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DEVELOPMENT OF AN ARTIFICIAL INTELLIGENCE IMPLEMENTATION PLAN FOR THE SPANISH PUBLIC SECTOR

MASTER'S DEGREE IN BUSINESS, PRODUCT AND SERVICE MANAGEMENT:

FINAL PROJECT

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"A mi tutora Blanca por su ayuda y dedicación

A Carmen por su intuición y apoyo en momentos clave."

*"The thing that's going to make artificial intelligence so powerful is its ability to learn, and the way AI learns is to look at human culture. I often tell my students not to be misled by the name 'artificial intelligence' - **there is nothing artificial about it**."*

Stephen Hawking

ABSTRACT

The present work proposes an AI implementation plan for the Spanish Public Sector as a guideline for accomplishing three main goals: (1) to acquire a better understanding of the AI framework in the context of the Public Administration, (2) to identify the principal actors of this process of radical transformation that all administrations will have to face in the near future, and (3) to provide a feasible prioritization strategy for determining which AI systems should be applied first, and in which particular areas of the Public Sector. The first step for developing this strategy has been to conduct a study of the current situation of AI in both scenarios Europe and Spain. Secondly, for determining the priorities among the AI systems subjected to study -Machine Learning, Deep Learning, Bid Data analytics, Natural Language Processing, Computer Vision, Content Generation and Reinforcement Learning-, a quantitative analysis based on the PACE prioritization matrix has been carried out. Finally, the order of public areas to approach with the implementation of AI systems -Education, Healthcare, Smart cities, Citizen-Public Administration interaction and Security-, has been based on a qualitative analysis of the current situation of the considered public areas.

Keywords:

- Artificial intelligence
- Public sector
- Public Administration
- Public government
- Citizens
- E-government processes
- Public processes
- Process improvement
- Citizen participation
- Smart government

RESUMEN

El presente trabajo propone un plan de implementación de la IA para el sector público español, con la intención de servir como guía para el cumplimiento de los siguientes objetivos principales: (1) adquirir una mejor comprensión del marco de IA en el contexto de la Administración Pública, (2) identificar los principales actores de este proceso de transformación radical que todas las administraciones tendrán que afrontar en un futuro próximo, y (3) proporcionar una estrategia de priorización viable para determinar qué sistemas de IA deben aplicarse en primer lugar, y en qué áreas concretas del Sector Público. El primer paso para el desarrollo de esta estrategia ha sido la realización de un estudio de la situación actual de la IA tanto en Europa como en España. En segundo lugar, para determinar las prioridades entre los sistemas de inteligencia artificial objeto de estudio -Machine Learning, Deep Learning, Bid Data analytics, Computer Vision, Natural Language Processing, Content Generation y Reinforcement Learning-, se ha realizado un análisis cuantitativo basado en la matriz de priorización PACE. Por último, el orden de clasificación de los espacios públicos a abordar para la implantación de los sistemas de IA -Educación, Sanidad, Ciudades Inteligentes, Interacción Ciudadano-Administración Pública y Seguridad-, se ha basado en un análisis cualitativo de la situación actual de dichas áreas.

Palabras clave:

- Inteligencia Artificial
- Sector Público
- Administración Pública
- Gobierno Público
- Ciudadanos
- Procesos Electrónicos Gubernamentales
- Procesos Públicos
- Mejora de Procesos
- Participación Ciudadana
- Gobierno Inteligente

RESUM

El present treball proposa un pla d'implementació de la IA per al sector públic espanyol, amb la intenció de servir com a guia per al compliment dels següents objectius principals: (1) adquirir una millor comprensió del marc de IA en el context de l'Administració Pública, (2) identificar els principals actors d'aquest procés de transformació radical que totes les administracions hauran d'afrontar en un futur pròxim, i (3) proporcionar una estratègia de priorització viable per a determinar quins sistemes de IA han d'aplicar-se en primer lloc, i en quines àrees concretes del Sector Públic. El primer pas per al desenvolupament d'aquesta estratègia ha sigut la realització d'un estudi de la situació actual de la *IA tant a Europa com a Espanya. En segon lloc, per a determinar les prioritats entre els sistemes d'intel·ligència artificial objecte d'estudi -Machine Learning, Deep Learning, Bid Data analytics, Natural Language Processing, Computer Vision, Content Generation i Reinforcement Learning-, s'ha realitzat una anàlisi quantitativa basada en la matriu de priorització PACE. Finalment, l'ordre de classificació de les àrees públiques a abordar per a la implantació dels sistemes de IA -Educació, Sanitat, Ciutats Intel·ligents, Interacció Ciutadà-Administració Pública i Seguretat-, s'ha basat en una anàlisi qualitativa de la situació actual d'aquestes àrees.

Paraules clau:

- Intel·ligència Artificial
- Sector Públic
- Administració Pública
- Govern Públic
- Ciutadans
- Processos Electrònics Governamentals
- Processos Públics
- Millora de Processos
- Participació Ciutadana
- Govern Intel·ligent

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ACRONYMS

PA	Public Administration
PS	Public Sector
AI	Artificial Intelligence
EU	European Union
EC	European Commission
JRC	Joint Research Centre
ML	Machine Learning
DL	Deep Learning
NLP	Natural Language Processing
CV	Computer Vision
CG	Content Generation
RL	Reinforcement Learning
NUTS	Nomenclature of Territorial Units for Statistics
RDI	Research, Development and Investigation
ISA²	Interoperability Solutions for Public Administrations, Businesses and Citizens

1. INTRODUCTION

1.1. PRESENTATION

As electricity did once in the past, Artificial Intelligence (AI) is going to transform our lives in the present and future. Its rise in society is causing a huge impact in our ecosystem as it is currently known, and the AI expansion is only in its early stage. The aim of the present work is to provide certain guidance during this process of implementing the AI in the Public Administration (PA), to facilitate not only the transformation of the PA, but also the embracement of citizens to this new change.

In order to approach this problem and being able to propose viable solutions that may soften the transformation of the PA, countries have to act rapidly and work together for succeeding in this difficult challenge.

By focusing the investigation on Spain, this work aims to be considered as a support guide intended to cities that are obliged to face the AI implementation challenge, if they want to evolve properly and not to lag behind in this race to the future.

1.2. MOTIVATION AND JUSTIFICATION

AI is going to be the principal actor of change in the society as we know it by revolutionizing the way things are done in every area (money transactions, data analysis, healthcare, marketing, etc.). So, it is a very challenging and interesting topic to research and comprehend. In addition, it is a rising area of research and implementations; AI is an uncharted territory so there is still room for new investigation and perspective proposals.

Since AI implementation is a vast topic that penetrates in all areas of our society, it has been decided to focus this research into the Public Administration (PA) not only by the necessity of narrowing the field of study but also by the fact that the implementation of AI in the PA has a bigger margin of improvement than in the private sector, since the majority of governments are investing much less money in artificial intelligence than private companies, which are much more innovative and prepared for this change.

Within this context, another challenge of AI capabilities in the Public Administration is that its implementation is accompanied by some uncertainty. On the one hand, AI applications are seen as enablers of increased efficiency and effectiveness, by automating plenty of tasks normally carried out by humans, augmenting predictability, capacity for decision-making and improving services to citizen queries. Nevertheless, on the other hand, the introduction of AI is accompanied by challenges related jobs destruction caused by automation, privacy infringements caused by digital surveillance, and the reinforcement of biases in policymaking caused by algorithmic governance (Sun & Medaglia, 2018).

In conclusion, the present work has been conceived as a way of guidance to cities and governments that are starting to confront the emerging implementation of AI in plenty of areas. These organisms have to adapt rapidly in order to provide a more efficient experience to citizens in their interactions with the administration by offering a personalized treatment, by providing better information of the public processes (forms, regulations, etc) of its services, and by encouraging them to embrace and adapt the new structure which will bring citizens and PA much more closer.

1.3. STRUCTURE

This thesis is structured in 4 principal sections: firstly, the introduction, secondly, the objectives, methodology and literature review, thirdly, the situation of AI in the EU and the situation of AI in Spain and finally, the prioritization proposal of public areas to apply AI, the AI strategy proposed and the conclusions and future research.

In the first section, the topic has been presented and its contribution to society has been detailed, particularly for Spain, due to the fact that the analysis will consider the characteristics (strengths and weaknesses) of this country.

Then, the second section describes a summary of the objectives of the present work, a feasible and efficient AI strategy for the Spanish Public Sector (PS). Moreover, the research methodology used is detailed and finally, the literature review analysis of the AI field will be carried out. In this section the public areas considered for applying AI and the main AI techniques to take into account for improving the PA will be defined, so that the reader may identify the wide range of options involved when implementing the AI.

Thereafter, in section 3, the guidelines of the EU will be exposed in order to establish the needs of the state members for working together during this process of change. It is important to understand that the European Commission (EC) has defined certain activities and rules to be accomplished by the countries involved. Afterwards, the work will focus on Spain, which is where there is intended to propose an AI implementation strategy for the PA, and to do so, it is crucial to analyze the current situation of the country regarding this topic. In addition, a comparison between Spain and the top AI-leading countries of the EU will be presented.

Finally, in the fourth section, a prioritization of the most appropriate AI capabilities will be shown. In other words, it is important to convey to the reader that there are plenty of AI possible applications. Nevertheless, there are restrictions to consider as well. For instance, the application time needed to respect, so, perhaps a given capability has an enormous potential for improving several scenarios of the PA, but it is not mature enough for implement it in a short/mid-term. After classifying the AI capabilities to utilize, the PACE prioritization matrix tool will be used for determining the public areas to take into account in the proposed strategy. Lastly, the conclusions and future research in this matter will be presented.

2. OBJECTIVES, METHODOLOGY AND LITERATURE REVIEW

2.1. OBJECTIVES

The objective of the present work is to provide an AI implementation guide for the PA field. The targets of this guide are the Spanish cities that are facing the disruptive change of AI and must confront its application by meeting the deadlines imposed by the EU. Within this context, in order to develop the strategy of AI application, a prioritization concerning both the public areas to tackle and the AI techniques to consider will be made. It will be based on two aspects: 1) The Hype Cycle for AI where the maturity of each AI technique will be analyzed; and 2) the PACE prioritization matrix technique which will serve as a tool for defining the most important areas of the PA to approach. In the following chapters, both aspects will be fully described.

In addition, for achieving this goal, 5 research questions have been proposed as a starting point for investigating the AI application in the Public Sector (PS). The following lines detail the research questions (RQ) selected for this study, containing the principal aspects to take into account for applying responsible, competent and efficient AI capabilities in the cities:

- RQ1: Why is it crucial to implement AI in the Spanish PA and how to do it?
- RQ2: Which AI capabilities can be used in the PA?
- RQ3: Which of these capabilities are more feasible to implement?
- RQ4: Which AI capabilities will have a more significant impact in citizens and in which areas of the PA?
- RQ5: Which ethical guidelines must be considered during the AI application?

As the main RQ includes the other four, in the image below is represented the structure of the questions approached in this work. In addition, these questions will serve as a guide for the literature review analysis detailed in chapter 1.3.

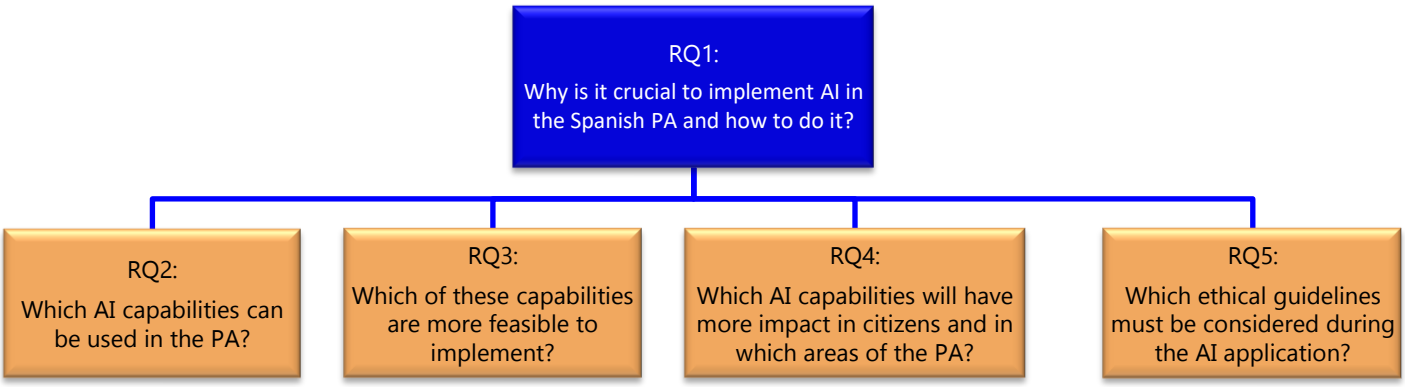


Figure 1: Research questions structure

2.2. METHODOLOGY

Due to the objectives of the present work, it has been decided to elaborate an investigation work based on two stages: first, the data collection using scientific data bases, and public institutions reports as the main source, and second, data analysis observer impression, where qualitative data will be studied, and from which, conclusions will be extracted and presented in a structured manner.

The following paragraph detail the research method utilized in this work for collecting the data. It encompasses three subsections: 1) Criteria for selecting the literature, 2) Keywords and 3) Data collection refinement.

