

# **Comprehensive Review on the Challenges that Impact Artificial Intelligence Applications in the Public Sector**

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## **Abstract**

Artificial Intelligence (AI) is one of the emerging technologies being adopted both in the government and the public sectors with nascent applications. Although there are several anticipated optimistic effects of the implementation of AI in governments' functions, they need to manage and overcome several challenges to successfully adopt AI technologies and realize their benefits. AI applications were examined from the literature, with limited research studies to address the challenges in the public sector. The purpose of this paper was to explore the challenges of AI adoption in the public sector and present their impacts. Findings showed that AI challenges were perceived differently by various scholars, with limited empirical data to showcase the real adoption in the public sector. A conceptual framework on AI adoption challenges and its impact on the public sector was developed by integrating information provided by current literature. The results from applying such framework could be significant for the policy-makers and the government entities who aim to implement the AI in various units of the government and improve their processes and services to the community.

## **Keywords**

Artificial Intelligence, Public sector, Technologies, challenges

## **1. Introduction**

The industry has transformed in the last years due to successful innovations in the production processes and developments in technology (Pereira and Romero 2017). New capabilities for managing its emerging complex functions have been evolving, however, increasing complexity generates uncertainty about the technological capabilities and suitable approaches needed (Schumacher et al. 2016). Significant challenges of environmental, societal, and technological developments have been addressed through different technologies, e.g the Internet of things, Cyber-Physical Systems, Artificial intelligence, and Cloud-based Manufacturing. A new phase of the industrial revolution has addressed numerous emerging technologies (Zhong *et al.* 2017).

Artificial Intelligence (AI) has a strong relationship with machine learning, data science, data mining, and predictive analytics (Akerkar 2019). Governments' interest in AI has been increasing in recent years which has resulted in more investments (Bharadwaj, 2019). AI has been energized with Big Data and is becoming more influential. However, through its computing techniques, AI can make sense of Big Data. A rational agent could be autonomous and learn what it can. For example, a vacuum-cleaning agent can learn to forecast any dirt will appear (Russell & Norvig, 2016). Developments in the automated technologies have opened doors for intelligent urban mobility with the rise of the smart city programs.

The study provides a thorough review of the challenges that face governments to adopt Artificial Intelligence applications successfully in public systems. The findings could be used by scholars, professionals, and decision-makers to ensure better preparation and adoption of disruptive innovation to execute AI projects planned by the governments. The applications of AI in the public sector are in infancy with increasing arguments on the challenges facing AI adoption. According to Duan et al. (2019), limited research studies identify the critical factors which influence the use of AI. In addition, there is a lack of guidelines and governance systems for disruptive technologies (Sun & Medaglia, 2019).

The public sector is one of the most developing contexts with big efforts made by the governments to enhance the citizens' services and improve the processes. The purpose of the research is to investigate the challenges incorporated with the AI projects implementation in the public sector. The following research question was addressed: *what are the challenges of AI implementation and their impact on the public sector?* By answering this question, the challenges facing the adoption of AI projects are targeted as realized by the government stakeholders.

## **2. Research Methodology**

The methodology applied in the literature review is based on promoting research knowledge and putting it into action by making sense of large information to answer different questions. It relies on reviewing, identifying, and assessing existing evidence in order to generate a clear and strong direction to a certain research question. It requires access to a wide range of databases and journals. (Mallett et al. 2012).

The research papers were used based on well recognized and peer-reviewed journals with a range of 10 years of issue. It covers several keywords related to artificial intelligence concepts e.g technology, disruptive, emerging, innovation, machine learning, cognitive, automation, smart, and intelligent systems.

Google scholar was widely used in this paper as one of the most powerful academic search engines to discover resources for journal articles. Also, it is an accessible and sophisticated academic search engine where many journal publishers are using. It allows researchers to expand the reach and accessibility of the articles and answer search queries with many related results.

