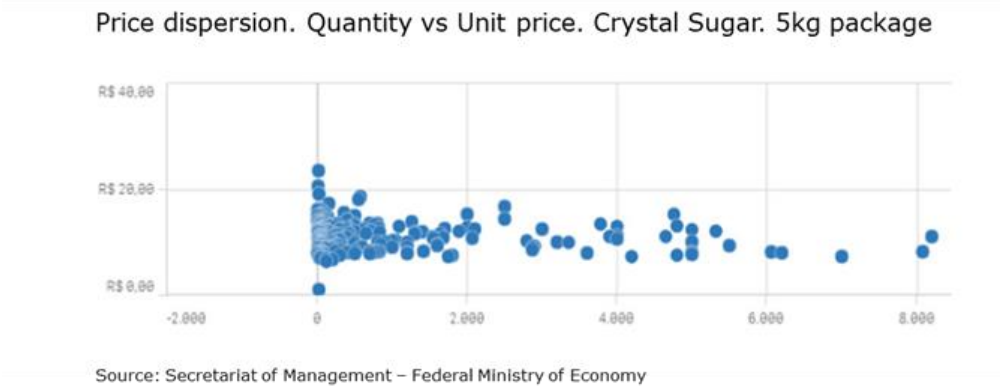
Source: Secretariat of Management – Federal Ministry of Economy

In the face of discrepancies in search prices, distorted values must be disregarded. It is what determines the TCU in Judgments 2.943 / 2013-Plenary and 2.637 / 2015-Plenary. Prices that are clearly out of market average should be purged from the sample. This task of handling discrepant data is greatly facilitated by the price dispersion panel.

situations of food and nutrition insecurity. Direct Purchase is executed with resources from the Ministry of Citizenship and operationalized through Conab (National Supply Company). Allows the purchase of products such as rice, beans, corn, wheat, sorghum, cassava flour, wheat flour, whole milk powder, cashews and Brazil nuts at reference prices set by the Program Manager Group, up to the annual limit of R $ 8,000.00 (eight thousand reais) per family unit. When the market price of any of the products supported by the modality is below its reference price, Conab broadly discloses in the affected region that it will install a Purchase Pole (its own or accredited Storage Unit, warehouse or other location indicated by Conab) to where interested family farmers move in possession of their produce as well as the required documentation. Conab reviews the documentation and provides product classification. If everything complies with the requirements, issue Acquisition Invoice

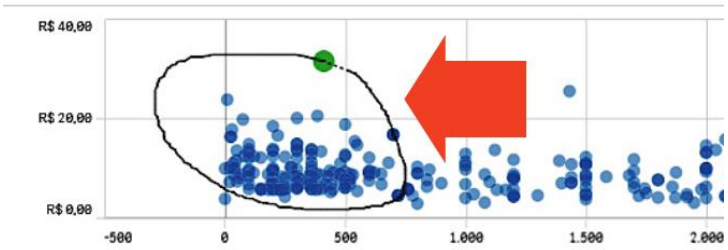
[141] After a recent restructuring, the SIASG is no longer seen only as a set of government procurement sub-modules - supplier registration, catalog of goods and services, electronic bidding platform, price registration system , the contract management system, the payment order issuing system, the electronic trading floor, the electronic quotation and a communication tool between its users and a statistical data extractor (Data Warehouse) - and has gained relevance as a support, transparency and control instrument in the execution of procurement activities, through the computerization and operationalization of all its activities, as well as in the management of all its processes.

Figure 34: Price dispersion panel example



As illustrated in Figure 35 below, there is a concentration of values around $ 10.00 and below 2,000 units purchased. The tool allows the selection of a set of data of interest by means of a simple drawing of a circle around the dice. The filtering process is very intuitive, iterative and dynamic, which simplifies the exclusion of data not relevant.

Figure 35: Price dispersion panel - selection of data



Source: Secretariat of Management – Federal Ministry of Economy

Table 9 below provides a list of built-in filters that allow public procurers, as well as any interested citizen or organisation browsing the Price Panel, to undertake responsive searches in a couple of minutes, on average less than 7 minutes.

Table 9: Public procurement panel filters

FILTER	TO FIND AND COMPARE
Year of purchase	Year of purchase (date of contract)
Material (goods) Name (PDM)	Standard Description of Goods (PDM) e.g. pen ballpoint, laptop, car vehicle, paper A4
Goods and Services Codes	Search by the Good Code Number (CATMAT) or the Good Code Number (CATSER). Example: 217773, 25197, etc
Material Description or Service Description	Search by description item detailed. Example: Ballpoint pen, plastic, transparent material.
Purchase Object (subject matter of the contract)	Search for the description in the object of the contracted goods and services
CNPJ / CPF or Vendor Name;	Search by Legal Entities or Natural Persons ID/Tax number or contractor's name (awardees)

Company size	Search by the size of companies that have been awarded public contracts
Supply Unit	Search by the supply unit of a particular product or service (meters, tones, boxes, etc.
Superior Organ	Search by the name of the superior organ;
Organ	Search by the name of the linked agency that made the purchase
UASG	Search by procuring unit within the same contracting entity
Procurement method:	Search by procurement method, i.e. open national or international tendering, selective tendering, limited tendering
Purchase Period	Search by predefined time intervals e.g. the last 180 days
Purchase form	Search by Price Record (SISRP).
Registered (practised) Prices	(SISPP - Practiced Prices System);
Level of government	Allows search by federal, state, or municipal sphere.

Source: Secretariat of Management – Federal Ministry of Economy

Underlying technology

The **solution consists of a BI application**, based on Qlik Sense that allows for crossing and homogenising data from several sources and information homogenization. Given the variety of parameters written differently, but with the same semantic and conceptual meaning, it is possible to simply and quickly unify such information to increase the scope of analysis for market price researching.

The following technology companies were contracted by the Ministry of Economy to support the development and setup of the solution:

- Software Development Company: Jointecnologia[142]
- Data Creation and BI Consulting Companies, Business Intelligence: IN – Inteligência de Negócios[143] and Qlik Corporation[144]

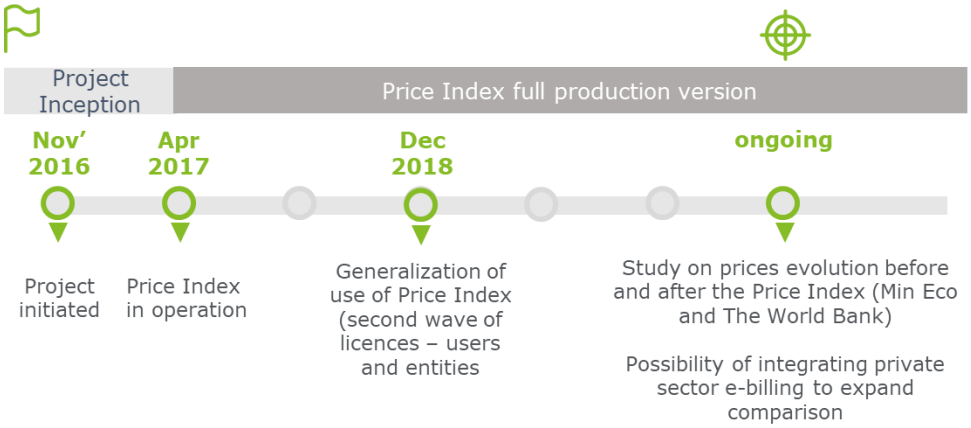
The **data crossing solution is proprietary**, while the portal programming language is an open framework.

Implementation

Taking into account the installed capacity and the ability to develop the project within a relatively short duration, **it was decided not to run a pilot**. Instead, and with a view to engage with stakeholders, an early presentation with experienced users for validation and approval of the proposal took place.

[142] https://www.jointecnologia.com.br/
[143] https://www.in1.com.br/
[144] https://www.qlik.com/us

Figure 36: Timeline for the development of the Price Panel



Users from government entities – including public procurement officers responsible, for example, for the purchase of medicines (Ministry of Health) and for purchasing books and catering services (Ministry of Education), as well as public buyers from the Federal Police (Ministry of Justice) - were **invited to test the dashboard directly from the QlikSense Desktop IT tool**. At that time, the tests were performed directly on the interactive graphics provided by the mentioned tool, because the HTML development was under construction. Once the project reached the final stage already including development in Web format, the same users were invited again to try the tool and report their user's experience. This allowed the project team to rapidly map the weak points in the Price Panel use and also to make the visual interfaces more friendly and engaging.

The **Price Panel is connected with the purchasing platform itself (compras.net)** which generates all public procurement data. This allowed to overcome the system limitations through data cross-over without having to evolve or change the legacy system.

Currently, the **Department of Logistics, Standards and Systems of the Secretariat of Management of the Ministry of Economy** (central body of the federal government) is **responsible for maintaining the Price Panel** solution and outlining its future evolution e.g. upgrades and further integration with other tools within the framework of the e-Procurement system of the country. The identification of needs for evolution is based on the user's feed-back gathered through the dedicated Call Centre.

Results and future expectations

The Price Panel is a product that **brought much more transparency to public markets** insofar as it enables an independent, non-biased and real time based price research. As in many other areas of the public procurement modernisation the practical implementation of this tool shows how important is the original quality of data and how decisive the integration between applications and tools within the broad e-GP system is, especially with those components of SIASG where actual contract prices are registered. As it currently stands, the market price research is mainly focusing on contracts for the supply of goods (77%) with the remainder (23%) focussing on categories of services.

Key results from practical use of the Price Panel by the contracting entities from the Federal Government are:

- **Average length of price research dramatically reduced from 6 weeks down to a few minutes** (6 minutes. As a result, the time required to perform this task is no longer a reasonable explanation for not carrying out a reliable price research in accordance with current;
- **Public procurers no longer depend on the willingness of suppliers** approached on a one-by-one basis to respond to surveys or **to provide cost estimates** to acquire a reliable information about price behaviour on the market.

- **Greater transparency of the price estimation process**. Before the introduction of the Price Panel, the price research related information (the outcome of the lengthy and cumbersome process of surveying potential suppliers or asking them the provision of cost estimates) was simply archived within the procurement procedure files for auditing purposes (to prove compliance with the legal duty of researching prices) therefore they were of no use for other contracting entities nor potential suppliers competing for new contracts in the public market;
- **Greater integrity and fidelity of reference prices** as these are real prices charged to contracting entities by contractors/suppliers. By bringing the price research process under the control of the public administration – suppliers are not relied upon at all – the Price Panel provided access to much more accurate information about the market, which is a critical requirement for better procurement planning and for increasing the economic efficiency of procurement activities.

Results may also be expressed by **numbers using the portal**. In the first month, 13,000 users accessed the price panel, and this **reached 160,000 monthly hits in May 2018**. On average, the user remains active for less than 7 minutes in each consultation.

In addition to these observed results, the price panel is expected to drive a **reduction in contract prices**, induced by broader and more transparent competition. Basing the total maximum contract price on reliable market research/information increases the alignment between both the public and the private market of all categories of goods and services that are procured in both.

So far only qualitative assessments are available through (i) the testimonials of public procurement officials; and (ii) the reports on the user's feedback through the call centre facility. Nevertheless, **a quantitative impact study including the analysis of prices before and after the Price Panel is being conducted** by the Ministry of Economy in partnership with the World Bank.

With reference prices closer to the market, bidding results tend to have a lower profit margin, which implies lower selling prices to the Government.

Looking ahead

There are plans to potential cross-check the price data used with Electronic Invoice data. These prices have the potential to feed into the Panel's price base and allow research to be even more accurate.

Costs and Requirements

Costs	Human resources	Other

• **€225.088** (Nov' 2016):
  • technological solution, including data acquisition and processing: 75%
  • Consultancy services: 25%
• **€450.176** (Dec' 2017)
  • Generalisation of access – more licenses
	• In-house: ICT Experts of the Ministry of Economy (2 ICT Experts)
	• Consultants: 1 Consultant (Qlik); 1 Consultant (web development)
		• Cloud infrastructure to support all application modules

In terms of **finances**, the total initial investment in the project by the Ministry of Economy reached **EUR 225 088** (Nov' 2016). This is split as follows:

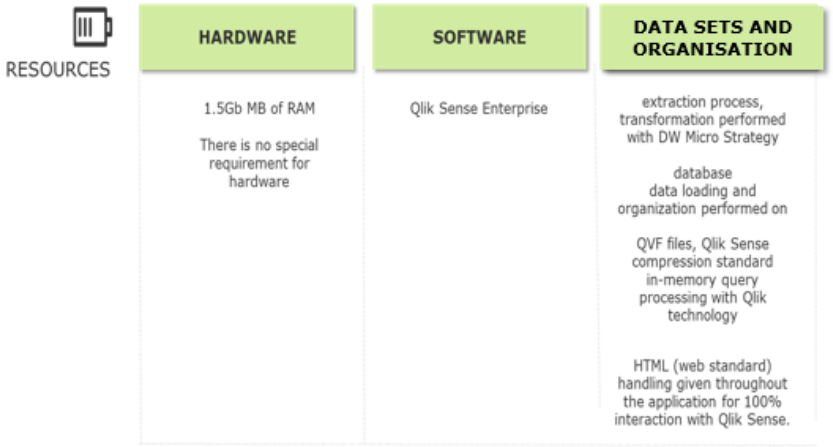
- technological solution, including data acquisition and processing: **75%** (EUR 168.816)
- Human resources from Federal Ministry of Economy : **25%** (EUR 56.272)

About one year after the implementation of the project (Dec 2017) the growing interest shown by more and more contracting entities in the Price Panel led to an additional investment of **EUR 450 176** to acquire the additional licences needed under a perpetual software licencing agreement.

Consultancy services have been used to create the solution on the proprietary software used (Qlik Sense). There was no need for training as the managers involved in the demand were in-house IT Professionals of the Ministry of Economy who were already aware of the whole public procurement related processes and tools.

Due to the ability of the tool to offer a very simplified presentation of records, there is a low need for data qualification. There was no data cleaning process. The philosophy is that the tool presents the necessary information for use and adjustment by the user, always linked to the critical analysis of the data.

Figure 37: Hardware, software, and data requirements



As far as **other requirements** are considered, the most relevant is to assess to what extent (size and time) the existing capacity of the infrastructure is able to support the cross-checking of mass data simultaneously undertaken by all federal contracting agencies. Currently, the tool has hundreds of simultaneous accesses at peak times, with over 12,000 accesses on working days.

Risk and mitigation

Although no major risks were identified – in terms of likelihood and impact – the following aspects call for a close monitoring as the system expands:

- **Infrastructure capacity**: To avoid capacity risks to materialise, including the potential need for new investments to support greater capacity, it is necessary to introduce mechanisms for data segregation so that overload of the system with huge amount of data can be avoided
- **Misuse by some non-professional users** may slow down the system for those who log in to actually do their price research work. The use of robots for scraping data by direct access, i.e. without human intervention, as well as training programmes and online videos/tutorials built into the Price Panel application may help prevent this situation to occur
- the **lack of an open-source tool** able to guarantee a similar performance and reliability in the event of a discontinuity of Qlik technology, can perhaps be regarded as a weakness and a risk.

Following two years of operation, none of these risks have had any material impact. However, the risk assessment needs to be updated in line with Price Panel usage statistics and, as soon as they become available, with the outcome and recommendations from impact studies which are in preparation.

Challenges and lessons learnt

The main challenge to change the way the application was regarded. Initially, it was thought that it would only be possible to make price research possible in the system after data standardization and cleaning. By adding a BI tool, it was possible to create a solution in which the user gained autonomy to solve these issues themselves.

The **major obstacle to the implementation** of this mechanism was the **quality of the catalogues**[145] for goods and services which are fed in a decentralized manner by more than 3,000 purchasing units. This updating system has the potential to generate all kinds of distortion caused by an erratic completion of object descriptions (subject matter of the contract) and the actual supply units. Omission, duplication and wrong information being recorded. There are over 259,000 items catalogued in Compras.net, without standardization, for the most part. For example, if the product "crystal sugar" is searched several supply units are possible e.g. Kilogram, 5kg package, 1kg package, 2kg package, 30kg bundle, unit, 1kg bag, etc. This diversity may make a comparative analysis unfeasible. The Federal Court of Auditors has recommended that the catalogues be enhanced and standardised to complement the price panel.

The most difficult and complex decision when developing the solution was whether it would be necessary to clean the catalogue before creating the price panel. **The option adopted was to create the Panel with the available data**, mitigating the risks of misstatement through detailed filtering and result analysis mechanisms, user empowerment and further improvements in the catalogues of goods and services.

The **engagement of qualified solution users as early as possible** at the design stage is considered key to avoid rework and redesign with the consequent additional investment costs and a possible negative user's experience. Theoretical framework studies and interviews with procurement managers of different contracting entities were conducted to collect perceptions and add opinions on usability of the tool. The premise was to build the solution from the real and concrete need of managers. When testing the tool with a small group of public procurers, the main feedback was that the tool needed to be simplified.

Having this **premise of simplicity** present the development efforts focused on producing an interface that required just a few clicks, featuring a summary of the prices charged and the main statistical calculations: average, median, lowest and highest price.

The prices of public contracts, in the format they were published on Compras.net were difficult to consult and analyse and only data experts could perform price searches for a pre-determined category of goods or services. With the Price Panel, it was possible to integrate in an intuitive view the data of an analytical vision tool (BI, DW, among others) and allow easy and public access for users to make their queries.

[145] Catalogue for Goods (CATMAT) and Catalogue for Services (CATSER).

4.5. Blockchain case studies

The following chapter presents **five case studies** in which public administrations make use of blockchain as a primary technology to transform or improve their public procurement processes and functions:

Case study 11: HHS Accelerate

Lead Organisation: Department of Health and Human Services (HHS)

Location: USA

Technologies: Blockchain, AI & ML and RPA

Level of government: National

Problem Statement: HHS has multiple legacy systems for contract writing and other procurement functions. These multiple systems create barriers to sharing information across the department as well as to analysing and driving savings by consolidating contracts. In addition, the Department struggles with continued reliance on paper-based processes.

Description: Through the HHS Accelerate programme, HHS has developed a data lake running on blockchain that operates on top of (and without disrupting) its legacy systems. Data is pulled from the existing contract-writing systems, tagged on the blockchain and stored. On top of this data lake, containerised micro-services, drawing on robotic process automation and machine learning technology, have been developed which automate procurement functions at every phase. Finally, a single interface for procurement officers and HHS employees has been developed which allows users to manage each step of the acquisition lifecycle, from initial market research to evaluation and contract close-out.

Lessons learnt: The HHS Accelerate project has been developed following a gradualist approach, with functionality built out incrementally and without disrupting other systems. This has been a key factor limiting the risk associated with the project and is a key lesson to take from the project. HHS Accelerate has also demonstrated that blockchain can be effectively used to support a data management approach, operating at scale to provide a data lake consolidating information from multiple legacy systems.

Cost: €31.6 million ($34.7 million) over 5 years

Impact: Limited. Not yet fully operational. Predicted savings of €233 million (US$ 256 million) over five years

Future expectations: The business plan under which the system has been developed predicts that the system will generate savings of 256 million dollars over 5 years.

Human resources: Working with 2 separate contractors. HHS fulfils the system integrator role itself.

Risks: Incremental approach followed to limit risks associated with large-scale IT projects

Other requirements: Organised human-centred design sessions with the workforce to ensure the new system meets their needs and requirements, and to build support for the project within the organisation

Project timeline: April 2018 - present

Project status: In development (due to go live in Jan 2020)

Email: OCIO.HHS@hhs.gov

Website: https://www.hhs.gov/

Context and problem statement

The US Department of Health and Human Services (HHS) is a federal body with the mission to "*enhance and protect the health and well-being of all Americans by providing for effective health and human services and by fostering sound, sustained advances in the sciences underlying medicine, public health, and social services*". The organisation has a US $24 billion annual spend, which is allocated to a wide range of goods and services, from drugs and medical devices, to grants for research programmes, to food, buildings and maintenance.

In order to manage and store information on this spend, the organisation has multiple legacy IT systems, including five contract-writing systems and dozens of other associated acquisition support systems. As a consequence, HHS faced multiple barriers hampering efficient and effective procurement processes and improved procurement outcomes. The key challenges the organisation faced were:

- **Barriers to sharing information** across the Department
- **Difficulties in effectively consolidating contracts** and spend across the Department leading to foregone savings (i.e. the price paid for the same good/service by different parts of the organisation differs significantly)
- Continued **reliance on paper-based processes**
- **Burdensome process for industry partners** to do business with HHS involving repeat submission of information, ultimately leading to reduced competition and lower- value acquisition outcomes

Objectives and vision

The visions for the HHS Accelerate project is to provide a single digital platform to cover the entire acquisition lifecycle – from acquisition planning to post-award - for the Department. Concretely it aims to:

1. **Inform acquisition decision making** through the provision of real-time, agency-wide data
2. **Improve and accelerate acquisition business processes** through process automation
3. **Improve interaction with industry partners** and reduce their administrative and financial burden
4. **Meet contract-writing needs** of the Department

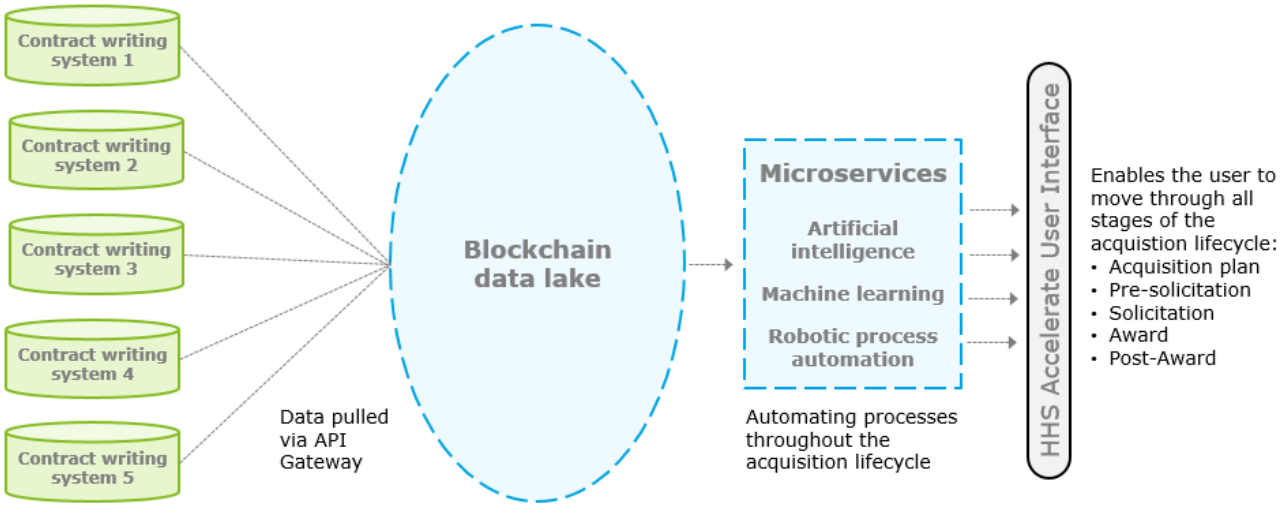
Technological solution and implementation

Blockchain is the core technology underlying the HHS Accelerate project. It is used to support a **data lake which operates on top of existing legacy systems**, while allowing these legacy systems to continue running undisrupted. The data from the HHS' five main contract writing systems is pulled via an API gateway. This provides about 1 terabyte of data on roughly 100 000 contracts.

This **data is cleaned using a machine learning tool** and standardised. Following this, the data is tagged on a private, permissioned blockchain - hyper ledger fabric - providing an immutable record of that data. The bulk of this data is then stored off the blockchain on an alternative (Mongo DB) database.

On top of this data, "**microservices**" - drawing on emerging technologies including machine learning and robotic process automation – are run, **automating a range of acquisition processes**. Users (acquisition officers) in the Department access these micro-services **via a single eProcurement interface**, enabling them to move step-by-step through the processes of the acquisition life-cycle from the planning stages to post-award. The overall structure of HHS Accelerate is visualised in Figure 38: HHS Accelerate Architecture below.

Figure 38: HHS Accelerate Architecture



Key Components of HHS Accelerate

The key components of the HHS Accelerate solution are therefore:

1. A data management approach drawing on blockchain technology;
2. Development of microservices to automate procurement functions;
3. Establishment of a one-stop procurement platform.

Each of these elements are elaborated upon in the sections below.

Data Management Approach drawing on blockchain technology

HHS Accelerate is based on a **long short term memory recurrent neural network**. This approach to data management mirrors the way data is treated by the human brain, with different types of data stored in different ways:

- **Transactional memory** – transactional data is stored on the blockchain
- **Long term memory** – other data is stored off the blockchain, on a Mondo DB database. It is however tagged so that it is linked to the blockchain, and any changes to the data will be registered on the blockchain.
- **Motor skills memory** – Data that will be used to run microservices is stored in a separate container.

A key benefit of this approach, with its split between transactional and long-term memory is that it allows the system to **automatically adjust the weighting of a particular transaction with a vendor according to when this transaction took place**. If, for example, a vendor failed to deliver adequately on a contract in the past, the HHS Accelerate system will automatically weight this as more significant if it happened several months ago, compared to if it happened many years ago.

Another key benefit of using blockchain as the base technology on technology is that it ensures that there is an **immutable, time-stamped record of all vendor transactions and contracts with HHS**. This record is drawn upon also for features such as the pre-population of vendor profiles on the HHS Accelerate user interface. Vendors are able to customise further these profiles, for example by providing. The **blockchain provides an identity management layer**, ensuring that only authorised users can access specific data. For example, only the vendor's employees would be able to customise the vendor profile.

The final key feature of the HHS Accelerate approach to data management, is the separate storage of data that is used to run micro-services. This microservice approach, drawing just on the necessary data, allows for a decentralised, incremental approach to the development of automated acquisition processes.

Development of microservices to automate procurement functions

HHS Accelerate has **built out a range of microservices which automate different phases of the acquisition process**. These microservices can be divided into two basic types, an analytics suite and a process suite:

- **Analytics suite** – allows for the analysis of historical contract data, providing an overview of the prices, terms and conditions under which different goods and services were purchased. This data can be filtered according to a range of different dimensions, such as the purchasing department.
- **Process suite –** allows for the automation of a range of business processes throughout the acquisition lifecycle. Examples include:
    - **Financial responsibility determination** - drawing on pubic data on vendors from sam.gov and other sources in order to determine whether HHS can do business with them.
    - **Suggested clauses** to be included in a contract for a particular good/service. Drawing on historical data and the requirements provided in US regulation, this microservice suggests clauses for inclusion to the user together with a confidence score (i.e. the probability that the clause should be included).

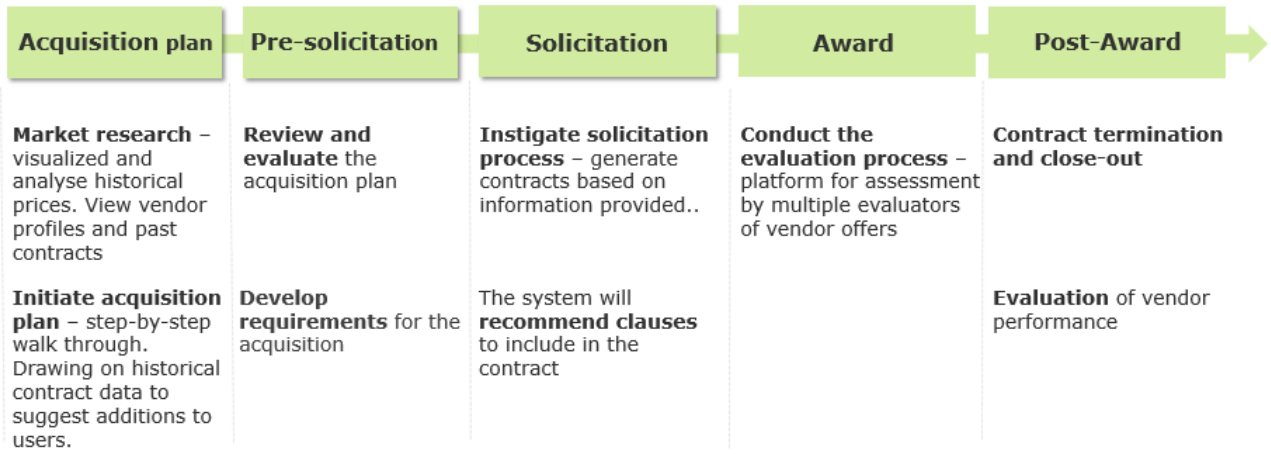
Establishment of a one-stop procurement platform

Drawing on the data stored on and off the blockchain, as well as the microservices described above, HHS Accelerate provides a single user interface to cater to every step of the acquisition process going through the acquisition plan, pre-solicitation, solicitation, award and post-award stages. On this platform, users are able to perform functions and processes including:

- **Conducting market research**
    - Visualise and analyse historical prices for goods and services, filtering by different types of dimensions including vendor type, location, etc.
    - View vendor profiles, the details of past contracts they have been awarded, and their catalogue.
- **Initiating an acquisition plan** – users are walked step-by-step through basic questions to determine the type of good/service they will need and the required contract.
    - Draw on historical contract data to add details about their requirements
    - Insert evaluation criteria based on historical documentation and canned language, or customised as required.
- **Instigating the solicitation process**
    - Generate a contract based on the information on requirements provided. Users are able to select clauses to be inserted. HHS Accelerate automatically recommends clauses to be inserted, providing a confidence score for the likelihood a given clause should be inserted, as well as providing an overall confidence score of the overall likelihood that the contract meets US regulatory requirements.
- **Conducting the evaluation process** – The system provides a platform on which each evaluator can provide their score of different vendor offers, and the final decision can be communicated to the candidates.
- **Evaluating** past vendor performance

This selection of processes supported by HHS Accelerate and their place within the acquisition cycle is visualised below in Figure 39.