2.2.1. Criteria for selecting the literature

In this research 3 types of sources have been selected:

1. Papers extracted from relevant scientific searchers:
   - Science Direct: http://sciencedirect.com
   - ACM Digital Library : https://dl.acm.org/
2. Reports from European organisms and institutions
   - European Commission
   - Countries ministries of innovation and science (notice that depending on the country the official name of the ministry may have slight differences)
3. Reports published by top world-leading companies:
   - McKinsey
   - PwC
   - Microsoft

2.2.2. Keywords

The selection of words has been based on several factors to encompass the bias of this work: firstly, the Artificial Intelligence concept for filtering only papers that study the PA from the prism of AI. Secondly, to consider all the PA synonyms for covering the widest range. Thirdly, to add the citizen concept for ensure that the references taken into account consider the behavior of the citizenry regarding this topic of study. These are the keywords used in the literature research:

- *Artificial intelligence; public sector; PA; public government; citizens; e-government; processes; public processes; process improvement; citizen participation; smart government.*

2.2.3. Data collection and analysis method

For the scientific searchers the input parameters utilized where the following: 1) introducing the keywords detailed above; 2) restricting the publication year from 2018 to the present; 3) Full text and abstract containing "Artificial Intelligence" and "Public", respectively; 4) selecting only the open access sources. Moreover, the VPN access to UPV was used in order increment the number of papers with admittance to the content. The table below show the refinement applied in the search:

Table 1: Literature research refinement

Refinement	Restriction
Content format	PDF (only)
Publication format	Scientific journals (only)
Abstract containing	"Public"
Publication year	2018 and 2019 (only)
Full text containing	"Artificial Intelligence"

Science Direct search flow diagram: See in the left side, the results considered for each stage of the search, and in the right side, the filter/restriction applied:

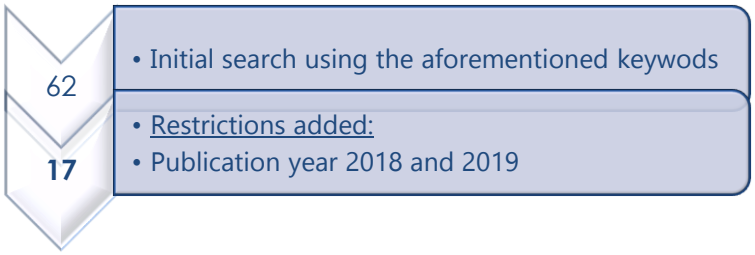


Figure 2: Science Direct search flow diagram

The image below shows the refinement used in the search:

Figure 3: Science Direct search

ACM Digital Library flow diagram of the search: See in the left side, the results considered for each stage of the search, and in the right side, the filter/restriction applied:

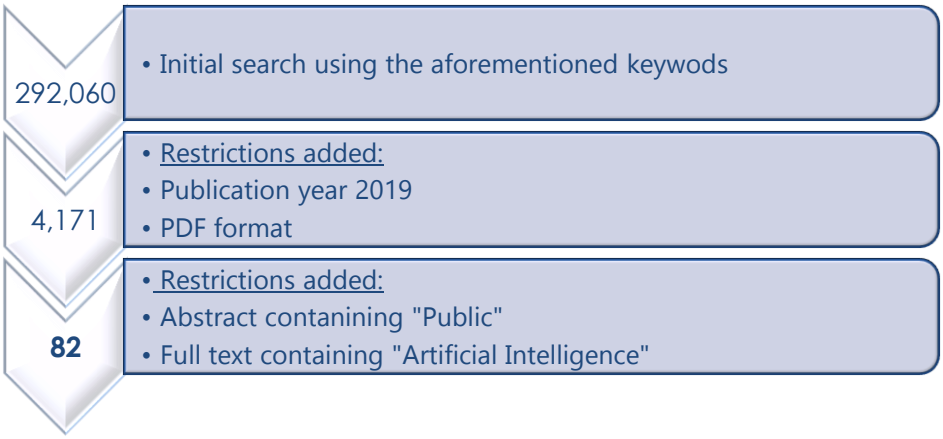


Figure 4: ACM Digital Library search flow diagram

The image below shows the refinement used in the search:

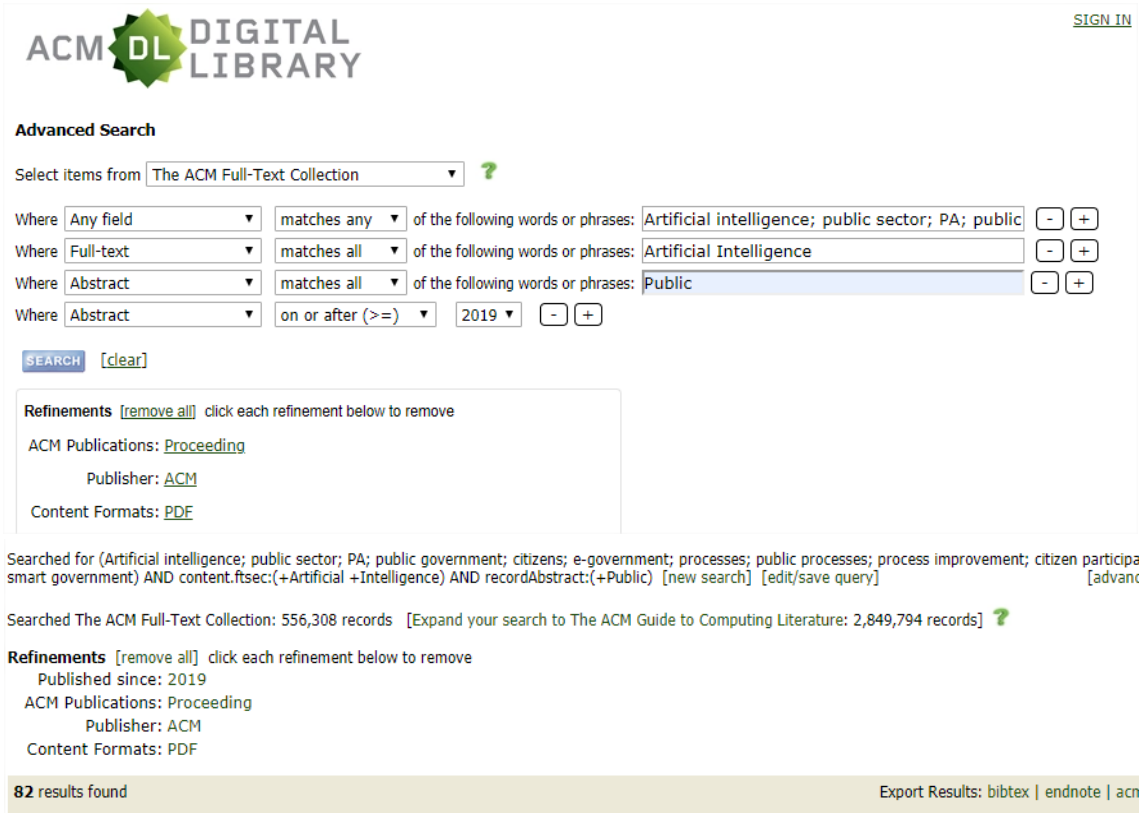


Figure 5: ACM Digital Library refinement

After applying this bias, the number of references was reduced to 99 references, 82 extracted from ACM DL and 17 from Science Direct. However, after an overview of the content based on the improvement of PA, the number was reduced to 39 references.

Furthermore, for completing the research and access to papers that research this topic in a more general and wide-ranging manner certain studies of leading private companies (Microsoft, McKinsey, MIT and PwC) and public organisms have been considered

(European Union (EU) Research Centre). Concretely, 6 references where extracted from these sources.

After an exhaustive analysis of all the relevant papers for this research topic (selecting the papers that take into account the capabilities of AI, its main areas of implementation or the role of citizens regarding AI), the final number of references was reduced to 45.

2.3. LITERATURE REVIEW

The aim of this section is to structure the aspects studied in the literature according to the aforementioned research questions, and to organize the main ideas included in these previous studies, to obtain tendencies, differences, opportunities and conclusions in the AI field for the Public Sector and evaluate the main implications that could result from its implementation. This analysis will provide an added value and a different perspective from the transformation of the administration and the citizens.

Artificial intelligence refers to "any machine or algorithm that is capable of observing its environment, learning, and based on the knowledge and experience gained, take intelligent actions and propose decisions" (European Commission, Joint Research Centre, 2018). Valle-Cruz and Sandoval-Almazan (2018) define AI as the "simulation of living beings' behavior by means of intelligent software and machines".

2.3.1. Why is it crucial to implement AI in the Spanish PA and how to do it?

First of all, regarding the first research question, the references have been grouped by five topics in order to acquire an overview of the state of the art and answer the research questions proposed. These groups are benefits for citizens, AI capabilities, improvement areas of PA, government digitalization and ethics. These topics were defined considering both literature review and reports elaborated by the European Commission and top consulting firms in the world.

Table 2: State of the art analysis: references by topic

REFERENCE / TOPIC	ARTIFICIAL INTELLIGENCE:				
	Benefits for Citizens	AI Capabilities	Improvement Areas of PA	Government digitalization	Ethics
Poes et al., (2019)		X			
Cheng et al., (2018)				X	
Chatfield & Reddick, (2018)		X	X		
Sun & Huo, (2019)		X			
Mergel et al., (2018)	X			X	
Soe & Drechsler, (2018)	X			X	
Ribeiro et al., (2019)		X			
Wirtz et al., (2019)		X		X	

Lage et al., (2018)			X		
Lin & Ho, (2019)		X	X		
Renteria et al., (2019)				X	
Mergel et al., (2018)	X			X	
Mainka et al., (2018)	X			X	
Cartelli et al., (2018)	X			X	
Dutra & Soares, (2018)	X			X	
Cortés-Cediel et al., (2018)				X	
Lindgren & van Veenstra, (2018)	X			X	
Basri et al., (2019)	X			X	
Agbozo & Spassov, (2018)	X	X		X	
Prieto et al., (2018)	X				
Gaut et al., (2018)		X		X	
Kankanhalli et al., (2019)	X	X	X	X	X
Sun & Medaglia, (2018)		X			X
Sinha et al., (2019)	X				
Gerontaset al., (2018)	X			X	
Millard, (2018)				X	
Kalyanakrishnan & Panicker, (2018)		X	X		X
Luciano et al., (2018)				X	
Tryfonas & Crick, (2018)	X				
Yoon et al., (2018)				X	
Buyle et al., (2018)	X				
Liu & Kim, (2018)	X			X	
Casares, (2018)	X	X	X	X	X

Makridakis, (2017)	X				X
Agbabiaka, (2018)	X			X	
Valle-Cruz & Sandoval-Almazan, (2018)		X	X	X	
Toch & Birman, (2018)		X			X
Li et al., (2019)		X			
Androutsopoulou et al., (2018)	X	X	X	X	
Appio et al., (2018)			X		
Chui et al., (2018)	X	X	X	X	X
PwC, (2018)	X	X	X	X	X
European Commission Joint Research Centre, (2018)	X	X	X	X	X
MIT Technology Review, (2018)		X			
Microsoft, (2019)					X
TOTAL / TOPIC	23	20	12	27	10
PERCENTAGE OF PAPERS / TOPIC	**51,11%**	**44,44%**	**26,67%**	**60,00%**	**22,22%**

Source: own elaboration

First of all, it is necessary to explain certain aspect regarding the methodology of the analysis carried out; given that each reference can investigate more than one topic, the sum of all percentages will be superior to 100%.

As shown in the table above, the literature is principally focused on the digitalization of governments and the benefits that the AI will provide to citizens, 60% and 51.11% of the total references studied, respectively. These two topics are highly present currently in the public sector state of the art due to PAs are facing the disruptive changes regarding the information and communication technologies (ICT) advancements, and they have to adapt rapidly for providing a proper service to the citizenry in comparison with private institutions.

Apart from that, a 44.44% of the papers study the AI capabilities in the PA which is a crucial aspect to take into account for implementing efficient solutions to current problems.

In contrast, the "Ethics" and "Improvement Areas of PA" categories are considered to a lesser extent regarding references related to the enhancement of the Public Sector by using the Artificial Intelligence.

After this initial analysis, this work aims to focus not only in using the AI for optimizing the PA approach to citizens but also in detailing which areas should be tackled and in what order for the first stages of the AI implementation.

2.3.2. RQ2 and RQ3: Which AI capabilities can be used in the PA and which are more feasible to implement?

After analyzing the most relevant topics taken into account in the state of the art, another division has been made, concerning the research questions 2 and 3 that analyze which AI capabilities may be applied into the PA its implementation. Within this context, only those capabilities related to the PA needs have been considered. For selecting them a filter of the organization of AI eighteen capabilities considered in Chui et al. (2018), has been made, and 6 categories have been selected due to their capacity of enhancing Public Sector processes: 1) Machine Learning (ML); 2) Natural Language Processing (NLP); 3) Computer Vision (CV); 4) Reinforcement Learning (RL); 5) Content Generation; 6) Analytics.

It is important to clarify that this selection involves only software AI capabilities due to it encompasses the Artificial Intelligence frame; this is because all hardware capability such as robots, autonomous vehicles, chatbots, etc, have software behind it. Nonetheless, the hardware will be considered in chapter 4 for and 5.

The paragraphs below will define each AI capability and justify their selection for this work analysis:

I. **Machine learning (ML):** is the generic class of algorithms that learn from the data by learning patterns and applying them. These algorithms, as mentioned in (Hao, 2018) "use statistics to find patterns in massive amounts of data (numbers, words, images, clicks, etc.). If it can be digitally stored, it can be fed into a machine-learning algorithm. Machine learning is the process that powers many of the services we use today—recommendation systems like those on Netflix, YouTube, and Spotify; search engines like Google and Baidu; social-media feeds like Facebook and Twitter; voice assistants like Siri and Alexa". In public services, interaction between citizens and a chatbots needs the use of machine learning and natural language processing (Kankanhalli et al., 2019).

   It includes Deep Learning (DL), which is a subset of Machine Learning that can cope with noisier data by increasing significantly the number of neural layers and neurons, and the amount of data used for the training, (European Commission Joint Research Centre, 2018). Advancements in deep learning will

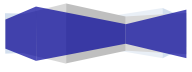
allow, with other technologies, achieving the sixth level in autonomous vehicles (Lin and Ho, 2019). Structured deep learning might be used to automatically enroll individuals in welfare programs for which they are qualified (Chui et al., 2018).

II. **Natural language processing (NLP):** this AI capability has the potential of recognizing patterns from the types of data they use, particularly unstructured data rich in information. NLP is able to identify patterns in historical data, which are being used for diseases prevention, prediction of criminal activities or detection of frauds in justice. It is also combined with data mining and text mining for extracting citizens' sentiments from text or multimedia content on and used for biometric identification (Androutsopoulou et al., 2019). NLP is also used in universities for detecting plagiarism in student assignments (Chui et al., 2018).

III. **Computer vision (CV):** this AI capability has countless possibilities in identification field: images, faces, individuals, objects. CV is used in several areas of the Public Sector such as traffic control, medical diagnosis, fingerprinting matching and facial comparison, (Androutsopoulou et al., 2019).

IV. **Reinforcement Learning (RL):** large-scale and high-speed simulation modeling which improves on supervised learning by enabling the machine learning algorithms to choose actions and discover which sequences of actions lead to mastering a predefined task. This is applicable to many real-life problems, (CogitAI, 2019). RL is another set of algorithms that focus on experience-driven sequential decision-making, i.e., they make software agents take action to maximize some notion of cumulative reward. RL combined with DL is the basis of many recent successes in complex games, such as Go, Poker and Dota, where computers have been able to beat leading human experts in the field. Practical applications of these algorithms are starting to be applied in many domains, such as autonomous driving, unmanned aerial vehicles, stock markets, and defense (European Commission Joint Research Centre, 2018). Particularly, RL is important for the present work due to its versatility for approaching problems of different subjects. So it is easily adaptable for the Public Sector in matters such as transport decision routes, chatbots training or self driving cars.