## **3. Theoretical Background and Previous Research**

### **3.1 Artificial Intelligence (AI)**

Artificial intelligence (AI) stands for any technology that realizes and understands the surroundings and improves taking successful actions at certain goals (Russell & Norvig, 2016). AI technologies can contain natural language processing, machine learning, robotics, speech recognition, and rules-based systems. (Eggers et al. 2017). AI-based disruptive technologies and inspired systems can be found in many industry areas like financial services, automotive, travel, construction, media, and entertainment (Bughin et al., 2017). Artificial Intelligence, which consists of machine learning and deep learning, uses the capabilities of the big data generated to optimize processes and gain new perceptions with defined pattern recognition in order to acquire knowledge from experience (HANNOVER MESSE, 2019). AI existed for more than six decades; however, the development of the computing capabilities and big data technologies expanded the AI new generation in recent years which became an area for researches. (Duan et al., 2019). AI provides precise prediction and mapping of real systems, e.g energy system, which can be useful in modeling and planning activities. Computing and AI techniques such as fuzzy logic, neural networks, genetic algorithms are being implemented (Suganthi et al., 2015).

### **3.2 Artificial Intelligence in the Public Sector**

With a degree of ambiguity, AI implementation in the public sector still in its early stages compared to the private sector. The governmental public sector started to adopt the AI technologies and cognitive computing to a large amount of data to enhance public capacities on decision making which include the designing, implementation, and evaluation of cognitive computing and machine learning to develop the public management and improve taking decisions (Desouza, 2018). AI can be used in social policy to predict youth with high risk in order to target the interventions (Chandler et al., 2011). In the regulation area, health public inspections in restaurants can be developed using AI and advanced technologies (Kang et al., 2013). In education, AI through different systems and developed algorithms can predict the school teacher who has the highest value (Rockoff et al., 2010). The adoption of automated technology is essential for achieving the quality of life, boosting efficiency, and reducing the governmental cost of services (The National, 2019).

The daily development of machine learning capabilities encourages world governments to invest in AI studies. It was estimated that the US government will increase the investment in cognitive and artificial intelligence technologies at a Compound annual growth rate (CAGR) of 54.3% between 2018-2021.

A systematic and comprehensive review of existing relevant research studies was conducted from the literature, which was classified with three areas addressing the different challenges as follows: AI challenges and impacts and AI challenges in the public sector. (See Figure 1).

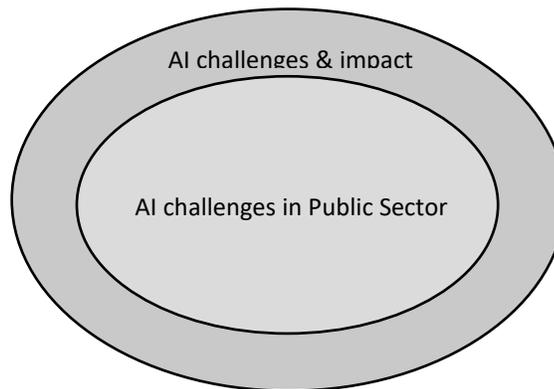


Figure 1: Levels of challenges in the literature that impact AI applications

### **3.3 AI challenges and impacts**

Artificial Intelligence as a term is not new since it was created in 1956 at Dartmouth College to enrich evolving research areas combining researchers on brain physiology, formal analysts of propositional logic, and computer engineers (Tzafestas, 2016). To ensure proper implementation of AI and good integration with Smart Cities, several challenges have been addressed which requires attention (Cheng et al., 2018).

Xu et al., (2014), had studied the different types of users develop trust in technology for active and passive users in a multi-user system. 54 members worked in teams in a multi-task environment with a shared technology have participated. The distributed questionnaire has measured the trust in technology, whereas the open-ended questions have captured the background of trust. It was found that the disruptive technology trust level varied based on factors related to the technology itself, the user, and the task.

