Capgemini Consulting

Unleashing the potential of Artificial Intelligence in the Public Sector

Will Artificial Intelligence (AI) radically change our public sector?

Uncertainty governs today's public sector. Drastic budget cuts, the urge for transparency and political volatility put public sector employees and their political representatives to the test. The more so in view of rapidly arising technologies. Artificial Intelligence (AI) is one of those digital innovations that can fundamentally change society including the public sector and its public servants. It may even help shape a new role and give new legitimacy to the public sector and governments in general. AI solutions (e.g. chatbots, process automation and image recognition software) transform public sector work and the public sector workforce. Will human public servants, judges and doctors become a thing of the past? Will virtual council workers, automated legal file sorters and Google DeepMind disease diagnoses determine our future? Capgemini Consulting researched the economic and societal potential of AI in the public sector, as well as corresponding risks and implementation challenges. We present a five-step implementation plan to realise the potential of AI and give recommendations on how to overcome implementation challenges and enhance public sector progress.

> ***"Artificial Intelligence is as multi-layered as human intelligence."***

Nine types of artificial consciousness

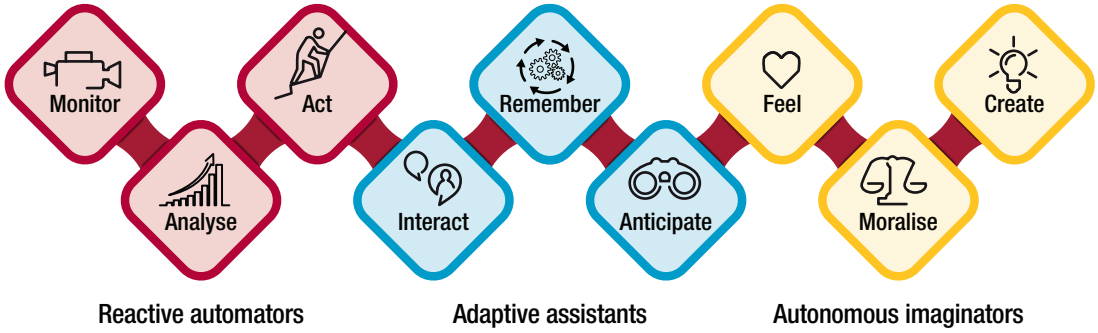
Artificial Intelligence (AI) covers various concepts and processes. Whereas human intelligence is supported by our brains and senses, Artificial Intelligence is informed by all sorts of technology (Robotics, Big Data, Sensors, Internet of Things, Speech Recognition, and so on). Human brains are multi-layered: different brain components have different functions (for speech, movement, memory etc.). Like human intelligence, Artificial Intelligence is multi-layered. AI can incorporate different levels of consciousness to fulfil different functions. Therefore, some AI technology is bound to perform a limited set of tasks (as comparable to a person missing certain brain parts). More advanced AI solutions combine multiple levels of consciousness (as in the case of a person with multiple brain parts working together). Based on nine different consciousness levels, we define Artificial Intelligence (AI) as: "*technology which allows digital systems to monitor, analyse, act, interact, remember, anticipate, feel, moralise and create*".

Artificial Intelligence solutions that *monitor*, have digital eyes, ears, noses, tongues and skins. These sensors gather information and record key data (e.g. automated CCTVs and Internet of Things sensors). AI systems that *analyse*, can process information, detect patterns and recognise trends (e.g. algorithms and Big Data analytics). When AI technologies *act*, they carry out tasks and start specific processes (for example password resetting and order placements). An AI solution that can *interact,* is able to listen, read, talk, write and respond to users of the AI solution (as shown in the use case on the social welfare sector). In order to *remember*, AI solutions should be able to store and find information (using for example cloud software and data crawlers). Furthermore, Artificial Intelligence that can *anticipate*, pre-emptively recognises patterns (e.g. predictive maintenance or policing heat maps that forecast where and when next crimes are likely to occur). AI solutions that *feel*, are able to identify, interpret and act upon human emotions (applications that understand our mood). AI systems that *moralise*, integrate morality into decision making processes (weighing multiple moral perspectives and consequences). Artificial Intelligence that can *create*, has the ability to give commands to itself and initiate processes from scratch (e.g. artificial painters and musicians).