V. **Content generation (CG):** although this AI capability is in a developing stage, it may help in the education field due to its potential for generating text and media (video, audio) content for educational purposes with quick production turnaround for wide distribution, Chui et al. (2018b)



VI. **Big data predictive analytics:** AI techniques not including deep learning that may be utilized for optimize processes within the administrations, network analysis or journey mapping. Concretely, it is an advance analytic methodology that examines data to predict a determined result by predicting what the most probable outcome of the content analyzed is. It uses several techniques: multivariate statistics, pattern matching, forecasting and predictive modeling (Krensky et al, 2018).

This analysis of the references will show on the one hand the study of which capabilities are more developed, and on the other hand, which ones are still uncharted or in the very first stages of research.

The table below shows the aforementioned organization:

Table 3: State of the art analysis: references by AI capabilities

REFERENCE	ARTIFICIAL INTELLIGENCE CAPABILITIES					
	ML	NPL	CV	RL	Content generation	Big data predictive analytics
Poes et al. (2019)						X
Cheng et al. (2018)					X	
Chatfield & Reddick (2018)			X			
Sun & Huo (2019)						X
Mergel et al. (2018)	_	_	_	_	_	_
Soe & Drechsler (2018)	_	_	_	_	_	_
Ribeiro et al. (2019)	X					
Wirtz et al. (2019)	X					
Lage et al. (2018)	_	_	_	_	_	_
Lin & Ho (2019)	X					
Renteria et al. (2019)	_	_	_	_	_	_
Mergel et al. (2018)	_	_	_	_	_	_
Mainka et al.,(2018)	_	_	_	_	_	_
Cartelli et al. (2018)	_	_	_	_	_	_

Dutra & Soares (2018)	–	–	–	–	–	–
Cortés-Cediel et al. (2018)	–	–	–	–	–	–
Lindgren & van Veenstra (2018)	–	–	–	–	–	–
Basri et al. (2019)	–	–	–	–	–	–
Agbozo & Spassov (2018)	X					
Prieto et al. (2018)	–	–	–	–	–	–
Gaut et al. (2018)	X					
Kankanhalli et al. (2019)	X					X
Sun & Medaglia (2018)	X	X				
Sinha et al. (2019)						X
Gerontaset al. (2018)						X
Millard (2018)	–	–	–	–	–	–
Kalyanakrishnan & Panicker (2018)	X	X	X			X
Luciano et al. (2018)	–	–	–	–	–	–
Tryfonas & Crick (2018)	–	–	–	–	–	–
Yoon et al. (2018)	–	–	–	–	–	–
Buyle et al. (2018)	–	–	–	–	–	–
Liu & Kim (2018)						X
Casares (2018)	X					
Makridakis (2017)	–	–	–	–	–	–
Agbabiaka (2018)	–	–	–	–	–	–
Valle-Cruz & Sandoval-Almazan (2018)	X	X	X	X	X	X
Toch & Birman (2018)	X					
Li et al. (2019)						X
Androutsopoulou et al. (2018)	X	X				

Appio et al. (2018)	X					
Chui et al. (2018)	X	X	X	X	X	X
PwC (2018)	X	X				X
European Commission Joint Research Centre (2018)	X	X	X	X	X	X
MIT Technology Review (2018)	X			X		
Microsoft (2019)	_	_	_	_	_	_
TOTAL / TOPIC	17	7	5	4	4	12
PERCENTAGE OF PAPERS / TOPIC	**68,00%**	**28,00%**	**20,00%**	**16,00%**	**16,00%**	**48,00%**

Source: own elaboration

On the one hand, the literature considered approaches different aspects of the PA improvement, there are several papers that do not deepen in the analysis of the AI from a technical point of view, and this is the reason why 20 out of the 45 references do not investigate the software behind the AI in a quantitative manner.

On the other hand, the table 3 shows that Machine Learning is the AI software capability more mature in the Public Sector, in this line of analysis, the amount of topics out of the total is significantly higher that all the others, 68% of the papers consider this particular capability for solving or analyzing PA problems. The two following capabilities more considered are Analytics and Natural Language Processing with 40% and 28%, respectively. Finally, Computer Vision, Reinforcement Learning and Content Generation are the less mature not only in the PA area of AI but also in all areas (compared with the aforementioned ones).

To conclude this analysis, it is possible to extract that according to the state of the art the proper AI capabilities to utilize in the AI implementation are those with more maturity, not only because of the imminent transformation of the PAs which implies that the results are expected in the mid-term, but also because of the costs reduction in investigation of those capabilities which are in development, and the efficiency of the algorithms developed with them.

2.3.3. RQ4: Which AI capabilities will have a more significant impact in citizens and in which areas of the PA?

Studies analyzed explain the benefits for citizens of applying AI in the public sector. Among these benefits are using data to predict and estimate the economic impact of changes in tax policy, analyze data to improve public safety and optimize transport in cities (Agbozo and Spassov, 2018). Currently, the use of chatbots in the public sector offers real-time access to information and support to citizens (Androutsopoulou et al., 2019). Internet of Things-enabled AI technologies can be used in areas of smart government such as energy and utilities to optimize the use of resources (Kankanhalli et al. 2019).

The present section studies which are the principal areas of the PA considered in the literature for using Artificial Intelligence. Since the PA covers plenty of areas, for the present work five main areas that are considered crucial for starting the implementation of AI in a medium-size developed city such as Valencia, Madrid, or Barcelona have been selected: 1) Smart city; 2) Healthcare; 3) Citizen-PA interaction; 4) Education; 5) Security. The selection of these AI implementation areas has been done according to the action area of local governments (entities to which this work is intended), which may have the power of managing the lights sequence or the chatbots that interacts with the citizen in their webpage rather than deciding the next steps of the AI implementation in more global areas such as justice, agriculture or economy that are managed in a national level.

With regards to the above, in the following paragraphs the five areas of the PA considered in this work for starting the implementation of the Artificial Intelligence will be fully described and each selection will be justified:

- **Smart city:** this area has been selected because of its large impact in the Public Sector, since "smart city" as a concept refers to the set of AI capabilities and Information and Communication Technologies (ICT) that can be placed in a city for improving its sustainability, efficiency and citizen's lives. Even if there is no common definition of what a smart city is, there are several accepted action areas in which the literature converges: the application of this technology in cities, as mentioned in (Li et al., 2019) "represents an advanced information-centric platform for supporting ICT services for application in e-government and PA, intelligent transportation systems, public safety, social dimensions, health care, education, building and urban planning, environment and energy and water management presents the domain fields of integrated applications that concern location, tourism, public transport, PA services, goods and service, financial services, and customer loyalty."

- **Healthcare:** this area has been considered for this work due to its significant technology advancements in the recent years and its importance for citizens.

AI is increasingly entering in this sector and it is one of the most promising areas for AI applications, because healthcare is the public policy area with higher investments. In addition, plenty of its application will simplify processes, predict diseases, improve efficiency in operations and make important findings in the research field. AI use in healthcare has been divided in two main branches: 1) the virtual branch: it encompasses "the study of deep learning information management to control health management systems, electronic health records, and actively guide physicians in their treatment decisions" (Sun & Medaglia, 2018); 2) the physical branch: concerning mostly the assistance not only for surgeons but also for elderly patients.

- **Citizen-PA interaction:** this area of impact is crucial for this work since the Public Sector innovation and modernization of PAs is not only a determining factor for economic growth in a global market (Cartelli et al., 2018), but also it is the action area most perceived, criticized and felt by citizens. In addition, city councils have power to transform and improve this interaction between the PA and people which is sometimes tedious and inefficient. Citizens normally have a high average waiting times no matter what the formality, process or petition they need to deal with the administration. Within this context, the AI implementation in this area will reduce queues, waiting times, number of mandatory attendances to public institutions to go through formalities, bureaucracy and paper consumption reduction.
  Ultimately, the objective of implementing AI in this particular area is to improve this important interaction among citizens and PA by converting the administration in an agile, digitalized, innovative and modern organization that be able to adapt rapidly to a this disruptive evolution.

- **Education:** the main raisons for selecting the field of education is due to it is mostly managed by city councils in important countries of the EU with a decentralized policy such as Spain or Germany, in addition, education is a very significant area for the future of every nation, and it has to evolve. In this line of analysis, the adaptation of education to the AI application has a large margin of improvement. As detailed in (Chui et al, 2018): "In education, more than 1.5 billion students could benefit from application of adaptive learning technology, which tailors content to students based on their abilities". A key factor in this field may be the accessibility to educational content e.g., online courses or intelligent "chatbots professors" for answering questions, which have the potential of increasing the opportunities in this field.
  In summary, the main challenges of the AI in education are both to maximize student achievement and teacher productivity. Several instances for overcome these challenges are: 1) adaptive learning technology, that could be used to suggest content to students based on past success or engagement with the

subjects; 2) Stress detection, as AI could also be used to detect student stress in early stages, even before a teacher be able to notice it.

- **Security:** a very important aspect of AI implementation is to protect the technology and ensure that it will be utilized ethically, and this is the main raison for selecting this particular action area.
  Within this context, security in AI presents certain challenges for society that are divided in three branches (Chui et al., 2018): 1) Harm prevention: including cybersecurity and physical threats; 2) Fair prosecution: including the adaptation of the laws (regulation) and smart contracts; 3) Policing: including street monitoring and crimes prediction. Evidently, in order to achieve a correct implementation of AI in the security field, it will be necessary to supervise the security policies for ensuring the ethic approach and for neither trespassing citizens' privacy nor safety.

After defining the action areas taken into account, the table below will show which ones have higher potential according to the state of the art:

Table 4: State of the art analysis: references by AI areas of impact considered in the literature

REFERENCE	AI AREAS OF IMPACT				
	Smart city	Healthcare	Citizen-PA interaction	Education	Security
Poes et al. (2019)	–	–	–	–	–
Cheng et al. (2018)			X		
Chatfield & Reddick (2018)	X				X
Sun & Huo (2019)	–	–	–	–	–
Mergel et al. (2018)			X		
Soe & Drechsler (2018)	X		X		
Ribeiro et al. (2019)				X	
Wirtz et al. (2019)	X				
Lage et al. (2018)	X				
Lin & Ho (2019)	X				
Renteria et al. (2019)			X		
Mergel et al. (2018)			X		

Mainka et al. (2018)			X		
Cartelli et al. (2018)			X		
Dutra & Soares (2018)			X		
Cortés-Cediel et al. (2018)			X		
Lindgren & van Veenstra, (2018)			X		
Basri et al. (2019)			X		
Agbozo & Spassov (2018)			X		
Prieto et al. (2018)			X		
Gaut et al. (2018)			X		
Kankanhalli et al. (2019)			X		
Sun & Medaglia (2018)		X			
Sinha et al. (2019)	X				
Gerontaset al. (2018)			X		
Millard (2018)			X		
Kalyanakrishnan & Panicker (2018)		X			
Luciano et al. (2018)	–	–	–	–	–
Tryfonas & Crick (2018)	X				
Yoon et al. (2018)			X		
Buyle et al. (2018)			X		
Liu & Kim (2018)			X		
Casares (2018)			X		X
Makridakis (2017)	–	–	–	–	–
Agbabiaka (2018)			X		
Valle-Cruz & Sandoval-Almazan (2018)	X				X
Toch & Birman (2018)	X				

Li et al. (2019)	X				
Androutsopoulou et al. (2018)			X		
Appio et al. (2018)	X				
Chui et al. (2018)	X	X	X	X	X
PwC (2018)		X	X		
European Commission Joint Research Centre (2018)	X	X	X	X	X
MIT Technology Review (2018)	–	–	–	–	–
Microsoft (2019)	–	–	–	–	–
TOTAL / TOPIC	13	5	26	3	5
PERCENTAGE OF PAPERS / TOPIC	**33,33%**	**12,82%**	**66,67%**	**7,69%**	**12,82%**

Source: own elaboration

The table 4 shows important differences between the diverse areas of impact that the AI will have in the PA. Firstly, the 66.67% of the references consider the interaction among citizenry and the Public Sector as a crucial factor. Secondly, the 33.33% explore the Smart Cities area. And thirdly, the areas studied in a lesser extent are Healthcare, Education and Security.

From these results it is concluded that Citizen-PA interaction it is the more important area to tackle at the beginning of the AI implementation in the PS due to this area of impact encompasses the others because citizens' interaction with the PA takes place in every area of the administration. Furthermore, a critical aspect for succeeding in this change is the perception of citizens; they have to feel a competent, reactive, trustworthy and efficient PA in all areas. Finally, it is important to mention that fundamental areas of the Public Sector such as Healthcare or Education are highly managed privately so the poor results in this analysis are not considered as very significant or the global of each area.

2.3.4. RQ5: Which ethical guidelines must be considered during the AI application?

Since AI algorithms are characterized for having the capacity of making autonomous decisions and they will impact enormously in citizens' lives, it is critical to define the ethical guidelines for implementing a trustworthy AI. Some references of the literature considered in this work study the ethical aspects of AI. For example, Casares (2018) indicates that when a goal is established, the artificial intelligence will decide by its own the means to reach that objective, but these means might be

ethically questionable. Kankanhalli et al. (2019) offers the example of autonomous driving, in which artificial intelligence would decide who lives and this would create ethical dilemmas. The European Commission, through its Joint Research Centre (2018) lists the issues that should be considered about artificial intelligence, including unfair AI decisions that could discriminate against particular groups or individuals. In the report developed by the McKinsey Global Institute (Cui et al., 2018), they indicate that discrimination could be generated by racial or gender bias in the samples used by trained algorithms. Another ethical issue is related to sharing patient data and that these data are misused for commercial purposes (Sun and Medaglia, 2018). An additional challenge that generates debate is the effect of AI in labor. Makridakis (2017) points out that this challenge would have different impact in developing and advanced countries, as the latter will replace unskilled and semiskilled labor by computers and robots, reducing their reasons for moving production and services to developing countries.

As the focus of this study is based on policies developed by countries which will be applied in the cities by the city councils, concretely, in Spain (state member of the EU), therefore, it is mandatory to examine the guidelines established by the EU organisms because these requirements are what European countries will be asked to implement.

In this line of analysis and the need of considering all the issues related to AI the EC has gathered an independent group of 52 experts in the AI field for investigating the ethical impact to take into account and accomplish a safe, transparent and trustworthy AI. This guide was presented in June 2018, but, as AI is in a constant change, a revision will be made in 2020.

