New Technologies for Innovation in Public Services: A Review of Case Studies

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Abstract. This paper analyses case studies of Artificial Intelligence and Big Data Analytics applications for innovation in digital public services. Recently, many governments at all levels are using these technologies to improve service provision to citizens. However, they are not always aware of their potential for disruption and of the emergent ethical questions. In order to have a better insight of their applications and provide a initial point for policy makers, we review several case studies and analyse how these new technologies are being used to meet specific needs.

Keywords: artificial intelligence, big data, digital governance, public services

1 Introduction

New technologies are being adopted in the private sector, and citizens quickly accept them as they are familiarised with the use of social networks and mobile applications. Their access to innovative services such as the ones used in banks and e-commerce platforms, has improved in recent years. Because citizens are conscious on how to receive new services that better satisfy their needs, they put pressure on governments to innovate. Many governments are using and applying Artificial Intelligence (AI) and Big Data and Data Analytics (BD) techniques in order to innovate in such services[1].

This paper analyses case studies of AI and BD applications for innovation in digital public services, being its main objective to provide a landscape review of good practices. There is little experience in using these new technologies which are generally driven by cost efficiency, but also involve the potential for disruption and usually raise ethical questions. In this sense it's essential to understand how emerging technologies are being used to meet specific government and citizens' needs, how government organisations drive their approaches to innovations, and which innovation capabilities are necessary within the government, and this review aims at contributing to this end. The cases presented are intended to be illustrative, by no means complete, and to provide a sense of current activities

and future directions that can especially help local governments in public policies for the adoption of AI and BD aiming at innovation of public services.

The rest of this paper is structured as followed. Section 2 provides a background to two main concerns for the adoption of AI and BD - ethical issues and privacy, as well as explains government-citizens interactions; and Section 3 states related work. Section 4 and 5 explain the possibilities of innovation with BD and AI respectively, each presenting according study cases. Finally, Section 6 concludes the paper.

2   Background

In this work, we assume AI and BD as extensive terms since there is no single precise definition. AI refers to devices, software and systems that are able to learn and to make decisions in almost the same manner as people [24]. AI allows machines, devices, software, systems and services to function in a sensible way according to the task and situation at hand. Big Data refers to large volumes of data that cannot be processed effectively with the existing applications. The processing of Big Data begins with the raw data that isn't aggregated, and there is the need to add semantics to it. Data Analytics involves applying an algorithmic process to derive insights and, for example, running through several data sets to look for meaningful correlations between each other[26]. Both together, BD is used to make better decisions as well as to verify or refute existing theories or models.

Applying AI and BD raises different types of issues, like ethical, privacy, and enhance interactions between government institutions and service recipients.

2.1   Ethical issues

The public sector differs from the private sector in its capacity for innovation, and it seems to stay behind in matter of new technological advances. For the society, the former has a certain ethical obligation to citizens, safeguarding personal data that can be used to identify a person directly[2–4]; mitigating the possibility of misuse of collected data for commercial purposes; mitigating the possibility of discrimination caused by the technology, for example elderly or disabled people that cannot use digital services[2, 5]; mitigating the possibility of discrimination in algorithmic decisions, caused by possible stigmatisation, racism, etc. [2, 5, 6]; and deciding who is responsible for accidents caused by autonomous cars, or even ensuring adherence to cultural principles in its algorithms.

2.2   Privacy

Privacy, which means the selection of which personal information is revealed to the world, is considered as a human right in many jurisdictions. The large amount of data that are currently handled in electronic systems means that people are exposed to greater levels of scrutiny while more and more aspects of

their everyday lives are captured as data[3], [4], these being names, usernames, passwords, emails, phone details, credit card numbers, Smart ID cards[7], car plaques, or even faces[3]. Another important concern is capturing movements, images of private property, or even maintaining personal data without citizen's consent. It is important to highlight the damage that prediction systems can do, given that they make decisions based on private user information[3, 8]; and the threat of the enormous amount of user data stored by the emergence of Internet of Things[9].

2.3   Interactions

Government agencies interact with many stakeholders, including other government entities, citizens, business, tourists, non-government organizations, employees, and others. Thus, there is a vast variety of services in which governments can innovate[10]. First and foremost, interaction with other governments can happen between the same or different government level, and within the same country or with other countries. Such interactions allow to perform collaborative strategies, exchange information and mutually provide services, for example share data to improve national policies, or improve global airport security. In fact, the potential benefits of these type of interactions is immense[4, 10].