Allam & Dhunny, (2019) showed many Artificial Intelligence applications with the existence of Big Data in Smart Cities. Although there were many concerns about confidentiality and ethics, the adoption of AI could largely impact the urban governance and economic growth. The technology factor needs to be considered concerning societal integration in smart cities which could be implemented through reviewing important dimensions of Culture, Governance, and Metabolism; which is the base for the Smart Cities. A Smart City framework was proposed to support the use of big data and Artificial Intelligence with a primary focus on urban sustainability and livability. It was found that highly competent people were required to oversee the complex processes of digitization.

Duan et al., (2019), claimed that there are various challenges and impacts associated with the use of AI systems for decision-makers. Different cultures (Organizational and national) and personal values have been identified as factors affecting AI technology acceptance and successful adoption. e.g Chinese entities are different than others in approaching AI technologies

According to Davenport & Ronanki, (2018), technology understanding can be a challenge for any implementation success. Organizations shall define their desired tasks or outcomes and decide which AI technology can perform the requirements. Technical issues in agent-based systems are becoming a bottleneck for AI applications with regards to human intuition and judgment to support the executives with intelligent decision making (Duan et al., 2012)

The energy sector is one of the sectors that has been affected by the development of AI which helped in the high implementation of renewable energy sources. It mitigates the effect of climate change which is impacting the cities, countries, economy, and the people livelihoods.

It was found that the education sector needs to be more advanced, to provide clear methods and tools in influencing minds and creativity (Allam & Dhunny, 2019). Some universities started using an initial form of AI, IBM's supercomputer Watson which provides student advice at any time throughout the year (Singh, 2018). It was noted that all the domain's benefits are affecting directly on the economy domain, with an increase of efficiency for the current financial models created to fit the emerging benefits.

The same is being observed for the healthcare domain which has been affected by AI by assisting the physicians in the diagnostics process (Alkim et al., 2012); (Amato et al., 2013), sickness follow-up (Coiera, 1993), treatment planning for patients and medicine for critical care (Hanson & Marshall, 2001).

AI impacted the Mobility domain through its applications (Alam et al., 2018); (Arfat et al., 2017); (Mehmood et al., 2017); (Schlingensiepen et al., 2016); (Alazawi et al., 2011). Due to the data revolution, a lot of benefits have been obtained with some challenges related to the storage models, e.g cloud computing (Tawalbeh et al., 2016). Appropriate policies can support to ensure the effective integration of AI in all the domains (Allam & Dhunny, 2019).

### **3.4 AI challenges in the public sector**

Many researchers were attracted by viable and commercial applications of the AI (Ransbotham et al., 2017). AI impacts were studied in areas related to the automotive industry, high tech, retail, media, education, financial services, and tourism (Bughin et al., 2017). However, there is a lack of empirical research studies on AI in the public sector which is still in its early stages. Santa Cruz Police California in 2011 piloted an AI tool based on analytics methods by examining historical data of crimes' time and locations to predict future incidents. They managed to reduce 27% of the crimes. (Goldsmith, 2014).

The number of empirical research studies covers the effect of AI in the public sector is limited compared to the exceptional nature of the problems and challenges that are facing the public sector. The various challenges have been identified by some papers. First, AI is found to have a big impact on most of today's workforce. Mainstream professionals like managers, doctors, accountants, and journalists will be gradually replaced by less expert people with new types of expertise and high-performance systems (Susskind & Susskind, 2016). Second, there is a growing focus on ethical issues and social rules linked to AI implementation which could balance between the acquisition of data and privacy (Begg, 2011). Third, regulatory issues are one of the important challenges to be considered when adopting AI, including the governance framework that should be applied to the different areas in the public sector (Winfield, 2018). Fourth, the user acceptance and technology trust can be considered with the AI applied technologies (Hengstler et al., 2016)

Sun & Medaglia (2019) investigated the challenges of AI implementation in the public sector as realized by the key stakeholders. Drawing on the theoretical lens of framing, the authors analyze a case of adoption of the AI system IBM Watson in public healthcare in China, to uncover how different groups of stakeholders (government policymakers, hospital managers/ doctors, and IT firm managers) perceive the challenges of AI execution. The findings show that different stakeholders have different, and sometimes contradictory framings of the challenges. The paper aimed to provide an empirical basis to present AI challenges in the public domain which was found as social, economic, ethical, political and policy, organizational & managerial, data, and technological challenges.