In (AI HLEG, 2018) the AI experts propose ethical guidelines in this matter considering three principal stages: the definition of the ethical principles or fundamental rights that must be respected during the stages of the AI implementation, the key requirements that AI systems must accomplish, and an assessment list for ensuring the proper development of stages 1 and 2. These three stages will be listed in the lines below:

I. **Fundamental rights for the application of AI**
   i. Respect for human autonomy
   ii. Prevention of harm
   iii. Fairness
   iv. Explicability

II. **Key requirements for AI systems**
   i. Human agency and oversight: "AI systems should both act as enablers to a democratic, flourishing and equitable society by

supporting the user's agency and foster fundamental rights, and allow for human oversight".

ii. Technical robustness and safety: "AI systems should have safeguards that enable a fallback plan in case of problems."
iii. Privacy and data governance: including data protection, privacy, quality, availability and accessibility,
iv. Transparency: including traceability of AI processes that must be documented, explainability of the technical processes of AI systems and communication so that people be aware when interacting with AI software or hardware.
v. Diversity, non-discrimination and fairness: for enabling "inclusion and diversity throughout the entire AI system's life cycle".
vi. Environmental and societal well-being: "Including sustainability and environmental friendliness, social impact, society and democracy"
vii. Accountability: "Including auditability, minimization and reporting of negative impact, trade-offs and redress".

III. **Assessment:** two processes are proposed by the AI experts group of the EC (AI HLEG, 2018):
   i. Qualitative process: to ensure representability, where a narrow selection of entities from different sectors and sizes will join forces in order to pilot the assessment list and the governance organization in practice and to provide feedback.
   ii. Quantitative process: interested stakeholders may join to manage the assessment list and provide feedback through an available open consultation.

In summary, the deployment of AI not only in PA but also in every layer of society is a highly complicated task to perform, and, despite the benefits of AI, the institutions managing this change must be fully aware of its potential dangers and deviations for being able to implement efficient corrections. These guidelines must be respected by every organism willing to apply AI within its infrastructure so that all people involved will not be in any danger.

Besides this expert group managed by the EC, there are several influential organizations and groups such as The World Economic Forum's Centre for the Fourth Industrial Revolution, the IEEE, AI Now, The Partnership on AI, Future of Life, AI for Good, and DeepMind have determined a set of principles that have as its principal objective the maximization of AI benefits for humanity and the limitation of its risks.

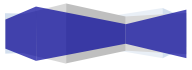
Some areas with an existing consensus are (PwC, 2018):

› Designing AI with an eye to societal impact

- Testing AI extensively before release
- Using AI transparently
- Monitoring AI rigorously after release
- Fostering workforce training and retraining
- Protecting data privacy
- Defining standards for the provenance, use, and securing of data sets
- Establishing tools and standards for auditing algorithms

For concluding the literature review, after having analyzed all the papers it is observed that AI is going to provide much more benefits than risks for the PS providing an enormous margin of improvement for every branch of the PA, and if Governments adapt to change and implement the proper controls, AI will make society's life easier and better. Particularly it is noted that the government digitalization is quite considered in the literature, but there is a lack of studies concerning the prioritization of public areas to tackle during this deployment. Furthermore, it seems that ML the most influent AI capability for problem solving in any area of the PS, and finally, the literature shows an important concern regarding the interaction between citizens and the PA, smart city, healthcare and education.

Then, in chapter 3, the situation of AI in both the European and Spanish landscapes will be analyzed. Firstly, the EU guidelines, instructions and deadlines that the states members must comply with will be described, and Secondly, Spain current situation regarding the AI will be studied and compared with the leading European countries in this matter.



3. AI: ITS SITUATION IN THE EU AND IN SPAIN

3.1. AI IN THE EU: GUIDELINES

After this initial analysis of the general literature, this study focuses on the European framework. Within this context, the EC has established two main programs for controlling, measuring and ensuring a proper deployment of the AI in Europe: the AI watch portal and the Coordinated Action Plan. Both will be described in the following subsections.

3.1.1. AI Watch Portal

The public internet portal of the EU defines the AI Watch portal's aim which is "to monitor the development, uptake and impact of Artificial Intelligence for Europe" (European Commission, 2018).

It not only advices on the different layers impacted by AI, for supporting the application of the European AI initiative, but also provides a methodology to detect opportunities, risks and potential barriers of the AI utilization. Concretely, concerning the PS, in the immediate future AI Watch will recommend AI techniques and tools for helping the development of AI solutions in governments that will be transferred to individual city councils (depending on the country management of the PA). In addition, AI watch will boost innovation researches co-developed between states members and the EC for implementing AI solutions for smart public services (European Commission, 2018). Deepening in the PS and summarizing the AI Watch action for this sector, it establishes in (European Commission - AI Watch, 2018) three main goals for monitoring correctly the AI revolution:

I. To offer a guide of the AI utilization in the PS and in the delivery of public services in the countries of the EU.

II. To establish a methodology for evaluating the impacts of the acceptance of aI in the PA.

III. To develop methods for evaluating the potential impacts of the AI application to recognize strengths and threats, and to support public services.

To conclude the above, these principles will be an asset and will provide guidance for all the state members of the EU that must cooperate and to combine efforts in the EU for being a competitive leading member of this disruptive technological change.

3.1.2. The Coordinated Action Plan on AI (COM (2018) 795)

The EC is developing as well a coordinated strategy to boost the development and application of AI in Europe. This plan proposes several actions whose aim is to increase the states members, Switzerland, Norway and the EC cooperation in terms of quantity, quality and efficiency concerning 4 fields of action: increasing investment, data availability, boost of talent and trust assurance. For this AI-induced transformation, the aforementioned parts involved agreed to monitor the application of the plan on annual basis. The action plan presented by the EC is the following:

I. Mid-2019 deadline: all member states have until mid-2019 for sharing with the EC and the other members their national AI strategy. Obviously, each country will decide the content of its strategy taking into account its national situation.

II. Periodical discussions: the member states advised by a Sherpa Group ("Representatives nominated by the Member States' Group on Digitising European Industry and Artificial Intelligence" (European Commission, 2018)) will meet biannually for discussing the advancements of the coordinated plan.

III. 2019 assessment: at the end of 2019 the progress will be evaluated and benchmarks for comparing accomplishments and failures will be performed.

These measures confirm that the EU has structured a thorough AI transformation strategy, by setting deadlines, organizing continuous improvement discussions and scheduling progress assessments. In this line of analysis, regarding the PS, the EU Coordinate Plan presents a 4 actions approach for the enhancement of PA services:

I. Digital Service Infrastructure improvement: the main goal regarding this area is to build a Digital Europe Program to implement for the 2020 horizon. To do this, two programs are crucial: Connecting Europe Facility (CEF) and Interoperability Solutions for Public Administrations, Businesses and Citizens (ISA^2):

   i. CEF: is an instrument managed by the Innovation and Network Executive Agency (INEA) which is dedicated to increase EU PS growth through shared investments between the member states. It will improve current European connections and it will develop new ones within the areas of transport, telecommunications and energy.

   ii. ISA^2: this program sustains the evolution of digital innovations within Europe by providing cross-border and cross-sector interoperable public services, from which public entities can benefit.

ISA² focuses on 54 actions grouped in 9 work packages related to interoperable digital solutions. These packages include software free-available solutions that European countries decide whether or not to use. Depending on the area to tackle the AI is present in this solutions or not, e.g., the work package concerning 'Big data opportunities for public administrations' describes the use of AI for predicting patterns through ML and data mining. Nonetheless, the AI use is still theoretical in some stages of ISA²; the solutions related to AI use have still to be. For example in the EC website (https://ec.europa.eu/isa2/solutions_en) where the solutions are presented it is detected the lack of content regarding work packages that may need the application of AI systems (European Commission, 2019)

Table 5: ISA² solutions AI impact

Work Package	Related to AI	Solution provided (** AI related)
Key and generic interoperability enablers	No	e-Documents Reference Architecture: help public administrations make informed decisions about e-Documents solutions.
Semantic interoperability	No	No
Access to data / data sharing / open data	**Yes**	No
Geospatial solutions	**Yes**	No
e-Procurement / e-Invoicing	**Yes**	e-Certis: a tool for mapping certificates necessary in public procurement
Decision making and legislation	**Yes**	No
EU policies – Supporting instruments	No	No
Supporting instruments for PA	**Yes**	EIRA and CarTool: European Interoperability Reference Architecture and Cartography tool NIFO: The National Interoperability Framework Observatory EUPL: European Union Public License IMAPS: Interoperability Maturity Assessment of a Public Service OpenPM²: Open project management methodology IQAT: Interoperability Quick Assessment Toolkit
Accompanying measures	No	No

Source: (European Commission, 2019)a

As table 5 shows, the AI impact in ISA² solutions is not developed yet. According to this analysis, from the 9 work packages, 6 might be related with AI-systems and only 3 have implemented solutions. However, after the investigation of these tools, no evidence indicating the current use of AI techniques was found.

In contrast, even if the lack of AI in ISA² solutions (in the present year) is significant, its solutions for the PA are widely utilized by European countries. In the map below is shown which countries of the EU (in green) use at least one of these ISA² solutions:

Figure 6: Member States using ISA² solutions

Source: (EC Geographic Information System, 2019)

For deepening in this analysis, the following table will list the number of solutions used by each country of the EU:

Table 6: ISA² solutions utilization per country

Work Package	Nº of ISA² solutions
Spain	19
Italy	14
Belgium	12
Netherlands	11
Finland	10
Germany	9
France	8
Ireland	8
Luxemburg	8
Sweden	8
Estonia	8
Poland	8
Czechia	8
Denmark	8
United Kingdom	8
Slovakia	7
Greece	7
Portugal	6
Lithuania	6
Austria	6
Croatia	6
Bulgaria	6
Latvia	5
Hungary	5
Romania	5
Cyprus	5
Malta	4

Source: (European Commission, 2019)b

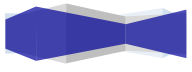
Table 6 shows significant differences regarding the quantity of applications used by each European country. Nevertheless, the quantity of ISA² solutions implemented does not have to be proportional to the quality of public services, and less in relation to AI. In chapter 3.2 a comparison between the leading countries of the EU and Spain will be made and this analysis will be complemented.

II. European network of Public Employment Services (PES): this strategy consists in sharing best practices on AI service between countries in order to capitalize the knowledge and to learn from others' experiences. The

European network is formed by the 28 member states plus Iceland, Norway and the EC.

III. e-Translation: with the aim of connecting Europe, the EC proposes to boost the investments in further developing NLP tools and algorithms in order to potentiate the multilingualism in the PA.

Once established and analyzed the European framework within the AI field, it is needed to determine where Spain is. With this research it will be possible to study its PS: strengths, weaknesses, improvement points, etc. As a consequence, it will be feasible to propose AI tools and a prioritization of public areas to approach. This analysis will be presented in the following chapter.



3.2. AI IN SPAIN: CURRENT SITUATION

In order to decide on the appropriate levers to promote the growth of AI Spanish Public Sector, it is crucial to position Spain's infrastructure regarding AI. To do so, it is important to focus on both a global perspective and a specific perspective of the country in this matter. Therefore, three different factors will be studied.

Firstly it will be needed to analyze the current situation in other European countries, the developments that have been made and in where is Spain positioned in comparison. Since AI is a topic which is rapidly evolving, it is critical to determine the current situation of Spain in aspects such as AI research and the number and quality of private and public entities committed with AI collaboration within Europe. With all this information it will be feasible to establish how far Spain is from the AI-leading European countries.

The second step in this analysis will concern the Spanish national strategy regarding AI, presented in the meeting of April 4th 2019. Concretely, 2019 is the official deadline imposed by the EU for the AI Coordinated Plan program. Given the topicality of this report, the issues tackled and the priorities established by the Spanish government, this recent information will be determinant for this study. In addition, a comparison between Spain AI national strategy and the cutting edge countries of the EU in AI will be made. The countries selected for this analysis are Germany, Sweden, France, Denmark, Finland, Lithuania and United Kingdom, which according to the EC are the most prepared for the AI disruptive change that the world is starting to face.

Finally, the AI investments of the most important Spanish city councils will be analyzed in order to quantify the importance, dedication and responsibility that each city considers regarding AI transformation.

3.2.1. AI: Where is Spain in Europe?

By introducing the comparison between Spain and European countries, several factors will be taken into account. As analyzed in (European Commission JRC, 2018) research, this study will be based on three principal indicators: 1) the main AI players in Europe (investigation centers and public and private entities commitment to AI), 2) the AI landscape in research (literature published and conferences), 3) The AI collaboration network within Europe (information flux, collaborations and participations between countries). Then, 4) the benchmark of AI national strategies developed by the top leading countries in the matter of PA. Finally, in subsection 5) the Government AI Readiness Index, where is categorized the preparation of governments for taking advantage of the benefits of AI in the delivery of their services to citizens (Miller & Stirling, 2019), will be detailed and the position of Spain in Europe will be studied.