Figure 39: Sample of processes supported by HHS Accelerate



Development of HHS Accelerate

The approach taken towards the development of HHS Accelerate has been gradual and incremental. This has been a deliberate strategy in order to reduce the risk and cost of the solution. The micro-services approach taken together with the fact that the blockchain datalake operates on top of legacy systems, means that business functionality can be built out step by step instead of all at once.

The project team initially built the underlying blockchain infrastructure with a set of 10 nodes. Together with this they built a first series of microservices, including the automated financial responsibility determination and pre-population of market research report. This was done between April and September 2018.

On the basis of this developed infrastructure and services, the project won an "authority to operate" in December 2018, meaning that it was approved for further development. Once this was won, between December 2018 and June 2019, built out the additional functionality, including the interface and services for each stage of the acquisition lifecycle.

The system will be tested in October 2019 and should go live in January 2020. The timeline for the development of HHS Accelerated is shown in Figure 40.

Figure 40: Timeline for development of HHS Accelerate

Human-centred design approach

Crucial input for the development and design of HHS Accelerate has been provide through human-centered design sessions with the HHS workforce. The project team **organised hundreds of these sessions with**

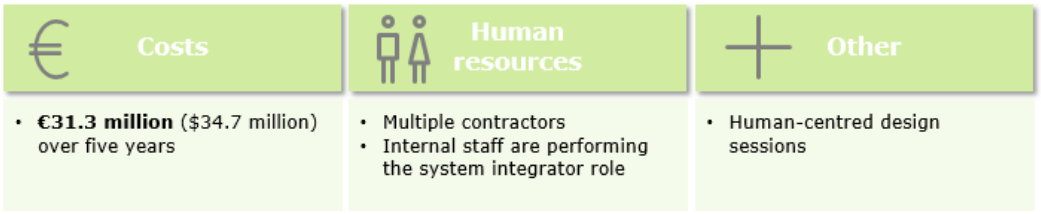
members of the workforce, getting input from them on how they currently implemented acquisition processes, and their existing pain points. The team developed and re-developed the new system in 2 week design sprints, returning each time to the workforce in additional design sessions for input on how the new developments could improve their working processes.

Results and future expectations

HHS Accelerate is not yet fully operational – it is due to go live in January 2020. The business plan under which the system has been developed predicts that it will **generate savings of 256 million dollars over 5 years**. The savings will be generated through 3 streams:

- **Move to commercial cloud environment**
- **Process improvement** – As an example, the automation of the financial responsibility determination has resulted in a reduction in the time it takes to complete this process from 35 days to 1 second.
- **Spend rationalisation** – The overview and analysis of department spend now enabled by HHS Accelerate has allowed the team to identify US $720 million in potential savings. The Department aims to capture 4 percent of those potential savings over 4 years.

Costs and requirements



The total cost of HHS Accelerate is estimated at **€31.3 million** (US $34.7 million) **over 5 years**. HHS Accelerate is **working with multiple contractors** in order to develop the overall solution, while internal staff are performing a system integrator role. One of the contractors developed the initial blockchain infrastructure and microservices, while the other was hired to build out the rest of the acquisition lifecycle.

A key requirement for the success of the workforce has also been **winning support from the rest of the organisation**. One key way in which this has been achieved has been through the human-centred design sessions previously described, which have demonstrated that workforce needs and requirements are at the heart of the project, and helped build familiarity with the system.

Risk and mitigation

The main risk that the HHS Accelerate team saw when setting up the project was that the system would fail to deliver the functionality it aimed at – **a high proportion of large-scale digitalisation projects fail** in this way. It was for this reason that the **HHS Accelerate approach has always been incremental**. New functionalities are developed and rolled-out step-by-step without disrupting the existing legacy systems. As a consequence, the risks associated with a new IT project have been minimised.

An additional risk relates to the **sensitive, confidential nature of the data being handled**. This risk is mitigated through a key component of the project – the blockchain datalake – which guarantees the data cannot be tampered with and can be tracked. It provides an identify management layer which ensures that only authorised users are able to access the data.

Challenges and lessons learnt

The experience of HHS Accelerate so far is vindicating the **gradualist approach adopted**. The development of the project has shown that this strategy can be cost-effective and limit the risks associated with large IT

projects. This strategy is enabled by the microservices approach pursued, which allows for business functionality to be built out one step at a time.

The project **places data management at its core** – with the business case developed for the project suggesting that this could drive very large savings. It demonstrates that blockchain can provide the technological basis for this data management approach. Blockchain's decentralised nature means that it can function as a useful technology for the integration of data from different sources (with data uploaded at the different nodes of the blockchain network). Meanwhile, its secure nature can help address concerns about the sharing and use of sensitive data.

A **final challenge for the project relates to organisational issues** and the need to win over internal stakeholders and the workforce. The **human-centred design approach helped to address this challenge**, however this necessitated a large scale investment and effort, with hundreds of these sessions organised.

Case study 12: Smart Procurement Tool

Lead Organisation: Digipolis

Location: Belgium

Technologies: Blockchain

Level of government: Local

Problem Statement: Digipolis is responsible for IT systems and services for the City of Antwerp. The Digipolis Buy from Startups project (2015) aimed to stimulate the procurement of innovative IT solutions and services with smaller scale creative entrepreneurs. As such, the project tried to focus on innovation as well as on a lean and mean procurement process. Although successful over the past few years, these efforts were still hampered somehow by its reliance on the federal eProcurement portal as the interface by which requests for quotations and the supplier offers were submitted. With the Smart Procurement Tool project (2018-19), Digipolis wanted the e-submission and e-awarding part of the innovative procurement process, i.e. the part that is currently managed in Public Procurement, replaced by an innovative, more user-friendly ,intuitive and future-oriented application better matching the needs and nature of the supplier target group (*one-stop workflow*).

Description: Digipolis developed a blockchain-based application enabling the publication of a request for proposal together with the submission of vendor offers. The publication and the submission of offers is done via a dedicated user interface (https://antwerpen.digipolis.be/nl), connecting with the Smart Procurement Tool. The metadata of the offers, with timestamps, are uploaded to the blockchain, providing assurance that they have not been tampered with. A private Ethereum blockchain solution is used, and currently Digipolis is the only organisation to host the nodes, and able to write data onto the blockchain.

Lessons learnt: Blockchain projects can be relatively straightforward and simple to implement in a technical sense. Regular and detailed user input is required to ensure that the solution developed is well tailored to their needs.

Cost: approximately €100 000 (covering development, testing and implementation)

Impact: Limited. Not yet operational. The smart procurement tool goes live in January 2020.

Future expectations: They system is due to go live in January 2020. Regarding future developments, the Digipolis team would like to explore how other public organisations could benefit from this project.

Human resources: 5 person (not FTE) Digipolis team supported by IT contractor with blockchain expertise (Ballistix.digital)

Risks: Limited – some risks due to unfamiliar nature of blockchain solution.

Other requirements: User input from procurement department and from the potential IT service providers (suppliers) to ensure the smart procurement tool, the revised workflow and user interface is adapted to their needs.

Project timeline: Nov 2018 – Dec 2019

Project status: In development

Email: info@digipolis.be

Website: https://www.digipolis.be/

Context and problem statement

Digipolis is the publicly owned company responsible for IT for the City of Antwerp. All IT services, software and hardware development for the city's local authorities (city administration, local police department, fire brigade etc.) are managed by it.

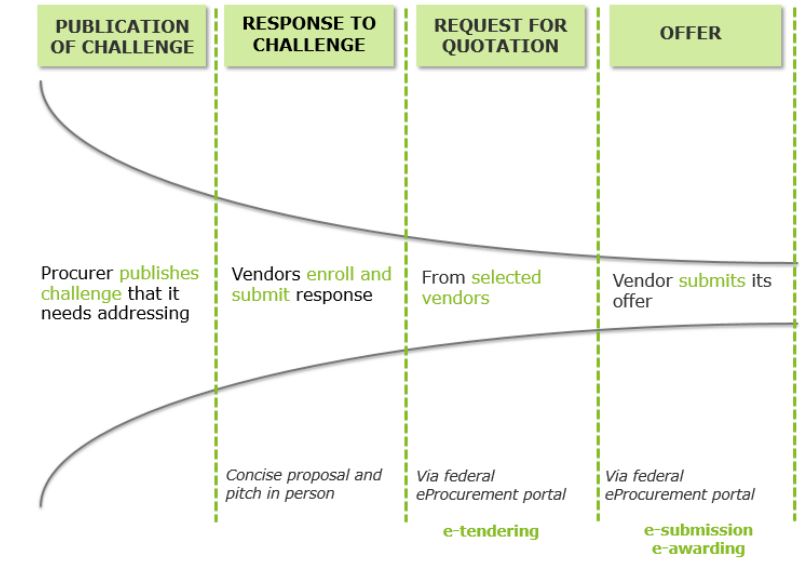
Digipolis has designed and implemented the **Antwerp City Platform as a Service (ACPaaS)** model as the framework for the delivery of IT services to these local authorities. Under this model, loosely coupled modular components are developed which can be re-used as building blocks for different services and platforms by users across the city.

In order to support the ACPaaS approach, Digipolis tried to reach to out a broader range of companies – in particular SMEs and start-ups – in order to support the development of the different components of ACPaaS. Building ACPaaS requires fresh ideas, innovative solutions and short lead-times. For this reason Digipolis attempted to set up in parallel a low-threshold and intense collaboration with young, creative entrepreneurs. Smaller-scale companies are usually a better fit for the development of these small modular components as larger vendors tend to favour all-in-one solutions. However, smaller-scale companies are often reluctant to do business with the public sector, perceiving public procurement procedures as difficult and potentially bureaucratic.

In order **to encourage the participation of smaller companies in tenders, Digipolis introduced a "Buy from Start-ups" programme**, providing a lean and mean and more appealing procurement procedure for smaller-scale and startup companies. This procedure applies to contracts worth under €144.000 (negotiated procedure without prior publication). It operates according to the following steps:

- **Publication of challenge** – Procurer publishes a "challenge" that it wants addressed, rather than a list of detailed specifications, and requests potential solutions from vendors;
- **Response to challenge –** Interested vendors enroll on antwerpen.digipolis.be. They submit a concise proposal outlining how they would approach the challenge and pitch their approach in a 30-minute face-to-face meeting;
- **Selection and request for quotation –** Procurer selects a limited number of vendors and requests a quotation from them;
- **Offer –** The vendor submits its full offer.

Figure 41: Buy from Start-ups procurement procedure



While the first stage of this process is conducted on the Digipolis Antwerp website (https://antwerpen.digipolis.be/nl), with the vendor enrolling and submitting their initial response to the challenge on this website, the later stages are not. The publication of the request for quotation and the offers from the vendor are both **done via the federal government eProcurement portal**. Switching between the two platforms is **not very user-friendly** for the companies submitting their offers, and was off-putting to the small companies that the buy from startups program intended to attract.

Objectives and vision

Digipolis aimed to **create its own eProcurement portal** for the publication of requests for quotations and the receipt of offers from companies under the Buy from Start-ups procurement procedure. Its objectives for this portal were that it should:

- Provide a **user-friendly experience**: with a simple and intuitive work-flow
- Be **fraud-proof**, providing a secure and transparent method for the submission of offers
- Be compatible with the **ACPaaS principles** (i.e. modular, re-usable components)

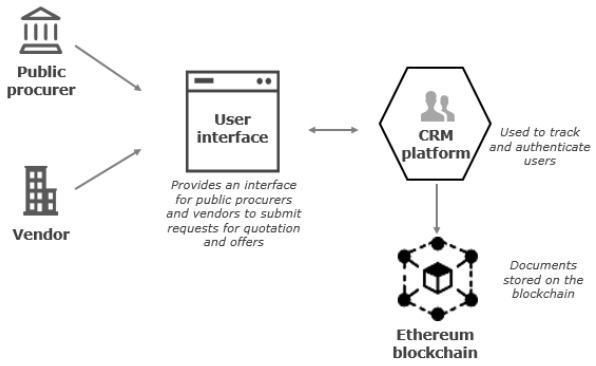
Technological solution and implementation

To meet these objectives, Digipolis has **developed a blockchain-based smart procurement tool** which enables procurers to publish a request for quotations and vendors to submit their offers.

The smart component tool consists of:

- **A user interface -** via which the procurer publishes the request for quotations and the vendor submits its offer. User authentication is enabled via the CRM solution;
- **Customer Relationship Management (CRM) solution –** enabling user authentication (for potential suppliers);
- **Blockchain component** – the submitted request and offers are added to the blockchain, providing guarantees that the documents have not been tampered with.

Figure 42: Components of the smart procurement tool



In more detail, the process by which requests for quotation are published, offers are submitted, and the contract is awarded is as follows:

1. The procurer publishes a request for quotation via the user interface;
2. A smart contract with this request is uploaded on the blockchain;
3. Vendors submit their offers via the user interface;
4. The offers are uploaded to the blockchain;
5. The procurer closes the process;
6. The procurer assesses the offers and awards a contract;
7. A trigger is sent to the smart contract which generates an event recording the result;

8. The procurer enters the result of the award in the Digipolis CRM system, which automatically sends award and non-award letters to the respective vendors by email.

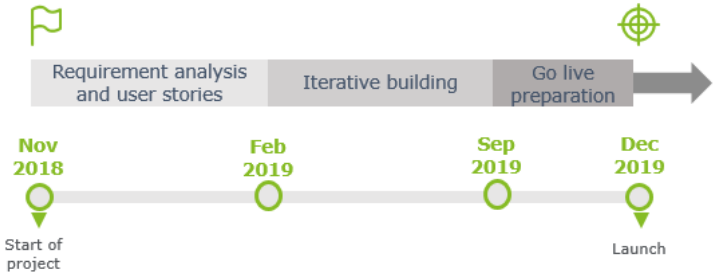
The **smart procurement tool has been designed with both blockchain-based and non-blockchain-based components**. This has been done **to ensure compliance with public procurement rules**. Vendors do not directly write their offers onto the blockchain, but instead submit their offers to a Digipolis file server. Only metadata, including a time stamp is added to the blockchain. The lack of direct access to the blockchain on the side of the vendor is done to prevent them from seeing whether (and how many) other vendors are submitting offers. In accordance with public procurement law, the final outcome of the procurement (contract award) is revealed to the vendors once the procedure is completed.

The use of blockchain as one of the technological components of the solution adds a level of reliability to the tool. The documents submitted by both the procurer and the vendor are added to the blockchain together with time stamps, providing assurances that they have not been tampered with from this point on.

Ethereum is the blockchain technology used, and the application created is a **private, permissioned** blockchain (i.e. only a limited number of users are able to write or read the data on the blockchain). The choice for this particular technology makes it possible to switch to the public Ethereum chain in the future, if and when relevant. The blockchain operates using **proof of authority** to validate the data that is added. At this point there are only **two nodes** to the blockchain, and both are **hosted by Digipolis**. Digipolis is currently talking with the Belgian federal government to see if they will host an additional node. A blockchain with more nodes expands the value proposition of using blockchain technology: there is increased trust, as nodes are no longer hosted by one partner; increased transparency; increased vigilance; and increased security and availability (elimination of a single-point-of-failure).

The smart procurement tool was developed over the course of a year, proceeding through phases of requirement analysis and user stories; iterative building; and go live preparation, according to the timeline outlined below.

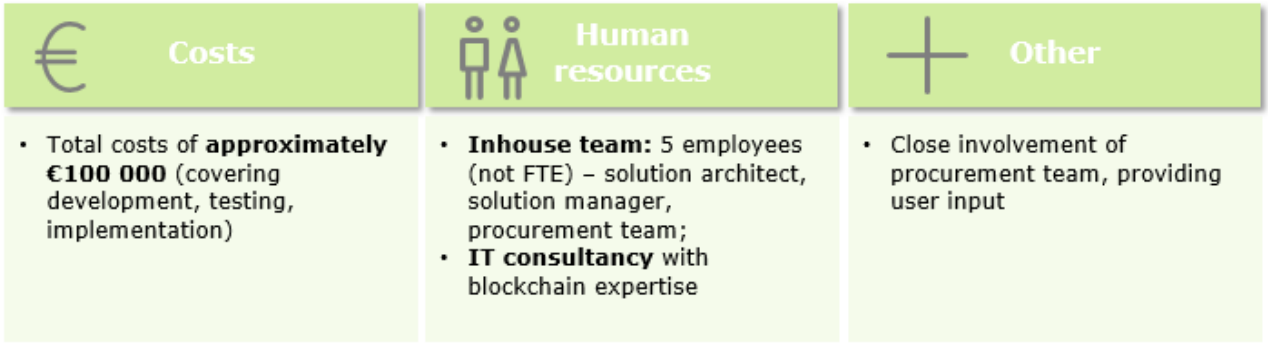
Figure 43: Timeline for smart procurement tool project



Results and future expectations

The smart procurement tool is **due to go live in January 2020.** As yet, there are therefore no results to report on. In terms of future developments, the Digipolis team would like to explore how other public organisations could benefit from this project, either by extending the tool so that other organisations are able to publish their own requests for tender on the blockchain, or by enabling them to set up their own blockchain. In addition, the Digipolis team will look into adding additional nodes to the blockchain hosted by other organisations in order to increase the level of transparency and security.

Costs and requirements



The smart procurement tool was **provided for a total cost of approximately €100 000** covering the development, testing and implementation of the tool. The project did not necessitate any additional spending in terms of infrastructure or hardware (e.g. servers for the blockchain to run on).

The project was delivered by a **Digipolis team of 5 people** (not full time) **supported by an IT contractor with blockchain expertise**. The profiles in the Digipolis team consisted of a solution architect, solution manager, and experts from the procurement department (who are the end users of the solution). From BallistiX.digital, a mix of different profiles contributed to the project including front-end developers, back-end developers and designers.

The other requirements for the project were fairly limited. However the close involvement of the procurement department from the start was a key factor for the successful development of the solution, ensuring it was well tailored to user needs.

Risk and mitigation

The overall risks for the project were viewed by Digipolis as quite limited, and the team was confident that it could drive it to a successful conclusion. That said, there were **some risks associated with the use of a new technology that the in-house team did not have experience with**. This risks were reduced however due to the relatively small, exploratory nature of the project. In addition, the team had the fallback solution of the federal eProcurement portal, the solution they were previously using, if the smart procurement tool project did not turn out to be a success.

Challenges and lessons learnt

Overall, the project was **relatively straightforward in a technical sense**, and one that could be easily implemented by many other public authorities around Europe. A key lesson of the project could therefore be that public authorities should not be put off by the unfamiliarity of emerging technologies such as blockchain. In at least some cases these technologies can be easily implemented. An important success factor when making use of these technologies remains that **user input is properly gathered to ensure that the tool is properly tailored to their needs**.

Case study 13: Blockchain-based Proposal Evaluation System

Lead Organisation: Yeongdeungpo-gu District Office; Glosfer

Location: Republic of Korea

Technologies: Blockchain

Level of government: Local

Problem Statement: Yeongdeungpo-gu District Office had a largely paper-based tendering system. As a consequence the Office's tendering processes were not transparent and not seen as trustworthy by other stakeholders. In particular, the evaluation of vendors' bids for public contracts was often contested by losing vendors.

Description: Yeongdeungpo-gu District Office set up a digital tendering platform coupled with a blockchain record on which to store individual scores by members of the evaluation committee for vendor bids for public contracts. These evaluation scores are initially stored on an internal database that serves the digital tendering platform, and then transmitted and stored together with a time stamp on the private blockchain, which is based on proprietary Hycon technology. Participating vendors and other authorised stakeholders in the blockchain network are able to view these scores using a web or mobile app.

Lessons learnt: Blockchain can be successfully integrated with other digital technologies to guarantee the transparency and auditability of evaluation procedures. The main challenges associated with this relate to people, rather than being technical – it is necessary to overcome resistance to the use of blockchain technology.

Cost: €115 000 (151,000,000 KRW)

Impact: Mid-range. System used 30 times a year; Increased transparency and auditability of evaluation procedures.

Future expectations: Going forward, the Office intends to continue its use of blockchain technology, It has awarded Glosfer the 2nd phase of the project, focused on measuring and recording the performance of employees.

Human resources: 4 consultants over 3 months (1 project manager; 1 system architect, 2 developers)

Risks: Privacy of the data and security of the system. Korean legislation establishes strict rules on what data can be made public by the government.

Other requirements: Support from internal stakeholders regarding the use of blockchain.

Project timeline: July - October 2018

Project status: Fully deployed

Email: bogyu@glosfer.com

Website: https://www.ydp.go.kr/english/main.do

Context and problem statement

Yeongdeungpo-gu District Office is a municipality authority located in Seoul City, Republic of Korea. It has an internal procurement office, which ensures the local government can access the goods and services it requires to carry out its duties as a local authority.

The **procurement processes in place, however, are largely paper-based**. This is the case for the **evaluation of tenders from vendors** for public contracts with the Office. For this process, members are appointed to an evaluation committee, and each member must individually evaluate the vendor offers for the contract. These individual evaluations are then entered in an excel file and stored within the Office's IT environment.

Under this process, **these individual evaluation scores were not made transparent** and there was little evidence that the proper processes were followed for any particular evaluation. There was no way of demonstrating that each responsible evaluation committee member had awarded a particular score to each vendor at a certain point of the evaluation process, and that the contract was finally awarded on the basis of these individual evaluations. As a result, the **Office's decisions to award contracts to particular vendors were often contested by the losing competitors**. The existing process was not considered to be either transparent or trustworthy.

Objectives and vision

Yeongdeungpo-gu District Office's **objectives were to create a transparent and trustworthy system for the evaluation of public tenders**, thereby also reducing concerns and disapprovals by losing vendors. It aimed to ensure that the results of the evaluation could be made transparent to participating companies, auditors, and internal stakeholders, in a way that showed that they had not been tampered with.

In order to achieve this, the Office's **vision was to digitalise the evaluation process, drawing on blockchain technology to record the results of the individual evaluations**.

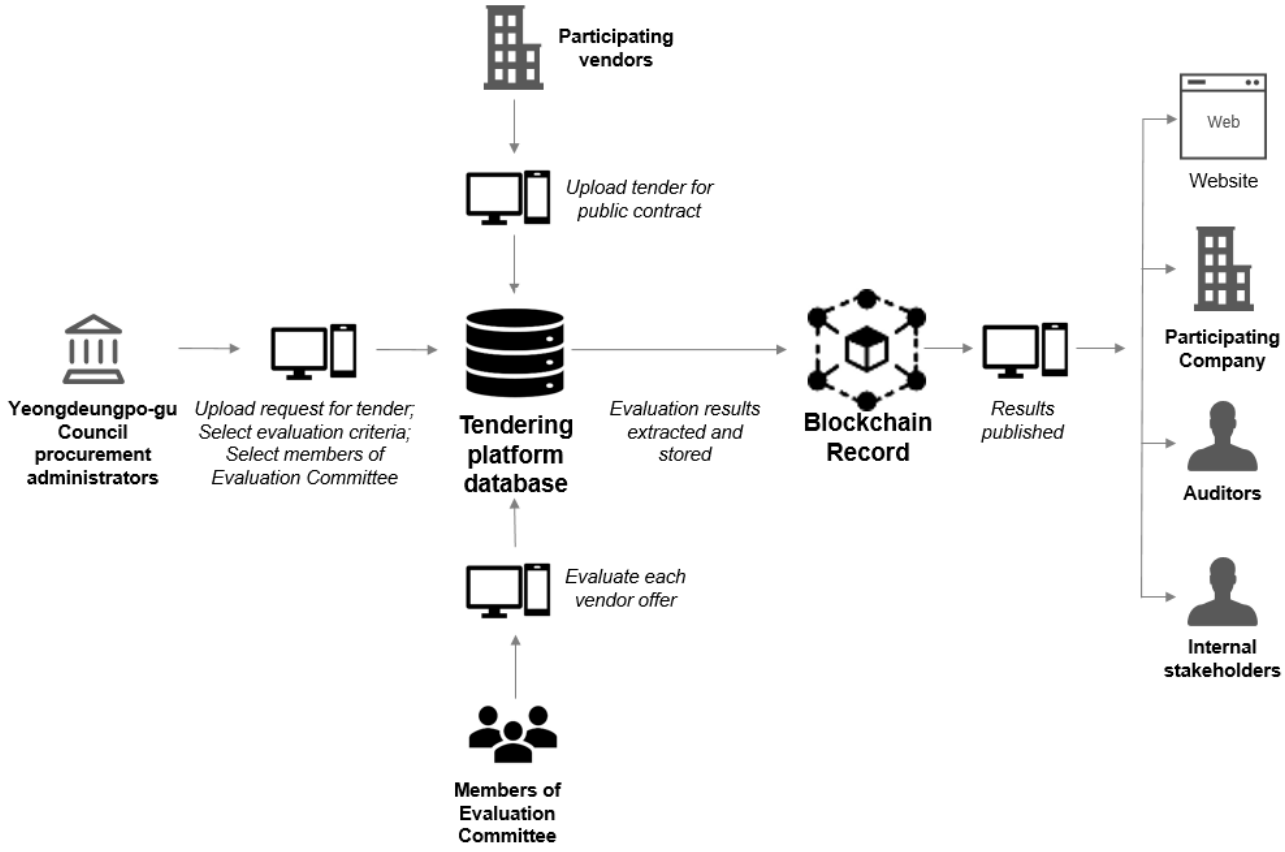
Technological solution and implementation

In order to implement this vision, the Office resolved to digitalise the main steps of the tendering process, including the evaluation of vendor bids by members of the evaluation committee. It procured a solution with the following primary components:

- **Tendering platform –** This **provides functionality to cover the main steps of the tendering process**. It provides a platform for the Office to post its requests for tender and receive offers from vendors. In addition, **on this platform, members of the evaluation committee can score the bids** from different vendors. The platform is accessed via a web or mobile application. All related documents are stored in an internal database. The following functionality is enabled:
    - Upload by the Office of new requests for tender
    - Selection by Office procurement administrators of evaluation criteria for the tender
    - Selection by Office procurement administrators of the members of the Evaluation Committee
    - Upload by the vendor of their tender along with supporting documentation
    - Evaluation by the members of the Evaluation Committee of each vendor offer.
    - Publication by the Office of the decision of the tender
- **Blockchain record –** The **evaluation scores from each member of the evaluation** committee are transmitted from the tendering platform database, encrypted, and **stored on a private blockchain with a time stamp**. Other authorised stakeholders – the participating companies, auditors, internal stakeholders - are able to access this blockchain online.

This system is depicted below:

Figure 44: Tendering platform and blockchain record



The **blockchain solution used is private and hosted within the municipality IT system**. It is based on **proprietary blockchain technology** known as Hycon – which is developed by Glosfer, similar to hyperledger or ethereum solutions, but adapted to prioritise speed. The data stored on the blockchain is the score given to the vendor by the evaluator together with a time stamp of when this score was awarded.

This **data is saved directly from the tendering platform database** after it has been entered by the evaluator via the web or mobile application. Other personal data, such as the name of the evaluator and the name of the vendor contact are not stored on the blockchain but instead remain off-chain on the database within the Office's IT environment. Participating vendors and other authorised stakeholders are provided with a username and password via with which they can use mobile or web application to view the data on the blockchain.

Development of the solution

Yeongdeungpo-gu Office **outsourced the development of the tendering platform and blockchain record** to a Korean IT company, Glosfer, specialised in blockchain. The system was developed over a **three month period between July and October 2018**. This three month period can be broken down into the following three phases:

- July – August (1 month): Design of the solution
- August – September (1 month): Development of applications
- September – October (1 month): Testing of solution

Once the system was operational, the Glosfer project team also provided trainings on how to use the system and its applications.

Results and future expectations

The tendering platform and blockchain record is **used roughly 30 times a year** and is operating smoothly. **It has improved the transparency and ability to audit the evaluation process for tenders** as well as providing increased convenience for members of evaluation committees, who are now able to evaluate tenders via web or mobile app. The effectiveness of the solution in increasing transparency and reducing potential corruption was recognised by the Seoul Metropolitan Government's Audit Committee, which named it as the **winner of its "2018 Contest for Best Anti-Corruption Practice**".

Going forward, the Office intends to continue its use of blockchain technology, awarding Glosfer the 2nd phase of the project, focused on measuring and recording the performance of employees.

Costs and requirements

Costs	Human resources	Other

• **€115 000** (151,000,000 KRW), split between:
  • Planning – €19 000 (25,000,000 KRW)
  • Design and publishing – €19 000 (25,000,000 KRW)
  • Development - €77 000 (101,000,000 KRW)
	• IT Contractor: 4 person team:
	  • Project manager
	  • System architect
	  • 2 developers
		• Compliance with development and security guidelines established by Korean eGovernment framework

The total cost of the project has amounted to **151,000,000 KRW** (€115 000). This is divided across the following components:

- Planning - 25,000,000 KRW (€19 000)
- Design and publishing - 25,000,000 KRW (€19 000)
- Development - 101,000,000 KRW (€77 000)

A **four person team from Glosfer** worked on the project for its 3 month duration, consisting of the following profiles:

- 1 project manager
- 1 system architect
- 2 developers

The development team also had to meet certain **requirements established by the Korean eGovernment framework**. These requirements include a range of development and security guidelines that 3rd parties have to comply with, which put some restrictions on the types of technology that can be used.

Another general requirement was **to gain support from internal stakeholders in the Office regarding the use of blockchain**. In many cases, government officials associate blockchain with bitcoin and have a negative stance towards it. It was necessary to overcome the resistance to the use of this technology.

Risk and mitigation

One of the main risks of the project related to **privacy and security** concerns given the sensitive nature of the data. South Korean legislation establishes strict rules about the type of data that the government can make publicly available. In order to comply with this it was necessary to save certain types of (personal) data off the blockchain. For the same reason, the blockchain solution provided is private and hosted within the municipality's IT environment. In order to ensure compliance with these various regulations and minimize the risks associated with the project, the **Office established a consultative group of experts** with a close knowledge of the eGovernment and other regulations.