Another type of interactions is those with businesses(Government to Business, G2B), which can benefit from many public services, such as registering new companies or paying taxes, while providing immediate information and maintaining digital communication active. Efficiencies of these type of communications can be achieved with reduction of paperwork. Another interesting type of G2B interaction consists in the public sector providing a platform in which businesses and other actors contribute in the co-creation of public services[4, 10, 11]. Additionally, there is the interaction with non-profitable organizations, which includes providing information, defining regulations and providing financial support to said organizations, including associations with social organizations, charities, and political parties[10].

One of the most important interactions is with citizens (Government to Citizens, G2C). The objective of this kind of interactions is to establish or maintain a direct relationship with citizens, while a variety of services is offered[4]. Another objective is to strengthen relationships between public authorities and citizens that live under their jurisdictions. G2C interactions through technology includes direct exchange of instant messages with public administrators, electronic vote, online tax declaration, online payment of city utilities, and the provision of digital services, such as change of residential addresses, and renovations of driving licenses[10]. For example, in Bahía Blanca (Argentina) several services can be accessed through the internet[4]. Another example is the case of Austria, in which they tried to implement an electronic ID, even though it was not very well accepted[7].

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[4] www.bahia.gob.ar/servicios

Furthermore, there are interactions between the public sector with visitants tourists or visitors (Government to Visitors, G2V). G2V interactions include informational services to explain how to move within a country or territory, and provide information for visa applications and issuing[5], booking tickets to national parks or cultural events, among others. Technological innovation has been used extensively on this domain, specially through providing online information and digital marketing to future tourists[10]. Some destination campaign examples include Your Singapore[6], or Experience Catalunya in Spain[7].

Finally, we must also consider interactions between government and its employees (Government to Employees, G2E), which are very similar to those between a business and its employees. The objective is to offer a variety of tools, documents and data that help employees to maintain communication and coordinate work in their offices. For example, government agencies can use an intranet to provide information to its employees. Public administrators can keep online record of personal information of their employees or create shared platforms for internal documentation to promote paperless interactions[4, 10].

3   Related work

AI and public governance is an emerging area of research. The systematic literature review in [20] acknowledges the lack of theorisation of most of research articles, and that most research is exploratory, conceptual, qualitative and practice-driven. Critical issues related to AI in the public sector, like ethical considerations, fairness, explainability, bias, privacy, safety, and societal impact among others, remain with relatively little understanding. In this sense, we present three works describing and analysing AI case studies in the government, and another three works introducing policy recommendations.

Several AI applications are categorised and described in [21]. Seven types of applications are presented: monitoring, discovering, predicting, interpreting, interacting with the physical environment, interacting with people, and interacting with machines; and the domains are ample, ranging from agriculture to education, from environment to business operations.

Three cases of AI applications in government are presented in [22], describing drivers, goals, barriers and risks. The authors highlight the governments' dilemma of the obligation from protecting citizens and the temptation to increasingly adopting algorithms in the sake of efficiency, and advocate for a common framework to evaluate the impact of the use of AI in the public sector. The paper shows that even seemingly trivial application of AI by the government can be an instrument of exercising control over the citizens, even in democratic regimes.

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[5] Examples are India (www.indianvisaonline.gov.in/visa/tvoa.html) and USA (esta.cbp.dhs.gov/esta)

[6] www.yoursingapore.com

[7] experience.catalunya.com

In the following we describe related works in the area of policy recommendations. Six strategies to help governments start off with AI are presented in [23], in the context of describing AI applications. The strategies are: make AI a part of a goals-based, citizen-centric program; get citizen input; build upon existing resources; be data-prepared and tread carefully with privacy; mitigate ethical risks and avoid AI decision making; and, augment employees, do not replace them. The aim is that governments can approach the use of AI in citizen services with a focus on building trust, learning from the past, and improving citizen engagement through citizen-centric goals and solutions.

The government of Finland has recognised the utilisation of artificial intelligence as an important driver for creating conditions for strong economic growth and a higher rate of employment, and the Steering Group of the Artificial Intelligence Programme within the Ministry of Economic Affairs and Employment developed in [24] a strategy consisting in eight actions in order to adopt the necessary transformations. The actions are: enhancing the competitiveness of companies through the use of artificial intelligence; utilising data in all sectors; speeding up and simplify the adoption of artificial intelligence; ensuring top-level expertise and attract top experts; making bold decisions and investments; building the world's best public services; establishing new cooperation models; and making Finland a trendsetter in the age of artificial intelligence. The importance of digitalisation of all sectors, education by improving learning in the society and building skills for the employees; and an ethical perspective of AI service were recognised in the policy recommendation document [25].