3.2.1.1. The Main AI Players in Europe

Within this context, the EU has developed a European AI coordination plan concerning all state members, Norway, Switzerland and the Commission. The most powerful countries of the EU in this matter are proposing particular AI strategies based on their characteristics. Particularly, this common approach is focused on four key areas: increasing investment, the increase of data availability, fostering talent and ensuring the trust in AI. Nonetheless, each country is different and must analyze its strengths and weaknesses for managing the AI transformation of the Public Sector in a proper and efficient way. If we examine the current situation in Europe regarding the AI leading countries in AI investigation, it is shown that in Spain there is still plenty of work to do, especially in all cities apart from Madrid and Barcelona. See Figure 7 below:

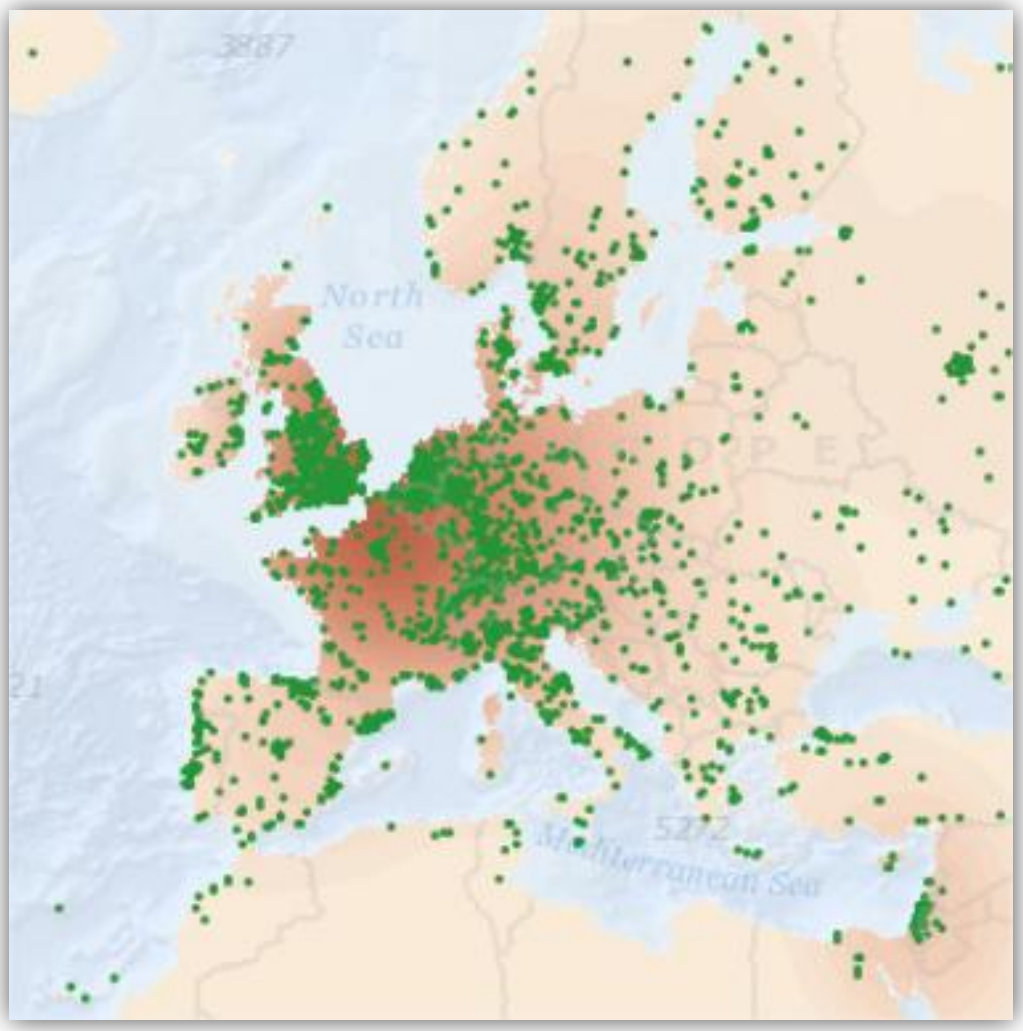


Figure 7: AI main players in Europe

Source: European Commission JRC Report, 2018b

This figure shows the density of the most important AI players in Europe. AI players refer to those countries leading in the research of this topic and whose

universities, research centers and private enterprises are involved in AI economic activities such as AI-services, R&D procedures, industrial manufacturing, etc. In this line of analysis, the map illustrate that Spanish density is significantly low in comparison with countries as France, Germany, Italy, Belgium, United Kingdom, Netherlands, Switzerland, Denmark and Sweden.

3.2.1.2. The AI European Landscape in Research

Other fact to consider for the positioning analysis of Spain is the research-leading countries. In the AI techno economic Segment report of the European Commission Joint Research Centre (EC JRC) it is shown the following map (Figure 6) representing the activity of the EU NUTS2 regions (Nomenclature of Territorial Units for Statistics, from the NUTS Regulation, the average population size of the regions in the respective level corresponds to what is presented in the below table) concerning their participation in research, patents and EU projects within the AI area:

Table 7: NUTS Regulation – Population size

Level	Minimum (people)	Maximum (people)
NUTS 1	3 million	7 million
NUTS 2	800,000	3 million
NUTS 3	150,000	800,000

For a proper understanding of figure 6, the following legend is detailed indicating (from higher to lower blue color intensity, the impact of each city in AI in the aforementioned features. Plus, the orange dots indicate the AI research centers with higher activity in AI publications between 2009 and 2018:

Table 8: Figure 6 legend

	Very High		*Low*
	High		*Very Low*
	Medium		*Other/ No data*
	Leading Research Centre		

Source: own elaboration

Once detailed the specifications of the picture, see Figure 8 in the next page:

Figure 8: AI European Landscape in Research

Source: The AI Techno-Economic Segment – (European Commission JRC, 2018)

In connection with the previous chapter, in this map is also shown that Spain's impact in research is below the average of the EU leading countries. In fact, Spain has not any "Very High" region in the AI research field, and it only has investigation centers in 6 regions, and countries as France, Italy, Germany and United Kingdom, among others, have 13, 11, 24 and 21 respectively. Also, in the picture it is possible to appreciate that the density of investigation centers is lower in Spain than in those countries, including Belgium, Switzerland and Ireland, which indicates that Spanish government might increase the investment budget related to R&D, particularly in AI, for being able to join the leading countries of this AI transformation and achieve the goal of adapting and improving the efficiency of the PA.

3.2.1.3. AI collaboration network within Europe

The third indicator to take into account in this subsection is the collaboration network between European countries regarding the AI research. In the following graph is represented the network of collaborations intensity and direction within Europe for AI research projects and activities from 2009 to 2018 (Figure 9):

Figure 9: AI Collaboration Network in Europe

Source: The AI Techno-Economic Segment – (European Commission JRC, 2018)*c*

Figure 7 shows the central core of collaboration in north Europe. It involves United Kingdom, France, Germany, Belgium and Switzerland. In contrast, the position of Spain regarding this matter is similar to the observed in the other two indicators. Even if it is a country with certain participation in the AI-related research activities, Spain is still far from the leading countries in this area.

To conclude this subsection, the comparison of AI national strategies between Spain and the aforementioned 7 European countries will be made. For this analysis only the information related to AI in the PA will be considered.

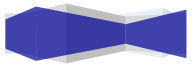
3.2.1.4. AI Benchmarking: AI in the PA

Given that Spain is at the early stage of implementing AI in the PA, it is important to analyze what other countries do regarding this matter, study their strategies and consider if they are susceptible of being applied in Spain. In this line of analysis, the "AI Watch" that gathers plenty of information concerning not only specific research activities of the EC JRC, but also other European countries' actions and approaches to the AI implementation.

It is significant that there are only 7 countries that have published official documents in the EC official website detailing its particular national strategy for AI. So, in order to develop a plan for Spain, these strategies will be compared and studied. Conclusions and proposals will be extracted from the analysis. These are the 7 countries that this subsection will study regarding AI in the PS: Germany, France, Denmark, Finland, Sweden, United Kingdom, Lithuania and Spain.

Therefore, for analyzing the approaches of these countries, the strategies will be grouped as in chapter 2.3 but with some variations. Since this study concerns national strategies that must present solutions regarding all AI implications, the first organization of the Literature Review chapter where references were structured depending on the principal AI-related topics —e.g., benefits for citizens, AI capabilities, improvement areas of PA, government digitalization and ethics—, will not be used due to the fact that it is confirmed that all countries have considered these 5 areas in their strategies. So, three factors will be considered in this analysis: a) the AI capabilities intended to be applied, b) the areas of the PS primarily intended to be improved in each national strategy and c) the specific AI solutions proposed in each country's PS, differentiating which solution is already in use and which is planned for the future. In this line of analysis, a table was intended to be performed for comparing different parameters such as AI capabilities to be applied, AI areas of impact and AI current and future applications, the idea was to organized these factors according to each country AI strategy

Unfortunately, the table could not be performed due to the fact that its study was not conclusive from the AI application in the PS point of view. This was because the considered documents present a very qualitative analysis, so for several countries no specific data confirming the AI factors aimed to study has been found.



3.2.1.5. Government AI Readiness Index 2018/2019

It is critical to know the position of Spain concerning the AI implementation in the PA for determining how prepared is the country and which approach for an AI guideline is feasible and which might be unrealistic. The present work has defined so far that Spain is not a leading country in the AI field. Nevertheless, is important to quantify which is the exact position and how big is the distance between the Spanish government and the cutting-edge governments in Europe.

Since the impact of AI technologies is going to be significant not only in the PS but also in all sectors of society as it is known, it is crucial to control this disruptive change. Therefore, this quantification of the countries regarding the AI implementation in the PS has been actualized this year by the Canadian International Development Research Centre (IDRC) and Oxford Insights have developed an index to measure how prepared are the governments of each country of the world for applying AI techniques in the delivery of public services

Within this context, in (Miller & Stirling, 2019) 194 countries have been analyzed according to 11 metrics organized in 5 areas: governance, infrastructure and data, skills and education and government and public services:

- Governance:
  - Data protection/privacy laws
  - National Strategy
- Infrastructure and data:
  - Data availability
  - Government procurement of advanced technology products
  - Data/AI capability
- Skills and education
  - Technology skills
  - Private sector innovation capacity
  - Number of AI start-ups
- Government and public services
  - Digital public services
  - Effectiveness of government
  - Importance of IT to government's vision of the future

After analyzing all these metrics, a grade from 1 to 10 is given to each country. See in Figure 10 the position of Spain in the overall ranking for government AI readiness in 2018/2019 (find the complete table annexed).

Rank	Country	Score
1	Singapore	9.186
2	United Kingdom	9.069
3	Germany	8.810
4	United States of America	8.804
5	Finland	8.772
6	Sweden	8.674
6	Canada	8.674
8	France	8.608
9	Denmark	8.601
10	Japan	8.582

Rank	Country	Score
31	Czech Republic	6.673
32	Mexico	6.664
33	Latvia	6.548
34	Ireland	6.542
35	Uruguay	6.522
36	Spain	6.332
37	Lithuania	6.288
38	Slovenia	6.232

Figure 10: Overall ranking for government AI readiness

Source: (Miller & Stirling, 2019)

As shown in the above figure, Spain is in position number 36 with a score of 6.332 out of 10. In addition Spain is under, a priori, less developed countries in a general basis, but concerning the AI application in the PA such as Latvia, Uruguay or Czech Republic and also some that do not appear in the image as Portugal or Poland. In this line of analysis, although Spain is in a relative high position (36/194), there is a considerable number of non-developed countries in this analysis of Latin America (33 countries with an average index of 3.682), and Africa (54 countries with an average index of 2.708), which is 97 evolving countries with much less technological resources than Spain. Therefore, it is needed to compare Spain with its neighbors in Europe.

So, once established the position of Spanish AI-potential in the world, Table 9 illustrates the position of Spain in Europe.

WESTERN EUROPE		
Regional Rank	**Country**	**Score**
1	United Kingdom	9.069
2	Germany	8.810
3	Finland	8.772
4	Sweden	8.674
5	France	8.608
6	Denmark	8.601
7	Norway	8.079
8	Netherlands	7.659
9	Italy	7.533
10	Austria	7.527
11	Switzerland	7.461
12	Belgium	6.859
13	Luxembourg	6.857
14	Iceland	6.809
15	Portugal	6.693
16	Ireland	6.542
17	**Spain**	**6.332**
18	Malta	5.961
19	Greece	5.760
20	Cyprus	5.668
21	Liechtenstein	2.619
22	Monaco	2.430
23	Andorra	2.290
24	San Marino	2.071
Average		**6.570**

Table 9: Western Europe ranking for government AI readiness

Source: 2019 Index data for report – (Miller & Stirling, 2019)

The above table shows, according to this analysis, how unprepared Spain is for introducing AI technologies in its PS, in comparison with the other Western European countries. In fact, Spain is 0.238 index points under the European average, not to mention the 2.737 points of difference comparing with the First position (United Kingdom).

This analysis certifies the reaction that has to be carried out by the Spanish government for reaching the top positions of the table. To do so, high investment should be intended to AI systems research and development, and talent attraction

programs for professors and professionals of the private sector should be implemented in order to manage the AI constant evolution. Thus, the AI national strategy of Spain which is a starting point for overcoming this challenge has been already defined and published and will be analyzed in the next subsection.

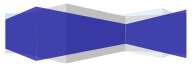
3.2.2. Spanish AI National Strategy for the PS

As mentioned in the previous paragraphs, the Spanish government, concretely, the Ministry of Science, Innovation and Universities (MCIU), presented on 4th April 2019 its national strategy (Spanish RDI Strategy in Artificial Intelligence) regarding the management of AI into the EC. So, in order to provide a feasible and adapted plan for the PA in a regional framework, it is determinant to analyze the constraints, opportunities and weakness of Spain in a national framework. To do so, the factors considered in the Spain AI national strategy report will be studied and conclusions will be extracted and serve to define the bias proposed in chapter 4.1 for prioritizing the PS fields to approach. For instance, if there is a determined sector significantly undeveloped or inefficient compared to the others, it may be needed to apply AI techniques for increasing its productivity before tackling other sectors. In contrast, given a very efficient public area, in comparison with others, it may be an adequate plan to give preference to other areas containing a bigger amount of problems to be solved. Furthermore, other factors will be considered as well such as maturity of the AI solutions or the implementation costs, but the prioritization proposed will be fully detailed in the next chapter.

Starting the analysis of the present subsection, the Spanish national strategy for AI establishes several objectives for controlling, developing and promoting AI in the present and future with 2030 as the implementation deadline of its proposals. Particularly, this analysis will focus on those proposals concerning the management and application of AI in the PS: Firstly, the presented improvement areas and the objective defined for them will be evaluated. Secondly, the improvement points and threats in these public areas will be analyzed. Thirdly, the maturity and research of the proposed AI capabilities will be evaluated.

3.2.2.1. Public Areas: proposal and objectives for AI application

In the PA field, 4 main areas are proposed as those that may need a more significant transformation where AI could be increase the productivity and efficiency by permitting the management of a bigger amount of data, shorten processes time and predict problems. These areas are 1) Public Administrations; 2) Education; 3) Smart cities and territories; 4) Health and 5) Safety. The government of Spain has established objectives for each one of the presented branches of the PS that are intended to be accomplished with the use of AI systems. The following lines detail these assigned goals in (Spanish Ministry of Science, Innovation and Universities, 2019):



- Public Administrations
  - Digital transformation of public services
  - Response times reduction
  - Data protection
  - Ensure the interoperability among PA entities
- Education
  - Personalized learning according to the knowledge, professional preferences and progress of students
  - School leaving rate reduction
  - Teachers adaptation to AI digital competences and ethics
- Smart cities and territories
  - Make mobility more secure
  - Improve cities sustainability
  - Increase the connectivity within the country
  - Transport accidents reduction
- Health
  - Improving the prevention diagnosis and treatment of cardiovascular, neurodegenerative diseases in general and childhood obesity and breast cancer in particular
  - Costs reduction
- Safety
  - Threats detection
  - Development of an AI protection for AI attacks
  - Crime prevention and detection

3.2.2.2. Public Areas: threats and improvement points

Is evident that in a utopian situation all areas will be improved and all objectives will be accomplished. Nevertheless, there are critical constraints and threats that endanger the transformation of the PS in all of the aforementioned public areas due to the controversial aspects involved in the AI transformation. The management of private data is highly sensitive because of the impact that an error or a security breach may cause, not to mention the possible disappearance of several public jobs may occur as a consequence of the AI implementation.