At the beginning of the project, another risk was considered to be that the security features of the municipality system might hinder the proper integration of the tendering platform and blockchain record. When implemented, however, this risk did not materialise and the integration was successfully implemented

Challenges and lessons learnt

The project has demonstrated that **blockchain can be successfully integrated with other digital technologies** to provide a digital tendering solution that guarantees the transparency and auditability of the evaluation processes followed to award public contracts. The **main challenge** associated with the project was not technical but instead involved **overcoming legal regulations regarding blockchain technology** as well as negative attitudes towards blockchain. Thanks to the successful implementation of the project, some of these negative attitudes were overcome.

Case study 14: Blockchain HackMX

Lead Organisations: National Digital Strategy Coordinator at the President's office in Mexico, State Government of Jalisco, IBM Mexico, University of Guadalajara (UdeG) and C-Minds

Location: Mexico

Technologies: Blockchain

Level of government: Regional

Problem Statement: Public procurement procedures can be prone to corruption. Despite Mexico's progress on the issue, particularly with the adoption of the Open Contracting Standard in 2013 and various regulatory procurement developments, the magnitude of the challenge still requires an urgent understanding of how new technologies, such as blockchain, can be used to make these processes more transparent, efficient and reliable.

Description: The main goal of Blockchain HACKMX is to identify the scope and implications of using blockchain technology in terms of regulations (need for new rules and compliance with existing ones), public policy, technological infrastructure and safety.

The Blockchain HACKMX initiative pursues two objectives:
1. Creation and deployment of the network Blockchain HACKMX;
2. Development of use cases

A number of use-cases have been developed, the most relevant of which, from a public procurement perspective is the one carried out in the State of Jalisco – which is responsible for some centralised purchasing. The proof of concept solution developed stored data from the following internal procurement phases on the blockchain: 1. Request to procure an item; 2. Direction of the request to a procurement specialist; 3. Assignment of procurement specialist; 4. Publication of the contract notice. The proof of concept was developed on Hyperledger Fabric and integrated (in a test environment) with the State's central procurement platform "SEPAF System". The use case tested the use of distributed ledger technology for public procurement processes, creating completely traceable, immutable, transparent and reliable processes.

Lessons learnt: The project implementation demonstrated the importance of collaboration between units and government agencies as well as the benefits of integrating State Gov IT officials, experts from industry (IBM) and University students in a project team to enhance technical capacity. In addition, a good scoping of the strategy for a pilot project is essential to minimise the risk of trying to build use-cases that are too large, too ambitious or have a high probability of failure. A good roadmap has to prioritize the gradual growth of the project, gaining ground phase by phase as the results spring and are communicated.

Cost: No financial investment in the project. The project was resourced through donated time from employees in the organisations involved in the initiative The technical solution was developed and installed on the Government´s infrastructure

Impact: Limited. Only a pilot project. The project helped to develop the blockchain ecosystem in Mexico to promote the design and implementation of use cases using Distributed Ledger Technology (DLT).

Future expectations: It is hoped that the pilot will promote the application of Distributed Ledger Technology (DLT) to public procurement processes. This has the potential to reduce duplication of work by government officials, increase transparency and provide certainty to bidders.

Human resources: 42 professionals involved at different levels of engagement over the course of 9 weeks (equivalent of 8 FTEs).

Risks: Political changes (change in government) during pilot implementation period could reduce the likelihood of scaling the pilot. Privacy risks due to the processing of confidential data.

Other requirements: Political support from the governor's office to integrate a multidisciplinary team of public servants from all areas associated with the procurement process. Commitment from IBM Blockchain Engagement Leader to train University Students on the development of the solution.

Project timeline: Blockchain HackMX April 2017-Nov 2018

Project status: Pilot completed

Email: yolandama@iadb.org; mtrayolanda@gmail.com

Website: https://www.gob.mx/innovamx

Executive summary

The State of Jalisco is a pioneer state in the exploration of the use of new technologies for public innovation. At the end of 2018, the Government of Jalisco, in collaboration with the National Digital Strategy Coordination, industry (IBM, Krieger), the academia (University of Guadalajara) and civil society (C Minds), developed an exercise aimed at identifying the opportunities and limitations of the use of distributed ledger technology (DLT). In particular, practical, technical and regulatory requirements of DLT when applied to the standard public procurement process and procedures were examined.

The collaborators explored the priority areas of the procurement process where DLT could be applied within a very short period of 9 weeks as the pilot had to be undertaken before the end of the government mandate. To determine the scope of the exercise, several challenges were identified in the public procurement process such as:

- Duplication of work and reprocessing as the same information is captured many times for different purposes across the procedure life cycle.
- Delays in the collection of signatures (through a lengthy flow of authorisations, endorsements and approvals) because different administrative units are requested to participate in the process and the communication among them can take weeks.
- Cases of discretion that can provide the opportunity for corruption, since there was no traceability in all activities throughout the process
- Restrictions on changes to bidding documents e.g. the annexes describing the technical specifications, since changes in extensive technical documents were hard to identify
- Bureaucratic processes, conducted by several administrative units who have to comply with their own procedural rules. While these rules do not normally add any value to the process they generate a huge entropy that usually results in lengthy procurement procedures (recurring argument to justify the recourse to less competitive procurement methods;
- Difficulties in the process of reception and evaluation of goods and services quality and conformity (contract performance monitoring) mainly due to the fact of having each procuring entity undertaking such a task relating to their "own supplies" without a common standard quality control system in place

Due to the time limitation (9 weeks), the scope of the assessment of the DTL use was reduced to cover only one of the stages of the whole public procurement process, not the whole. The selected stage was the initial one, which includes the following activities:

- Request for procuring an item - as the procurement process is centralized to leverage demand and negotiate conditions, each administrative unit request items (PO) from the procurement unit
- Direction of the request to a procurement specialist, the procurement unit analyses the good or service and directs the PO to the procurement specialist for the good or service.
- Assignment of procurement specialist, the procurement specialist handles the assignment according to procurement rules for the specific good or service.
- Publication of the contract notice, once the PO complies with all rules related to the good or service terms of service are published.

The **system developed for this exercise was based on IBM Hyperledger Fabric**. In general, the work carried out focused on addressing the logic of transactions, the life cycle of assets (assets) and the management of participating users. The integration with the e-procurement platform was done within a test environment.

Despite the short duration of development phase and the need to move to the production phase in a real environment before strengths and weaknesses can be better assessed, and quantified, the following aspects emerged from the pilot exercise:

- the **importance of intersectoral collaboration**, since the use of technology makes communication easier, faster and cheaper but does not replace the need to divide roles and tasks across organisations, as this division is shaped by legal and policy provisions;
- the **need to promote training** in view of strengthening the skills and preparedness for the use of new technologies within the public sector environment;
- the **strategic importance of creating use cases and experiments** to better assess the added-value that can be expected from the introduction of new technologies and mitigate risks before scaling systems;
- the **importance of focusing on the user's experience** and avoiding digitizing inefficient administrative processes .

This project **confirmed the effectiveness of DLT technologies as a means to improve the public procurement process** and to encourage more efficient public spending. In turn, it provided inputs for the development of other similar use cases, for the escalation of the present and, in general, for the use of DLT technologies in public administration beyond the procurement area. The lessons learnt from this use case will serve to encourage, inform and strengthen the exploration of the potential of new technologies to improve public management in Mexico and elsewhere since the shortcomings it wants to tackle are common to many countries and systems.

Context and problem statement

Public procurement procedures are the means by which governments provide services, products and public infrastructure to citizens. Government expenditure on public procurement contracts represents 29%[146] of total government spending. This activity represents one of the main economic activities of government and a fundamental element in the execution of public spending[147]. However, the Open Contract Partnership states that public procurement procedures are the most prone to corruption.

According to an OECD study[148], 57% of bribes were paid in the context of public procurement to get public contracts awarded. Some studies[149] show that in Mexico direct awarding – a non-competitive procurement method – is used in 74% of the procedures whereas, the request for quotations from 3 suppliers is used in 7% of the cases and only 18% of the contracts are formed following a public tendering procedure which is, in the law, prescribed as the default method.

Despite Mexico's progress on the issue, particularly with the adoption of the Open Contracting Standard in 2013 and various regulatory procurement developments, the magnitude of the challenge i.e. two-thirds of contracting is done through direct awarding, **requires an urgent understanding of how new technologies, such as blockchain, can be used to make these processes more transparent, efficient and reliable**.

Mexico was experiencing a political transition at the end of 2018 (in Nov 2018 the 6 year Presidential term ended, and in December 2018 the Jalisco State Government term ended). This provided a strategic opportunity as the incumbent was politicaly receptive at the end of their term to testing the use of DLT / blockchain technologies for public services through a proof of concept in the State of Jalisco.

The use of DLTs for government processes in Jalisco was also foreseen in the regulatory framework that emerged from the publication of the Law and the Procurement Regulations, which favors data standardisation and establishes a centralised management of the State e-procurement platform. Additionally, the

[146] OECD Preventing Corruption in Public Procurement (2016) http://www.oecd.org/gov/ethics/Corruption-Public-Procurement-Brochure.pdf
[147] As established by the Network for Accountability
[148] OECD Foreign Bribery Report (2014), http://dx.doi.org/10.1787/9789264226616-en
[149] https://mundo.sputniknews.com/america-latina/201903291086375545-corrupcion-obras-publicas-mexico/

Government of Jalisco had already adopted the Open Contracting Standard which ensures a process of data standardization and facilitates the integration of systems through the Application Programming Interfaces (APIs).

Objectives and vision

The project aimed to build a DLT case in the area of public procurement, test it and pave the way for a later adoption by the next leadership team at the State Government.

The main objective was to **create completely traceable, immutable, transparent and reliable processes**. An additional objectives included **reducing duplication of work** by government officials

The project aimed to build a **better understanding of the benefits and risks** associated with using DLTs on public procurement, and contribute to the assessment of whether the application of DLTs in public procurement processes would necessitate for **changes in the e-procurement regulatory framework**.

Technological solution and implementation

Scope

The **project was structured into three stages**, consisting of:

- acquiring political support at the highest level and running a pilot at both the President and Governor Offices;
- Technical development;
- Consolidation and testing of solution.

Figure 45: Stages of the project

First stage	Second stage	Third stage
▪ Approach to Jalisco Government to confirm the interest and capacity of undertaking this use case. Their positive reaction was followed by defining the scope of the project and forge alliances. The critical path of the project was co-designed by all Partners. ▪ Setup of a Team of voluntary developers (graduate students of the UdeG working on a *pro bono* regime who have shown interest in learning DLT programming). A kick-off session and several training sessions were carried out by IBM on Hyperledger, and by the Secretariat of Planning, Administration and Finance (SEPAF), to explain the public procurement procedure and the e-procurement platform architecture. ▪ The Ministry of Innovation, Science and Technology (SICyT), National Digital Strategy Coordination (CEDN), C-Minds and Krieger accompanied the process.	▪ Technical development by the UdeG with mentoring from IBM and advice on public procurement related matters by SEPAF. ▪ Project management facilitation by C Minds and strategic direction by CEDN, SICyT and C Minds/Krieger.	▪ The necessary developments were consolidated, and the APIs were activated. ▪ Solution tests were conducted in a controlled environment and results were presented to the working group and key stakeholders. ▪ A presentation of the use case was held as part of the annual retreat of the National Digital Strategy Coordination in 28th Nov 2018. The event was important because it coincided with the final stage of the presidential term in which all initiatives supported by the CEDN were shared with the public presented their impact and results.

Implementation

The technological solution was developed according to the concept and design that emerged from the user needs research and assessment. Design workshops were carried out with experts from the procurement office, internal control unit, and suppliers. Based on this the following procurement tasks were focussed on:

- request for procuring an item,
- direction of the request to a procurement specialist,
- assignment of procurement specialist and
- publication of the contract notice.

The proof of concept software was developed with IBM Hyperledger Fabric, using the Composer Playground development environment with the intention of simplifying programming and concentrating efforts in the implementation of the business logic necessary for the blockchain network to be integrated into Jalisco government e-procurement platform. In general, the work carried out focused on implementing the transaction logic, the life cycle of the procurement request and the management of the participating users.

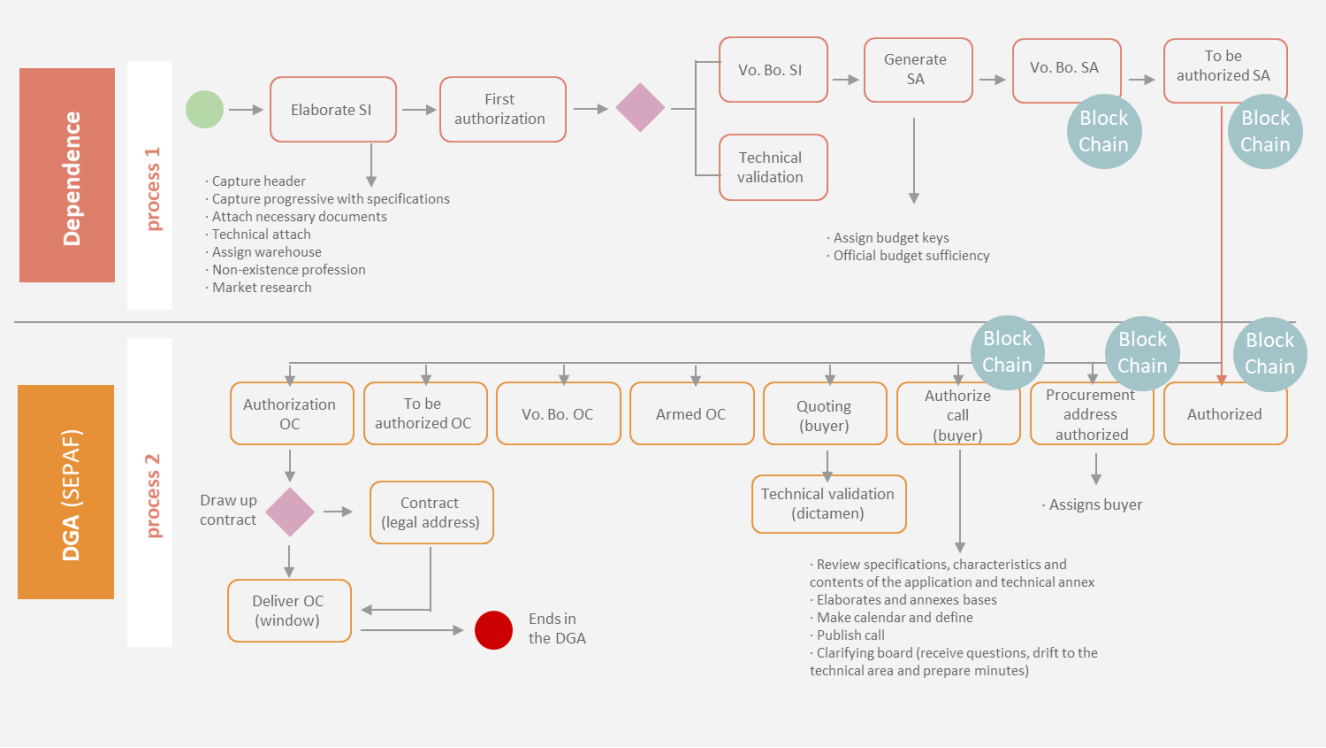
The work was carried out in three phases:

- **Designing the system architecture** - implementing the operating logic of the platform;
- **Interconnecting the systems** - Generating an API to integrate the solution into the purchasing system of the Jalisco government;
- **Storing the system on the cloud** - the deployment on a Hyperledger Fabric network in the cloud.

Phase 1: designing the system architecture

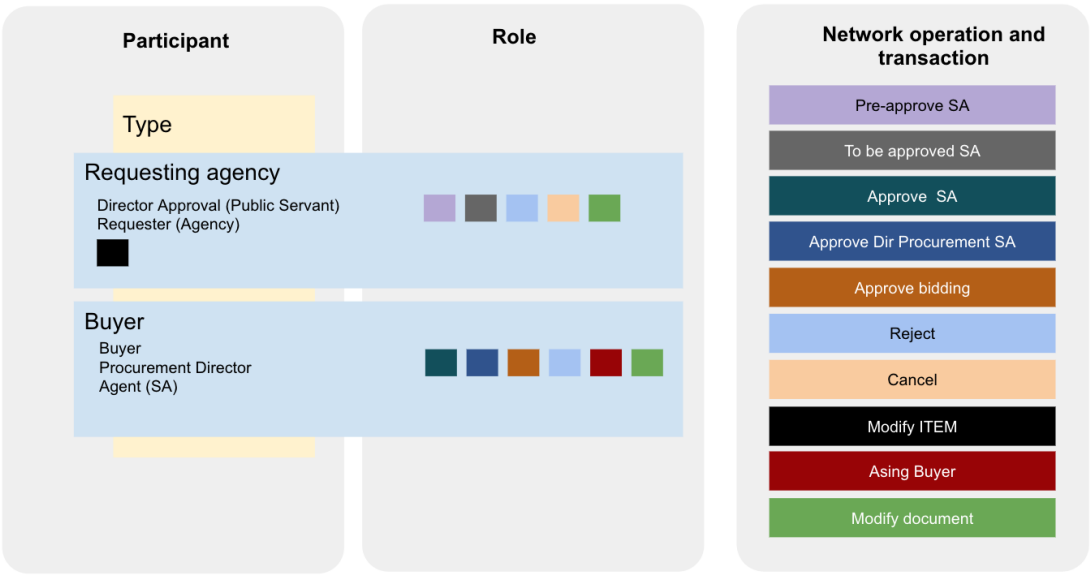
Based on the procurement tasks that had been selected, SEPAF designed a map and flow of the process that allowed identifying the points of interaction with the purchasing system and subsequently designing a data model, a system of roles / permits and the functionalities that would integrate the smart contracts that would be built on Hyperledger.

Figure 46: Process flow



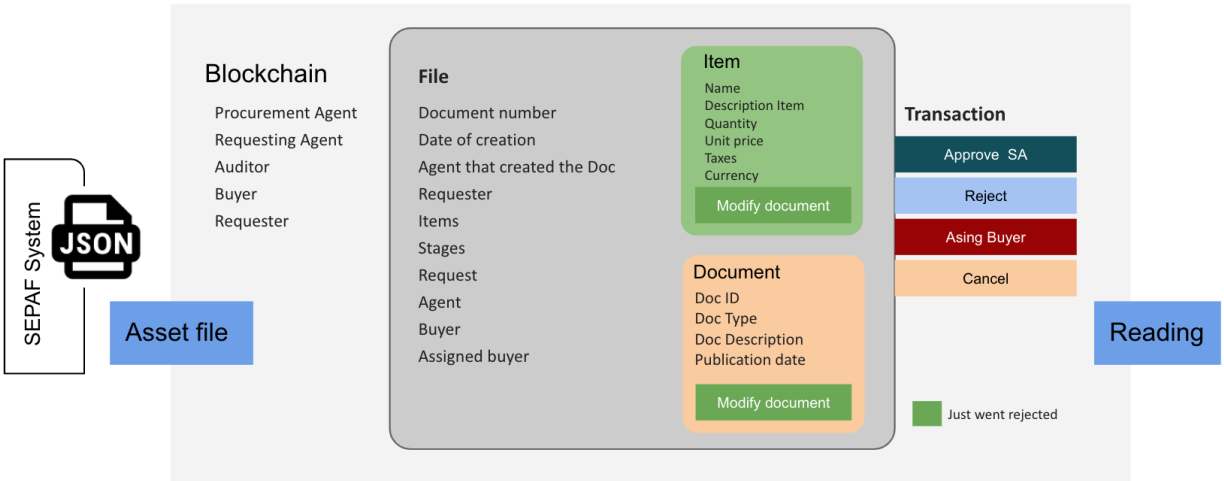
Subsequently, transactions and participants in the smart contract (protocol intended to digitally facilitate, verify, or enforce the negotiation or performance of a contract) were determined; thus having the roles of the Agency requesting a good/service, procurement specialist and auditor, which have permissions based on rules aligned to the public procurement procedure. Among the possible actions to be executed are: approve, authorize, reject, cancel, modify a document or assign procurement specialist (buyer) (Figure 47).

Figure 47: Operations implemented in the smart contract



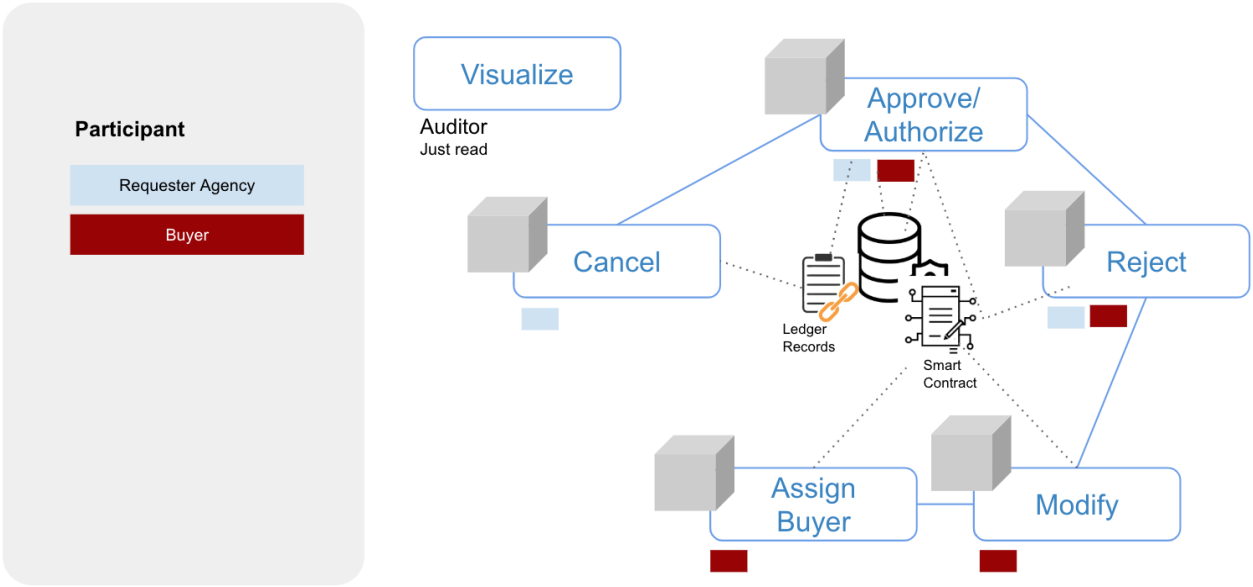
Likewise, one of the main elements was the design of the asset and its life cycle, which in this project was the Bidding Process File that contains fields related to the four phases of the tender and which transactions or operations are added on the basis of the activity of the dependencies and buyers. The fields that the asset stores include the buyer's information, the planning stage for each related document and the bidding stage (Figure 48). The type of variable and the name it receives were taken from the structure defined by the Open Contracting APIs exposed by the SEPAF system.

Figure 48: File/Document



Once the participants and assets were determined, business rules were created that determine which roles have permissions for certain actions and in what part of the asset's life cycle, allowing transaction logs to be stored in the distributed database (Figure 49). These features ensure that each node in the network has its own updated transaction log, maintaining the complete detail of each one and reducing fraud opportunities.

Figure 49: Roles and permissions



Phase 2: interconnecting the systems

Following the completion of the implementation of the operational logic of the network and the smart contract, an API was generated that allowed the integration between the SEPAF purchasing system and the Hyperledger Fabric network. This RESTful API (JSON format) was generated using the Composer Playground tools which allows the communication of transactions as soon as they happen in the purchasing system to the smart contract in the distributed network.

It is important to mention that the API includes encrypted communication through the use of certificates (generated by a certificate authority that lives within the Hyperledger network). In addition, it has an architecture that avoids direct contact between the systems; that is, there is an API in the Hyperledger network which connects solely to a local API mounted on a virtual machine on the infrastructure of the purchasing system (with which the SEPAF software interacts). This increases communication security and allows SEPAF to communicate with the API within its own firewall.

Phase 3: Storing the system in the cloud

Finally, all the components of this software (the smart contract and the data of the stored transactions) are stored on a Kubernetes cluster in the IBM cloud. This distributed network contains all the necessary infrastructure, protocols and software so that Hyperledger Fabric can give this software the expected blockchain capabilities.

Results and future expectations

The project **helped to develop the blockchain ecosystem** in Mexico to promote the design and implementation of use cases using Distributed Ledger Technology (DLT) in the field of public procurement. It is hoped that the application of DLT to public procurement process will reduce duplication of work by government officials, increase transparency and provide certainty to bidders.

Costs and requirements

There was no financial investment in the project, with the involved organisations instead providing resources to the project by staffing it for its 9 week duration. In total 42 FTEs were involved in the project over these 9 weeks. The technical solution was developed and installed on the Government´s existing infrastructure, and there were therefore no additional costs associated with this.

Risk and mitigation

A short assessment identified two potential areas of risk which should be taken into account and investigated in more depth in the next steps of the project implementation: privacy and confidentiality of information, and cyber-security.

The **privacy and confidentiality risks** are mainly related to improper processing of personal data and unwanted disclosure of confidential information. Mitigation measures may include the enforcement of laws and regulations on the protection of personal data, the introduction in the solution of all available tools and techniques designed to assure privacy, the training on proper processing of personal data and confidential information in accordance with the existing legal framework and good practices as well as the adoption of confidentiality agreements with all parties involved.

Cybersecurity risks were also considered in the project risk assessment. DLT technology is linked to reduced security risks due to its decentralised nature, which means information is not stored all in one place. The use of a distributed (decentralised) base reduces the risk of information loss over the entire platform. Nevertheless, the occurrence of cyber-attacks has been considered in the risk assessment and the use of a public-private blockchain, coupled with the adoption of an information security policy that includes prevention and attention to incidents, could be mitigation measures to adopt.

Challenges and lessons learnt

The project developed a proof of concept that allowed to validate the feasibility of this solution and show in a tangible way that a high level of quality and reliability was possible. However, there are still a number of implications and pending issues that need to be sorted as the application approaches the production stage.

Test environment and simulated data

The integration with the purchasing system, including the e-bidding platform, was made within a test environment and used simulated data, so a more extensive process of testing and quality assurance will be required before the implementation in a real case. The project focused on the construction of the smart contract and its satellite components, leaving aside other interface and user interaction components like the functionality and permission rules to enable a sound and efficient access of Auditors. Such a role is not yet served by a dedicated feature/tool allowing for a full and direct consultation of the information available in the network and validation of the transactions made and the information contained in the blockchain.

Transactions recorded in the smart contract

Ideally, each user who participates and interacts with the transactions that are recorded in the smart contract should have a certificate that allows them to prove their identity and sign transactions. Due to time

constraints (3 months before the end of the government term) this functionality has not been made available and all operations had to be signed via the back-end of the e-procurement platform. The project was simplified by using Composer Playground as a primary development tool, so there is still potential for performance improvement and personalisation of the functionalities of the smart contract, the network, the consensus method, among other features of the software.

The importance of Intersectoral Collaboration
This exercise could not have been achieved without the efforts of all the organizations involved, from the national government (CEDN), local government (SEPAF, SICyT), industry (IBM, Krieger), academia (UdeG) and innovation laboratories (C Minds). The potential and scope of intersectoral collaboration and inclusive public innovation experiences, should not be underestimated in ventures of this type.

Creation of talent and training
One of the main challenges to achieve a more general adoption of new technologies is the lack of talent with knowledge and experience in the field. It is important to involve the academy and train specialised talent on collaborating with technology experts. Beyond that, it becomes a priority to start training public servants on new technology issues and their potential impact as early as possible in the project life cycle. The interaction and collaboration between academy and industry experts will help lead and organise the project resources in a results-driven manner to achieve a high-quality final product, fit for solving the identified problem or need and able to deliver the expected tangible results.

Explore the Potential of New Technologies
This exercise demonstrates the importance of beginning to explore the potential of new technologies, such as Blockchain and Distributed Ledgers, to solve challenges identified as priorities at local and national levels, as long as these types of technologies demonstrate that they solve a clearly identified problem more efficiently than other existing technologies.

Generation of Use Cases
It also becomes important to document and share with the public the information generated by the project, and as many similar projects as possible, so that the ecosystem of public innovation and technology can progress in symbiosis and not in isolation.

Scope and Design
In addition, a good design strategy for a case study is essential to minimize the risk of trying to build use cases that are too large, too ambitious or have a high probability of failure. A good route plan prioritizes the gradual growth of the project, gaining ground phase by phase as the results spring and are communicated.

Case study 15: Blockchain Feasibility Study

Lead Organisation: Ministry of Internal Affairs and Communications (MIC)

Location: Japan

Technologies: Blockchain

Level of government: National

Problem Statement: In order to do business with any Japanese public organisation, a supplier must first be evaluated as "qualified" by the contracting authority. To do this, the supplier must submit a qualification application together with supporting documentation. Potential suppliers currently have to repeatedly provide this information to different public organisations. This is a waste of time for both companies and tendering organisations, which must each validate the documentation submitted.

Description: MIC assessed the suitability of blockchain technology to support a single data source on which supporting documents submitted by companies for qualification were stored together with the results of past qualification procedures. This solution piloted included a data publishing solution – on which these documents and information were stored, together with a hyperledger fabric blockchain – on which this data was tagged – providing assurances that it has not been tampered with.

Lessons learnt: Blockchain solutions can be developed to facilitate sharing of procurement data between public organisations. However these solutions may not be cost-effective compared to legacy or alternative technological solutions.

Cost: €1.33 million (160 million yen), split between €330 000 (40 million yen) in 2017; and €1 million (120 million yen) in 2018.

Impact: Limited. Pilot solution not implemented due to a lack of cost effectiveness; increase of understanding of the capabilities of blockchain and the use-cases for which it is and is not effective.