Social welfare use case

Virtual chatbot assistant 'Alex' alleviates the customer support desk at the Australian taxation office. 'Alex' managed to:

- Realise a first contact resolution rate of 80%, exceeding the industry benchmark of 60-65%
- Automate most frequent issues, allowing agents to spend more time managing complex requests
- Conduct more than a million conversations with citizens



Nine consciousness levels along AI's evolutionary path

Three evolutionary stages of Artificial Intelligence

The nine levels of artificial consciousness evolve over time. We structure the nine levels of consciousness into three evolutionary stages. AI solutions can be: *reactive automators, adaptive assistants or autonomous imaginators*. Initially, Artificial Intelligence solutions were like *reactive automators*. AI was aimed at process automation. On the basis of rule-based programming, AI technology could monitor, analyse and act accordingly (e.g. automated routine tasks by a computer). *Adaptive assistants* combine the consciousness levels of reactive automators with contextual sensitivity. This complements AI solutions with interaction, memory and anticipation. Within this evolutionary phase, AI systems adapt to new circumstances and can learn from prior experiences. As a result, AI solutions become more valuable, providing predictive analyses with more accuracy (see textboxes on existing public safety software and potential public health solutions). We picture *autonomous imaginators* as AI technology that combines the latter evolution stages with three additional consciousness levels. At this stage, AI has evolved from repetitive and contextualised systems into independent artificial beings. This third step creates generic AI solutions that can feel, make morally driven decisions and create new things autonomously. Autonomous imaginators have the emotional awareness, moral reasoning and creative imagination that are key in our society, and the way we value human values in public services particularly.

Key examples of current AI practices in the public sector show that most AI applications are in the first two evolutionary stages (reactive automators, and adaptive assistants to some extent).[1] On the one hand the current two evolutionary stages can mature and expand. On the other hand, innovation can evolve AI solutions towards autonomous imaginators. Importantly, AI can fundamentally change our society, for the good and for the bad. The (as yet mostly untapped) potential of AI manifests itself in terms of higher productivity, efficiency gains, employment opportunities and higher public service quality. At the same time, loss of employment, inequality and a loss of control constitute potential concerns.

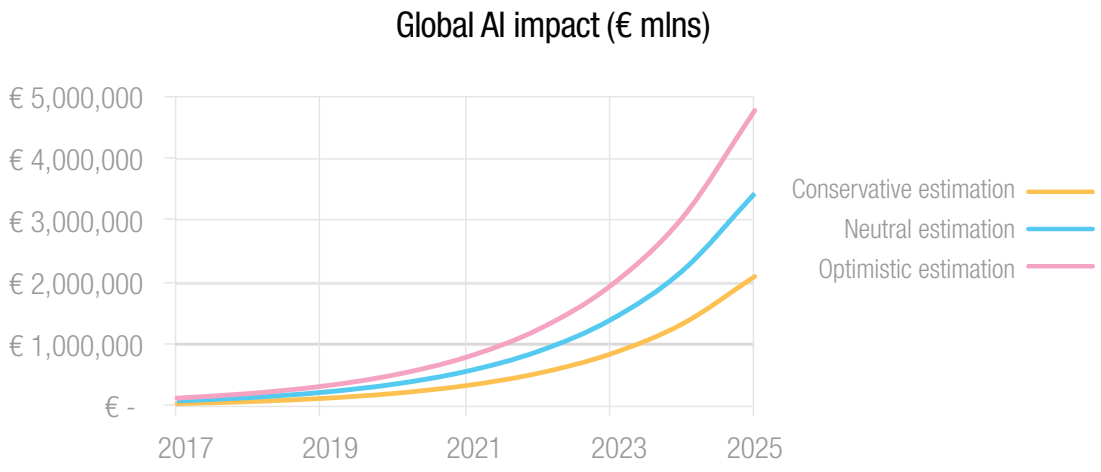
Public safety use case

The USA Cincinnati Fire Department has developed an AI system that classifies emergency calls based on their urgency. This AI solution:

- Prioritises those in need of an ambulance and those who can be treated on site
- Reduced delays in getting patients to the hospital by 22% on a total average of 80.000 medical emergencies per year