Within this context, it is not only important to develop an efficient security infrastructure that protect privacy violations or performance malfunctions, but also to ensure the expertness of researches in charge of the PA transformation within the AI field, because even if mature AI technologies are implemented, it is needed to ensure that the data feeding the AI algorithms is correct for the results aimed to achieve. If not, undesired outcomes will be obtained.

With regards to the opportunities and improving points concerning the situation of Spain, it will be determinant to exploit those specific indicators of each public

areas such as average waiting tames, school leaving ratio or crimes number per year, so that it may be possible to detect which changes could be applied in the first place and where is crucial to intervene first.

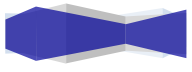
The following table details the threats and improvement points for each public area considered in (Spanish Ministry of Science, Innovation and Universities, 2019) that may be the key for a responsible and efficient prioritization:

Table 10: Spanish PS threats and improvement points

AI areas of impact	Threats	Improvement points
PPAA	› Difficulty of categorization of citizens interactions types	› Increase processes digitalization › Response times reduction › Lack of data accessibility (European Commission, 2017)
Education	› Teachers adaptation to digital competences involving AI › Unethical or incompetent management of the data studied	› **18,3%** of early school leaving rate (European average = 10,6%,)
Smart cities	-	› Deathly transport accidents amount (**1,943** in 2017)
Health	› Doctors training for the use of cognitive assistants › Unethical / incompetent management of the data studied	-
Safety	› Automated attacks with AI systems › Maturity of the current used algorithms	-

As shown in the table, it seems that Education might be one of the first public areas to approach with the AI application due to its significant problem with the school leaving statistics which is 7.7 percentage points higher than the European average, not to mention that Education is a determinant pillar for the development of a country. Also, the Public Administrations area has several improvement points to be tackled with AI application. In addition, training the professionals of each sector seems to be a transversal problem in the future due to the lack of AI immersion of the average citizen.

In contrast, in the Smart cities area, there is a significant lack of information regarding present and future threats. The same case occurs for the improvement



points in Health and Safety. However, this analysis provides an overview of the current situation of the PS areas to approach in next chapter.

3.2.2.3. Public Areas: AI capabilities

Once described the public areas objectives and threats, this subsection will study the technical factors of the AI application to the PS that Spain has proposed in the presented national AI strategy. Concretely, the use of each AI technique will be distributed according to the intended public area. See the table below where the AI techniques to be used in each area are detailed. Furthermore, the maturity of the proposed AI capabilities will be defined according to three categories; (1) High (2 to 5 years), (2) Medium (5 to 10 years) and (3) Low (more than 10 years). This categorization has been made according to the maturity level of AI defined in (Gartner, 2018) (Table 11):

Table 11: AI capabilities intended to be used in each public area

AI areas of impact	AI capabilities (software)	AI capabilities (application)	Maturity level
PPAA	› NLP	› Chatbots › Automated administrative procedures	Medium
Education	› ML	› AI predictive models › Intelligent tutoring systems	High
Smart cities	› ML › DL	› Multimodal planning algorithms › Multi-criteria optimization › Autonomous vehicles › Intelligent traffic prediction systems	Medium Medium **Low** Medium
Health	› ML with Big data analytics	› Predictive diagnosis › Intelligent cognitive assistants	Medium **Low**
Safety	› CV › ML › NLP	› Security cameras images analysis › Social patterns for prevention	Medium Medium

Source: (Spanish Ministry of Science, Innovation and Universities, 2019)b

As shown in Table 10, there is a long way to go as a consequence of the significant difficulty that implies to control AI capabilities. However, research is constant and advancements in the AI field are continually going forward.

In conclusion, this chapter has situated Spain in terms of AI advancements in the European framework. It has illustrated how Spain is not the most unprepared

country but it is still far from the leading countries in the matter. In the following chapter, the prioritization of public areas to approach will be carried out and the AI implementation plan proposed in the present work will be detailed.

4. AI STRATEGY: RESULTS AND CONCLUSIONS

The present chapter aims to propose a feasible AI implementation plan with the support of the analysis effectuated in the previous sections. Its structure is the following: (1) prioritization proposal, where all factors involving the implementation of AI in the PS will be categorized according to several parameters, (2) AI implementation plan, where the proposed plan will be presented as a flow diagram, whose stages will be fully defined, and (3) conclusions extracted and future research in the matter will be argued.

4.1. PRIORITIZATION PROPOSAL

In this subsection the public areas to approach with the application of the AI will be sorted according to several parameters. The first factor to take into account will be the technical situation of the AI capabilities considered to be applied in the PS. To do so, the AI Hype Cycle will be analyzed. In the second step of the prioritization proposal, the PACE prioritization matrix that will be used to categorize will be defined. Finally, the prioritization analysis will be presented; firstly, the AI applications to tackle, and secondly, the areas of the PS where AI will be applied. It is important to specify that the AI capabilities prioritization will be conducted by using a quantitative methodology, whereas, the prioritization of public areas will be analyzed using a qualitative perspective due to the lack of quantitative information regarding the application of AI in public areas.

These analysis will permit to discard those AI capabilities and public areas that will provide fewer benefits to the PA and serve as guideline for meeting the 2030 horizon set by the EC in the coordinated action plan which aims is to increase the sustainable development performance of all member states.

4.1.1. AI Hype Cycle

The AI capabilities prioritization will be supported by the AI Hype Cycle presented in (Gartner, 2018). It is a deep research of the maturity and development of AI technologies where their current stage of progress is measured. Within this context, 5 stages represent the cycle of the technologies. However, only the last stage is the one that ensures the success of a determined AI capability. In fact, the remaining 4 just represent the path that a given capability needs to bring value into the market, in this case, into the administrations. See below the definition of each stage:

I. **Innovation trigger:** this trigger may be originated by certain events such as a public demonstration or a product launch that generates interests in both the industry and press. Nonetheless, no success is ensured yet.

II. **Peak of inflated expectations**: in this stage enormous expectations are created regarding the innovations. Publicity and conferences are the protagonists of this phase but no contribution to science or industries is effectuated.

III. **Trough of disillusionment:** this stage represents the decrease of the previous expectations and enthusiasm. So, the technologies fall into oblivion.

IV. **Slope of enlightenment:** continuous research, hard work and investments in a given technology lead to an understanding of its applicability, potential benefits, and threats.

V. **Plateau of productivity:** this stage represents the success, where the benefits and advantages of a determined technology are finally demonstrated and the growth period of adoption starts. The studies argue that around the 20% of the target audience of the technology is adopting it when entering this stage.

Once all stages have been defined, the Hype Cycle for AI 2018 is presented in the image below. The cycle contains the AI capabilities status for July 2018, which is the most recent cycle found in the literature. So, it is possible that some AI systems have experienced certain evolutions in this year. Anyway, the global picture would be very similar to the maturity and situation represented in the image. Particularly, the AI Hype Cycle considers two axes, the vertical axe references the expectations of the capabilities, and the horizontal axe, references time. Furthermore, each time window represents the aforementioned stages of the cycle. Finally, the legend below shows the approximated remaining time for each capability, to arrive to the last stage (Plateau of Productivity).

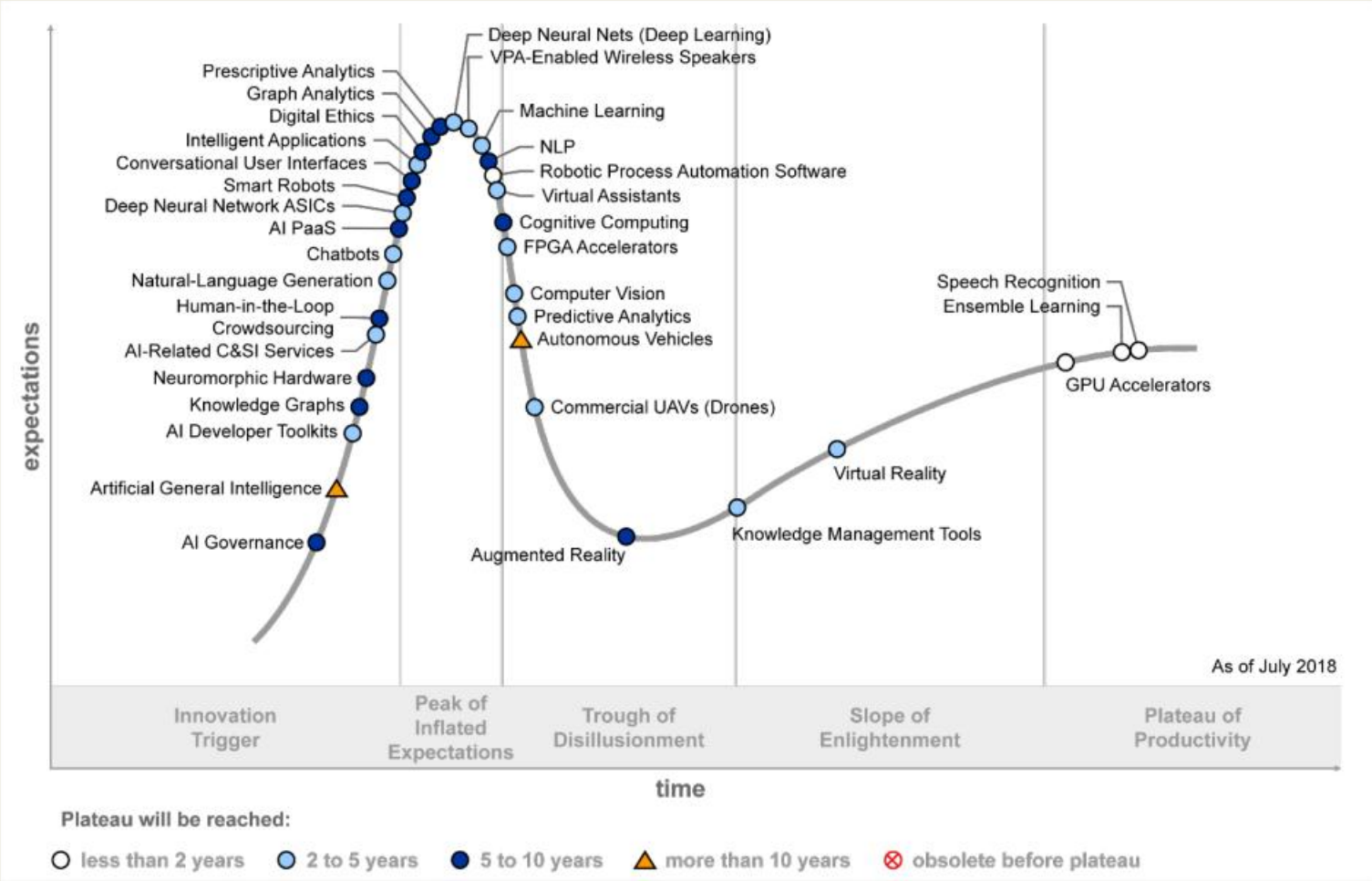


Figure 11: Hype Cycle for AI, 2018

Source: (Gartner, 2018)

As shown in the above figure, the vast majority of AI systems are concentrated in stage 2, Peak of Inflated Expectation, which is rather discouraging due to the fact that almost every AI capability intended to be used in the PS, is situated in that stage, which is far enough from the succeeding phase 5. ¿Does this mean that success is too far? Not at all, any analysis, research or test has predicted that the digital transformation of the PA is not going to be an easy project to carry out. So, in order to success, it is mandatory to embrace this situation and work hard. Therefore, returning to the present analysis, in order to prioritize and discard the AI capabilities in which the proposed strategy is going to focus on, the PACE decision matrix will be used.

4.1.2. PACE prioritization matrix

First of all, it is necessary to describe the concept of the PACE prioritization tool. It is a matrix based in 2 axes. The first axe references the ease of implementation of a given task, or strategy. And the second axe references the benefit (high, low) of implementing the task. Naturally, it is needed to define the parameters to define what is easy or difficult to implement, and what is considered to provide a higher or lower anticipated benefit. Immediately afterwards defining the parameters of difficulty and benefit, the list of tasks is distributed in the matrix, which is composed by 4 areas:

Priority, **A**ction, **C**onsider and **E**liminate (PACE):

- **(P) Priority:** this area will contain those tasks, or in this case, public areas for AI application and AI capabilities with higher ease of implementation and higher potential benefit.
- **(A) Action:** the action area will have those tasks with slightly lower benefit but are still easy to apply.
- (**C) Consider:** the consideration area includes those tasks that will be reviewed after implementing (P) and (C). At this point, it can be decided whether the analyzed difficulty of application is worth the benefit that the task will return eventually.
- **(E) Eliminate:** the elimination area will contain, as the name implies, those tasks that should be removed of the implementation plan because of their low benefit and their difficulty of execution.