Future expectations: Based on its cost-benefit analysis of the blockchain solution, MIC has decided not to invest in developing the project further.

Human resources: Consortium led by NTT Data and Mitsubishi Research Institute, and supported by academic experts.

Risks: The lack of operational examples of large-scale blockchain systems leads to a low level of certainty over the development and scaling of the project.

Other requirements: Supplier qualification application and supporting documentation submitted in digital form.

Project timeline: 2017-2018

Project status: Pilot project completed

Email: kyotsu-id@ml.soumu.go.jp

Website: http://www.soumu.go.jp/english/

Context and problem statement

The **Ministry of Internal Affairs and Communications (MIC)** provides support to public administrations attempting to modernise and digitise their administrative procedures and their interactions with citizens. In addition, it provides shared systems including networks and portals to other ministries. Within MIC, the Information and Communications Bureau is responsible for planning and preparing a comprehensive ICT strategy and promoting ICT utilisation.

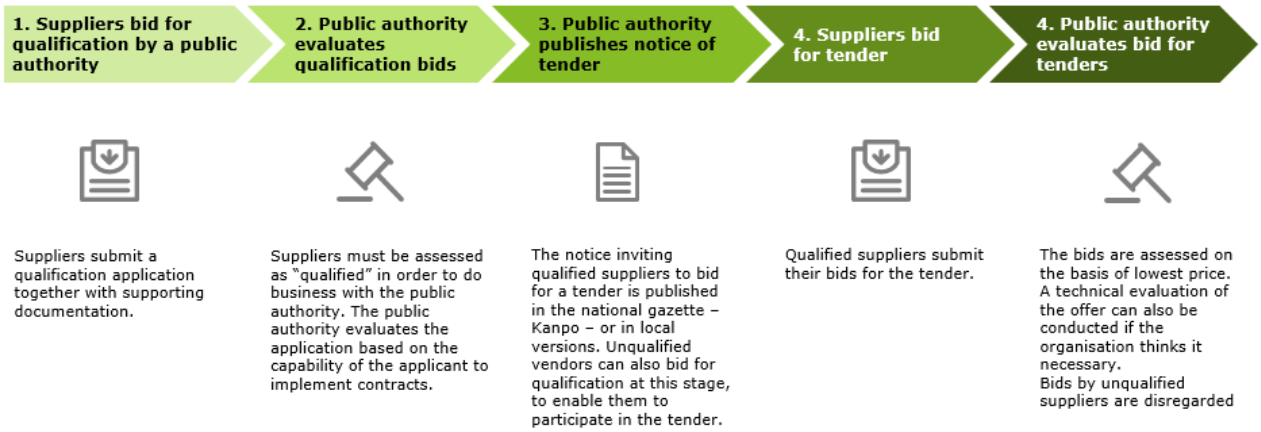
The **Information and Communications Bureau** analyses and explores different technologies that could support more effective shared IT systems for Japanese administrations. Blockchain is one of the technologies that it is interested in, and it has established a **Blockchain Utilisation Working Group**, including academic experts, in order to explore the technology's potential.

The working group believes that blockchain, among other areas, may have **potential in procurement**, by facilitating the sharing of information between different public organisations. Japan currently has a fragmented public procurement system, within which information is not easily nor automatically shared between different organisations. This results in public entities repeatedly collecting the same information from economic operators in different procurement processes and phases. The **business qualification phase** is one example where the sharing and re-use of data would lead to significant efficiency gains.

Similarly to European systems, Japanese public authorities can follow two main types of procedures in order to procure goods and services: the open or the selective tendering procedure. However, an economic operator must first be qualified by the contracting organisation to be eligible for any tender. In practice, this means that the **company is evaluated on whether it has sufficient competences and experience to provide high quality goods and services**. In order to receive its qualification, the company must submit a series of documents providing evidence of such professional and technical capacities. Although the documents required may differ between public organisations and tenders (e.g. depending on the topic), these typically include a company identification certificate, historical records of the company, financial statements and a tax payment certificate.

Under the open – and most common – procedure, an invitation to bid for a tender is extended to all qualified suppliers. The resulting bids are generally evaluated against the criteria of lowest price (although a technical evaluation can also be included if necessary). The preceding qualification of suppliers is therefore performed to ensure that all companies bidding have sufficient competences to implement the contract. The steps according to which the qualification of suppliers and the open procurement procedure are carried out are summarised in Figure 50 below.

Figure 50: Supplier qualification and open procurement procedure



Currently, there is **no central system allowing different public bodies from different public entities to access and re-use qualification documents,** nor to see the results of previous qualification procedures[150]. As a consequence, these **are repeatedly submitted by suppliers to different public authorities** that they aim to do business with. The existing system therefore wastes time for both suppliers and public authorities, which have to repeatedly validate these documents.

Objectives and vision

MIC aimed to determine whether blockchain could provide the foundational technology for a **single database in which the results of qualification procedures and related supporting documents could be stored and accessed by public entities across Japan**. It aimed to further assess what type of blockchain technology would be best suited to such an application, and whether overall, a blockchain-based system could reduce the administrative costs associated with public procurement.

MIC's longer term vision is to identify and implement a technological solution that will:

- Facilitate data sharing in the area of procurement across the Japanese public sector;
- Promote more efficient public procurement procedures, saving time and resources for both the public sector and economic operators.

The planned pilot project plays an exploratory role in the context of these broader objectives. The aim is to better understanding capabilities of blockchain, how it can be applied to public procurement, and the strengths and weaknesses of different blockchain technologies.

Technological solution and implementation

A **solution running on hyperledger fabric technology was piloted** in order to explore the effectiveness of blockchain technology for storing and sharing information related to supplier qualification. The selection of hyperledger fabric for the pilot was made following an assessment of three potential blockchain technologies: hyperledger fabric, ethereum, and bitcoin core. Each of these options was evaluated against the main criteria of quality, maintenance/operation, and cost. These criteria together with sub-criteria and factors to take into account when evaluating them were develop in a previous study carried out by the Ministry of Economy, Trade and Industry. Using these criteria, it was judged that hyperledger fabric was the most suitable blockchain solution for this type of use-case.

Under the piloted solution, when a company applies for qualification from a public organisation, the following process is followed:

1. The company submits the qualification application together with supporting documentation to the public administration;
2. The public administration conducts the qualification review and either grants or refuses the qualification of the company. It uploads the results of the qualification and the supporting documentation to a data publishing solution;
3. The uploaded data is tagged on the blockchain.

When the company wants to apply for qualification from another public organisation, the following process is followed:

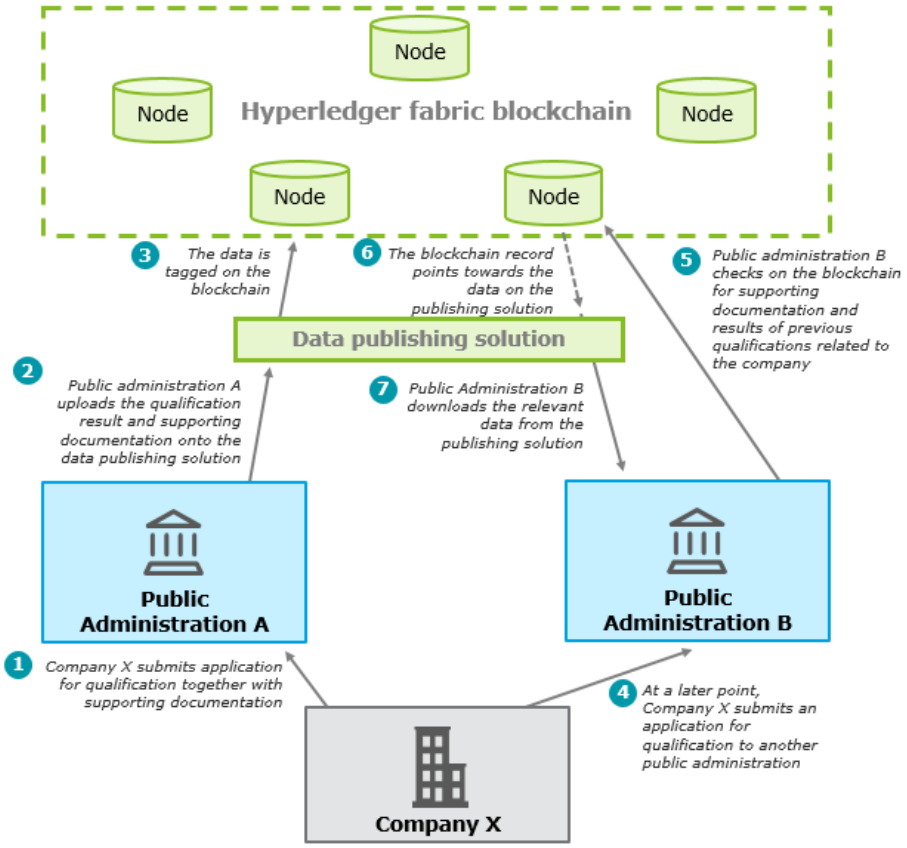
4. The company submits its qualification application;

[150] There is a unified supplier qualification procedure under which participating ministries and agencies at the national level will recognise as qualified any suppliers which have been awarded qualification by other participating organisations. However, this system does not extend to local level authorities and does not involve the sharing of the supporting documentation.

5. The public administration checks on the blockchain whether supporting documentation and previous qualification results are available for the company;
6. The blockchain points towards the data stored on the publishing solution;
7. The public administration downloads the data from the publishing solution and uses it to support its qualification review.

The process is shown in Figure 51 below.

Figure 51: Blockchain solution - business qualification



The **data is not stored directly on the blockchain itself** because the data capacity of the hyperledger fabric solution is low and this would be slow and inefficient. Instead, **the data is published on a separate platform with a tag pointing towards this data stored on the blockchain**. The blockchain solution provides evidence that the data stored on the publishing solution regarding the company was uploaded at a given time and has not been altered or tampered with. If the data has been changed, then the tag stored on the blockchain will no longer match the data. The pilot project also highlighted the need to provide a solution if the data tagged on the blockchain is erroneous. The immutable nature of blockchain means that data cannot just be deleted with the result incorrect information could be stored on the blockchain indefinitely. To resolve this, some sort of updating solution needs to be developed capable of marking data stored at an earlier point as erroneous, and pointing towards new data that is correct. However, this functionality was not developed during the pilot project.

Results and future expectations

The pilot was successfully completed and a demonstration was carried out with dummy data to show that supplier qualification results and related documents could be stored on the blockchain as planned. However, **the pilot has not been taken forward on the grounds of cost-effectiveness**. Although the project revealed potentially large benefits due to increased efficiency of implementing the new blockchain, these

benefits were outweighed by the large implementation and maintenance costs associated with such a system.

It was **estimated that the new system could save public administrations ¥2.7 billion (~€22 million) per year** by facilitating a more efficient qualification procedure in which information is shared. When the benefits to private companies applying for qualification are also accounted for this yearly savings figure reaches ¥32 billion (~€270 million). **However the yearly operating and maintenance costs of a medium sized blockchain system are expected to be from ¥2.9 to ¥4 billion (~€24 – 33 million)**, together with initial set-up costs of ¥2 billion. Given, this the results of the cost-benefit analysis were that the savings generated for public sector administrations were not high enough to justify the high investment required.

Costs and requirements

Costs	Human resources	Other

• Total costs of €1.33 million (¥160 million), split between:
  • €330 000 (¥40 million) in 2017; and
  • €1 million (¥120 million) in 2018.
	• Pilot project implemented by a consortium led by NTT Data and Mitsubishi Research Institute, and supported by academic experts.	• Supplier qualification and supporting documentation submitted in digital format

The **overall cost of the pilot project** assessing the suitability of the blockchain technology for storing and sharing information on qualifications was **¥160 million (€1.33 million).** This was split between ¥40 million (€330 000) in 2017 and ¥120 million in 2018 (€1 million). The project was carried out by a consortium of organisations and academics with expertise in blockchain technology.

The leading consortium members were NTT Data and Mitsubishi Research Institute. A pre-requisite for this blockchain application is the submission of the qualification application and supporting documentation in digital format, allowing it to be stored on the data publishing solution and tagged on the blockchain.

Risk and mitigation

The **risks associated with the pilot were limited** as the solution was developed in order to explore the potential of blockchain technology, was never implemented operationally, and only processed dummy data. A number of **risks were still identified**, however, **regarding scaling the pilot up to a full-scale production model**. The main risk related to **uncertainty about the future performance of any operational blockchain system**. There are very few large-scale blockchain systems in operation making it very difficult to judge this question or draw any relevant comparisons. MIC believed there was considerable risk of performance degradation in a large-scale blockchain system operated over the long-term.

Challenges and lessons learnt

Overall, MIC's pilot project provides a **cautionary note regarding the potential application of blockchain technology to provide a common system to share procurement information**. The results of their experimentation and analysis suggest that for at least some use-cases, **the additional costs of implementing this new system will be too high to justify the benefits to the public sector**.

A number of **technical challenges** are also provided by blockchain in this and similar use-cases. One of these challenges is that as **blockchain technology is not suitable for storing large amounts of data quickly**, it is necessary to provide an additional system on which the bulk of this data can be stored.

Additionally, **blockchain presents a challenge in relation to the immutability of the data stored on it**. Given this quality, it is necessary to find a system to deal with situations in which erroneous data is stored on the blockchain, in order to correct and update this data.

4.6. RPA case studies

The following section presents **four case studies** in which public administrations make use of robotic process automation as a primary technology to transform or improve their public procurement processes and functions:

Case study 16: Purchasing Management Platform

Lead Organisation: Portuguese Institute of Oncology of Lisbon (IPO)

Location: Lisbon, Portugal

Technologies: RPA & blockchain

Level of government: Local

Problem Statement: IPO faces several constraints and bottlenecks, which call for a reengineering of its procurement function. The key challenges IPO faces in procurement management include a high dependency on paper-based processes and a low level of automation, resulting in time wasted on repetitive manual tasks and operations, and a high risk of human error. In addition, it faces challenges in complying with the new Public Contracts Code, with the complexity due to the large numbers of internal and external stakeholders involved in procurement, and difficulties in implementing a proper and timely follow-up and monitoring of the whole process. The current technological solutions in use at IPO are limited in terms of guaranteeing real transparency and effective automation of the whole process.

Description: The Portuguese Institute of Oncology of Lisbon (IPO), with support from everis Portugal s.a., is developing an all-in-one procurement platform that will support all hospital staff involved with procurement. The platform will centralise the entire procurement process in a single solution, from need identification to purchase order issuance and its contractual monitoring, through the use of emerging technologies. The main objective of the project is to simplify the procurement process, increasing its agility and transparency. The platform design covers the legal requirements from the Portuguese Public Contracts Code, helping the key users to comply with its complex rules, obligations and deadlines. The platform is also integrated with relevant external entities, such as Vortal (e-procurement platform), Portuguese Electronic Official Journal (DRE), Official Journal of the European Union (JOUE) and Base.gov (national web portal dedicated to public contracts), allowing for the automatic exchange of information and the speeding up of the entire process.

Blockchain is a foundation technology used to develop the platform – a hyperledger solution is used to store procurement data on a distributed and decentralised network, and ensure transparency. It is used to encrypt and secure the data and automate some procurement tasks through the use of smart contract digital signatures. RPA technology is also used for the automation of procurement task in order to reduce human error and increase process productivity

Lessons learnt: An in-depth financial sustainability analysis should be conducted as soon as possible; Deep knowledge about the organisation and its processes is necessary to make these projects a success. This knowledge must be shared as soon as possible with the stakeholders implementing the project (i.e. contractors/consultants); The basis architecture should be the first technological step, and this should be iterative, to allow an exploration of the best approach towards new and less familiar technological solutions; Detailed knowledge of the Public Contracts Code is also a requirement for success.

Cost: approximately €240.000 (over three years)

Impact: Limited. Project not yet implemented

Future expectations: Some key concrete results that can be expected from the use of the new platform including increased process and business efficiency; improved employee output; increased transparency and reliability; and better overall user experience.

Human resources: External consultants: Proof of concept - 4 FTE, 7 months; Full-

Risks: Confidential information must be processed - mitigated by use of blockchain technology;

scale – 6 FTE, 9 months. Internal project team with business and IT stakeholders.

Some lock-in risk due to proprietary RPA software.

Other requirements: Cloud infrastructure, based on PaaS; knowledge on RPA and Blockchain; Specific business knowledge of the organisation (to enable business process modelling).

Project timeline: Sep 2018 - present

Project status: In development, reaching user acceptance testing

Email: jpedro@ipolisboa.min-saude.pt

Website: http://www.ipolisboa.min-saude.pt/

Context and problem statement

The Portuguese Institute of Oncology (IPO), in Lisbon, is part of the SNS (Portuguese National Health Service). It provides patients with a high standard of integrated care, drawing on a long experience in Oncology. It is one of the most relevant Institutions for oncological treatment in Portugal, following permanently more than 57.000 patients, with 10.000 new patients per year, including 400 children. IPO manages an annual budget of approx. €80 million.

IPO faces several constraints and bottlenecks, which call for a reengineering process of its procurement function. The key challenges IPO faces in procurement management are:

- **High dependency on paper-based processes and a low level of automated processes** within the procurement function, even though e-GP has been generalised in Portugal from the e-notification to the e-award stage since 2008. The purchasing process includes multiple printed documents and circulates around the hospital as needed between internal stakeholders, increasing the risk of losing relevant information and documentation, and making it very difficult to track the process, identify its status and owner, prioritise tasks between procedures and control critical deadlines. Moreover, it means that the whole process flow depends on having at least one FTE dedicated to managing the processes inside the hospital, an employee that could be dedicated to other more valuable tasks. The hospital has 10 FTE working at the procurement department, and with the current paper-based process, this makes it almost impossible to efficiently standardise between processes.

- The **need to comply with the new Public Contracts Code (PCC)**, adopted as a transposition of the EU Directive on Public Procurement (EU/2014/24), makes the procedures complex and more demanding. The PCC has many rules, obligations and deadlines. It is challenging to comply with all of these without a tool which helps the user to monitor and control all the ongoing procedures. The Board of Directors is determined in pursuing a solution that reduces non-compliance with legal requirements to the extent possible since it may entail heavy fines as well as a bad reputation of the hospital and staff.

- **Time spent on repetitive manual tasks and operations**. The same procedure information is required by many activities and forms throughout the process (Example: procurement documents – call for competition, terms of reference, technical specifications, draft contract, - and forms filled in and issued by external entities like Vortal, DRE, JOUE and Base.gov). Moreover, many of the procurement documents are issued based on legally approved templates which enables the automatisation of their filling. Today, procurement specialists have to collect and fill in the same information on each form and document as many times as the same information is required (e.g. item name, internal item code, etc), wasting much time that could be allocated to more valuable work.

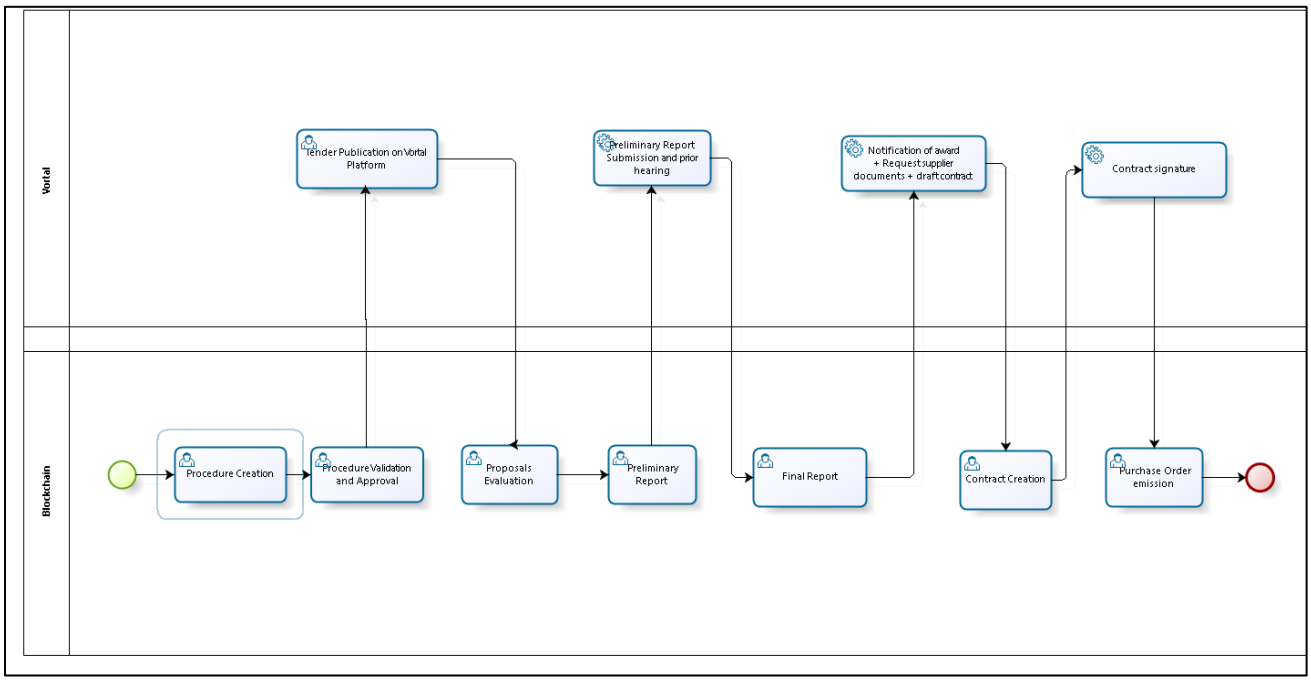
- **High risk of human error** in the choice of the proper procurement procedure and in the filling in of forms through a paper-based process and without any interactive tool that helps the public procurer to check compliance with applicable rules. Examples of rules and guidelines that are prompted to the attention of the procedure manager:
    - Rules regarding the division into lots in contracts above 135.000€ or the choice of economic operators to be invited to participate in direct award procedures;
    - Checklist of procurement documents that must be collected and sent to the Court of Auditors for in prior and post review of the contract.

- **High number of internal and external stakeholders involved in procurement**. The communication between stakeholders inside the hospital is made mainly by email or telephone in a 25-step workflow process. Even in the simplest type of procedure, a lot of different stakeholders with different roles have tasks with different objectives. Additionally, during an external audit and inspection, it is critical to prove that all the prescribed activities and verifications were undertaken. With the current process, it is difficult to track all the needed information in a timely manner. The risk of losing relevant documentation and communication is high, with potentially high costs.

- **Difficulties in implementing a proper and timely follow-up and monitoring of the whole process**, from needs identification up to contract's completion. Regarding the contracts monitoring and the evaluation of the providers' performance, since it is a paper-based process, the hospital does not have an overview of all active contracts and the level of service (LOS) agreed upon in each of them.

An **application to manage the procurement function exists at IPO, but it does not cover all the activities required**, resulting in a persistent need to obtain information and perform tasks on other applications without guaranteeing an end-to-end vision of the procurement process. Currently, IPO has a stock management tool which can create a procedure and issue a purchase order. Regarding integration with external entities, it is integrated only with Vortal and just one time at the beginning. This is clearly insufficient as to have an end-to-end vision with Vortal there are 8 different moments.

Figure 52: Vortal workflow during a procedure



Moreover, almost all the stakeholders involved in the procurement procedure do not have access to this tool as there is no functionality developed for their role. This tool does not generate and send alerts and notifications and does not allow uploading the documents that are required to fulfil the legal procedure requirements.

The current solutions in use at IPO, which could be qualified as technologically mature, are limited in terms of guaranteeing **real transparency** and **effective automation** of the whole process, from the identification of needs by the procuring unit to the issuance of the purchase order and the contract management.

To address the points above (need for real transparency and effective automation), blockchain technologies (which are inherently auditable and provide an immutable information baseline) and RPA (which addresses business process automation), respectively, were identified as the two main technological drivers for adding value to a to a new Procurement solution.

Objectives and vision

The main objective of the project is to **design, build and present a new integrated procurement management platform**, which simplifies and automates to the extent possible the procurement process, increasing its agility and transparency, through the use of disruptive technologies, lowering the overall consumed effort and errors emerging from manual operation.

As such, the main use case is the creation of the concrete procurement procedures (similar to RFPs), given the request, to be published on the electronic bidding platform (which is used laterally by the organisation and is on the integration points of the procurement platform).

With the new all-in-one procurement platform, IPO will be able to:

- Track, in real time, the whole process from need identification stage until the purchase order creation, track a process status, owners and timings through their mobile or computer;
- Centralise communications with all internal stakeholders;
- Prioritise tasks between procedures and control critical deadlines;
- Send the managers and officials involved in the procedures alerts and notifications on critical deadlines;
- Trace the whole procedure and share all activities, tasks and documents with external auditors;
- Reallocate employees to functions and tasks of more added value (less operational, more strategic in some cases);
- Benefit from enhanced compliance level offered by the automatic filling of forms and procurement documents (with this purpose, legal rules and procedural guidelines, as well as the suppliers' records, will be embedded in the platform in an interactive way);
- Monitor and evaluate the provider's performance throughout the whole contract cycle (up to completion).

The technological solution itself as well as the way in which it was implemented by IPO are described in the next sub-section.

Technological solution and implementation

The solution is based on a typical three-layer approach (presentation, logic and data), and will utilise a cloud-based infrastructure, to provide maximum reliability and scalability. For each layer, additional information is provided:

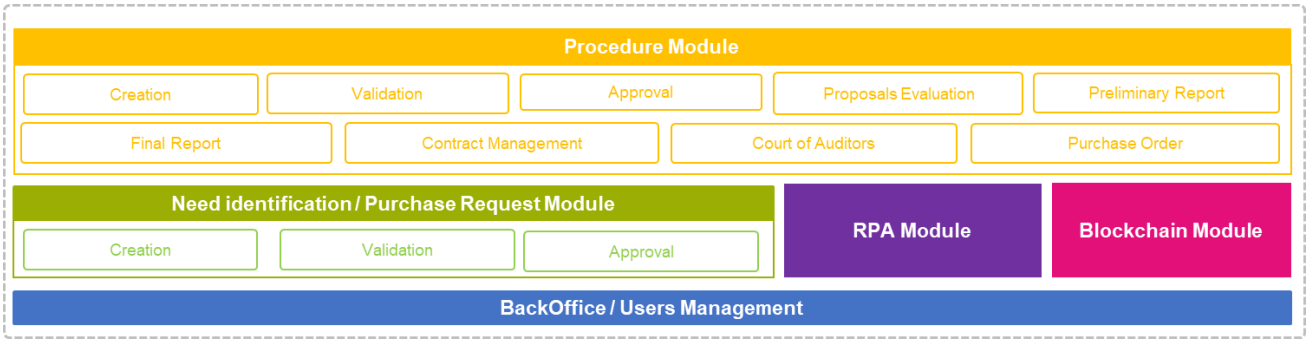
- **Presentation layer**: this layer ensures screen and controls presentation and is the layer of contact (interaction) from the solution with the operational personnel – modelling the business processes associated with the procurement business – being implemented using Java technologies as well as Robotic Process Automation (RPA), which automates some actions, lowering interaction, human error and improving speed, agility and reliability;
- **Logic layer**: this layer implements business logic and supports, technologically, the execution of the business processes, serving as "glue" between all layers and integrations with other systems. This layer is implemented using Java technologies;
- **Data layer**: this layer serves as a data and business process information repository. Although a support database is used, mainly for configuration and support activities, the main technology used is Blockchain, ensuring the information, once generated is immutable, and easily auditable, providing reliability and, most importantly, transparency for the all procurement process.

The work has been developed in collaboration with Vortal[151] who is the supplier of the electronic bidding platform which is being used by the organisation (it is an integration point) and other smaller stakeholders

[151] See: http://en.vortal.biz/

for other non-critical integrations. There is a mix of open source and proprietary technology (RPA platform Blueprism).

Figure 53: High-level vision of the platform



Main features

As mentioned before, the main objective is to develop an all-in-one procurement platform that will centralise the entire procurement process within a single solution. The platform comprises 5 main modules. The first one is the *Need Identification Module* through which is possible to create the request and, when required, to have it endorsed by a Head of Department and approved by the Board of Directors. The second one is the Procedure Module which converts identified needs into legally compliant procedures covering the whole procurement cycle. From the proposals evaluation until the contract management stage the application is integrated with the e-bidding platform run by Vortal. This *Procedure Module* comprises a dedicated-menu specifically designed to allow the access of Auditors from the Court of Auditors to ongoing procedures which is regarded as a major improvement in the way the control function is performed in the pre and post award stages to the extent that it permits a real-time access to what is going on within the procedure and is fit to save time and other resources normally spent to hold meetings and exchange requests for information and documents. The remaining three modules - RPA, Blockchain, and the User's Management modules - are instrumental to the first two and aim to ensure their effectiveness and efficiency.

Software and applications: the application is modular, in a 3-layer architecture. Blockchain / RPA components also exist on the cloud architecture;

System architecture: the application is Java-based (Spring Boot, Tomcat);

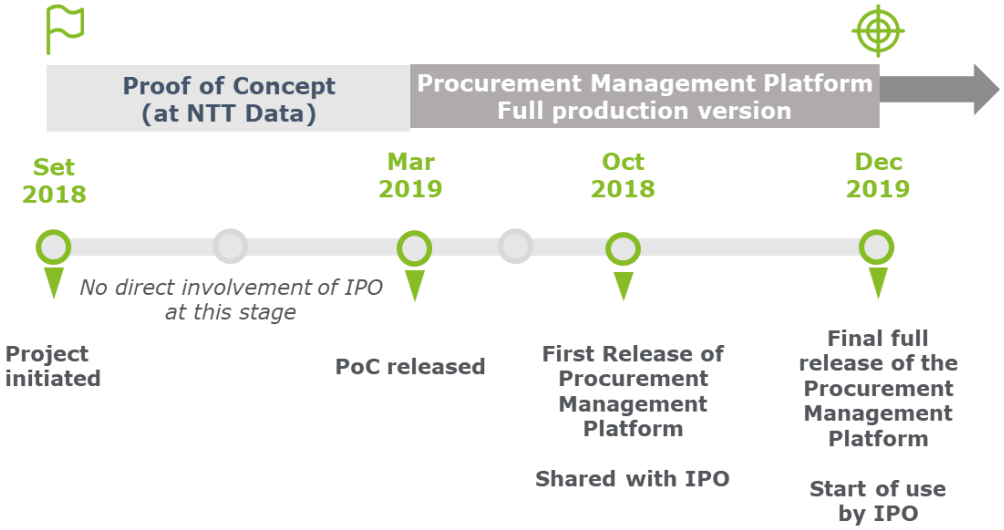
Data sets: Databases are implemented in MySQL.