Various challenges are facing the adoption of AI. Table 1 below shows the exploratory findings and their relevant research questions that could be studied.

Table 1: Exploratory findings of AI impact and challenges (in general) vs. AI in the public sector

Reference	Domain / Impact	Challenges	Discussion	Questions
<b>AI impact and challenges</b>				
Cheng et al. (2018) Xu et al. (2014) Allam & Dhunny (2019) Borah et al. (2013) Zhou et al. (2009) Baker (2000) Singh (2018) Alkim et al. (2012) Amato et al. (2013) Coiera (1993) Hanson & Marshall (2001) Alam et al. (2018) Arfat et al. (2017) Mehmood et al. (2017) Schlingensiepen et al.(2016) Alazawi et al. ( 2011) Schlingensiepen et al. (2016) Tawalbeh et al. (2016) Barns (2016) Duan et al., (2019) Davenport & Ronanki, (2018) Duan, Ong et al. (2012)	-Governance -Economic growth -Increased efficiency -Enhance mobility through its application -Sustainability -Improve performance -Resilience -Education	Technology  Technical issues in agent-based systems  Societal  Governance  Economic  Data  Competent People  Complexity  Policies  Culture & personal values	-Develop user Trust level on Technology - Trust varies based on the technology, the user and the task. - Technology Understanding to perform the desired task - Technical issues to human intuition & Judgment  -Confidentiality -Ethics -Culture  -Increase efficiency to fit the emerging benefit  Storage model challenge, e.g cloud computing Ensure effective integration with domains  -competent people to oversee the complex processes	What are the AI challenges facing the application in the UAE?
<b>AI challenges in the Public Sector</b>				
Ransbotham et al. (2017) Bughin et al. (2017) Mitchell et al. (2016) Goldsmith (2014) Nuance Communications (2016) Eggers et al. (2017) Marconi et al. (2017) Schatsky et al., (2015) Eggers et al. (2017)	-Automotive -Healthcare -High tech -Retail -Media -Education -Financial services -Tourism -Tax services	Workforce	Replace the workers  Categories to limit the replacement: 1. Relieving 2. Splitting up 3. Replacing 4. Augmenting	What are the challenges facing AI adoption in the UAE public sector?

Material Handling & Logistics Staff (2001). Darryl K. Taft (2014) Jennifer DeLaOsa (2016) Lauren Razavi (2016) Russell & Norvig (2016) Susskind & Susskind (2016) Batko & Szopa (2017) Begg (2011). Winfield (2018) Hengstler et al., (2016) Sun & Medaglia (2019)	-Enforcement -crimes prediction -Embedded learning ability - Suitable for the public because of dynamic changing environments	Social Regulatory  Technology  economic ethical Organizational & managerial Data	Expert will be replaced by less expert with a new type of expertise  Pressure on losing jobs Ethical issues, Privacy Governance framework should be applied User acceptance Technology trust
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#### 4. Discussion

A thorough review of existing relevant research studies was conducted from the literature. The study has identified three main levels of challenges that face AI adoption which is related to AI challenges and impact in general, and the challenges related to AI in the public sector. Therefore, it can be concluded that various challenges are facing the adoption of AI in the government. Figure 2 represents a conceptual framework for the challenges and impact of AI adoption as concluded from the literature.