See in the figure below the areas represented in the PACE decision matrix:

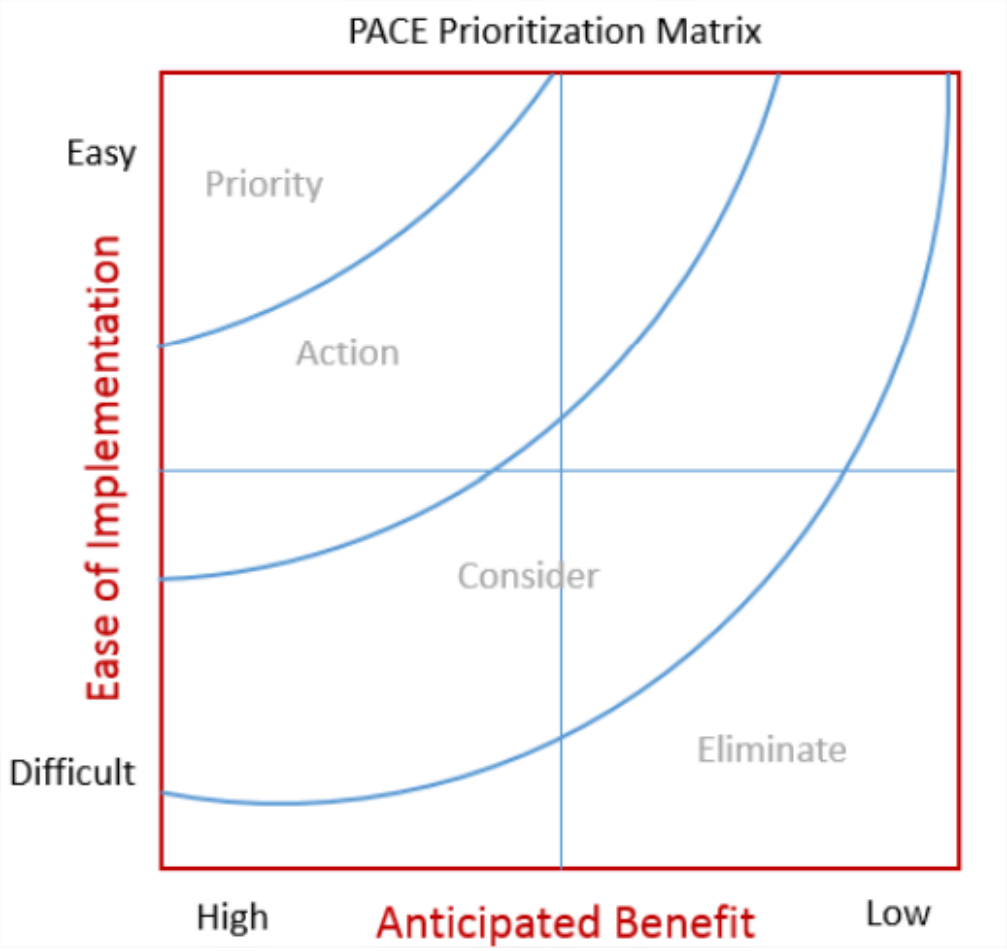


Figure 12: PACE prioritization matrix

Source: (Northern Illinois University Faculty Development and Instructional Design Center)

Once defined the tools on which the prioritization process will be support by, it is time to define the process. A prioritization of the AI capabilities to apply into these areas will be effectuated. Finally, according to the defined order of the AI capabilities, the public areas where these capabilities will be applied will be defined. Here below is represented the flow diagram of the AI capabilities prioritization process:

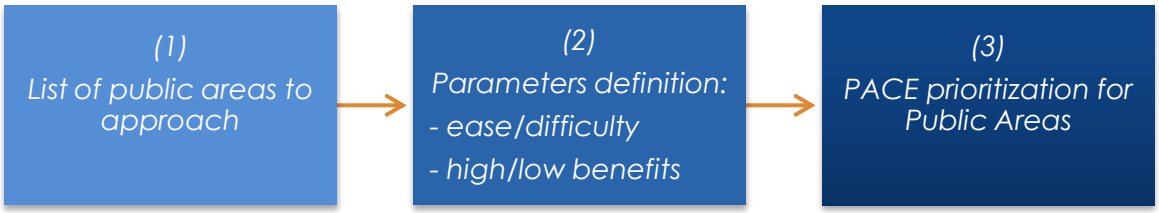


Figure 13: prioritization process flow diagram

4.1.3. Prioritization process

4.1.3.1. Quantitative analysis: AI capabilities

As defined in the previous figure, the purpose of the present subsection is to select the complete list of AI capabilities that will be considered in the prioritization matrix.

List of AI capabilities:

In order to separate all AI possible techniques from those being considered by AI research institutions and those that are starting to being applied by several governments, the selected group of AI systems to work with in this PACE prioritization matrix has been formed with the support of the study made in both chapter 2.3 (Literature Review) and chapter 3.2.1.4 (AI benchmarking: AI in the PA) containing the AI capabilities intended to be applied in the PS which have been proposed by the literature and the European countries, including Spain, in theirs AI national strategies:

AI capabilities
1. ML (Machine Learning)
2. DL (Deep Learning)
3. NLP (Natural Language Processing)
4. CV (Computer Vision)
5. RL (Reinforcement Learning)
6. Big Data predictive analytics
7. CG (Content Generation)

Parameters definition: in this part of the PACE prioritization process will be defined the specific factors to determine both axes of the matrix, (1) the ease/difficulty of implementation and (2) the high/low anticipated benefit. An assessment will be assigned to all factors in order to quantify the weight of each aspect considered for being able to determine the location of the AI capabilities in the areas of the PACE matrix. This distribution will be effectuated by summing all the assessment points provided to each AI capability.

These factors will be fully detailed in the following lines:

- **Axe 1 of the PACE matrix: Ease/Difficulty of implementation:**

This axe encompasses all factors that difficult the AI implementation. Finally, 3 factors have been selected regarding AI capabilities: maturity level, usage frequency and implementation costs. It is important to mention that because of the topicality of the subject it has been difficult to find reliable data for several factors that even if there exist plenty of qualitative analysis and studies there is a considerable lack of quantitative ones. Nevertheless, for adding value to the present work, it has been decided to still describe those factors in order to depict the low quantity of information regarding certain aspects of AI in Spain.

Here below are detailed the factors for Axe 1:

- Current maturity of the AI capability: the first factor evaluates each capability according to its maturity level. Therefore, when the maturity of a given capability will be higher, it will be considered as easier to implement, and vice versa. So, to quantify this factor, an assessment has been assigned for each level of maturity

  In Table 12 below is shown the definition of each maturity level and its given assessment:

Table 12: Maturity levels

Maturity level	Status	Products / Vendors	Assessment
Embryonic	› In laboratories	› None	1
Emerging	› Commercialization by vendors › Research and tests effectuated by industry leaders	› First generation › High prize › Much customization	2
Adolescent	› AI capability processes comprehension	› Second generation › Less customization	3
Early mainstream	› Tested technology › Fast evolution	› Third generation › Rise of out of the box methods	4
Mature mainstream	› Robust technology › Evolution stop	› Dominant vendors	5
Legacy	› Not appropriate for new developments	› Maintenance revenue focus	1
Obsolete	› Scarce application	› Only used/release market	0

Source: (Gartner, 2018)*b*

Note: the assessment quantification has been effectuated according to the subjective weight given to each area by providing equitable differences between them

- Usage frequency: this factor will consider the frequency of each AI capability. It is crucial to determine the number of areas where an AI technique may be applied. Logically, the more public areas to apply a given AI capability, the easier it will be to implement this capability in

Spain. As in the previous factor, an assessment will be assigned to each capability according to the usage frequency. Find below the selected assessment:

- High frequency: 3
- Moderate frequency: 2
- Low frequency: 1

See in Table 13 the representation of this factor.

Table 13: Usage frequency of AI capabilities

AI capabilities	Healthcare	Smart cities	Education	Security	Citizens-PA interaction	Assessment
ML	2	2	2	2	3	**11**
DL	2	2	2	2	3	**11**
NLP	2	0	2	2	3	**9**
CV	0	1	1	3	1	**6**
RL	1	0	0	0	0	**1**
Big Data predictive analytics	2	2	2	2	3	**11**
CG	2	0	0	0	2	**4**

Source: Own elaboration on McKinsey Global Institute – (Chui et al, 2018c)

Note: the assessment quantification has been effectuated according to both the mapping usage frequency analysis and the use of AI capabilities for societal benefit of the aforementioned reference of the literature

- Implementation costs: in this factor is aimed to consider the costs of each AI capability in the public areas such as: software development, raw material for sensors, cars, drones, advanced computers, data quality and quantity enhancement, etc.
  Unfortunately, it has been very difficult to find any references to the available AI budget in Spain, the two words of AI are neither mentioned in the General Budget of Spain (PGE in Spanish), nor in the specific budget of important cities in Spain such as Madrid, Valencia or Barcelona, where the only aspect that may be related to AI is the RDI area. However this budget area may encompass plenty of actions where AI is not used. In the table below is represented this data:

Table 14: Spanish cities RDI budget

City council	Total Budget (millions of €)	Budget in R+D+I (millions of €)	Share of total (%)
Valencia	849.22	3.89	0.46 %
Madrid	5,226.00	9.36	0.18 %
Barcelona	2,647.48	2.55	0.10 %
Average	2,920.90	5.27	0.18 %

Sources: (Ayuntamiento de Madrid, 2019) (Ajuntament de València, 2019) and (Ajuntament de Barcelona, 2019)

The table shows that any city council reaches the 1% of the budget for RDI matters which denotes an important lack of implication in the AI development and benefits that could be extracted from it. However, aside of percentages, since in Spain each region manages its own public areas, those cities with bigger budget will have more power to invest in AI.

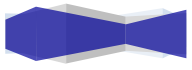
To conclude the analysis of this factor, even if it is logical to argue that the cost of developing the algorithms of a surgery intelligent robot or an autonomous vehicle, testing it and inserting it into both the healthcare and the transport markets, will be much higher than the cost of developing the software of chatbots in all areas of the PA in order to provide a better delivery of public services, or applying cameras in the schools with CV techniques for detecting strengths and weaknesses that may help the goal of deliver a personalized learning. Nonetheless, no specific reliable data has been found for presenting a feasible analysis regarding this factor.

› **Axe 2 of the PACE matrix: High/Low anticipated benefit:**

This prioritization axe encompasses all factors that may provide an immediate benefit. In this analysis, 3 factors have been selected regarding AI capabilities: time of adoption, benefit potential in society and business impact defined as the range of action of a given AI capability. Here below are detailed the factors for Axe 2:

- Time of adoption: this factor will consider the time remaining for each capability to become productive in society. It will be supported by the analysis presented in the priority matrix for AI Gartner (2018b). As fewer years of adoption, higher priority will be assigned. Concretely, those in group 4 will be discarded since it would be highly difficult to implement them by 2030. Categorization, defined in the AI Hype Cycle figure. The assessment for categorizing the AI capabilities in the PACE matrix are shown below between parentheses. Notice that these punctuations have been selected subjectively in order to achieve an equitable assessment.
  i. Less than 2 years (3)
  ii. 2 to 5 years (2)
  iii. 5 to 10 years (1)
  iv. More than 10 years (0)

- Benefit potential: the present factor will evaluate the impact of the AI capabilities in terms of change potential, that is, how disruptive the complete implementation of a given AI system or technique will be. Therefore, the higher benefit that a given AI system may provide, more priority will be assigned to it. Within this context, the assessment of this priority, as in the previous factor, is depicted between parentheses according to a subjective point of view which intends to maintain equitability concerning the weight intended to all aspects of this axe. The levels have been extracted from (Sicular & Brant, 2018)
    i. Transformational (3)
    ii. High (2)
    iii. Moderate (1)
    iv. Low (0)
- Business impact: in this factor will be considered the range of action of a determined AI capability. That is, that a given AI capability, once it will be fully productive will have potential of having impact in plenty of areas of the society which will provide much more benefit than a capability with a narrow field of application. In this line of analysis, three levels have been defined: high impact (which will influence all sectors), moderate impact (which will influence several sectors) and low impact (which will influence very specific sectors). Notice between parenthesis the subjective assessment assigned to each level of impact:
    i. High - all sectors (3)
    ii. Moderate - several sectors (2)
    iii. Low - highly specific sectors (1)



Assessment:

The present subsection will gather the punctuations assigned for both axes of the PACE prioritization matrix. Within this context, the results will be presented in two different tables. Firstly, table 16 will show the final assessment for axe 2 of the PACE matrix (ease/difficulty of implementation), and secondly, table 17 will illustrate the final assessment for axe 2 (high/low anticipated benefit).

Additionally, in order to present the results more graphically, a colour legend has been defined in such a way that each color refers to an area of the PACE matrix. This selection has been effectuated by identifying the limits of each area of the PACE matrix according to the maximum values of axe 1 (20 points) and axe 2 (9 points). That will be:

- **Area 1 (Priority):** those AI capabilities within the following interval
  - Axe 1 ≥ 13,75 out of 20 points of ease/difficulty of implementation
  - Axe 2 ≥ 4,5 out of 9 points of high/low anticipated benefit
- **Area 2 (Action):** those AI capabilities within the following interval
  - Axe 1 ≥ 7,4 out of 20 points of ease/difficulty of implementation
  - Axe 2 ≥ 2,25 out of 9 points of high/low anticipated benefit
- **Area 3 (Consider):** those AI capabilities within the following interval
  - Axe 1 ≥ 2 out of 20 points of ease/difficulty of implementation
  - Axe 2 ≥ 0,5 out of 9 points of high/low anticipated benefit
- **Area 4 (Eliminate)**: those AI capabilities within the following interval
  - Axe 1 ≤ 2 out of 20 points of ease/difficulty of implementation
  - Axe 2 ≤ 0,5 out of 9 points of high/low anticipated benefit

In this line of description, the following table will show the legend used for each area:

Table 15: color legend for PACE assessment

	Priority
	Action
	Consider
	Eliminate

Source: own elaboration

Once the legend and the assessment criteria have been described, Table 16, which encompasses the punctuations of the factors contained in axe 1, is shown below:

Table 16: Axe 1 of the PACE matrix assessment

EASY / DIFFICULT TO IMPLEMENT ASSESSMENT			
AI capability	**Maturity**	**Usage frequency**	**Results**
Big Data predictive analytics	4	11	**15**
ML	3	11	**14**
DL	3	11	**14**
NLP	2	9	**11**
CV	3	6	**9**
CG	2	4	**6**
RL	1	1	**2**

Source: own elaboration

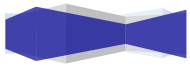
As illustrated in the table, the most promising AI capabilities are big data predictive analytics, ML and DL.

Thereupon, it is shown table 17, which encompasses the assessment of the factors contained in axe 2:

Table 17: Axe 2 of the PACE matrix assessment

HIGH / LOW ANTICIPATED BENEFIT ASSESSMENT				
AI capability	**Time of adoption (years)**	**Impact level**	**Business impact**	**Results**
ML	2 to 5	Transformational	High	2+3+3 = **8**
DL	2 to 5	Transformational	High	2+3+3 = **8**
Big Data analytics	2 to 5	High	High	2+2+3 = **7**
NLP	5 to 10	Transformational	Moderate	1+3+2 = **6**
CG	2 to 5	High	Moderate	2+2+2 = **6**
CV	5 to 10	High	Moderate	1+2+2 = **5**
RL	More than 10	Low	High	0+1+3 = **4**

Source: own elaboration



As confirmed by the present analysis, ML, DL and big data predictive analysis remain at the top positions concerning the factors of anticipated benefit.