Since the strategy for adopting the new platform was to substitute entirely the previous solutions in use, there is no cross-over with legacy solutions and Data migration, when and if requested by the IPO, has been limited to maintaining the track-record of completed procedures for statistical and audit purposes.

The solution can be combined with other technological solutions and integrates with some other services already in place (e.g. stock management tool and Board's decision-making tool). For the development, an existing accelerator was used for rendering code, while for the RPA, there is an RPA robot infrastructure available.

The actual implementation was carried out in two main phases, as presented below.

Figure 54: Timeline for the development of the Procurement Management Platform



Proof of concept

The project started with a PoC (with limited scope) run at NTT. This PoC was built with a waterfall development lifecycle (requirements gathering, analysis, design, implementation, testing and validation). Afterwards, the scope was increased to include all features, following the same methodology.

The main objective of the PoC was, to a limited scope, prove that the underlying technologies (which were the object of extensive R&D work) were viable and could bring the expected value to the solution, and hence, to the business processes to be improved. This was technically validated at this stage by NTT, and the decision of developing the full product and increase the scope and inherent functionalities was taken jointly by everis and NTT.

Full production version

The full product was developed, taking into consideration two releases, basically corresponding to: (i) direct award procedures; and (ii) all other procedures (e.g. open and selective tendering procedures, framework agreement, etc). Since the direct award module is complex and includes most of the solution features, it was the first to be fully developed and implemented.

Results and future expectations

Since the main objective is to digitalise the whole process, it will only be possible to measure results after having the full production version in operation so both solutions can be compared with real statistical data on their usage. Notwithstanding, the following key concrete results can be expected from the use of the new platform:

- Increased process and business efficiency: processes speed up on their completion and validation / accuracy;
- Improved employee output: staff who deal with procurement processes have a better work experience, producing more with better results and with low error margins;
- Increased transparency and reliability: processes are more transparent, with a higher degree of reliability;

- Better overall user experience: resulting in higher satisfaction from the users;
- Increased institutional business value: through improved perceptions of external stakeholders.

The solution covers a transversal process throughout the organization and will be leveraged taking into account both the particularities of the health sector and the interaction with other business sectors through the transactional modules that establish a relation with potential suppliers and actual contractors. Thus, after gaining hands-on experience in real terms, the platform is expected to further improve by adding additional functionalities and features (e.g. new electronic auction platforms, integration with Enterprise resource planning (ERP), suppliers' past performance evaluation)

Costs and Requirements

Costs	Human resources	Other

≈ **€240.000** (Year 0 -Year 3)
- everis technological solution, including data acquisition and processing: 90%
- IPO Lisboa Human Resources: 10%
 	
Going forward an annual maintenance fee of €28 000 can be forecast
	• IPO Lisbon (IPO) Team with the following profiles: project director, project coordinator; procurement specialist;
	• Everis:
	  • Proof of Concept: 4 FTE - Manager, Project Manager /Architect, Functional Leads and Developers
	  • Full scale: 6 FTE - Manager, Project Manager, Architect, Functional Leads and Developers
		• Cloud infrastructure for supporting all application modules

In terms of **finances**, the total estimated investment in the project by the Portuguese Institute of Oncology of Lisbon (IPO) is about **EUR 240 000**. This is split as follows:

- everis technological solution, including data acquisition and processing: **90%** (EUR 216.000)
- IPO Lisboa Human resources: **10%** (EUR 24.000)

Renewal costs (annual maintenance fee) of approximately **13%** of the cost of the Everis technological solution (€28.080) are forecast.

The project is implemented by an internal team of IPO (comprising both business and IT internal stakeholders), supplemented by project management, functional and technical capacities provided by an external consultant (everis). These teams interact and work together on a regular schedule (weekly / biweekly meetings), holding specific meetings for specific needs, according to the high-level product development plan.

There was a need to have a multidisciplinary team, having functional knowledge (health sector) and technical knowledge (java, blockchain, RPA). Additionally, several layers of expertise were applied, from development to architecture and project management.
As stated in the table above, the following profiles have been deployed throughout the project (from PoC to developed product):

- Manager: Relationship manager and everis global team coordination;
- Functional Leads: business process modelling and functional analysis/requirement definition, and project follow-up;
- Project Manager: project management, project and milestone control;

- Technical Architects: Target model definition, technologies investigation and R&D, and development team coordination and support;
- Developers: operational development team.

As this is a cloud solution, a low latency internet connection should also be ensured for optimal usage.

Risk and mitigation

There are a limited number of risks associated with the project, including in the area of privacy and security, and lock-in associated with the technologies used.

Risks regarding **privacy/confidentiality/security** are mostly related with the confidentiality of the data. To this extent, not only are the requests being stored on the blockchain (which provides reliability) but also they are encrypted for privacy.

The procurement processes must be auditable to the maximum extent, to ensure total transparency. Given this, the storage of the data on the blockchain ensures that it is reliable and auditable by third parties, which can participate in the blockchain ecosystem.

The only **lock-in risk** is with the RPA technology (Blueprism) which is proprietary. Despite this, the RPA strategy could be adaptable to a new container, following the same automation logic, and changing the syntax. The remaining technologies are open source.

Challenges and lessons learnt

The main **challenges** identified were, from a functional view: the procurement process, despite taking advantage of technological innovation, needed to be optimised. As such, a deep analysis of the process was done and it was reformulated to be more effective. Example: Rethink and design the whole process of needs identification by centralizing all hospital requests and eliminating paper, email and phone requests. Redesign board decision making by including pre-approved purchase orders on the platform. On the other hand, from a technological view, some of the technologies (e.g. Hyperledger Sawtooth) used were not known to everis. As such, in the first stages of the PoC, a "try before buy" approach was used, to gain knowledge and prove the technology before its final application to the project.

The project implementation so far has provided already some **lessons** learnt which should be considered for the development of future similar projects, such an **in-depth financial sustainability analysis** should be conducted as early as possible: a technology can be functional and resolve the problem, but if it is not sustainable on the solution business case, there can be other options that can solve the problem as well. Additionally, a **comprehensive knowledge about the organisation and its business processes** is necessary to make the project a success. This knowledge must be shared with external consultants and contractors involved in the project as early as possible, not only for the purpose of analysing and designing the requirements, but for the inception (through design thinking or similar approaches). Also, when designing the solution, and defining what the solution should be technically (e.g. which technological blocks, what technologies, how do they "speak" to each other), it is necessary to keep a **detailed record of major decisions**, as the uncertainty related to new technology exploration may lead to several decisions, which have to be kept throughout the process (so major benefits and disadvantages can be remembered and not overwritten as the exploration process unfolds). Finally, a very **specialized knowledge on the legal framework and procurement policy** is required in order to be able to synthesize and enact all rules, obligations and deadlines into business requirements ensuring the procurement platform is fully compliant from a legal point of view.

Case study 17: Truman – Automation of Vendor Application Assessment

Lead Organisation: Federal Acquisition Service (FAS), General Services Administration

Location: USA

Technologies: RPA

Level of government: National

Problem Statement: The FAS provides procurement services to other government organisations, processing $55 billion of acquisition spending each year. It manages central contracts (Multiple Awards Schedules) via which other government bodies can purchase products and services. It has multiple IT systems supporting its tasks, and this complexity leads to workforce inefficiency. The process to approve a vendor for a Multiple Award Schedule contract is particularly inefficient – it is lengthy and time-consuming, with multiple administrative steps at which human error can creep in.

Description: FAS utilised RPA technology in order to automate the initial stages of the award process for a Multiple Awards Schedule. The developed bot extracts information from a vendor's application and complements it with information from other online sources in order to fill in a Pre-Negotiation Memo, which is used by employees as the basis for the ensuing negotiations with the vendor. FAS used uiPath software for this RPA implementation. The bot was fully deployed, however it is now being revised following changes to the Multiple Awards Schedule process. FAS is now exploring additional applications of RPA technology to its processes.

Lessons learnt: It can be a major challenge to win the support of other parts of the organisation for new technology projects. Although a slow process, these efforts to win over key internal stakeholders are crucial for the success and future development of the project. Another critical factor for success is picking the right process to automate – this process should be both rules-based (and so suitable for RPA) and with high potential for impact through automation (e.g. because it is highly time consuming to perform manually).

Cost: €315 000 (US $350 000): Roughly €90 000 ($100 000) on licenses, and €226 000 ($250 000) on consultancy fees.

Impact: High. 3750 government FTE hours reallocated; 98% faster processing time of vendor offers; 100% resolution of backlog; increased revenues from agency fees; guaranteed compliance with federal acquisition regulations.

Future expectations: Looking ahead, beyond the revised implementation of the TRUMAN bot, FAS is already planning to expand the way it is using RPA and looking at new processes that could be automated.

Human resources: External consultants with RPA experience developed the automation.

Risks: IT security risks – possibility of unplanned actions by bots; Concerns that the technology brought little added value.

Other requirements: Subject matter expertise, and detailed knowledge and documentation of the process to be automated is a necessity.

Project timeline: 1 year project, 2018

Project status: Pre-production (assessing additional areas for automation

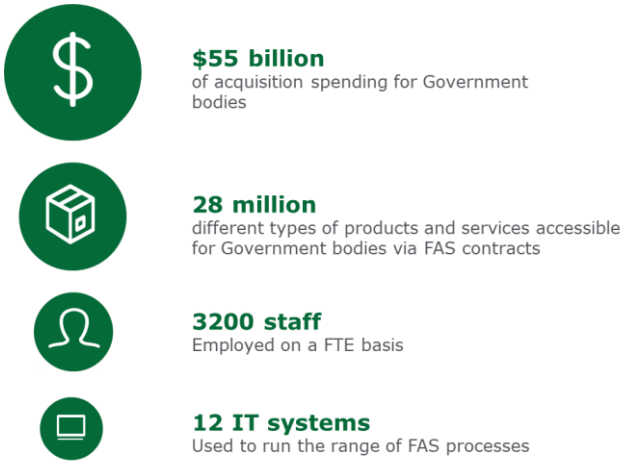
Email: Anthony.Frater@gsa.gov

Website: www.gsa.gov/fas

Context and problem statement

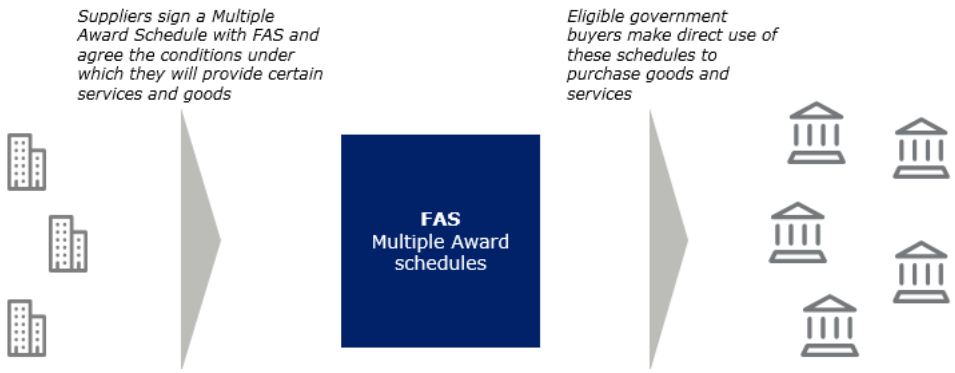
The General Services Administration (GSA) provides support to federal agencies and departments in the areas of "real estate, acquisition, technology, and other mission-support services"[152]. Within the GSA, the **Federal Acquisition Service (FAS) is dedicated to acquisition and procurement services and support**. It processes $55 billion (€50 billion) for government agencies and departments each year, managing contacts through which they can access 28 million different types of products and services. FAS has a staff of 3200 FTE employees to perform this work. In addition, to data it has 12 different IT systems that have been installed to run the different task-related processes. The complexity associated with running these multiple systems leads to inefficiencies from a workforce perspective, with employees having to learn how to operate and switch between multiple different systems.

Figure 55: FAS in figures



One significant work-stream for the FAS is the **operation of the Multiple Award Schedules (MAS).** These are long-term government contracts with vendors for the provision of different products and services. Over 11 million different products and services are available over these schedules, which eligible government buyers can purchase through a streamlined procedure. Approximately 21% of federal acquisition spending goes through these Schedules. The management of these contracts on a centralised basis enables the Government to achieve volume-based discounts on the purchase of given goods and services.

Figure 56: Provision of goods and services via Multiple Award Schedules



[152] US General Services Administration, 2019, FY 2020 ANNUAL PERFORMANCE PLAN AND FY 2018 ANNUAL PERFORMANCE REPORT, https://www.gsa.gov/cdnstatic/GSA%20FY%202020%20Annual%20Performance%20Plan%20and%20FY%202018%20Report_FINAL.pdf

In order **for a vendor to win a MAS contract, they must pass through a number of different steps**, and fulfil a range of various requirements, including demonstrating they have at least two years of corporate experience and providing evidence related to their past performance. Much of this information is recorded on another publicly accessible, government administered webpage – the System for Award Management (SAM). Vendors must also ensure they have and share a Data Universal Numbering System (DUNS) number, the number by which the Government identifies corporate entities.

Due to the wide number of requirements that must be fulfilled by the vendor and, consequently, verified by FAS employees, **the award process can be lengthy – taking up to 12 months**. In this and other areas, FAS therefore started to explore how new technologies could automate some of the steps involved, producing time savings for their employees, and a better service for both clients and vendors.

Objectives and vision

FAS explored robotic process automation (RPA) with the immediate aim of **providing time savings for its staff by automating repetitive, administrative tasks**. The automation of such tasks was also intended to enable the workforce to spend more time on high value analytical work, contract negotiation, stakeholder engagement, and training to improve skills. In addition, RPA was seen as a route to improve data integrity within the organisation, reduce instances of human error, and ensure compliance with federal acquisition regulations.

Technological solution and implementation

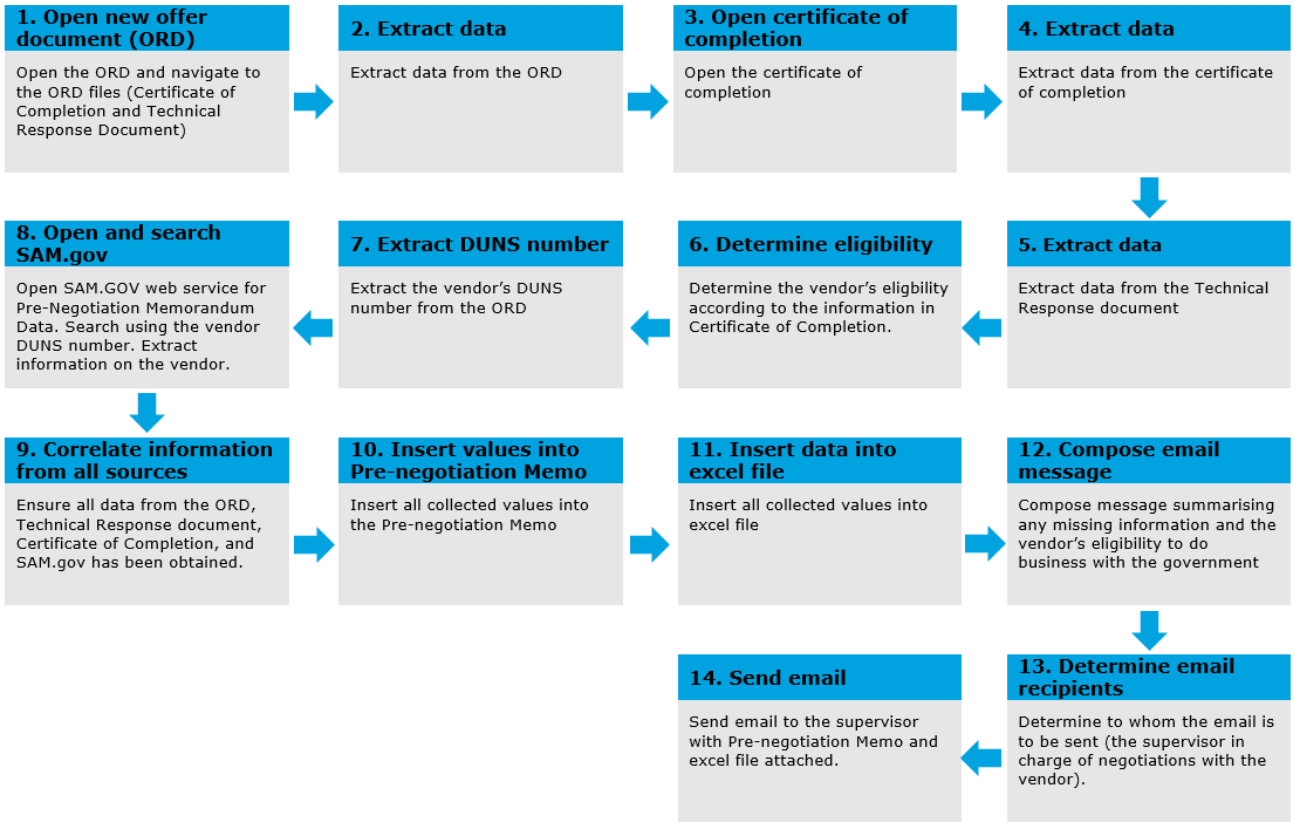
On the basis of these objectives, FAS, with the help of external consultants **reviewed its processes to identify those which could be productively automated**, and with the help of external consultants, developed and implemented a bot which could deliver the desired employee time savings.

The developed bot – called **TRUMAN** - is **applied to the first stage of the vendor application process for a MAS contract**. The vendor is required to submit extensive information as part of the application, filling in a number of templates with details on their company and their offer, and providing supporting documentation. The information required includes on pricing, previous financial performance, subcontractors, and the technical proposal. The bot is used to:

- Extract the necessary information from the documents submitted;
- Conduct a first assessment of the vendor's eligibility to do business with the government,
- Complement the data submitted with information from other government sources (SAM.gov), using the DUNS number included in the vendor offer as an identifier;
- Insert the information into a template – the Pre-Negotiation Memo – used to inform the negotiations with the vendor;
- Email the supervisor responsible for negotiations with the vendor, stating the vendor's eligibility to do business with the government, summarising any missing information from the application, and attaching the completed Pre-Negotiation memo.

The full process followed by the bot is described in Figure 57.

Figure 57: Process automated by the TRUMAN bot

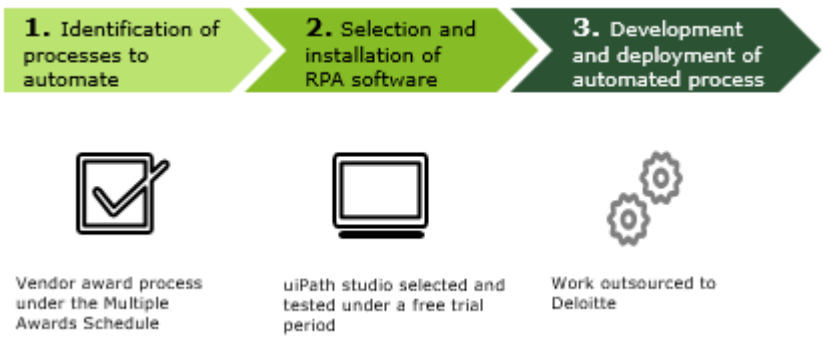


The developed automation is an "**attended bot**". This means that it **must deliberately be opened and run by the employee** (i.e. the employee must open the application on his desktop). This type of bot has disadvantages in terms of efficiency – it would be possible to produce greater time savings and a quicker delivery of the process if, for example, the bot ran automatically upon receipt of the offer from the vendor. However, it has advantages in terms of credentialing – if the bot was to run automatically, a solution would have to be developed to give it credentialed access to the FAS IT environment. Having an employee actively run the bot means that no such credentials are required for the bot.

Implementation

FAS took a number of different steps in order to successfully deploy RPA:

Figure 58: Steps towards deploying robotic process automation



The first step, **identifying a process to automate**, resulted in the selection of the vendor award process for MAS. The Schedules award procedure was chosen according to a number of criteria, including:

- **Rules-based process** – The approval of vendors' applications occurs according to a highly regimented set of rules. This makes it a candidate for RPA, which is only suitable for the automation of this type of unambiguous and clear process.
- **Familiarity with the process** - The process was very well-known and understood by the organisation. This reduces the barriers to automating the process, as its automation requires explicitly describing each step in a very high level of detail.
- **High potential impact** – 21% of FAS' acquisition is operated under MAS, with a large number of vendors requiring approval each year and a resulting award process lasting up to 12 months. Automation of MAS contract processes had thus a high potential for efficiency gains, namely through time savings.

The software chosen by FAS to develop and deploy the bot was uiPath Studio, which they tested under a free trial period, before purchasing an enterprise licences. FAS chose to outsource the tasks of developing, piloting, and deploying the automated process, as they did not have previous experience in either the software of the technology more generally. They outsourced this work to Deloitte, who **first piloted a bot in the FAS development environment, before rolling out the production version**.

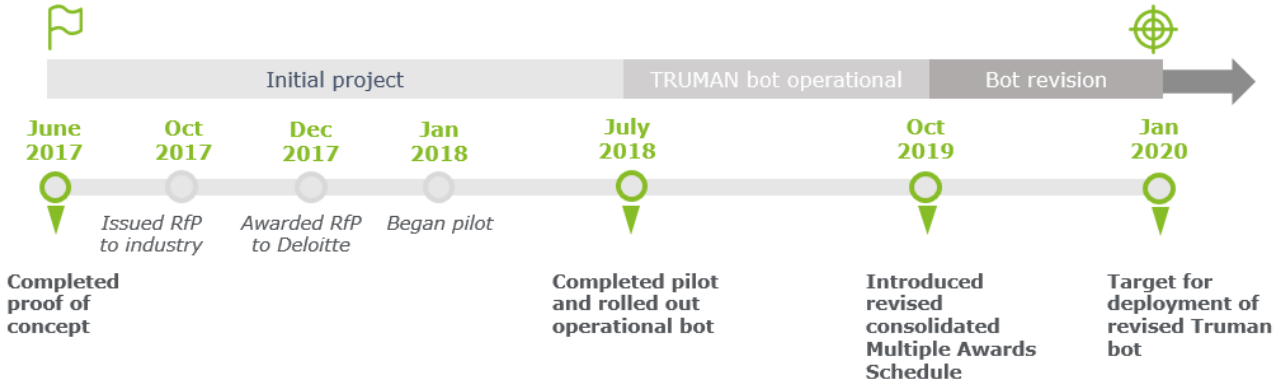
Timeline

Under the original project, the development and deployment of the bot was expected to take about 3 months, however overall it took close to a year. The delay is attributable to organisational barriers rather than technical ones – it was necessary to get internal stakeholders on board and supporting the project, including IT security and the office of the Chief Information Officer (CIO).

A full operational version of the bot was deployed in July 2018. However in October 2019 a new consolidated Multiple Awards Schedule process was introduced. This means that a revised version of the bot must be developed in order to match the new process. This revised bot is expected to be developed for January 2019.

The main steps of the project are summarised in Figure 59 below:

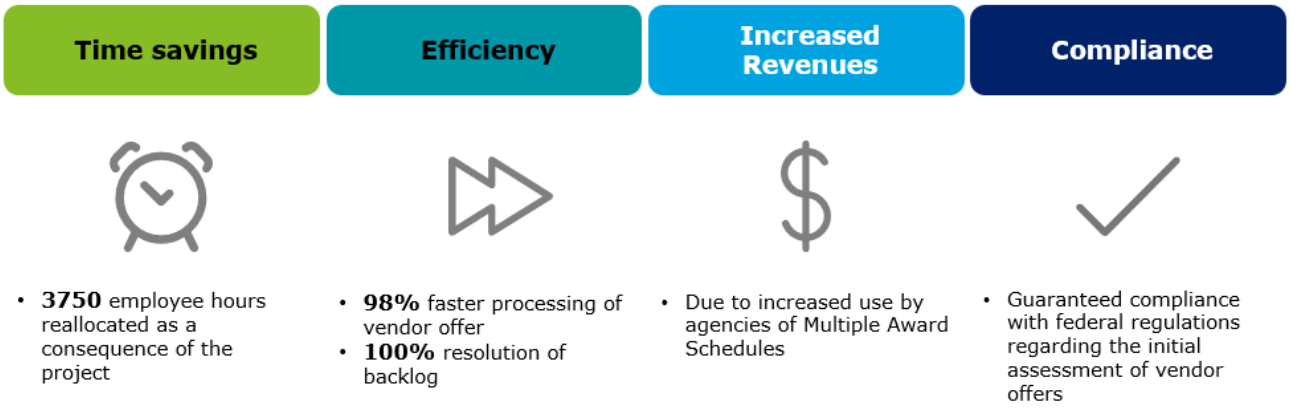
Figure 59: Timeline for TRUMAN project



Results and next steps

Due to the introduction of the new consolidated Multiple Awards Schedule, the TRUMAN bot is not currently operational. However, the revised version is due to be deployed in January 2020. During the period that the TRUMAN bot was operational (July 2018 – Oct 2019) there was also evidence of substantial benefits stemming from the project. The main benefit is in terms of the hours saved for employees. However, there were also impacts across a number of other dimensions as shown in Figure 60 below:

Figure 60: Impact of the TRUMAN bot



The **time savings of 3750 employee hours** recorded are the direct result of employees not having to spending time in the early stages of the MAS vendor application process. Prior to the automation of this part of the vendor assessment, the manual process took employees roughly 75 minutes.

The TRUMAN bot is able to **process an application in just 1 minute, meaning that it is 98% more efficient** than the former process. Consequently, **the backlog of vendor applications was also entirely removed.** The TRUMAN bot also contributes to increased revenues for the FAS, although it is difficult to precisely quantify this. FAS charges government agencies a fee each time they use a Multiple Award Schedule contract. More vendors with a Multiple Award Schedules means that more products are available through this route, more agencies will make use of the Schedule contracts, and FAS will receive higher revenues in fees.

A final impact of the new automated process is the **guarantee of compliance** with federal regulations as to the steps that must be followed when assessing a vendor offer. Although employees generally complied with these regulations using the manual process, this cannot be guaranteed and demonstrated in the way it can through the automated process.

Looking ahead, beyond the revised implementation of the TRUMAN bot, FAS is already planning to **expand the way it is using RPA** and looking at new processes that could be automated. The deployment of the bot has been popular with the workforce (as assessed through "townhall" meetings with the Regional Commissioner) who see that the technology relieves them from having to perform tedious and unpopular tasks.

One significant planned step is to u**pgrade the RPA software the organisation is making use of, purchasing the uiPath Orchestrator product** – which provides a management dashboard enabling deployment and control of bots across an organisation's IT environment. The use of this solution would also enable the deployment of unattended bots. In addition, a governance structure will be developed in order to ensure that the organisation maintains control and oversight over multiple bots deployed across its systems, and can ensure a standardised implementation.

Costs and Requirements

The overall cost of the deployment of the TRUMAN bot was approximately $350 000 (+/- €315 000). This total includes the costs of the RPA software (uiPath Studio), and consultancy fees, but not in-house human resources. The cost of licenses for the uiPath RPA software and the bot came to under $100 000 (+/- €90 000). Meanwhile the consultancy fees come to about $250 000 (+/- €226 000). Roughly 1/3 of this consultancy fee was directed towards the RPA development, while the remainder covered process assessment, modelling, the business case, and project management.

In terms of the **internal human resources** put towards the project, about 1/3 of the time of the project owner (Deputy Regional Commissioner) was put towards the project. Meanwhile, additional expertise and input was provided from Subject Matter Experts and other Executives as needed. Much of the time dedicated to the project involved building support and getting approval for it within the organisation. This included support from systems owners – who were generally happy to support the project, but stipulated that they were unable to provide resources to back it themselves. It also included the support of the CIO, who was initially against the project on security grounds. Winning over these stakeholders required **building a strong business case demonstrating the advantages of the automated process**.

Risk and mitigation

The main risks of the RPA project initially identified by the organisation included IT security risks and a potential lack of added value for the investment.

In terms of **IT security**, there were concerns that the bot could perform unexpected and unwanted actions, potentially risking the integrity of the organisation's IT environment. The organisation's central IT security team, had to be convinced that given the capabilities of the RPA technology, there was no prospect of this happening. One way in which the concerns of the IT security team were reduced was by the decision to only deploy an attended bot. This meant that the bot had no independent credentialed access within the IT environment, always had to be specifically activated by an employee, and had limited autonomy and capacity.

Other internal stakeholders had misgivings about applying this new technology and **did not see the value of making use of RPA technology** compared to other solutions which the organisation had more experience with, for example creating a script that performs the process, or creating an Application Programme Interface (API). As mentioned above, it was necessary to build up a strong business case, and demonstrate the capabilities of RPA through pilot implementations in order to win over these stakeholders.

Challenges and lessons learnt

One of the main challenges of the project has therefore been to **get the whole organisation backing the automation project**. This was a slow process, however the efforts to win the support of the key internal stakeholders were ultimately successful and laid a solid basis for the expansion of the project.