Realising the economic benefits of AI

The potential of an AI-driven public sector is twofold. Firstly, AI has an economic potential. Secondly, AI has higher public service quality to offer. Related to our economy, AI increases *productivity*. Public organisations can boost production rates by automating processes, optimise rational decision making with help of AI and simplify complex tasks with AI support. Furthermore, *efficiency* gains lay ahead, illustrated by improved logistics through supply chain optimisation, inventory optimisation and waste reduction because of resource efficiency. As we shift towards an AI driven society, *employment* opportunities arise. Cyber security trends showed how digital innovation created new professions, such as ethical hackers, firewall specialists and so on. Similarly, AI is expected to create new jobs. Humans need to: develop AI software, supervise and account for AI actions and complement AI solutions with social skills, etc. A recent Capgemini study among nearly 1,000 organizations shows that 83% of companies implementing Artificial Intelligence created new job roles, while 78% increased operational efficiency by more than 10%.[2] Moreover, Artificial Intelligence does not threat existing jobs. According to the global Center For Data Innovation[3], many types of employees (doctors, journalists, civil servants, police officers, taxi drivers, etc.) are likely to find themselves working with AI rather than being replaced by it. Artificial Intelligence also has a substantial *economic impact*. Our analysis of ICT related GDP growth[4] and AI sales figures[5], combined with an optimistic multiplier effect of 70 (due to wider productivity and efficiency gains[6]), results in an annual global AI impact of $5.61 trillion. This causes an extra 1.93 percentage point growth in world GDP by 2025.[7] Even in the case of a more conservative or neutral scenario (with a 30 or 50 multiplier magnitude), we can still expect a global impact of: $2.45 trillion (0.86 percentage point growth) or $4.03 trillion (1.41 percentage point growth).

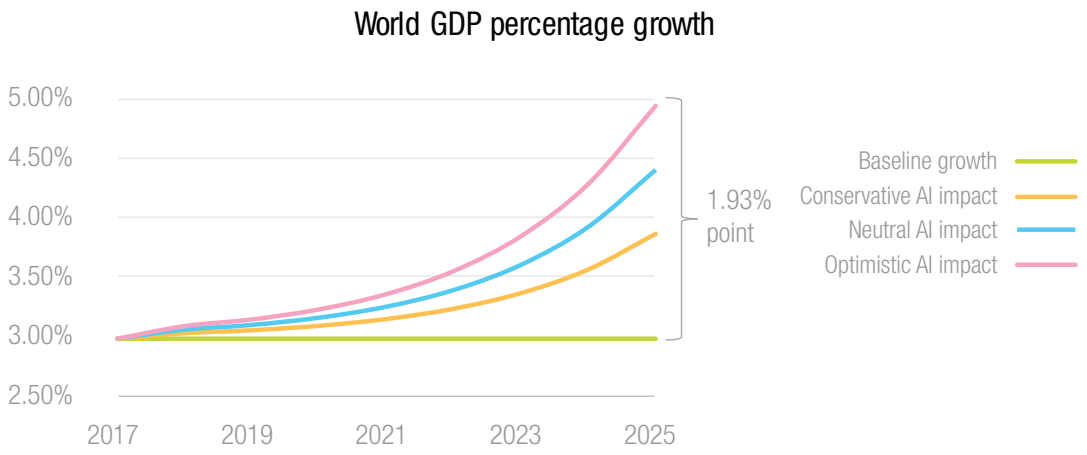


Global AI impact and public sector savings

Public health use case

Deadly diseases can disrupt entire societies. Identification and government response need to be fast and accurate. AI can be used for:

- Cross checking patients with similar symptoms from different locations
- Building a machine learning algorithm that detects patterns and warns when an outbreak might occur
- Preventing the spread of deadly infectious diseases (e.g. 11,316 deaths and $2.2 billion loss in GDP due to Ebola)