4   BD for innovation

Historically, there has been a production of big clusters of data in the public sector, such as national census. Nevertheless, said data is not acquired continuously, and are complemented with small polls, study cases, interviews, or focus groups, which are all very focused, time- and place-specific, and significantly expensive to generate and analyze[12]. The term Big Data does not have an academically agreed definition. However, there are some agreed main characteristics: great volume, great speed, exhaustive scope, possibility of indexing, relational and flexible[12]. All these are characteristics that would help solve the problem mentioned above, which is why it is clear that Big Data techniques can be a great assistance to the public sector.

Among communication technologies that allow the collection of data are RFID to label objects; Wireless Sensor Networks (WSNs); wireless networks such as WiFi or Bluetooth; and mobile phone networks such as 4G, LTE, LTE-A, or 5G[13]. Another use for this kind of technologies, is responding to behavior of people with whom governments need to interact. For example, in the same way that sentiment analysis has been applied to extract sentiments and feeling from citizen tweets[14], this kind of analysis can also applied as a means of producing some feedback to citizens.

Transport is a sector in which many data applications have been developed in order to provide a better service[15–18]. For area, in fact, is very complicated to analyze data, given that if, for example, someone would like to make a mobile application for citizens that analyzes information in their context, some challenges should be addressed, such as people always being in movement; relevant information to a citizen will depend on their proximity to a specific place; there has to be a guarantee that the application will be real time; communication unreliability will need to be supported; and data will have to be stored and accessed efficiently[16].

4.1 Case studies

CityOS, which is used in Dubrovnik, among other cities, is an open source library, APIs, and applications that allow to create platforms for smart cities. The frameworks and templates allow easy customization of application and hardware corresponding both to open data visualization as well as citizen applications.

There are several cases in the transport domain. MobyPark, which is used in Amsterdam, Paris, Brussels, Madrid, Barcelona, Milan and Düsseldorf, is a platform where people can look for parking spaces in a certain destination, book them on a certain period of time, and pay for them. Smile, which is used in Wien, is a platform in which the user can access public transport information, such as transport in their area, different options for getting from one point to another, and ticket pricing and booking.

Smart Traffic Lights, from Wien, is a project in which traffic lights are interconnected, and use certain algorithms to detect if a person intends to cross the road. Weather and environmental sensors also allow traffic lights to contribute to improving air quality through intelligent traffic flow control. The system also communicates with navigation systems in order to exchange valuable traffic related information. ITS (Intelligent Transport Systems), which is used in Copenhagen, is a product made by State of Green, a non-profit public-private partnership from Denmark. Its objective is the better coordination of traffic flow, prioritizing buses, and optimizing cycle paths, while also providing citizens with updated information about delays and alternative routes. Transit, used in Barcelona, is a mobile app for citizens, where they can consult traffic congestions, and set alerts for a specific area. App&Town Public Transport, used in Barcelona, Madrid and Laval, is another mobile app that provides the user with efficient and real-time routing information, taking into account any possible incidents that may occur and calculating the corresponding alternative routes. C-MobILE, used in Barcelona, Bilbao, Bordeaux, Copenhagen, Newcastle, North Barbant Region, Thessaloniki, and Vigo, is a program in which cooperative intelligent transport systems (C-ITS) and services are designed to deal with specific mobility challenges and deployed across Europe. All these cases are summarised in Table 1.

Table 1. Summary of BD case studies.

Name	Cities	Summary	Reference
CityOS	Dubrovnik	Open source framework for deploying smart city applications and hardware.	cityos.io
MobyPark	Several european cities	System for booking and paying parking places.	www.mobypark.com
Smile	Wien	System providing public transport informational services and enabling ticket purchase.	smile-einfachmobil.at
Smart Traffic Lights	Wien	Traffic lights communication and collection of data to improve traffic flow.	smartcity.wien.gv.at/site/en/ smart-traffic-lights
ITS	Copenhagen	System for the coordination of traffic flow, providing useful information to citizens.	stateofgreen.com/en/ partners/ramboll/solutions/ its-intelligent-transport-systems
Transit	Barcelona	System providing information and alerts about traffic congestion.	play.google.com/store/apps/ details?id=com.tsol.transit&hl=es
AppTown	Barcelona Madrid, Laval	Public transport real-time routing information	www.appandtown.com/index.html
C-MobILE	Several european cities	C-ITS design and deployment platform.	c-mobile-project.eu

5   AI for innovation

Another technology that has emerged in the last years is the one enabling the processing of large volumes of data to achieve results normally generated by humans. Case studies of G2C services fall into one of the following categories: answering questions, scanning and filling documents, classifying petitions, translation, and document creation. These types of applications can do governmental work more efficiently while freeing employees time to build better relationships with citizens[19]. AI applications designed for answering citizens questions is the most common, whether it is via direct contact with citizens to solve common questions through chatbots, or applications relying on, e.g. IBM Watson, that can be used in diverse areas, such as finance, judicial decisions, or even client management[19].