Another lesson to be taken from FAS' experience is the importance of **selecting the right process to automate**. This automation project resulted in over 50 000 saved employee hours as well as increased revenues from new vendors. This was only possible because an appropriate process was identified; one which:

- the organisation was very familiar with, and so could document and explain well;
- was rules-based (and so suitable for RPA);
- had high potential impact (e.g. due to the large number of hours it takes to perform manually, and the backlog of vendor applications)

RPA can therefore make a sizeable contribution to an organisation's efficiency, time-saving, compliance, and even revenue goals if appropriate processes are automated and organisational barriers are overcome.

Case study 18: Intelligent Automation

Lead Organisation: Finnish Government Shared Services Centre for Finance and HR (Palkeet)

Location: Finland

Technologies: RPA

Level of government: National

Problem Statement: In the course of fulfilling its mission of providing human resources and financial services to Government agencies and departments, Palkeet employees must conduct numerous time-consuming and tedious manual processes. These processes are often inefficient and suffer from high rates of human error.

Description: Palkeet has rolled out RPA technology across the organisation, with 26 bots now in operation, automating 70 different processes. Procurement processes automated include the processing of purchase invoices and the maintenance of its supplier register. For these automations, the organisation draws on UiPath software. On an ongoing basis it identifies and assesses processes for automation, with IT/automation experts collaborating with service owners to develop and deploy the necessary bots.

Lessons learnt: RPA is a mature technology that can deliver major savings and efficiencies for an organisation if targeted at appropriate processes. Care should be taken to ensure that common change and release management processes are followed before new automations are deployed in order to minimise disruptions. Automations should be piloted on a smaller scale before being rolled out across the organisation.

Cost: €1 million (between 2015 and 2020)

Impact: High. Time savings equivalent to 61 FTE employees as of end 2018.

Future expectations: Palkeet has forecast a return on investment of €6 million due to freeing up time equivalent to 116 FTE employees by 2020. Palkeet is currently on track to meet this target.

Human resources: 15 FTE employees, initially supported by IT consultancy with RPA expertise.

Risks: Early-bird deployment of RPA meant limited information available on challenges and good practices for the technology.

Other requirements: IT consultancy provided training to Palkeet employees on use of RPA technology.

Project timeline: 2015 - 2020

Project status: Fully deployed

Email: eija.hartikainen@palkeet.fi

Website: https://www.palkeet.fi/

Context and problem statement

Palkeet is the **financial and human resources service centre for the Finnish Government**. Its customer bases is agencies and departments across the entire state administration, covering 73 000 state employees, to whom it provides the following services:

- Financial services
- Human resources services
- Expert services
- Support and maintenance services

The organisation has an **annual turn-over of €51.3 million**, and provides financial statements for 74 separate organisations. It processes 1.4 million purchase invoices, 0.6 million sales invoices, and 1.2 million pay-slips per year.

Figure 61: Palkeet in figures

Many of the supporting manual processes that enable these services are time-consuming and tedious, and potentially off-putting to potential employees who will dedicate time and effort to performing them. In addition, these services are often affected by human errors. The Finnish Government has placed an emphasis in its Government Action Plan on "Digitalisation, experimentation and deregulation", which is one of its "key projects". In this context, Palkeet is exploring how digitalisation can help address the issues listed above.

Objectives and vision

Palkeet aimed to analyse how business automation could be used to improve its processes, and deploy Robotic Process Automation technology in order to:

- Increase productivity;
- Improve the quality of its services – reducing human error and increasing predictability
- Save employee time;
- Attract talent and create a more attractive work environment – by removing manual/menial aspects of existing job profiles

The organisation aimed to deliver the **first major RPA implementation in the Finnish public sector**. In support of this implementation it developed a business case which proposed an investment of €1 million in order to generate by 2021 a return on investment of €6 million with time savings equivalent to 116 FTE employees.

Technological solution and implementation

Palkeet has rolled out RPA technology across the organisation, with **26 bots now in operation, automating 70 different processes**. On top of this, 5 additional automations are under testing, while 15 are under development.

The **processes automated predominantly cover non-procurement aspects, however there are some examples of procurement automations**, as shown in Table 10.

Table 10: Examples of Processes automated by Palkeet

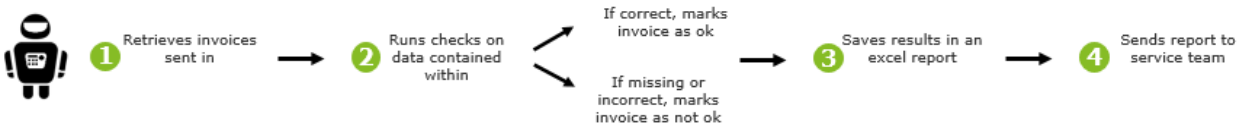
Procurement processes	Other finance processes	Human resource processes
Purchase invoice processor	Numbering of expense receipts and content requirements inspection	Move Presence and Absences From the Spreadsheet
Supplier Register Maintenance	Routing of expense receipts	
	Verification and reconciliation of expenditure	Reporting of service time calculation
	Accounting Reconciliation	Filling in the reconciliation table for accounts
	Reconciliation of opening and closing balances of balance accounts	Payroll Automation
	Monitoring of the circulation of expenditure receipts	Accounts Reconciliation
	Opening and Closing Seasons	Vacation planning run
	Automation of travel and expense invoice control	Vacation reports
		HR temporary table processing
		Reminding supervisors of fixed term contracts ending

As listed in the table above, the **Palkeet has automated two processes related to procurement, creating a bot that automatically processes purchase invoices, and another that maintains the supplier register:**

Purchase invoice processor – This bot runs a first check on e-invoices sent to Palkeet. It carries out the following steps:

1. Retrieves invoices that have been sent in;
2. Runs basic checks of the data contained within them (i.e. that it is in the right format, that no required data fields are missing, etc);
    a. If the correct data is provided, the eInvoice is marked as ok
    b. If there is missing or incorrectly formatted data, the eInvoice is marked as not ok.
3. Saves the error information in an excel report, together with the logged data and the percent of "ok" invoices.
4. Sends report to service production team, which manually processes the invoices.

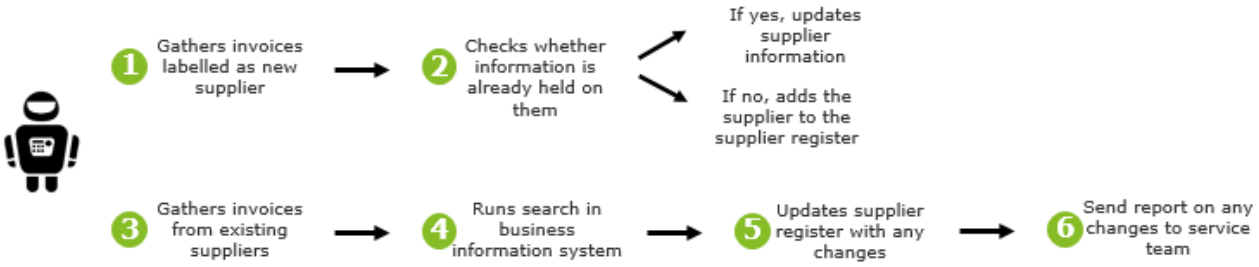
Figure 62: Purchase invoice processor



Supplier register maintenance - The bot adds new suppliers to the register when they enter into contracts with Palkeet, and updates the details of existing suppliers when there are relevant changes. It carries out the following steps:

1. Gathers all invoices labelled as "new supplier";
2. Checks, using business ID, whether information is help on them;
    a. If no, adds the supplier to the supplier register;
    b. If yes, updates supplier information;
3. Gathers invoices from existing suppliers;
4. Runs search in business information system (YTJ), using business ID, to see if there are any updates to supplier information;
5. Updates supplier register with any changes;
6. Sends report on any changes to service team.

Figure 63: Supplier register maintenance



Palkeet draws on several different tools in order to implement automations within the organisation. **The RPA software it uses is UiPath**. This is the process and orchestration tool used to model the processes to be automated through RPA and then to run the automation. For some automations, however, Palkeet makes use of the Winshuttle software – which is designed for automations involving the mass processing of SAP data and is better adapted for this type of use-case.

Development of Automations

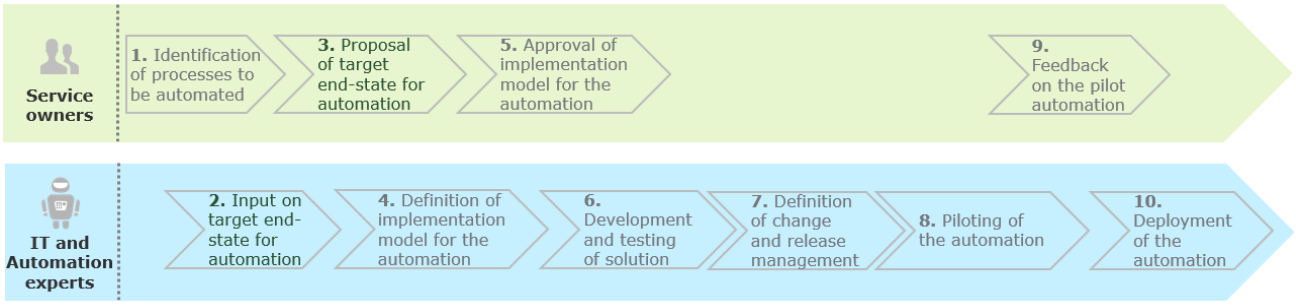
A number of steps are followed in order to implement any new automation, going from selection of the process to automate, through development of the bot, to implementation of the automation. Implementing these steps requires input from both the service owners and the IT experts.

- **Identification of potential processes to be automated** – *by the service owner.* This step is key as for RPA technology to have an impact it is necessary to select processes that are both susceptible to automation and which would benefit from it.
    - Assess whether the process is compatible with automation from RPA – for this to be the case it should be routine, highly standardise, and relate to data which is in electronic form. The process should also be well documented and described.
    - Evaluate effectiveness and benefits of process to be automated – this should include an assessment of the impact on other areas of the service model and the group's operations
- **Proposal of target end-state for the automation** – *Led by the service owner, with input from ICT, process, and subject matter experts.* This step defines the desired structure of the automated process;

- **Define implementation model for the automation** – *Led by the IT expert and approved by the service owner.* Including a schedule for the development of the bot.
- **Development and testing of solution** – *by the IT expert.* Developing the bot using uiPath and tests it in the robotic testing environment.
- **Definition of change and release management –** *by the IT expert* – to ensure internal stakeholders are properly prepared for the release of the bot.
- **Piloting of the automation** – *by the IT expert* **–** gathering feedback from the service owner and clients.
- **Deployment of the automation** – *by the IT expert, once approved by the service owner*.

These steps to develop and deploy an automated process are illustrated in Figure 64.

Figure 64: Steps towards automating a process

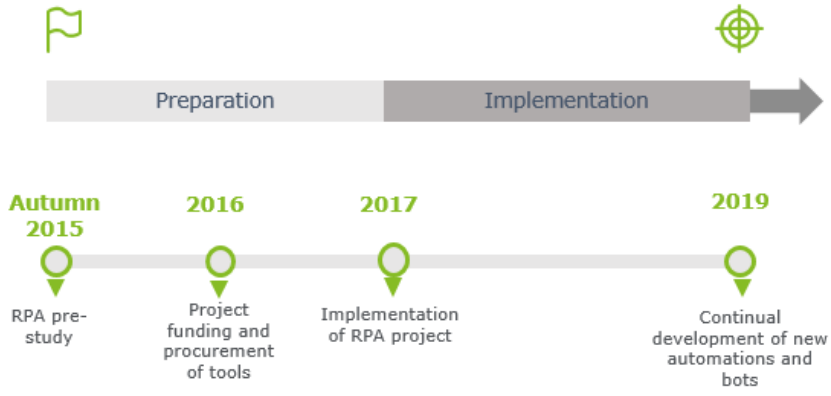


In the **early stages of Palkeet's RPA implementation, the organisation worked with NORIAN**, **an IT firm** specialised in accounting and finance, with particular experience in process automation. NORIAN supported the set up of Palkeet's robotic testing environment in the Finnish state IT architecture, as well as providing training to Palkeet staff to ensure they could develop and implement their own automations.

Timeline for the project

Preparation for the Intelligent Automation project began in 2015 with a study on the use of robotic process automation. Project funding was established in 2016 and the necessary automation tools were procured. Following this, implementation of automated processes began at the end of 2016, and has continued until the present day. Figure 65 below shows the timeline for the project.

Figure 65: Timeline for Intelligent Automation project



Results and future expectations

Palkeet is on track overall to meet the aims of its business plan for its RPA implementation, which forecast a return on investment of €6 million due to freeing up time equivalent to 116 FTE employees by 2020. **As of December 2018, the project had produced time savings equivalent to 61 FTE**.

Palkeet also monitors customer satisfaction through annual questionnaires. It sees it as a success that there has been **no dip in customer satisfaction during the period that this large-scale automation project has been implemented**.

Looking in more detail at the automated procurement process described earlier, the concrete results of these are as followed:

- **Purchase invoice processor** – has processed over 1 million invoices, saving 3374 working hours. The bot has a resolution rate of 72%, meaning it is able to process 72% of the invoices, while the others are flagged to the service team. The bot has increased the efficiency of invoice processing by 35%.
- **Supplier Register Maintenance –** used to maintain and add to the records of 14678 vendors, saving 260 work hours, with a resolution rate of 78%.

Costs and requirements

Costs	Human resources	Other

• **€1 million** split between
  ○ Licenses for software
  ○ Project costs to build up capability
  ○ Operational costs
	• Initial collaboration with IT company, NORIAN – who provided RPA expertise;
	• Team of 15 FTE Palkeet employees now working on RPA.
		• Training for Palkeet staff to ensure they had the internal resources to develop and deploy RPA bots.

The overall **investment by Palkeet in the project is forecast to be €1 million**, spent between 2015 and 2020. From the beginning of the project until the end of 2017, the costs were split between the components listed below in the following proportions:

- Project delivery – 25%
- Consultancy fees (including training) – 12%
- Licenses – 14%
- RPA infrastructure – 9%
- Development costs (in-house human resources) – 40%

At the **beginning of the project there was a close collaboration with Norian**, an IT company that provided expertise on process automation. However, as the project progressed, Palkeet began to increase its capabilities in-house, first virtually and then bringing a team onsite. This process was supported by **NORIAN, who provided training to Palkeet employees** during the implementation project in 2017 to build their capabilities in the use and deployment of RPA technology. **Palkeet now has a team of 15 FTE employees who work on RPA projects**. This team also provides services to Palkeet customers (other government agencies and departments), supporting them with their own RPA implementations.

A key requirement for the success of the project was also **winning support from the whole organisation for the implementation of RPA**, including the leadership, top management and customers. The project team invested a lot of time in telling the story of RPA and sharing a convincing narrative as to how it would benefit the organisation.

Risk and mitigation

The **main risk of the project related to the maturity of the RPA technology and the lack of inhouse expertise** when the programme was set up. Palkeet was an early-bird in terms of deployment of RPA, with some bots developed as early as 2015, and so there was limited information available about the potential and challenges of this technology. In order to try to mitigate these risks, Palkeet consulted widely with other stakeholders with some experience with Robotic Process Automation. In addition, it designed the RPA project according to an incremental approach, starting small and deploying those automations that work before moving on to bigger and more ambitious efforts.

Challenges and lessons learnt

Palkeet's implementation of RPA demonstrates that this is a **mature technology that can offer substantial impacts for organisations**, automating time-consuming processes to deliver greater organisational efficiency and produce time savings for employees.

Palkeet has developed a tried and tested method to deliver successful automated processes. Key lessons that other organisations can take from this methodology include:

- Automated processes should be **piloted on a smaller scale** before being rolled out to the wider organisation. An initial pilot can for example be limited to one production group in order to test any issues with the automation and gather feedback
- RPA deployment should **follow common change and release management processes**

Case study 19: Automation of Responsibility Determination

Lead Organisation: Office of the Chief Procurement Officer, Internal Revenue Service, U.S. federal agency

Location: USA

Technologies: RPA

Level of government: National

Problem Statement: The IRS procurement workforce has reduced from roughly 500 to 300 staff over the last 7 years, without a reduction in workload, resulting in an overworked employee base which struggles to complete its tasks in the allocated time. In addition, many IRS procurement personnel are eligible to retire in the next five years. Furthermore, in Fiscal Year 2018 approximately 42% of IRS's contract obligations occurred in the fourth quarter, and approximately 25% occurred in the month of September alone, highlighting the challenges of the workload surges, pressures, and constraints that occur at the end of the fiscal year. Many procurement processes and tasks are very time-consuming, tedious, repetitive, and subject to human error.

Description: The IRS Procurement Office integrated and deployed RPA technology in order to automate the responsibility determination process that must be performed by a contracting officer before any new contract is awarded to ensure that a new vendor is compliant with federal legislative and regulatory requirements. The RPA solution used is the cloud-based UiPath software. This manual, pre-award activity previously took employees hours to complete, but now requires roughly five minutes with the tool. The automation tool not only helps IRS save thousands of hours of staff time per year, but also increases compliance, strengthens reporting and audit capabilities, and enables contracting professionals to focus on more strategic work and make better-informed procurement decisions.

Lessons learnt: Executive sponsorship, external coalitions, and internal champions and support within the organisation are key to ensuring a successful introduction, development, and implementation of new technology. Additionally, it is critical to maintain a business philosophy of "start small, think big, and iterate often" with emerging technologies like RPA.

Cost: €180 000 ($200 000) in the first year (for design, development, user acceptance testing, deployment, etc.), with €180 000 / year ($200 000 / year) operational/maintenance costs going forward.

Impact: Estimated 18,000 hours in savings per year; reduction in errors: increased compliance with responsibility determination requirements; consistent results, reporting, and audit trail; enables greater productivity of procurement employees; supports making better informed contracting decisions; offers robust scalability for workload surges; and provides a valuable learning opportunity to explore RPA capabilities and use cases.

Future expectations: The IRS plans to expand the use of RPA by increasing the existing bot's capabilities, building additional bots and potentially sharing the existing bot with other agencies.

Human resources: Outsourced RPA to system integrator; 5 IRS employees involved internally.

Risks: Some minimal security risks, but limited due to bot only extracting public information from public sources, no access to sensitive or non-public information, and no credentialed access for the bot to IRS systems and databases.

Other requirements: Detailed description of rules-based process required in order to automate it.

Project timeline: deployed May 2019

Project status: Fully deployed

Email: mitchell.d.winans@irs.gov

Website: https://www.usa.gov/federal-agencies/internal-revenue-service

Context and problem statement

The Internal Revenue Service (IRS) is the **U.S. federal agency responsible for collecting tax revenue for the federal government** and ensuring that American taxpayers meet their tax obligations. In the course of fulfilling this mission, each year the agency **directs approximately €2.3 billion (US$ 2.6 billion) in contract spending**.

Within the IRS, the **Office of the Chief Procurement Officer (CPO) plays a leading role in managing these contracts**, and ensuring that the agency acquires the products and services it needs to fulfil its mission. The IRS is a bureau of the wider US Department of the Treasury, and the IRS Office of the CPO also provides procurement services to other Treasury bureaus which do not themselves have procurement offices. It conducts strategic planning activities, and **is responsible for general process improvements in relation to procurement**, reducing time burdens on employees and increasing efficiency.

In recent years, the Procurement Office has been faced with a number of challenges. There has been a **reduction of the IRS workforce from roughly 500 personnel to 300 over the last 7 years**, without any compensating reduction in its responsibilities and workload. This has contributed to an increased work burden on employees, with staff struggling to complete their tasks in the time allocated. Procurement staff also struggle with **large peaks in workload, with approximately 45% of contract spending occurring in the last quarter in Fiscal Year 2018**. During these peak periods, staff are particularly overworked.

The Procurement Office carries out a range of tasks in order to verify the suitability of and onboard new contracted vendors and to subsequently manage the associated contracts. **One of the processes carried out is a responsibility determination, which is required by US law**. Under this process, before awarding a vendor a contract, the contracting officer must verify whether the vendor is "responsible" If they judge that the vendor is not responsible, they must not award it the contract.

The contractor's responsibility is **assessed against a number of criteria** such as whether the contractor is in compliance with various laws and regulations, has any active exclusions (e.g., a suspension or debarment), adequate financial resources to fulfill the contract, and whether it has a satisfactory record of performance, business integrity, ethics, etc. The contracting officer judges whether the contractor meets these criteria **drawing on a mix of information submitted by the contractor and public information available on public websites** such as the Federal Awardee Performance and Integrity Information System (FAPIIS.gov) and System for Award Management (SAM.gov). Finding the relevant information on these websites generally requires a Data Universal Numbers System (DUNS) number, a unique identifier for businesses.

The responsibility determination is a well-documented rules-based process, during which the contracting officer must follow a strict series of steps. Although straight-forward it is highly manual, repetitive, and time-consuming, taking employees between 1 and 4 hours to complete depending on the scenario. With approximately **4,500 new contracts awarded each year by the IRS**, and a responsibility determination required for each one of those new contract awards, **the time burden associated becomes significant**.

Objectives and vision

The Procurement Office aimed to **review its processes to identify and create efficiencies**. Its goals were to:

- Reduce the time burden on its workforce
- Increase compliance with federal acquisition regulations and agency policies
- Improve contract management and make better informed contracting decisions
- Implement solution with minimal impact to the IRS information technology environment

The organisation envisioned a technological solution to drive these process efficiencies. It wanted to **investigate the potential of Robotic Process Automation (RPA) to automate standardised processes conducted during the acquisition lifecycle**.

Technological solution and implementation

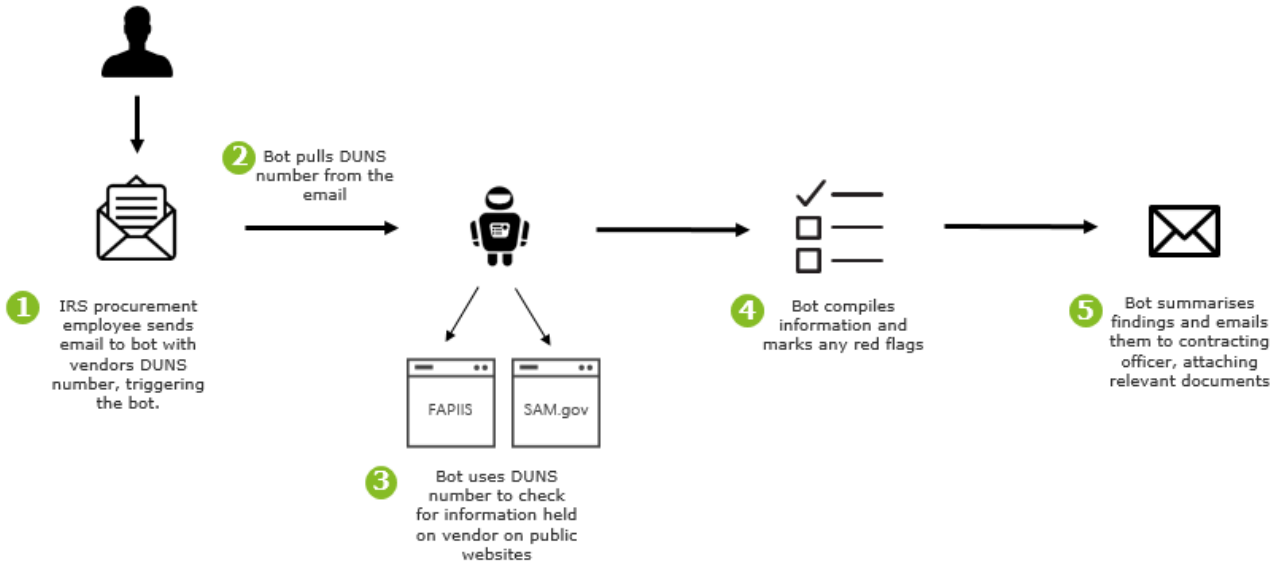
Using RPA technology, the **IRS Procurement Office automated the responsibility determination process that must be carried out to ensure a vendor is compliant with legislative and regulatory requirements** before any new contract is awarded.

The automated process is as follows:

1. IRS Procurement employee sends an email to the bot from their IRS email account with the vendor's DUNS number, triggering the bot;
2. Bot pulls DUNS number from the email;
3. Bot uses DUNS number to search for relevant information on FAPIIS.gov and SAM.gov
4. Bot compiles information and marks any red flags that would rule out the vendor from doing business with the federal government;
5. Bot sends email to contracting officer summarising the findings, attaching relevant documents and screen shots, and auto-populating a responsibility determination form for their review and signature.

This process is depicted in Figure 66 below.

Figure 66: Automated responsibility determination



The RPA solution

The IRS has implemented a **cloud-based RPA solution – with UiPath software running on the Microsoft Azure cloud**. This solution was integrated in the IRS IT environment by an SME systems integrator (a Woman-Owned Small Business and first-time IRS contractor), which was awarded the contract for the RPA implementation following an open procurement procedure.

Selection of processes to automate

RPA technology enables computer software (a bot) to mimic and replace the actions of a human working within digital systems (e.g. office suites) to execute a process. For example, an RPA bot could cut and paste

data from one place to another, merge data, process queries, download files, name and store documents, etc. There is a huge range of ways in which such bots can be deployed across an organisation.

To select which processes to automate the IRS analysed existing systems within the agency and **identified processes that were repetitive, rules-based and time consuming** for employees to complete. RPA technology is only suitable for processes that are rules based and highly standardised. Other criteria that were considered included whether the process required credentialed access to any systems (which is doable but would create additional complexity).

On the basis of these criteria, the responsibility determination was identified as a first candidate process to automate and use-case to learn from.

Timeline for development

Following the initial assessment of which processes to automate in late 2018, the **responsibility determination bot was developed and deployed in May 2019**. Since this time, the IRS Procurement Office has been exploring other potential areas and processes to which RPA could be applied.

Results and future expectations

The bot automating the responsibility determination was deployed in May 2019 and is now fully operational. It has already delivered a large return on investment, and is **estimated to produce time savings of 18,000 hours per year,** based on it automating the responsibility determination for approximately 4,500 new contracts per year. The responsibility determination must be performed at two different stages for each new contract. The bot is also credited with a reduction in errors in the performance of the responsibility determination, and ensures increased compliance with the regulatory requirements in this area. It also generates more consistent results, reporting, and audit trails; offers robust scalability for workload surges; enables greater productivity of procurement employees; supports making better informed contracting decisions; and provides a valuable learning opportunity to explore RPA capabilities and use cases.

Figure 67: Impact of responsibility determination automation

Looking forward, the IRS plans to expand its use of RPA, both by:

- **Increasing the capabilities of the current bot** – for example by potentially enabling it to access IRS data/systems (requiring credentialing) in order to carry out enhanced due diligence checks.
- **Developing additional bots** – for example for pre-award market research, invoicing, personnel security for onboarding contractor employees, contract closeout, conversational chatbots, other data reporting and regulatory requirements, etc.

- **(Potentially) sharing the existing bot with other agencies** – There has been interest from other Treasury bureaus and federal agencies. The Procurement Office is assessing whether it is feasible for other entities to use it.

Costs and requirements

Costs	Human resources	Other
• Implementation cost of €180 000 ($200 000); • €180 000 (€200 000) each year on maintenance and operational costs	• Outsourced RPA implementation to systems integrator • 5 employees working on the project internally • Help desk available to answer questions	• Process to be automated described in extremely high level of detail.

For the base year (i.e., for design, development, user acceptance testing, deployment, etc.), the cost of implementing the project was roughly €180 000 (US$ 200 000). On top of this base cost, roughly €180 000 (US$ 200 000) will be spent on operations and maintenance each year moving forward. These costs are split between:

- Maintenance of the cloud services and infrastructure (Microsoft Azure)
- Maintenance of automation platform (UiPath)
- Management of the RPA tool
- Provision of a help desk

In terms of the **human resources**, apart from the **expertise provided and work performed by the systems integrator** contracted to conduct the RPA implementation, **the IRS put 5 employees on the project internally**. The work performed on the project by these employees came in waves, with peaks for example when drafting the requirements package.

Another main requirement of the project was the **high degree of detail to which the automated process must be described**. The Procurement Office provided the vendor with a process script with extremely detailed information on the steps that must be carried out according to the responsibility determination requirements, and the specific way these steps are carried out by employees.

Risk and mitigation

There **are limited security risks** associated with the project, however as RPA is a new technology which many IRS employees were unfamiliar with, it was nonetheless necessary to address internal concerns about these aspects. The project team therefore spent a significant amount of time raising awareness internally about the technology and the project. Security risks were also reduced as the bot was not granted credentialed access to the IRS IT environment and does not interact with internal IRS systems and databases.

Challenges and lessons learnt

One of the main challenge associated with the project relates to the need to **win support from internal stakeholders** for an RPA implementation. It was necessary for the project team to conduct extensive internal awareness raising activities and build a coherent narrative about the benefits of the technology in order to drive the project to a successful conclusion.

4.7. 3D printing case studies

The following chapter presents **one case study** in which a public organisation makes use of 3D printing as a primary technology to transform or improve its public procurement processes and functions:

Case study 20: Additive Manufacturing at Deutsche Bahn

Lead Organisation: Deutsche Bahn, Mobility goes Additive

Location: Germany

Technologies: 3D printing

Level of government: National

Problem Statement: Deutsche Bahn is facing obsolescence issues and low negotiating power related to certain spare parts necessary for the maintenance and reparation of trains.

Description: In order to tackle issues related to waiting times associated with the replacement of certain spare-parts, and to increase its negotiating power over their pricing, Deutsche Bahn started to experiment with additive manufacturing in October 2015. As the company did not have all the required knowledge and infrastructure in-house, the Mobility goes Additive Network was established in September 2016. The Network brings together the entire 3D printing value-chain and is aimed at strengthening the cooperation among stakeholders in order to create synergies. Since then, Deutsche Bahn has identified over 120 use cases for 3D printing, and successfully printed more than 7000 components, which has resulted in important cost-savings linked to the procurement function of the state-owned enterprise.