Global AI impact and public sector savings

Improving public service quality

Realising the full potential of AI in the public sector has significant impact on our economy. Besides economic advantages, societal benefits are also foreseen.[8] Citizens can expect higher public service quality from AI solutions. Quality improvements are for instance visible in terms of *service personalisation*. Complex analytics allow public sector bodies to better understand the needs of citizens, for instance in the case of improved traffic management, predictive health care, optimising the maintenance of public areas and personalised education (see textbox on the educational potential of AI). Moreover, AI can improve the *reliability and accuracy* of services. Since AI systems can process and analyse more data than humans, citizens can benefit from pre-emptive analyses that are much more precise than those from human employees. In effect, services are delivered in a similar and consistent way every time. Consequently, *equality* is promoted. As AI systems respond similarly on the basis of pre-installed criteria, discrimination and decision-making biases can be avoided. AI also *saves time*, because AI technology processes information much faster and can work on more multiple tasks in parallel, as compared to its human counterpart. Another quality improvement relates to service *availability*. AI systems outperform human employees with full service availability: automated public services can operate 24/7/365 (regardless of public holidays and without being reliant on employee availability). In this way, queues and waiting lists are limited or no longer exist.

Education use case

Personalised education is highly beneficial for students, but hard to meet by teachers with overcrowded classrooms. AI can be used to:

- Provide personalised education irrespective of the number of students
- Create a virtual teaching assistant to support students when a teacher is unavailable
- Analyse student's progress and find discrepancies between what is taught and what is not yet understood
- Lower school drop-out rate (potential to affect 13% of 18-24 year old in the EU)

The dark side of public sector Artificial Intelligence

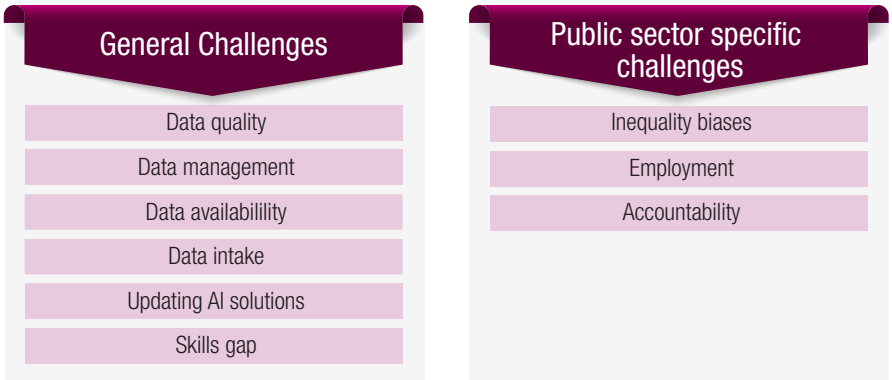
Despite the economic and societal potential of AI in the public sector, even this rose has its thorn. New technologies raise questions. What are the possible negative effects of AI in the public sector, in economic and societal terms? From an economic perspective one can question the employment effects of AI. Are robots a threat to our labour markets? Moreover, do AI solutions endanger our public values?

First of all, a recent Eurobarometer revealed that 74% of citizens expect that more jobs will disappear than new jobs will be created due to the use of robots and artificial intelligence.[9] Historically, technology has never caused a net decrease in jobs. However when it comes to digital, it would be difficult to predict the disruption it can create with regard to *employment*. According to Harvard economists Katz[10], there are no historical patterns showing shifts leading to a net decrease in jobs over an extended period. However, Katz has his apprehensions over the job displacement the digital technologies will result into, as it would be affecting a broader range of work. He expects the repetition of historical patterns in terms of short-term job displacement followed by a period of stability. Authors such as Michaels and Graetz[11], from the London School of Economics, studied the impact of industrial robots on manufacturing in 17 developed countries and concluded that technology replaces low-skill jobs primarily, which helps improve productivity.

Therefore, and from a societal point of view, it is questionable whether the positive employment potential (if existing at all) is equally shared among citizens. Based on White House research[12] *inequality* concerns are justified. Low income jobs have an 83% probability to be automated and replace by robots, opposed 31% of middle income jobs and only 4% for high income jobs. In order to avoid AI fostered unemployment, governments need to retrain and invest in their employees. Effect studies will enable public sector organisations to prevent and redistribute possible inequality effects. Moreover, we can question whether computers will truly overcome biases and really have objective judgments capabilities because the data on which decisions are based may be inherently biased.[13] In other words, are computers really treating people equally? In principle, computers are as biased as its programmer. As a result, AI solutions do not necessarily bring objectivity and neutrality to our citizens. Therefore, proper checks and balances need to be put into place and algorithms need to be transparent and auditable. On top of this, the idea of relying on AI software and robotic hardware creates a sense of *lacking control.*[14] The more AI solutions evolve into autonomous artificial beings, the more citizens and public sector employees may fear a loss of control.