Another category refers to scanning and filling documents, which is used specially in the legal field, where extensive and numerous documents need to be analyzed[8]. IBM Watson, for example, can also be used to scan and analyze documents, saving millions of dollars to companies of any kind[9][19].

Lastly, creating and assembling documents is used in diverse areas, both in public and private sectors. Document assembly can be made through natural

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[8] emerj.com/ai-sector-overviews/ai-in-law-legal-practice-current-applications
[9] www.ibm.com/blogs/watson/2016/07/10-industries-using-big-data-win-big

Table 2. Summary of AI case studies.

Name	State/Country	Summary	Reference
Facebook chatbots	North Carolina	Answering simple questions like resetting passwords to free up IT help desk personnel.	www.govtech.com/computing/ Chatbots-Debut-in-North-Carolina- Allow-IT-Personnel-to-Focus-on- Strategic-Tasks.html
KeyReply	Singapore	Chatbot company used by private and public sectors.	www.keyreply.com
MySurrey	Surrey, British Columbia	Mobile app powered by IBM Watson that answers common questions in natural language.	www.surrey.ca/city-services/15161. aspx, medium.com/cognitivebusiness/ watson-assists-cities-with- 311-3d7d6898d132
DoNotPay	US, Canada, UK	Robot lawyer that helps citizens with legal problems, and sorts and pre-fills forms.	donotpay.com, www.theguardian.com/ technology/2017/mar/06/chatbot- donotpay-refugees-claim- asylum-legal-aid
AI Translate	US	AI translation to fullfill the needs of residents who are not native English speakers.	aitranslate.com/government
UEBA	Mexico	Data analysis and decision making in the justice system.	justice-trends.press/es/el-uso- de-la-inteligencia-artificial-en -el-analisis-del-comportamiento- de-usuarios-y-entidades-en- el-sistema-de-justicia-mexicano

language generation (NLG), which is a method widely used by news companies to make previews of automated news[19].

5.1 Case studies

Most use cases are given as chat services. Facebook chatbots are used in North Carolina to simulate human conversations for regular questions, like resetting passwords, which make up about 80-90% of the tickets submitted to the IT help desk, and aiding internal IT help desk personnel, freeing them up to focus on more strategic tasks. KeyReply, whose service was used in Singapore, is a chat automation company that has helped many industries, like insurance, finance, healthcare, e-commerce, and logistics, connect with their customers, and also connect governments with citizens. MySurrey, from Surrey, British Columbia, is a mobile app powered by IBM Watson that allows citizens to access important information about the city, answering questions in natural language. It addresses 65 percent of 311 calls that have answers on the city websites, but are too difficult for residents to find, which can cost each between four and five U.S. dollars.

DoNotPay, used in the US, Canada and the UK, is a robot Lawyer that aids citizens with many kinds of legal problems, like cancelling service or subscriptions, appealing parking tickets, and it even helps refugees seeking asylum, and pre-fills the corresponding form. AI Translate, which has coverage in many US government agencies, is a company that provides AI translation to many systems so that residents who are not native English speakers may fullfill any essential requirements such as getting healthcare, safety, and any legal informa-

tion. UEBA, or User and Entity Behavior Analytics, is used in Mexico justice system to improve efficiency and security of prisons, analyzing data and creating patterns that can improve decision making such as individuals classifying, social reinsertion, physical security, logical security and cybersecurity. These use cases are summarised in table 2.

6   Conclusions

This work provides a review of AI and BD technological innovation landscape in government public services. Eight BD applications, mostly in the transport sector, and six AI applications, mostly intelligent chatboxes, were summarized. Main obstacles to technology adoption are the complex interactions between government and citizen, and other stakeholders, which could be worsened by emerging ethical and privacy issues. Only clear understanding of the technologies and citizen education, not an only efficiency argument, may help a wider adoption and benefit by the government. Our future work comprises increasing the number of case studies to analyze and proposing a conceptualization of the use of new technologies for public service innovation based on them.

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