Lessons learnt: Internal change management is a key enabler for disruptive digital transformation projects, and should be thoroughly planned and invested in. In addition, certification requirements and processes, including standardisation, may require adaptation in the context of 3D printed products. Close collaboration among key stakeholders, including public authorities, will be crucial in this respect and is expected to drive further research and developments in the area of additive manufacturing.

Cost: Initial investment of €950 000, and yearly budget of €600 000, plus the price of actual print outs (ranging from €1, to €5000-6000 per component)

Impact: High. Reduced vehicle idle time due to maintenance and reduction of overall procurement costs.

Future expectations: The Network further aims to address national authorities, including the Federal Bureau within the German Ministry of Transport, in order to promote the up-take of 3D printing in Germany.

Human resources: No additional human resources, the work is embedded in the already existing Innovation Department.

Risks: Financial risk related to the significant investment in the overall initiative, and, quality/reliability risks related to the end-products.

Other requirements: Detailed, technical information components to be printed e.g. the description of the component, including its use, the photo and/or illustration of the component, the size and precise measures of the component, the material of the component and whether specific security requirements apply, etc.

Project timeline: October 2015 - present

Project status: Fully deployed solution

Email: info@mobilitygoesadditive.com

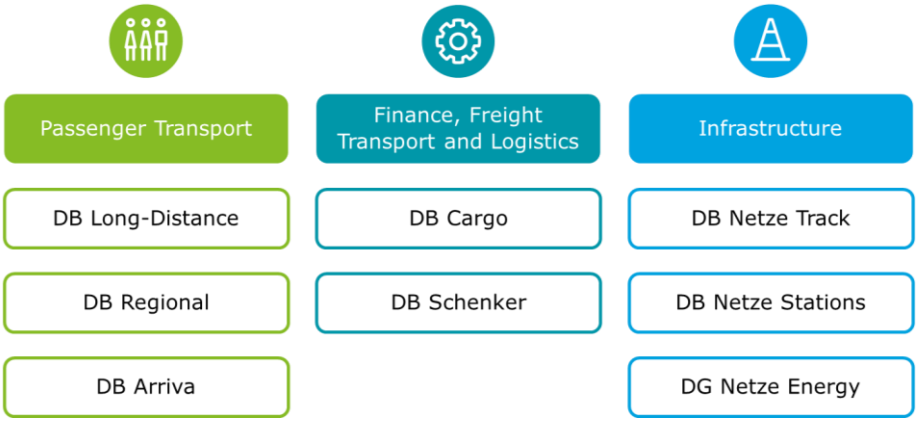
Website: https://mobilitygoesadditive.org/

Context and problem statement

Deutsche Bahn Group (DB Group) is a global transport and logistics services provider operating in more than 130 countries around the world and employing nearly 320 000 people. As a private joint-stock company, with the Federal Republic of Germany being its single shareholder, it is also Germany's national railway company. DB Group is organised in three main streams – passenger transport; finance, freight transport and logistics; and, infrastructure – which are further divided in various business units, as illustrated below.

Passenger transport, the core business of the company, is composed of three business units:

- **DB Long Distance:** provides national and cross-border long-distance rail services and road transport.
- **DB Regional:** provides a fully comprehensive regional transport network which links conurbation and rural areas.
- **DB Arriva:** the Group's subsidiary for the regional passenger transport outside Germany since 2010.



Source: Deutsche Bahn 2019, design by Deloitte

In 2018, the company provided transport services to over 4 669 million passengers, or 12.8 travellers a day either via rail (55%) or bus (45%) thanks to a rolling fleet of 274 ICE trains, 1 299 locomotives, 5 345 other rail vehicles (including metro, trams, rail buses) and 28 797 buses[153]. Alongside passenger satisfaction which attained 75.1% in average in 2018, punctuality is one of the key performance indicators (KPIs) for passenger transport. As regards rail transport within German borders, DB Group achieved a punctuality rate of 74.9% for long distance journeys and 94.0% for regional vehicles.

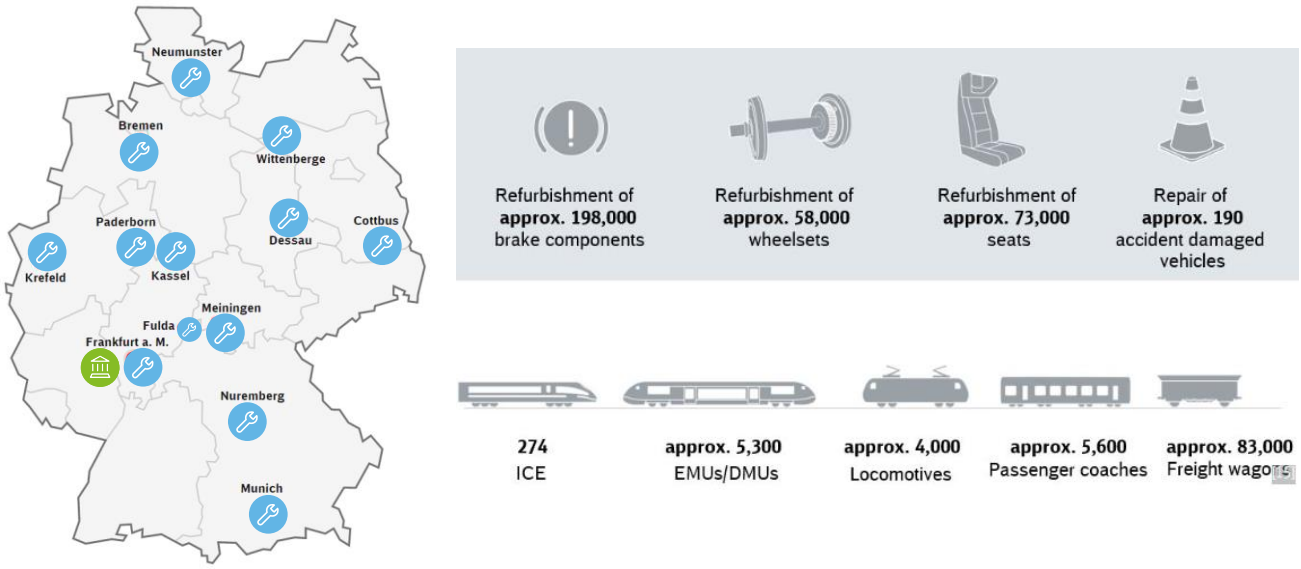
Technical issues and related maintenance of the fleet are naturally key elements having a negative impact on punctuality. Moreover, the German high-speed ICE network is composed of short connections to be caught in a series of 'hubs' throughout the country, meaning that missing one connection can result in hours of delay. Therefore, it is crucial that maintenance and reparations of the fleet are carried out as efficiently as possible.

Maintenance of the fleet is dealt with internally and at local level by DB Fahrzeuginstandhaltung, an entity of the group established in 2001 (part of the Finance, Freight Transport and Logistics stream), which employs 7 500 people (2018) and holds a network of 13 maintenance depots throughout Germany, each managing

[153] See : https://ir.deutschebahn.com/fileadmin/Englisch/2019e/Berichte/DuF18_e_web.pdf

series of workshops or ateliers (approximately 140 in total). The core services of the organisation include scheduled overhauls, accident repair, modernisation projects and refurbishment of rolling stock components.

Maintenance of vehicle components, such as brakes, engines and wheelsets, is the major component of DB Fahrzeuginstandhaltung. As highlighted in the figure below, in 2018, nearly 60 thousand seats, 75 thousand wheelsets and 200 thousand break components were refurbished, and 200 trains damaged in incidents were repaired throughout DB Group's fleet.



Sources: (L) Deutsche Bahn 2019, design by Deloitte; (R) Deutsche Bahn 2019

The main operational challenge faced by the maintenance depots is the high specificity of pieces, which also impacts their (timely) availability. Some spare parts may only be produced by a handful of suppliers, who therefore have a high level of negotiating power as regards pricing[154]. In addition, it can take months for some of these spare parts to become available, with knock-on effects on the punctuality of transport services. For some components, DB may even face obsolescence issues, with original manufacturers having completely stopped the marketing of certain products.

In summary, DB is faced with two main issues: long waiting times for sourcing and limited to non-existent negotiating power over price of spare parts. As a state-owned enterprise, similarly to other public procurers, these are key drivers impacting the overall performance of the organisation, and its added value with regards to taxpayers.

Objectives and vision

As a result, DB started to explore new ways of procuring certain spare parts and components for its maintenance depots. In October 2015, DB's Technology & Innovation division came across additive manufacturing, or 3D printing, as a possible means to:

- reduce waiting times associated with the replacement of certain elements, and,
- increase DB's negotiating power over pricing of spare parts.

The project was launched internally in the Technology & Innovation department, before being integrated in a separate nonprofit entity focused entirely on additive manufacturing. Today, additive manufacturing is a

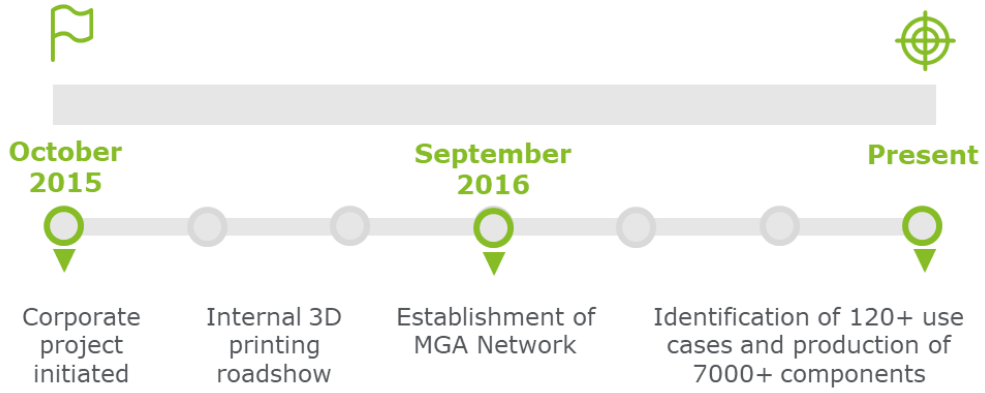
[154] DB is also often faced with minimum quantity orders for certain pieces which involve molding, which is not optimal when only one piece is required.

key area of DB's Technological Excellence (TechEx) programme, which focuses more broadly on digital transformation through emerging technologies across all functions of the Group.

Technological solution and implementation

By definition, additive manufacturing is "*the industrial production name for 3D printing, a computer controlled process that creates three dimensional objects by depositing materials, usually in layers.*"[155] In practice, there are more than 20 variants of 3D printing technologies, depending on the type of material and product to be printed. For instance, Wire and Arc Additive Manufacturing is used to produce big parts on metal, while Fused Deposition modeling or Fused Filament Fabrication is used to print plastic components.

In order to experiment with the technology, DB first launched a corporate digital transformation project inside the Technology & Innovation department. The project produced encouraging results, but as it required additional expertise lying outside DB, it was eventually spun off as a formal nonprofit entity, Mobility goes Additive (MGA)[156]. The following sub-sections describe both phases in more detail.



Source: Deloitte

Initial testing: 3D printing as a digital transformation project

As mentioned above, 3D printing was first trialled as a corporate project aimed at fostering digital transformation at DB, led by the Technology & Innovation division of the company.

When the first ideas about trying out 3D printing emerged, DB started with a top-down approach through the analysis of the maintenance depots' SAP systems and information available on the different vehicles, related machines, products and spare parts, in order to understand whether any of these could be printable elements.

However, as this strategy did not yield the expected results due to a lack of precise data, DB moved on with a more time-consuming but effective bottom-up approach by consulting directly the maintenance workshops' colleagues. This approach resulted in the creation of some preliminary spare parts i.e. 'testers', which were used in an internal 'road show' across all maintenance workshops and ateliers, aimed at convincing the staff about additive manufacturing being a reliable alternative to traditional sourcing form external suppliers.

Deployment at large-scale: Mobility goes Additive Network

After the positive conclusions of the testing and internal promotion period, DB launched the additive manufacturing of actual, missing spare parts to be replaced in trains. The first components printed were made exclusively of plastic, mostly polyamide. Since DB did not have its own 3D printers nor an in-depth

[155] See : https://www.twi-global.com/technical-knowledge/faqs/what-is-additive-manufacturing
[156] See : https://mobilitygoesadditive.com/en/

expertise of the technology, the company started to closely collaborate with 3D printing service providers in the industry to cater for its manufacturing needs. This ultimately resulted in the establishment of the MGA Network in September 2016, with DB as the founding member alongside 8 other organisations. While the MGA Network is formally independent from DB, its Executive Board – minimum 2 to 7 members – includes one representative appointed by the railway company[157]. However, unlike DB for which it is the sole shareholder, the Federal Republic of Germany is not involved in any way in the Network and/or its projects.

In just three years, MGA has grown into an international network of 105 members including companies, institutions and research institutes, all working on industrial additive solutions together, in order to promote innovation and create synergies. In particular, the membership is notably composed of[158]:

- Railway companies but also automotive (e.g. VW, F1 teams)
- Both big and small printing companies
- Big material providers (e.g. DSM, DASS)
- Software producers, including start ups (e.g. Autodesk)
- Research Institutes (e.g. Fraunhofer) and Universities
- Consultancies and lawyers specialised in legal questions related to additive manufacturing

In essence, the aim of the Network is to cover the entire supply chain of 3D printing, therefore making it possible to tackle topics that one party alone could not deal with. In this vein, the Network is organised around eight working groups highlighted in the figure below, each one dedicated to subjects requiring cooperation of a wide range of 3D printing stakeholders. The overarching goal of the Network is ultimately, to reduce overall research, development and implementation costs for all parties working with additive manufacturing, thereby ensuring its wider take-up.

Source: Mobility goes Additive 2019, design by Deloitte

As far as DB is concerned, its focus in the context of MGA is mainly two-fold:

- **Innovation scouting** i.e. identifying new use cases by matching maintenance product sourcing needs with new additive manufacturing technologies in order to address them more efficiently (mostly driven by the Technology & Innovation department);
- **Innovation implementation** i.e. launching the identified additive manufacturing use cases as projects in practice (mostly driven by the specific maintenance depots or workshops themselves).

[157] See : https://mobilitygoesadditive.org/wp-content/uploads/Association-Statutes_Mobility-goes-Additive-e.V_16.11.17.pdf
[158] See : https://mobilitygoesadditive.com/en/members/

The outcomes of DB's involvement in this context are further detailed here below.

Results and future expectations

On the one hand, regarding innovation scouting, DB has identified more than possible 120 use cases – some of which have already been implemented – related to maintenance and refurbishment activities since the launch of the overall initiative. These include notably ventilation grilles, fan propellers, enclosures, headrests, coat hooks, cable boxes and spare parts for coffee machines. In a broader context, additional use cases are notably handrails printed with Braille to be used in train stations to support the commuting of visually impaired people[159], or durable elastomers and flame retardant plastics to be used for safety purposes, which mean new opportunities for 3D-printed spare parts not only in maintenance.

On the other hand, regarding actual implementation of use cases as 3D printing projects, **more than 7000 components have been printed and put into actual use by the maintenance depots and workshops for rail and light-rail** (e.g. tram, metro, etc). Two thirds of those are plastic-based products while the remainder is manufactured into metal. Recently, DB even printed a 20-kilogrammes, 50*50 centimetres train break component into metal, which is a great achievement for additive manufacturing technologies.

Overall, the impacts witnessed by DB thus far are in line with the initial objectives of the initiative. While precise quantitative data is not yet available, the company notes the following positive returns.

First, vehicles in maintenance go back into circulation more swiftly, thereby **reducing vehicle idle time and related costs**. As an indicative example, an accident-damaged ICE high-speed train was recently put back on track in a timespan of three months, whereas just the waiting time for the required spare parts, would have amounted to five months through 'traditional' suppliers.

In addition, DB has realised that, as additive manufacturing involves the creation of a component layer by layer, it is therefore possible to enhance those areas of a given spare part which, based on experience, are especially prone to breakage. Consequently, this further **reduces the probability of subsequent faults and related maintenance and/or reparations**, which in turn, **increase the (timely) availability of vehicles**.

Second, the state-owned enterprise has a reliable alternative for procuring a series of spare parts, which **increases its bargaining power as regards its suppliers, and thereby reduces the procurement costs** as a whole (either the suppliers' price is pushed down, or, DB is able to print at lower cost). As an indicative example, DB estimates it has saved up to 50% of the costs that would have been borne under 'traditional' procurement by printing the Braille handrails.

In a nutshell, DB is convinced of the benefits related to the integration of additive manufacturing within its procurement function and processes, and is currently working on the development of specific KPIs to tangibly support this idea. At the moment being, three KPIs have been identified for the project:

- Number of additive manufacturing technologies scouted – target: 4 per year
- Number of actual printouts – target: additional 5000 by December 2019
- Magnitude of efficiency gains related to cost-savings – target: at least €750 000 per year

[159] These use cases have already been implemented and rolled out in Berlin Central and in other stations in the Aachen region.
See: https://www.deutschebahn.com/en/Digitalization_new/technology/New-Technology/3d_printing-3520386

While the first two indicators are rather straightforward to follow-up with, the achievement and measurement of the last KPI will be more challenging. DB aims to compute the cost-savings through a counterfactual analysis, using the vehicles in standstill, 'traditional' spare parts' waiting times and related costs as a basis, in comparison with the performance made possible thanks to additive manufacturing.

To conclude, alongside the work carried out in the Approval working group of MGA[160], these indicators will serve as key inputs the Network aims to put forward to address national authorities, including the Federal Bureau within the German Ministry of Transport, in order to promote the up-take of 3D printing in Germany.

Costs and Requirements

In terms of costs and requirements, additive manufacturing can be considered as a rather resource-consuming initiative.

Costs	Human resources	Other
• **Initial investment** €950 000 • **Annual budget allocation** €600 000 • **Cost of print-outs** €1 to €6000 per component	**No additional investment required in human resources.**	**Technical information** • Description and use • photo and/or illustration • Size and precise measures • Material • Security requirements • Risks-levels

Source: Deloitte

Regarding financial investments, in 2016, DB invested €950 000 in the early testing and internal promotion of additive manufacturing as well as and work to be carried out in the context of MGA. Since then, the organisation has allocated a yearly budget of €600 000 for the innovation scouting stream. The costs related to the implementation of 3D printing projects are borne by the given maintenance depots and workshops themselves, similarly to the costs that are related to procurement through 'traditional' means. The price of a 3D-printed component varies significantly, depending on its specificity and the materials used: from €1 for a coat hanger to €5000-€6000 for the most expensive parts manufactured thus far by DB.

In terms of technical requirements, as mentioned above, additive printing requires detailed information about the components to be produced, which is not always available. Indeed, DB procures its trains as complete, ready-to-transport vehicles, and does not necessary have extensive information up to the level of individual spare parts. Moreover, even the train suppliers themselves, possibly supplying a vehicle that was assembled of components procured from yet other producers, may not be aware, for example, of which specific screw was used in a given spare part.

An indicative list of information required includes notably:

- A description of the component, including its use
- A photo and/or illustration of the component
- The size and precise measures of the component
- The material of the component and whether specific security requirements apply (e.g. flame retardant)

[160] See: https://mobilitygoesadditive.com/en/key-topics/#1531350768276-129d3a5b-a719

When such data is not available in DB's SAP systems for procurement, nor known by the workshop colleagues and/or the suppliers themselves, the required components needs to be extracted from a vehicle and analysed separately, which requires more or less resources depending on the extent of the assessment required. The depth of such analyses depends on the safety characteristics of the component: while a basic analysis will be carried out for a coat hanger, an extensive analysis will be required for any components related to the wheels or brakes of the trains.

In order to smoothen the analysis process, and ensure it is done effectively, DB has developed a 'Post card' check list for internal use, guiding the eligibility assessment of a product in view 3D printing. Key steps include notably the evaluation of the size of the component, the type of material, the cost of the traditional vs 3D printing sourcing, the time pressure/urgency, etc.

Finally, in terms of human resources, the initiative required did not require additional manpower at DB, as it was integral part of the Innovation Division's work.

Risks and mitigation

As presented above, additive manufacturing is an initiative requiring a significant investment. Therefore, financial risks were considered as relatively high, up until the first positive results. Here, the main mitigation action was the work in collaboration with the entire 3D printing value chain through the MGA Network, which allowed to somewhat reduce the costs borne by DB.

In addition, especially at the start, the initiative presented the risk of not delivering good quality replacement products, which, instead of decreasing the vehicles idle time in maintenance depots, would have on the contrary increased it. To cater to this risk, DB invested a lot of resources in the testing phase, including the production of prototypes, before deploying the actual large-scale production. Furthermore, DB focused at first on small, low-risk products made of plastic in order to mitigate the security risks related to any faults of printed products. Here again, working with a multitude of experts through the MGA Network was a key enabler for DB.

Challenges and lessons learnt

According to DB, the biggest challenge of the initiative was change management within the organisation itself. As additive manufacturing remains a rather new, or at least not well-understood technology, DB was faced with a lot of resistance to change internally. The strategy to convince internal stakeholders about the benefits and reliability of 3D printing internally had to be found via trial and error, and eventually, the additive manufacturing 'roadshow' was successful.

Another challenge is the applicability of existing certification processes. In fact, DB is bound to have all its vehicles and related components certified for conformity, which the organisation nearly exclusively addresses via the use of (international) standards. However, standards for 3D printing do not exist (yet), due to the young 'age' of the technology. This means that today, DB has to prove the technical conformity of some spare parts through other, more time consuming ways, usually involving a third party/notified body.

Other challenges are related to the current capacities of additive printing technologies themselves: there are still important size limitations as to the components that can be printed. However, DB is confident that thanks to strengthened cooperation among key stakeholders, notably via the MGA Network, significant

advancements will be made in this field already in the short run. This is also one of the reasons that DB calls for increased promotion of the technology in all sectors in Germany[161], as well as internationally.

[161] In this vein, Medical goes Additive (AM), a new network focusing on the medical industry was established by MGA in 2018. The AM Network aims to support the development of individualised care applications and therapies, thereby improving the quality of life. To do so, it helps its members to tap into the medical 3D printing market which is estimated to grow from €0.26 billion in 2015 to €5.59 billion by 2030. See: https://medicalgoesadditive.com/

5 Results of the case studies

This chapter summarises the main findings of the case studies in terms of use-cases, impacts, costs, requirements, and risks. It draws comparisons across the technologies investigated in order to reveal common trends and any strategic implementation approaches required. In this vein, the chapter presents a number of transversal and technology-specific lessons for the application of emerging technologies in public procurement.

5.1. Overview of use-cases for emerging technologies across the case studies

Looking across the case studies, it appears the different technologies examined are used to achieve differing effects and ends. AI & ML is used to predict future demand, categorise procurement spend and provide customer/client service through the means of a chatbot. Big data and data analytics technologies are used to analyse historical procurement prices and provide data on procurement trends to inform decisions (through business intelligence). Blockchain is used to provide transparency into different parts of the procurement process, allowing users to validate procedures as well as to provide a "data backbone" of trusted information (i.e. a reliable single source of data). RPA enables automation of simple and repetitive tasks at various points throughout the procurement process. Finally, 3D printing enables the direct production of certain spare parts, thereby eliminating the dependence on external suppliers. An overview of the use-cases observed is provided in Figure 68.

Figure 68: Specific Use-cases across the 20 case studies by technology[162]

AI & ML	Big data	Blockchain	RPA	3D Printing
Demand prediction (Case 1)	Price analysis (Cases 7 & 10)	Data backbone (Cases 11 & 15)	Automation of procurement processes (Case 16 & 18)	Printing of spare parts (Case 20)
Spend categorization (Cases 2, 3 & 4)	Business intelligence (Cases 8 & 9)	Transparency of tendering processes (Case 12)	Automation of tendering processes (Case 17 & 19)	
Chatbot (Cases 5 & 6)		Transparency of evaluation (Case 13)		
		Transparency of procurement processes (Case 14)		

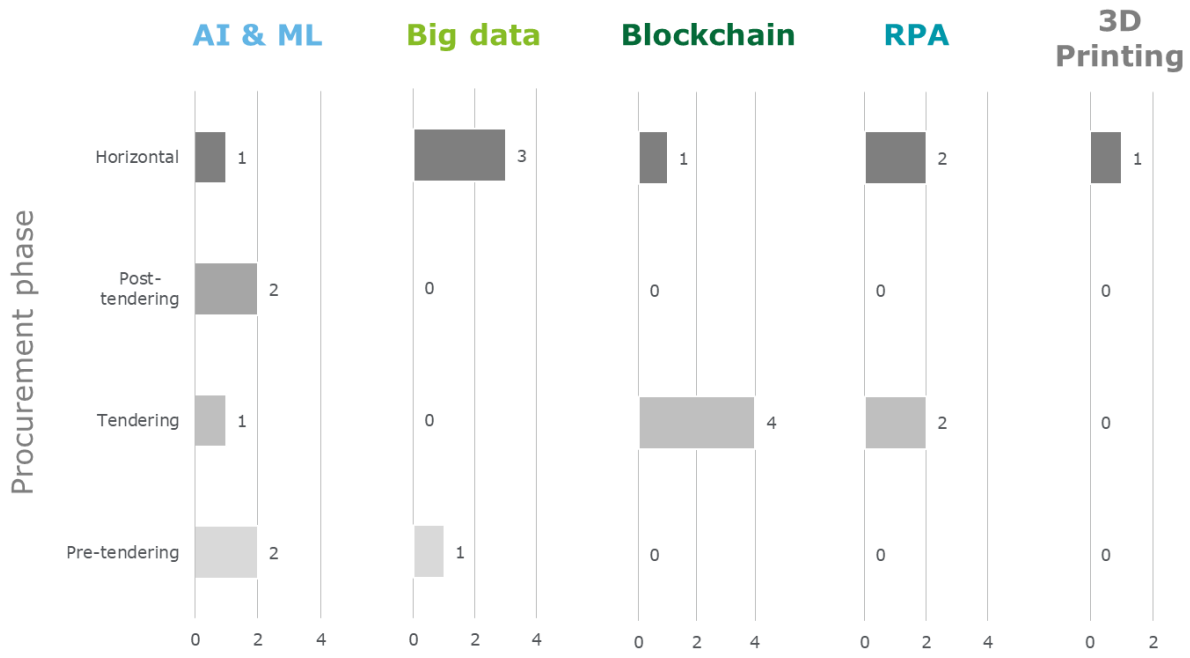
[162] These specific use-cases fit as sub-categories within the general use-cases presented previously in **Error! Reference source not found.** as follows:

- Analysis and evaluation: demand prediction, price analysis, business intelligence;
- Automation: automation of procurement processes, automation of tendering processes;
- Categorisation: spend categorisation;
- Chatbots: Chatbot;
- Data backbone: data backbone;
- Production of supplies: printing of spare parts
- Transparency: transparency of tendering process, transparency of evaluation, transparency of procurement processes

Several of the observed use-cases and technologies complement one another. For example, blockchain, when used to establish a data backbone, can enable the use of big data analysis, which in turn can feed into machine learning spend categorisation projects. However, one technology does not provide a replacement for another, indeed, each technology has quite distinct use-cases to which it is suited.

As shown in Figure 69 below, **each technology appears throughout all phases of the procurement process**. Moreover, each technology is applied in at least one case study as a horizontal application across multiple procurement phases. For AI & ML, RPA and 3D printing, at least half of the case studies feature this type of horizontal application. On the other hand, blockchain stands out as the technology most likely to be applied to the tendering phase (four out of five case studies).

Figure 69: Procurement phase of each case study by technology

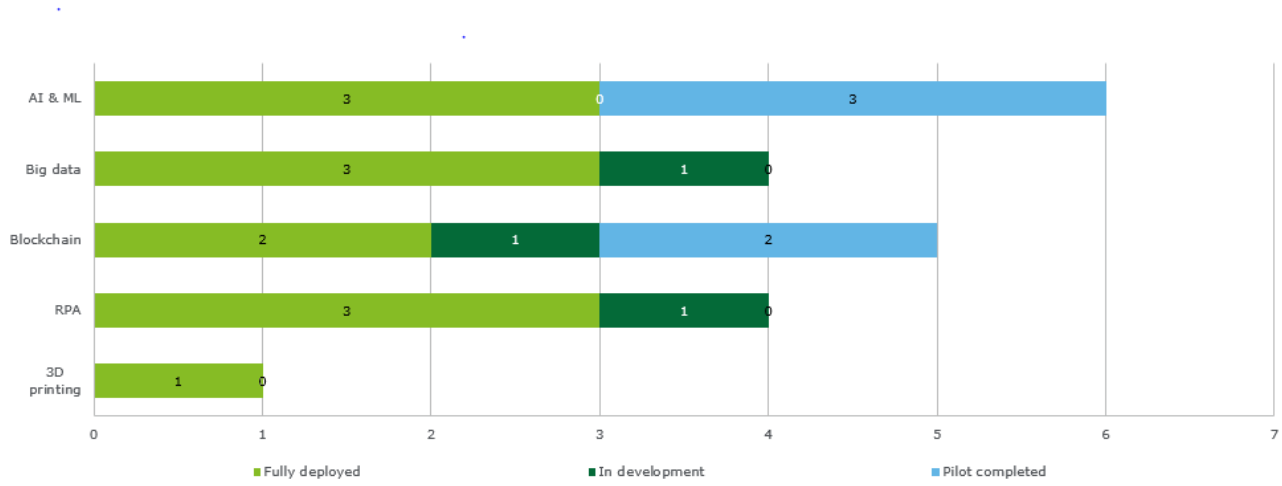


To conclude, although the way the technologies are used is different, it is possible to draw comparisons regarding the impacts and costs of their use, as well as the associated requirements and risks. Such a comparative exercise in presented in the next subsections.