General and public sector specific challenges for implementing AI solutions

Besides the overall AI potential and its risks, general and public sector specific implementation challenges may impede AI adoption in the public sector. In general, AI systems can only be successfully implemented if high *data quality* is ensured. A common challenge is to gather exhaustive and representative data to fuel the engines of AI systems. With the right data, *data management* has to be in place as well, to effectively structure and integrate data. In line with this, data needs to be available at all times and updated with real-time information (*data availability and data intake*). An important technological concern is how to program AI software that can be easily *updated*. Most AI solutions are aimed at performing a specific set of tasks. New tasks or substantial changes of tasks can cause severe problems and may force organisations to build an entirely new AI solution. Besides data related and technological challenges, another challenge is to bridge the *skills* gap between the current human workforce and one that is capable of developing and working with Artificial Intelligence solutions.



General and public sector specific challenges for implementing AI solutions

In the public sector, equality is paramount. Whenever human *biases* influence the development of AI systems, the systems are not likely to provide public services equally. Thus, the challenge is to develop guidelines and implement measures to ensure neutrality of AI programmers and developers. Another implementation challenge concerns the special *employment* status of public sector employees. Depending on the country, changing the public workforce into an AI driven one may be hampered by legal protection of civil servants. From a political and administrative perspective, AI solutions challenge our current understanding of *accountability*. Autonomous AI has the ability to draw and act upon its own conclusions. Who is accountable for unforeseen and undesirable outcomes? A new legal framework (regarding privacy preservation, legal principles, sworn professions acting as intermediaries, etc.) enables the public sector to put AI proof accountability into place.

Realising AI's potential for the public sector

Public sector organisations constitute the largest employers in most countries. Due to this scale, implementing AI in the public sector potentially offers significant impact on how our societies grow and how public goals can be reached. In order to successfully realise the potential of AI in the public sector, an implementation strategy following the steps of Discover, Develop, Implement, Innovate and Transform (DDIIT) is recommended.

The DDIIT approach helps public sector organisations to implement and maintain AI solutions in a solid manner. Firstly, public sector bodies need to *discover* which AI applications add value to their organisational processes and provide high quality services to citizens. During the development stage, public sector organisations seek to *develop* employee skills, software and hardware in order to implement the chosen AI solution. Countering inequality biases and employment challenges are vital during the development stage. When it comes to inequality and societal segmentation, external party audits can ensure neutral AI judgements as well as fairness (equal distribution of effects, for instance in the case of predictive analytics). Employment concerns can be mitigated by investing the money saved by AI in public sector employees and retraining them. Investing in education improves the employability of public sector workers. Facilitating innovation hubs, helps to leverage AI solutions and stimulates employees in finding new, creative job opportunities. When public sector organisations *implement, innovate and transform*, they effectuate initial AI solutions, optimise these solutions and may turn into fully AI driven organisations. During these stages, accountability measures are crucial. Inherent to deep learning is the 'black-box' nature of algorithms, which makes it hard to understand an AI's decision-making process. In many fields of government this will present a challenge as full accountability is needed. Clear audit trails and governance structures need to clarify who is legally, politically and administratively accountable for AI related processes and outcomes.

1	Discover	Discover potential applications of AI Do we have the right AI solution to solve our societal problem?
2	Develop	Develop relevant resources (human skills, software and hardware) Do we have the right resources/capabilities to implement AI?
3	Implement	Implement relevant skills, software and hardware Do we match the right AI solution with the right resources?
4	Innovate	Innovate AI solution to optimize existing processes Can we improve the AI solution to optimise our current processes?
5	Transform	Transform AI to create new public innovation Can we transform our public services into(new) AI driven services?