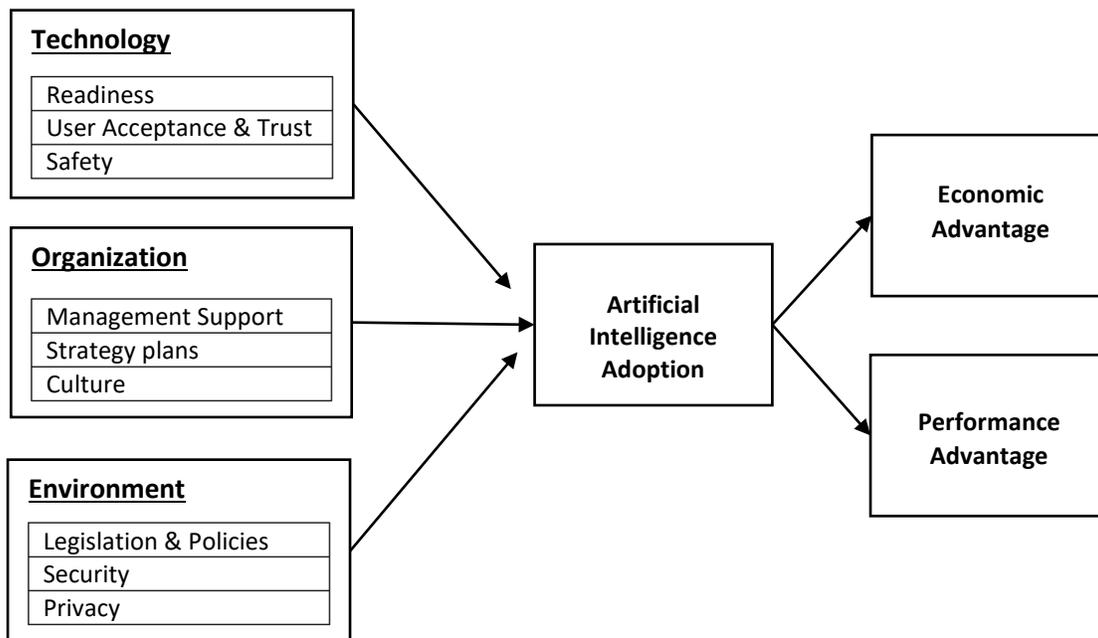


Figure 2: Conceptual Framework for AI adoption challenges and impact on the public sector

By exploring the challenges with different contexts in the public sector, different key findings can be observed.

First, the public sector is different in its challenges and nature than other sectors. The structure and organizations involved with the maturity level of involvement are affecting its challenges. The stakeholders of the public sector are unique because the government is controlling that sector with remarkable targets to improve it and provide desired benefits and quality services to the citizens.

Second, the majority of perceived challenges by different parties involved in the applications of AI are not necessarily technical. Although the technology is playing a major role in the successful adoption of AI applications, many other challenges are affecting the future of AI success in the government.

The third finding is that the risk of replacing humans workforce is a debatable impact in the public sector which becomes a hinder for AI development in certain domains.

Forth, the literature showed that AI challenges exploration were not studied enough in the middle east (MENA) region where the emerging technologies are not produced. The paper provides a base for future studies and contributions to focus on exploring the impact and the challenges of AI applications in those countries, especially where governments are taking outstanding actions and showing strong commitment to improve the services and provide a distinguished and improved experience to their citizens. e.g the UAE and Saudi Arabia governments from the MENA region.

Fifth, it was found that empirical research literature and studies are limited for the existing theoretical assumptions on the challenges and impacts of AI in the public sector. The academic researchers and professionals can create a systematic analysis of empirical data on the challenges of AI from real public sector projects as perceived by concerned stakeholders and focus groups.

Sixth, this paper examines the AI in the context of the public sector, with an exploration of the transport domain. Future studies could examine other sectors and domains, e.g education, and health services.

Finally, government policymakers are a key contributor to the examination of the challenges in the public sector and the success of the implementation. They have different perceptions and understanding than IT and technology developers.

## **5. Conclusion**

AI technologies are appropriate to the public sector context where there are always changes in environmental situations with no pre-programmed settings. Theoretical data of challenges from implementing AI in the public sector applications were explored and investigated, seeking answers to the research question. The findings open up new areas for future studies on the impact and challenges of AI implementation in the public sector from empirical data captured by different projects. They also provide a framework for decision-makers in the public sector to ensure the smooth adoption of such applications. As AI technologies and functions are being developed, it is highly recommended to study all the challenges that affect the adoption of the technologies besides the technical view.

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