5.2. Impact across the technologies

One crucial factor influencing the impact of the technologies used, is the level of development of the project, i.e. whether the solution is fully deployed, in pilot stage, or in development. As shown in Figure 70 below, for AI & ML and blockchain, a significant proportion of the solutions examined have not been fully deployed (yet), therefore limiting their possible impact thus far. Three out of six of the AI & ML cases are not yet fully deployed, while that number is one out of four for big data, four out of five for blockchain, one out of four for RPA, and zero out of one for 3D printing.

Figure 70: Project status of the case studies by technology



Impacts are most commonly quantified through the measurement of efficiency gains related to **employee time saved**. This is the case in AI & ML projects including CAITY (Case 4), Ask Laura (Case 6), big data and data analytics projects including MEDIAAN (Case 7), the Public Procurement Price Panel (Case 10), and RPA projects including Truman (Case 17), Intelligent Automation (Case 18), and the Automated Responsibility Determination (Case 19). Of these, the RPA case studies were generally associated with the highest measured employee time saved (from 2 to 29[163] FTE per year), while the time savings measured for AI & ML cases were smaller (no project saving more than 0.6 FTE per year). For the big data and data analytics projects the project owners believed significant time savings existed as the efficiency of certain tasks had been greatly increased, for example reducing the time it took to conduct price research from 6 weeks to 6 minutes. However, the effect of this in aggregate on time saved for employees had not yet accurately been measured.

Other impacts seen in the AI & ML case studies were, for the CAITY project (Case 4) increased **accuracy in spend categorisation** (as the automated solution developed was more accurate than the previous manual method used), and for the chatbot projects (Cases 5 and 6) increased **responsiveness to customer/client inquiries**.

However, some other projects including AI Product Management (Case 1), Explore State Spending (Case 2) and CPV Code Prediction (Case 3), have seen no impacts to date, as the solutions developed were not fully implemented. In the first two cases, the projects were not taken forward because of a lack of sufficient high quality (training) data making it impossible for the AI solution to reach an adequate level of accuracy. In the third case, the solution was developed by an external consultancy, however no organisation running a front-end eProcurement platform had yet made the necessary efforts to integrate it.

The **lack of clear and quantified measures of impact** is a common feature of the big data and data analytics case studies in the sample. In general, these projects have as an aim to enable more informed and accurate decision-making in relation to procurement. In theory, such initiatives could result in a measurable effect, for example, in better value purchases and lower public spend overall. However, this was not verified in practice through the case studies. The Public Procurement Price Panel initiative (Case 10) plans to measure the effect of the project on negotiating lower prices for public contracts, but has not yet

[163] 116 FTE are estimated to be saved by the Intelligent Automation project over the course of four years.

implemented this measurement exercise. Other cases, such as MEDIAAN (Case 7), have used user take-up as an indicator to estimate the results of the project: roughly 500 users work with the project's tool.

Several **blockchain initiatives** have not yet been scaled up to full-size projects. This was most notably the case for the Japanese blockchain feasibility study (Case 15), which found that blockchain would not be a cost-effective solution for the use–case planned (i.e. a single source of data for the qualification of vendors). For the project which has been fully deployed (Case 13), **increased transparency** is the main impact of the solution. Whether this has any wider effects, such as, for example, increased trust in public authorities or public procurement, has not been measured.

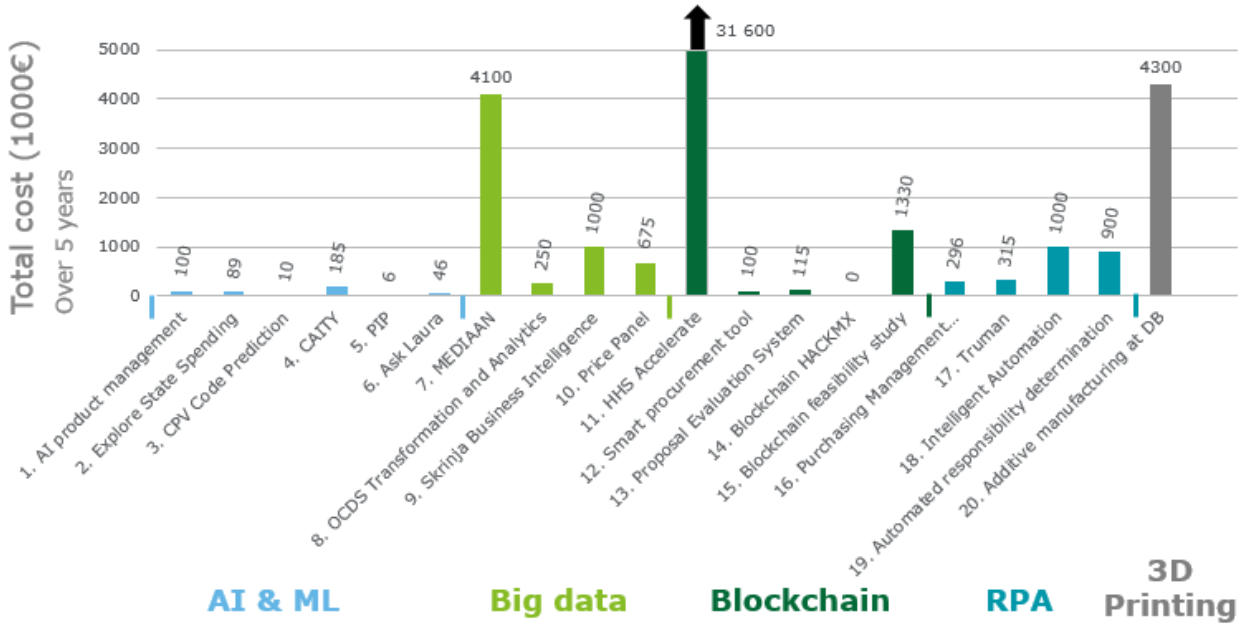
As mentioned above, **RPA projects** were associated with the highest measured employee time savings. In addition, these were also associated with a **more efficient completion of tasks**. For example, for the Truman project (Case 17) the RPA reduced the backlog of vendor offers requiring assessment by 100%. The other key impact identified is a **guaranteed regulatory compliance**. In two cases – Truman (Case 17) and the Automated Responsibility Determination (Case 19) the tasks automated are legally required. The use of RPA provides an assurance that given legal requirements are abided by.

Finally, for the single **3D printing case** in the study – Additive Manufacturing at Deutsche Bahn (Case 20) - the impacts are of another type and relate to **reduced vehicle idle time**. Through the direct printing of spare parts, Deutsche Bahn is able to reduce the waiting times associated with the traditional procurement of certain elements, and ensures trains are rapidly operational. It is also believed that the 3D printing project provides the procurer with **increased bargaining power** with suppliers, which should translate into better value contracts. However, this has not yet been measured.

5.3. Costs across the technologies

Projects with a wide range of costs were examined in the case studies, from projects with no upfront financial investments but supported through staff working time dedicated to the project as in Blockchain HackMX (Case 14)) to those that represent an investment of several million euros as in the MEDIAAN project (Case 7), HHS Accelerate (Case 11), and Additive manufacturing at DB (Case 20). The range of costs across the case studies is shown in Figure 71.

Figure 71: Cost of the case studies



There is **considerable variation in costs** in the case studies both **within and between the technology groups**. This suggests that the costs are driven by factors such as the **size and scope of the project** rather than the inherent cost of the technologies. The AI & ML projects are consistently among the lowest-cost case studies observed (from €6 000 to €185 000). However, it should be noted that this reflects the fact that a large proportion of them were pilots, and that fully implemented projects were done at a relatively small scale and consequently, with a relatively small impact. The chatbot projects in particular were possible to implement at a low cost, but also had little measured impact so far.

The big data and blockchain case studies both have one stand out high cost project - MEDIAAN (Case 7) for big data at €4.1 million, and HHS Accelerate (Case 11) for blockchain with €31.6 million. For the MEDIAAN project these costs were mostly related to human resource costs (3.4 million) with the remainder on hardware and licenses (€0.7 million). The cost breakdown is not known for the HHS Accelerate project.

The other big data projects all had mid-sized costs (between €250 000 and €1 million), reflecting the fact that they were significant projects involving the large-scale preparation, transformation and analysis of data involving sustained work from substantial teams. For example, the Skrinja Business Intelligence project (Case 9) had a team of 4 full-time employees supported by an additional 10 part-time employees. Meanwhile, the other blockchain projects with the exception of the feasibility study conducted in Japan (Case 15), were either pilots or relatively small projects. This is reflective of the fact that **organisations are still assessing the value of applying blockchain technologies**, and are often not yet willing to implement it in large scale projects. The obvious exception to this is HHS Accelerate (Case 11), which represents both the largest investment in the sample and has blockchain as a foundational technology (other technologies are also drawn upon, including RPA and machine learning). However, as this solution has not yet been fully deployed, it is too early to draw any conclusions about the success of this approach.

The **RPA projects are all mid-sized in terms of cost** (from €240 000 to €1 million) reflecting the fact that they are relatively large scale projects, with full-scale and operational implementations of the technology used to automate a variety of different tasks. As highlighted earlier (in Section 5.2), these RPA projects also

had the highest measurable impacts in terms of employee time saved. These findings suggest that RPA is a **relatively mature technology** that procurement entities are integrating into their daily activities.

Finally, the one 3D printing project is high cost, at €4.3 million. While, a sample of one is not sufficient to draw any firm conclusions, it may be that the nature of the technology inherently involves high start-up costs to cover the necessary infrastructure (printers) and resources (including technical know-how). It should be noted that the nature of the technology and use-case is quite different from the others explored, essentially involving a form of production.

The relatively limited information on quantifiable impacts available also makes it **difficult to conduct any kind of reliable cost-benefit analysis**, or compare the relative costs of the different technologies for a given level of impact. Of the technologies, the observed costs seem to confirm the impression that **big data and RPA projects tend to be larger, full-scale projects** and that these technologies are treated as more mature and operational than either AI & ML or blockchain.

5.4. Requirements across the technologies

The types of requirements considered for the implementation of the cases include human resources (number of staff and competences) and other requirements.

5.4.1. Human resource requirements

key requirement to implement any of the emerging technology projects described in the case studies is **accessing the necessary human resources**. Similarly to impacts and costs, there is a **large degree of variation** both between and within different technologies. **AI & ML cases** tend to **involve smaller project teams (1 or 2 people, generally not on a full-time basis)**, with a high proportion (in some cases almost all) of the work outsourced to consultancies with specialist knowledge.

The **blockchain projects** are in general somewhat larger than the AI & ML projects in terms of the human resources dedicated to them (at least 4 or 5 people, or following a consortium approach). Both Blockchain HackMX (Case 14) and the Blockchain Feasibility Study (Case 15) **set up consortiums** involving a mix of public sector, private sector and academic experts in order to access the necessary skills. This **consortium approach was also followed in the one 3D Printing project** (Case 20). In this case, a consortium was set up partly to benefit from the involvement of players at different stages in the value chain and partly as a mechanism to share costs.

The **big data projects in general are larger, longer term initiatives requiring sizable project teams** (at least a four person team and ranging up to 14). A notable difference to other projects in the study is that a **larger proportion[164] of the work seems to be driven from in-house**, with the necessary expertise on data identified internally. The MEDIAAN project (Case 7) and Skrinja business intelligence project (Case 9) exemplify this approach, with large and full-time project teams (six full-time, and four full-time supported by ten part-time, respectively) working on the initiative, although still with some outsourced support[165] in order to benefit from external IT consultancy expertise.

To a lesser extent, **this approach is also echoed in the RPA cases**. The Intelligent Automation project (Case 18) stands out in this regard. The project is **driven by a large in-house team of 15 FTE employees**.

[164] Precise quantification not possible with information available
[165] Figures not available on precise level of support from consultants

At the start of the project, external consultants[166] with RPA expertise were involved to help train the internal team and support the set-up of the technology tools and first automations. As the project progressed, this consultancy support was reduced as the in-house team took on the bulk of the project tasks and responsibilities.

5.4.2. Other requirements

Beyond human resource requirements, a number of other requirements for projects deploying emerging technologies have been identified. Several of these apply across the different technologies.

A common requirement is the **presence of existing eProcurement systems or platforms** used as building blocks. These legacy systems usually generate the underlying data that big data tools are used to analyse as in the Public Procurement Price Panel project (Case 10), or that machine learning tools are used to categorise as in the Explore State Spending project (Case 2). In the case of blockchain, the solution is often linked in some way to an existing eProcurement system so that the results of particular actions of procurement stages can be recorded in a reliable and transparent manner.

In cases where such an eProcurement system does not exist, it will need to be created separately. This is in fact a major part of several of the blockchain case studies. For example, the Digipolis Smart Procurement Tool project (Case 12) involves the creation of a non blockchain-based eTendering system, which a blockchain record is linked to. Similarly, the blockchain-based proposal evaluation system (Case 13) involved the creation of an off-chain (i.e. the associated data is not directly stored on the blockchain) digital platform for recording evaluation.

As a rule, all of the blockchain projects require substantial off-chain components where data is stored and processed. Blockchain as a technology is not suitable for processing large amounts of data, and so the approach taken by a number of projects is to provide an off-chain database where large data items are stored, while a "tag" pointing towards them is stored on the blockchain. This approach is followed in the HHS Accelerate project (Case 12), and was explored in the Blockchain Feasibility Study (Case 15).

The application of RPA technology is also reliant upon the existence of established digital systems for processing data. In general, RPA is used to for automating simple processes previously conducted manually within workflows carried out within existing digital systems.

Another general requirement for these projects, which is linked to the previous point about the existence of digital procurement systems, regards **access to good quality data**. This applies particularly to the AI & ML, big data and data analytics, and RPA projects. For the AI & ML projects, the data required is **structured training data**. In several of the projects, including Explore state spending (Case 2), CPV Code Prediction Case 3), and CAITY (Case 4), a machine learning tool is used in order to categorise spend. In order to do this, the machine learning algorithm must be trained on a large quantity of spend data that has already been categorised according to the groupings required. The availability of this training data was a key differentiator determining the success of these projects. For the Explore State Spending project (Case 2), there was an insufficient amount of categorised data (approximately 300 000 rows) and the categorisation algorithm never reached an adequate level of accuracy. The CAITY project implemented a very similar use-case, however it had access to a far larger data-set of categorised spend data (45 million rows). As a consequence, the project was much more successful – the categorisation algorithm developed has been deployed and has replaced the manual categorisation process previously followed.

[166] Number of consultants involved not available

For the **big data and data analytics projects, access to good quality data is also key to their success**. MEDIAAN (Case 7) and the Public Procurement Price Panel (Case 10) draw on previous spending data, while OCDS Transformation and Analytics (Case 8) and Skrinja Business Intelligence (Case 9) use general data on procurement procedures and outcomes. They structure this data according to some agreed upon format and standards (e.g. OCDS), and develop tools in order to analyse it.

An important determinant of the difficulty of the project, however, is the quality of the underlying data sources. If this data is well-structured and clean, the reformatting and standardisation of the data can be a relatively straight-forward task. However, if it is not the case, a very significant effort may have to be dedicated to ensuring that the data is in an appropriate state for analysis. As long as access to this data is ensured and information on how the data is currently structured is available, this is difficult but remains possible. The approach implemented by the EBRD in the OCDS Transformation and Analytics case (Case 8), in which they transform the data generated by existing eProcurement platforms to the OCDS standards and build Business Intelligence tools that run on top of this data, can be applied to data in a huge variety of states and formats. As long as the project team is provided with the necessary information on how this data is structured it can perform the necessary transformation – although the less structured and less clean the data is, the more difficult this will be.

The quality and structure of data held within an organisation can also be an important influencer regarding whether RPA projects are feasible. RPA is only able to automate very clearly defined and standardised processes. Typically tasks conducted by RPA involve copying or transferring data (e.g. text) from one cell to another. If the data that is being transferred does not follow the correct standards or is incorrectly formatted, the technology may not understand it as an input. In this case the tool may not be able to complete its task and human intervention may be required.

A final type of requirement, which was mentioned in numerous case studies applying different technologies was the **need to build support for the project with internal stakeholders and users**. This was particular apparent in larger scale projects, where it was necessary to secure funding for the project, win approval from those responsible for IT security, and promote the use of the solution across the organisation. For the HHS Accelerate project (Case 11), a gradual approach was taken toward the development of the technological solution developed to build up evidence of the validity of the approach and build internal support. User familiarity and support for the project was also promoted through the use of multiple human-centred design sessions – which gathered input from future users on the design of the new tools.

The experience of the Blockchain-based proposal evaluation project (Case 13.) also demonstrate the need to build support for the use of blockchain technology in particular. The project owners noted the lack of awareness of the potential use-cases of blockchain within the public sector, where there remains a persistent association with cryptocurrency. It emphasised the need for education on the potential applications of blockchain, and the value of being able to point to other blockchain projects that have been successfully implemented in the public sector as a means of building support.

In the area of RPA, the Truman project (Case 17) also demonstrates the need to build support for the project from different stakeholders. On the one hand, approval from the IT security office was required, as there were concerns about providing access to bots to the organisation's IT environment where it could potentially conduct unexpected actions. This was addressed by pilot demonstrations showing the capabilities of the technology and providing evidence that any security risks were very limited. On the other hand, it was necessary to get approval from various systems owners across the organisation in order to deploy the planned automation. In general, a **key feature of winning internal support was building a solid business case** which demonstrated the benefits and return on investment of the use of the technology. Another method was demonstrated in the Additive Manufacturing in DB project (Case 20) which used a

"roadshow" to convince staff in different locations about the reliability of additive manufacturing as an alternative to traditional sourcing form external suppliers.

5.5. Risks across the technologies

Overall, the **risks identified in the case studies were viewed as relatively limited** by the project owners. Those risks that were identified were largely shared across the different technologies. They included **privacy and security concerns, lock-in due to the use of proprietary solutions, and problems related to limited knowledge** of the emerging technology being used.

Privacy and security risks were mentioned across a large number of different cases. However, in general precautionary actions were taken at the start of the project and these risks were considered to be under control. For example, in the CAITY case study (Case 4), training data was stored during the early stages of the project on an external Azure server. This data was anonymised in order to avoid any privacy issues related to personal data, and security concerns were addressed had previously been awarded a security certification by the government. The MEDIAAN project (Case 7) on the other hand dealt with risks regarding unauthorised users accessing confidential data by applying a set of identity management tools. The project team was able to draw on tools provided at the central (Flemish government) level.

RPA projects tended to be more focussed on security issues as opposed to privacy. For several projects (17. Truman; 19. Automated responsibility determination), internal security providers had concerns about providing bots access to their IT environments in case they conducted unexpected actions. These concerns were addressed through demonstrations to these stakeholders regarding what the bots were actually able to do. In addition, for the Truman case, these risks were reduced as only "attended" bots – which must be activated each use by an employee – were deployed. For the Automated responsibility determination case, on the other hand, the bot was not given credentialed access to other IT systems.

In some of the big data and robotic process automation cases **lock-in risks** were also mentioned. The MEDIAAN project (Case 7), the Public Procurement Price Panel (Case 10) and the Purchasing Management Platform (Case 16) all draw on different types of proprietary technology in order to develop their solution, and all report some level of lock-in risk. In each case, however, this risk was judged to be relatively minor. Without an evident open-source replacement, the choice was made to make use of the proprietary technology, even if it was related to some risk of lock-in further down the line.

A final type of risk mentioned in several of the projects was simply that due to the "emerging" nature of the technology being used relatively little expertise and knowledge was available on its implementation, leading to uncertainties about expected outcomes. This was reported in the Intelligent Automation project (Case 18), Blockchain feasibility study (Case 15), Smart procurement tool project (Case 12.), and HHS Accelerate project (Case 11). The general approach used to address this risk in these cases has been the use of an incremental, phased approach. By starting and testing the concept on a smaller scale before rolling it out more widely it is possible to limit the risks of implementing a new technological solution. Following this sort of approach can also help build internal support. For the Skrinja Business Intelligence project (Case 9), the completion of an earlier big data pilot project familiarised internal data owners with the potential of big data projects and won their interest in the follow-up business intelligence project.

5.6. Lessons learnt across the technologies

A number of both general and technology-specific lessons can be drawn from the comparisons above and the detailed case studies. These lessons, listed below, can support public organisations move towards an effective implementation of the technologies described in this report.

5.6.1. General lessons

Lesson 1: Follow a gradual approach towards solution development and deployment.

See Case Studies **2, 4, 5, 7, 9, 11, 12, 15, 18**

A gradual approach can allow organisations to explore the potential of emerging technologies, build up their expertise in the domain, and limit the risks of unexpected outcomes. This approach is followed in a large number of the case studies, many of which have an initial pilot phase in which they explore the potential of the technology on a small scale. This approach is advisable for any large-scale IT implementation, but particularly for one drawing on emerging technologies for which there are fewer examples of successful implementation and a larger degree of uncertainty.

Lesson 2: Develop a strategy to build-up internal support for the project

See Case Studies **9, 11, 13, 17, 19**

A key determinant for success of projects, is winning the necessary support from internal stakeholders to get approval and funding for the development of the new solution as well as a high level of use once it is deployed. Project leaders tried a number of different approaches towards winning this support in the case studies. One of the key ways to build support is to develop a convincing business case that demonstrates the value that the technology can bring to the organisation. Another is to demonstrate small-scale implementations to give a taster of what can be achieved with the technology.

Lesson 3: Build data management capabilities as a facilitator of emerging technology projects

See Case Studies **1, 3, 7, 8, 18**

Data management capabilities are a key enabler of emerging technology projects, particularly big data, and AI & ML projects. These projects need large quantities of high quality, well-structured data in order to provide insights and support automated solutions. RPA also relies on good quality, standardised data in order to be able to process it. Before embarking on emerging technology projects, organisations should ensure they have a well-established approach to data management that can serve as a foundation for these projects.

Lesson 4: Assess the appropriate approach to knowledge management

See Case Studies **2, 4, 6, 18, 20**

The necessary expertise to implement emerging technology projects is often not available in-house. In order to develop these projects, organisations therefore need to assess how they can best access the necessary knowledge, whether it is already available internally, or needs to be reached through outsourcing, hiring employees with different skill profiles, or investing in training programmes. A mix of these different strategies is pursued in the case studies, and the appropriate approach will be specific to the project and the organisation.

Lesson 5: Ensure user feedback is incorporated into the solution design

See Case Studies **10, 11, 12,**

User feedback should be gathered and reacted to during the design phases of the project to ensure that the solution developed is well adapted to their needs. Failure to do so can result in either low take-up of the solution or increased costs due to the need to adapt the tool at a later stage. Input can be focussed on the existing solutions used and current pain-points or reaction to early prototypes of the solution being developed.

5.6.2. Technology-specific lessons

Technology: AI & ML

Lesson 6: Ensure access to high quality training data for AI & ML projects

See Case Studies **1, 2, 3, 4**

AI & ML algorithms require high quality training data if they are to predict outcomes or categorise data with sufficient accuracy. A key differentiator of successful and less successful AI & ML case studies was the availability of pre-categorised training data. If such data is not immediately available it may be possible to transform or clean existing data so that it is fit for purpose as training data. However, this can be a resource-intensive process. At the start of the project, the source of the underlying data should be identified and an estimate should be made of the effort and resources necessary to ensure it can be used as effective training data.

Technology: big data and data analytics

Lesson 7: Involve subject matter experts in data analysis to ensure proper interpretation of results

See Case Studies **9, 10**

The involvement of subject matter experts is crucial to ensuring that the results of big data and statistical analyses are properly interpreted. While data and statistical analysts have an important role to play in terms of providing technical competences, this should be complemented by input from non-IT experts who have detailed knowledge of the underlying subject area and issues to which the data refers. It is these experts who can both point towards promising areas for analysis and validate whether the results are convincing or could have alternative explanations.

Technology: blockchain

Lesson 8: Share knowledge of the potential applications of blockchain, which remain poorly understood

See Case Studies **11, 12, 13**

The blockchain case studies illustrate that the technology has a range of applications that extend well beyond the cryptocurrency use-case that it remains most known for. Efforts to educate internal stakeholders on the potential and value of the technology are required ahead of any implementation. The case studies have demonstrated that blockchain can be a promising technology both to ensure transparency and reliability at key phases in the procurement process and as an enabler of a data management approach, providing a reliable single source of data.

Technology: RPA

Lesson 9: Thoroughly assess which processes are most suitable for automation

See Case Studies **17, 18, 19**

RPA can be effectively used to automate processes with specific characteristics. The processes automated should be rules-based, repetitive and highly standardised. In addition they should be selected on the basis of which automations are likely to be high impact (e.g. because the current manual process is either time-consuming or experiences a high error rate). Organisations implementing RPA should conduct a comprehensive review of their processes against these selection criteria in order to assess which should be automated.

Technology: 3D printing

Lesson 10: Assess opportunities for collaboration with other stakeholders in the 3D printing value chain

See Case Study **20**

3D printing is a technology that can have high upfront costs if used on a large scale for the production of parts. In order to overcome this potential barrier to application of this technology, organisations should assess how they can best coordinate with other stakeholders in order to share costs, for example through the creation of a consortium that pools resources.

6 Conclusions and next steps

This chapter presents the overall conclusions that can be drawn from the study as a whole, including the development of the longlist, the case studies, and the lessons learnt. It proposes next steps that can be taken to continue the journey towards a digital transformation of public procurement in the EU.

During the course of this study, a longlist of 96 projects in which public organisations apply emerging technologies to their procurement processes and activities was developed, together with detailed case studies on 20 of the projects. The **longlist remains a live document** which can and should be added to as further projects are identified[167]. It provides a first port of call for organisations interested in the potential applications of emerging technologies to procurement and in discovering which other entities have experience in this area.

The 20 case studies selected from this longlist have been developed in order to provide detailed information on types of technological solution adopted together with the **impacts, costs, requirements and risks** associated with these solutions. The primary technologies presented in these cases studies are AI & ML (6 cases), big data and data analytics (4 cases), blockchain (5 cases), RPA (4 cases), and 3D printing (1 case).

For each of the dimensions mentioned, there is **substantial variation both within and between technology groups**. It appears that the costs of these projects are related to the scope and scale of the particular solution being developed rather than any inherent cost of a particular technology. That said, case studies on RPA and big data and data analytics in the sample tend to be more costly, reflecting that projects using these technologies tend to be more mature and implemented on a larger scale. The one 3D printing case study looked at was also a high-budget project, with high start-up costs linked to purchasing the necessary infrastructure.

The RPA case studies tended also to be the ones with the largest *measured* impacts (in terms of employee hours saved). However it is hard to compare these with technologies such as big data for which the aims (*e.g. improved decision-making)* are more difficult to measure (and often were not measured).

Regarding the main risks of the project, these were generally seen as limited, but a common theme was of **concerns regarding limited knowledge and expertise on the technology being implemented**. A frequent approach taken to address this concern was the **use of an incremental project approach**, whereby small-scale implementations (e.g. a pilot phase) were gradually built up into a more substantial deployment. This approach should be taken as a general lesson for public organisations interested in applying emerging technologies to their procurement processes.

The other key take-away from the study relates to one of the key requirements identified in multiple different case studies across different technology areas. A common theme was that a **high level of data management is a requirement for the application of these emerging technologies**. This applied to AI & ML cases in that a source of good quality training data is required in order to develop a well-functioning algorithm. It applies to big data and data analytics cases, which require well-structured data sources (or

[167] https://ec.europa.eu/growth/single-market/public-procurement/digital/emerging-technologies_en

need to establish this structure) as a basis for their analysis, and it applies for RPA cases as this technology is only able to process highly standardised data. Blockchain technology relates to this requirement in a different way as one of the use-cases of the technology can actually be as an enabler of data management, providing a trusted single source of data that other applications can draw upon.

The 20 case studies developed constitute a useful resource that public organisations can reference to better understand the potential of these different technologies, the steps required to implement them, and what they can expect in terms of both inputs and outputs if they implement similar projects.

Building on the findings of this study, **future work could investigate further some of the key enabling steps required in order to implement these technologies**. The possibilities suggested below were sourced and validated during a project Final Workshop on Emerging Technologies in Public Procurement[168] with EXEP[169] members and other stakeholders. Options endorsed by workshop participants include looking in greater detail into **data management approaches**, and developing recommendations on how organisations can best prepare and structure their data in order to support the future development of emerging technology projects. Additionally, a further analysis of legal issues (e.g. GDPR compliance) associated with data management and the application of emerging technologies could be conducted.

There is also a high level of demand for additional financial and technical support in this area at EU level. Financial support could be provided in the form of grants to facilitate the application by public organisations of emerging technologies to their public procurement functions. Meanwhile technical support could cover areas such as the provision of guidance to project owners on how to best sell these types of projects internally, including points to cover in a comprehensive cost-benefit analysis as part of the development of a convincing business case. Further work could also be done to **develop and share proofs of concept** for tools and systems using different emerging technologies in order to provide further inspiration and ideas for public organisations assessing how to transform their procurement function. Finally, a high impact way to support the further uptake of these technologies in this domain would be the provision and maintenance of a knowledge base, ensuring that different resources related to the application of emerging technologies to public procurement are widely shared and used. A first step towards this has been taken by making the case studies and longlist developed during this study available and searchable online on the study webpage[170]. However, this information should be maintained and further built upon.

The emerging technologies described in this study have great potential to transform the way that public procurement is conducted in Europe and beyond. In the featured case studies, concrete examples are provided of organisations which are leading the way towards a digital transformation of procurement. This study details the experiences, successes, and challenges faced by these organisations with the aim of inspiring others to follow a similar path.

[168] Held on 13 November in Brussels
[169] Multi-Stakeholders Expert Group on eProcurement
[170] https://ec.europa.eu/growth/single-market/public-procurement/digital/emerging-technologies_en