An AI implementation model

A super intelligent future is near

To conclude, the economic and societal benefits of Artificial Intelligence are promising for the public sector. The employment opportunities and cost savings are tremendous as are potential service quality improvements. AI helps us to enter a new era of sophisticated and smart public services. By investing in reactive automators, adaptive assistants and autonomous imaginators, we enter a new era of hyper intelligence to empower public services and citizens to serve the common good and reach societal goals. AI technology is ready to offer stability and growth in uncertain times. The implementation path of discovering, developing, implementing, innovating and transforming, helps public sector organisations to successfully realise the AI promise in the public sector. There is little that can be done to stop the process of AI-driven transformation. As depicted in the Spring 2017 Edition of the MIT Sloan Management Review, it is about "finding the sweet spot", combining both human and computers to reach so-called superior judgements.[15] The challenge lies in comprehending human decision-making, including heuristics, biases, group dynamics, creativity, imagination, and computer forecasting models, bootstrapping, predictive analytics and artificial intelligence. With many more wicked problems and more complexity ahead, public sector organisation have to come forward and take the next steps. Artificial Intelligence can solve today's challenges and prepares us for upcoming ones in our ever changing societies.

Authors: Dinand Tinholt, Sem Enzerink, Willem Sträter, Pieter Hautvast, Wendy Carrara

[1] See for instance: Ishir, http://www.ishir.com/blog/4662/artificial-intelligence-changing-public-sector.htm/, and Business Insider, https://www.businessinsider.com.au/the-ato-launched-a-siri-for-tax-and-has-called-it-alex-2016-12

[2] Capgemini, https://www.capgemini.com/wp-content/uploads/2017/09/dti-ai-report_final1.pdf

[3] Center For Data Innovation, http://www2.datainnovation.org/2017-house-of-lords-artificial-intelligence.pdf?mc_cid=b00e273e8f&mc_eid=203079e783

[4] Statista, https://www.statista.com/statistics/268584/worldwide-ict-revenue-since-2005/

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[6] White House, https://www.whitehouse.gov/sites/whitehouse.gov/files/images/EMBARGOED%20AI%20Economy%20Report.pdf

[7] OECD https://www.oecd.org/sti/OECD-Innovation-Strategy-2015-CMIN2015-7.pdf

[8] IBM, https://www.ibm.com/blogs/watson/2017/04/10-reasons-ai-powered-automated-customer-service-future/

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[10] Katz, Lawrence F., and Robert A. Margo. 2014. "Technical Change and the Relative Demand for Skilled Labor: The United States in Historical Perspective." In Human Capital in History, edited by Leah Platt Bouston, Carola Frydman, and Robert A. Margo, 15–57. University of Chicago Press

[11] Georg Graetz, Guy Michaels, CEP Discussion Paper No 1335 March 2015 Robots at Work, Centre for Economic Performance, http://cep.lse.ac.uk/pubs/download/dp1335.pdf

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[14] Future of Life, https://futureoflife.org/background/benefits-risks-of-artificial-intelligence/

[15] Shoemaker et al. (2017). Building a More Intelligent Enterprise, MIT Sloan Management Review, Spring 2017. Available at: http:mitsmr.com/x/58301

Methodological approach

Our AI impact figures stem from OECD data and market studies. These indicate a 0.35 percentage point ICT related GDP growth, from which 0.03 percent is related to Artificial Intelligence. We used the most recent annual growth for AI direct revenues (56.8 percent) in our model, and applied different multipliers (30 for a conservative, 50 for a neutral and 70 for an optimistic scenario). We included this multiplier effect, because of the broader AI productivity and efficiency effects (rather than solely the direct revenues of AI products and services). A multiplier with a magnitude of 50 means that each $1 AI revenue generates $50 in GDP. Consequently, the global Artificial Intelligence impact equals $5.61 trillion, causing an extra 1.93 percentage point world GDP growth by 2025.

Key Contacts

Dinand Tinholt
Vice President
Global EU Lead
dinand.tinholt@capgemini.com

Wendy Carrara
Principal Consultant
European Policy Expert
wendy.carrara@capgemini.com

Niels van der Linden
Principal Consultant
Public Insights & Data Lead
niels.vander.linden@capgemini.com

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