4.1.3.2. Prioritization process: PACE matrix for AI capabilities

In the present subsection, the AI capabilities will be distributed in the PACE prioritization matrix by combining the values obtained from both axe 1 and axe 2. Within this context, the list of the AI techniques will be shown just above the matrix for providing the reader with the number and the final values assigned to each AI capability:

Table 18: Global assessment results for the PACE prioritization matrix

Number	AI capability	Results of Axe 1 Interval [20, 0]	Results of Axe 2 Interval [9,0]
1	ML (Machine Learning)	14	8
2	DL (Deep Learning)	14	8
3	NLP (Natural Language Processing)	11	6
4	CV (Computer Vision)	9	5
5	RL (Reinforcement Learning)	2	4
6	Big Data predictive analytics	15	7
7	CG (Content Generation)	6	6

Source: Own elaboration

See below in figure 14 the PACE prioritization matrix completed with the seven AI capabilities:

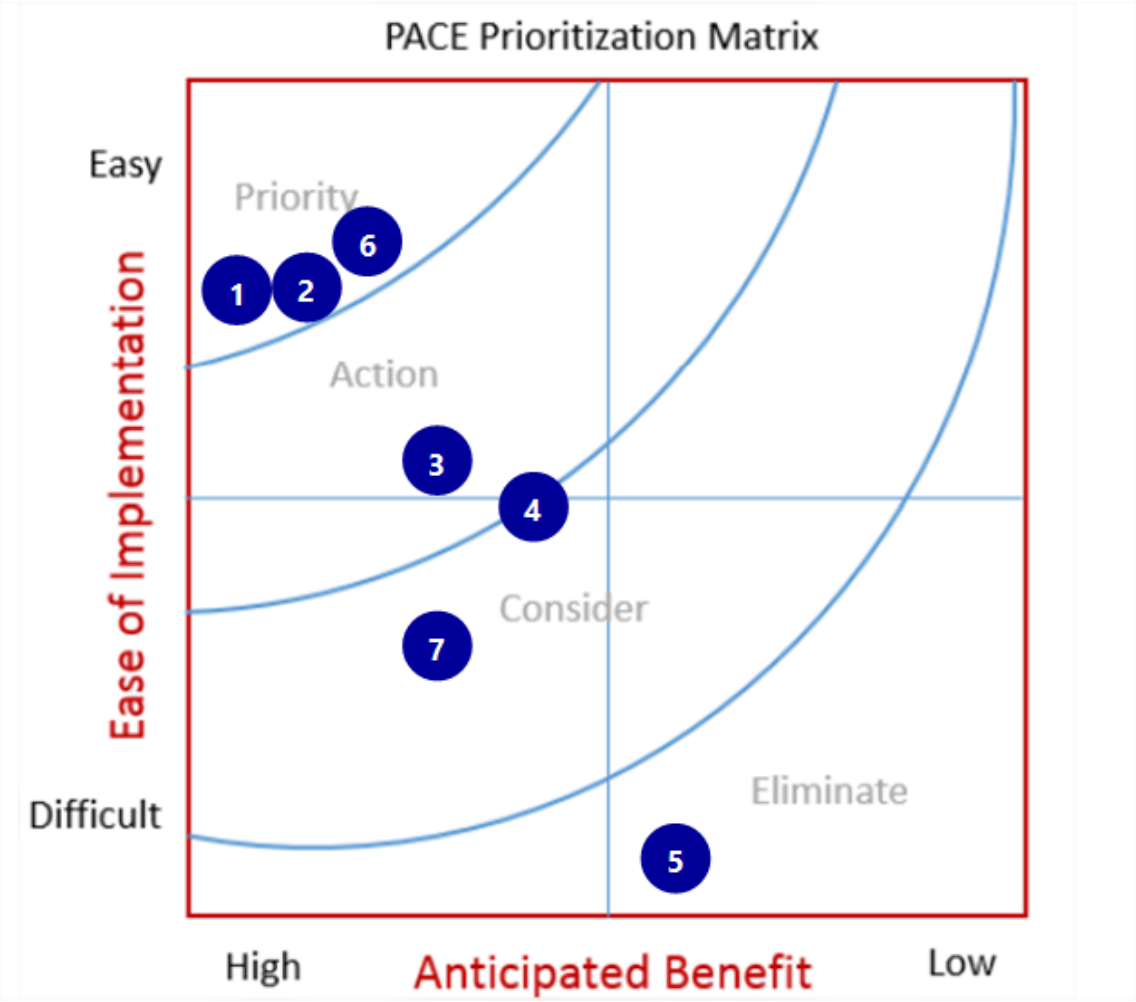


Figure 14: Global assessment results for the PACE prioritization matrix
Source: Own elaboration on Figure 11

According to the above results, the distribution of AI capabilities into the PACE matrix will be the following:

- **Area 1 (Priority):** (6) Big data predictive analytics, (1) ML and (2) DL
- **Area 2 (Action):** (3) NLP
- **Area 3 (Consider):** (7) CG and (4) CV*
- **Area 4 (Eliminate)**: (5) RL

(*) Since CV is located between area 2 and area 3, there is need to decide in which area is finally located. To do so, it has been decided to give more importance to both the business impact and the potential benefit of the capability whose values are less promising than for the AI capabilities in areas 1 and 2. Therefore, as CV area of application is mainly security, concretely, for vigilance cameras, it may be logical to locate this capability in the Consider area, considering that it may cause certain public resistance and ethical controversy in terms of privacy due to CV algorithms are capable of not only watch an image and identify faces but also of

detect the feelings of humans or their sensations as rage, fear or agitation. In addition, its potential benefit, measured in the literature studied, is not as high as in other capabilities.

And now, in the next subsection, a qualitative analysis will be presented to prioritize the public areas where AI is intended to be applied.

4.1.3.3. Qualitative analysis: AI public areas of impact

According to the results of the previous categorization of the AI capabilities, the present paragraph will identify the public areas where AI should be applied in the first place. To do so, several constraints of each public area that may delay the AI implementation process will be submitted to debate. And, based on this analysis; assumptions and conclusions will be presented and used for developing a feasible and logical prioritization strategy.

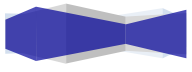
Starting this qualitative analysis, 6 constraints have been considered. Concretely, 4 have been selected of a larger group detailed in Chui et al. (2018d). The first 3 bottlenecks are completely related to data: a) data accessibility, b) data quality, c) and data volume. The 4th concerns citizens: public resistance to a given AI systems and applications. Finally, the 2 remaining constraints, Spanish sector needs and ethics, has been added based on a rational assumption which is on the one hand, that Spain may have specific needs or areas to improve firstly due to a current inefficient performance, and, on the other hand, that the ethical aspects will play a major role in the AI transformation at all levels of society as it is known, including in the PA.

The following lines will detail the aspects to take into account of these constraints for each public area:

- **Data accessibility:** it may seem obvious that AI algorithms need to be feed with data, the bigger the amount the more promising the results will be. Within this context, a fundamental part of data is its accessibility. Privacy and cooperation may be critical barriers in this topic because for providing a full access to data, not only privacy could be eliminated and that would be dangerous, but also, countries, private and public institutions are not willing to share their data at the present.

  Within this context, what will be necessary to have best access to data?

  - Privacy: there are several sectors such as Security, Healthcare whose entities control data which has highly sensitive information that cannot be shared so easily to specific companies that may be able to develop, for example, ML algorithms that predict the symptoms of a determined disease. Also the Education area has



very sensitive data concerning children that will be polemic if shared.

Therefore, regulations on data utilization that protect the public entities and the people affected by this data are becoming more and more necessary.

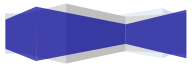
- Cooperation: regarding this matter, there are powerful companies such as satellite companies, social media platforms or telecommunications that own plenty of data that will be crucial for accelerating the AI implementation. So, the principal problem concerning this aspect is how to convince these companies for sharing the data with public institutions so that public areas as Smart city, Security or Citizen-PA interaction might be improved. Again, regulation seems to be the most feasible option for compelling the companies to cooperate.

› **Data quality:** another aspect to consider concerning data is its quality. AI algorithms not only need accessible data to be performed but also they need truthful, coherent data which is ultimately, data quality. Even if there are AI systems capable of managing highly unstructured data, they need to be feed with datasets without incongruent information that may mislead the algorithms to wrong solutions or predictions.

This constraint may be overcome with transparency and cooperation between entities for taking full advantage of the AI potential and mostly, for avoiding errors.

› **Data volume:** the last constraint concerning data refers to its volume. In order to achieve AI systems that perform properly, they have to be supplied also with sufficient data quantity so that the quality of the training is good enough for algorithms to extract correct and feasible conclusions. This data input may have plenty of formats such as, text, image or video due to AI systems are being developed for taking into account and comprehending different forms of data.

Regarding this matter, it may be reasonable to argue that the PA, Healthcare and Security are the public areas possessing larger amounts of data rather than Education that mainly concerns personal data of students which is divided in different schools and universities, or Smart cities, where data is separated in several organizations that must cooperate for achieving the common goal.



› **Public resistance:** this restriction aims to debate the lack of confidence that people have in the AI. Therefore, there are several sectors where implementing AI capabilities may be much more difficult than others.

For example, there will be much more people resistant to have surgery under the control of an intelligent robot, than people resistant to ask a chatbots which documents are needed to apply for the rental assistance. Therefore, in this matter, the sectors that may avoid better the public resistance constraint will be Education, where students are more and more used to learn with technology, Citizens-PA interaction, where the potential of AI is almost unlimited due to the improvements that could be developed such as: reducing waiting times, mistakes, costs, paper consumption, work load of civil servants, number of mandatory visits to the PA, etc.

In contrast, the AI advancements in Security, Healthcare and Smart cities public areas might be decelerated due to public resistance because things as having surveillance drones around the city, trusting the diagnosis of your disease to a robot or move around the city with autonomous vehicles might scare a little bit. So, it is probable that these particular AI systems will have to wait more time for being fully accepted by society.

› **Spanish sector needs:** this restriction is considered to be crucial for the prioritization of public areas where AI will be applied first. Its importance remains in the specific problems of Spain that could be improved significantly with the AI implementation. Below are shown the concrete weaknesses found by analyzing the literature concerning the situation of Spain that affect several of the public areas considered:

- Education: a critical problem nowadays in Spain, as stated in Table 9, is the early school leaving ratio. In Spain the 18,3% of students leave school before finishing it which is highly alarming, even more so when the average rate of European countries in this matter is only 10,6%. This statistic must encourage the Spanish government in general, and the city councils in particular intend immediate efforts and actions for mitigating this problem. To do so, AI techniques may be implemented in schools in order to modernize the educational system and personalize the learning for tutoring students more closely and for detecting their true motivations and evaluating their competences that make them want to continue studying.

  In addition, by applying AI in schools young people will get used to it earlier and this may make a difference for the future

development of AI. Once society will embrace its benefits and potential it will be much easier to take advantage of it.

Finally, the barrier for introducing AI in Education will be the training of teachers. In order to provide an education of quality it is crucial to understand how operate AI algorithms.

- Healthcare: this concrete public area has an enormous potential concerning AI applications such as predictive diagnosis, intelligent surgery, intelligent robots for elderly assistance, etc.

  Nonetheless, on the one hand it is highly expensive to build and maintain these AI systems, not to mention that the accuracy of their performance should be almost perfect for being accepted by society. To all of this is added that the current health system in Spain works properly (in general terms, obviously many things might be optimized, but the debate here is in which order of priority AI should be implemented in Spain). In this line of analysis, an indicator that measures that a good job is being done in terms of health is life expectancy at birth. See the graph below where Spain's situation regarding this matter is presented:

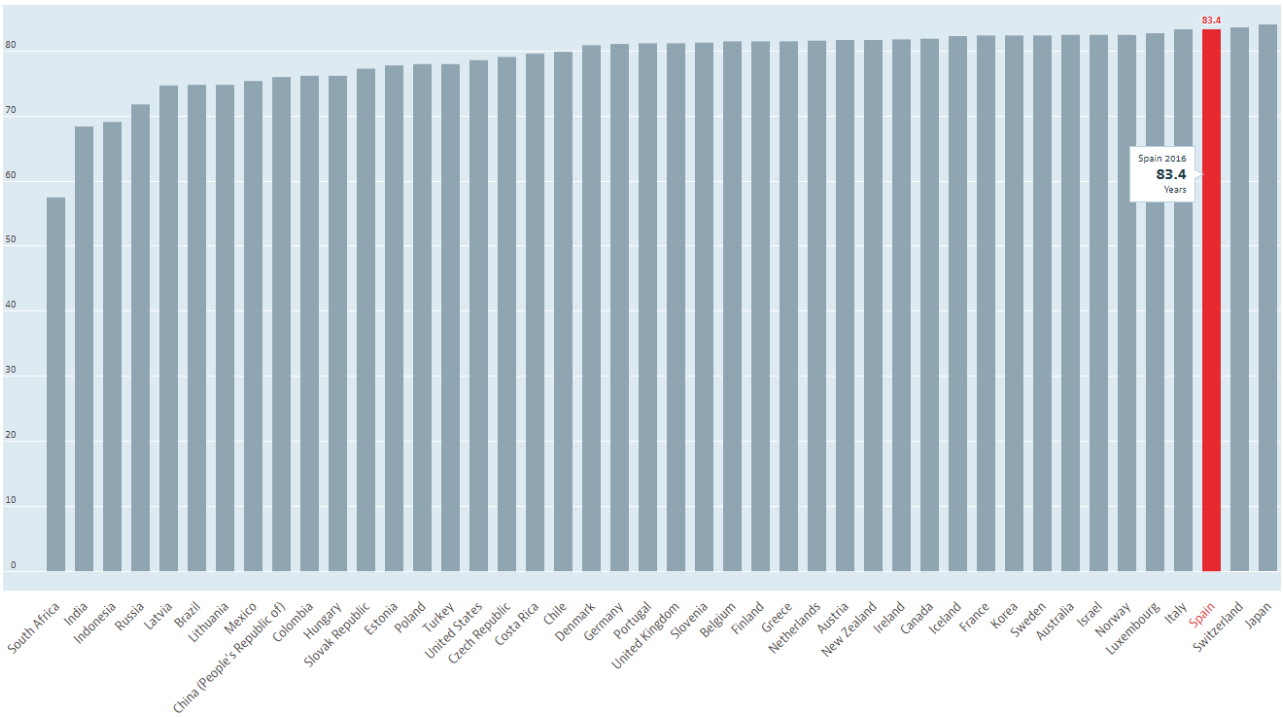


Figure 15: Life expectancy at birth in the EU28, 2016

Source: (OCDE data, 2017)

As shown in Figure 14, Spain is the 3rd country with more life expectancy at birth with 83.4 years.

- Smart cities: concerning this area a specific statistic extracted from the Spanish AI national strategy informs that only in 2017, 42,765 people between deaths, serious injuries and moderate injuries took place in Spain (Dirección General de Tráfico, 2019). So, sensors based in AI predictive analytics or ML could reduce significantly this numbers.

  Another concern regarding this public refers to CO2 emissions, which means gross direct emissions from fuel combustion related to human activities. Figure 16 shows the CO2 emissions of the EU28 measured in tones per capita:

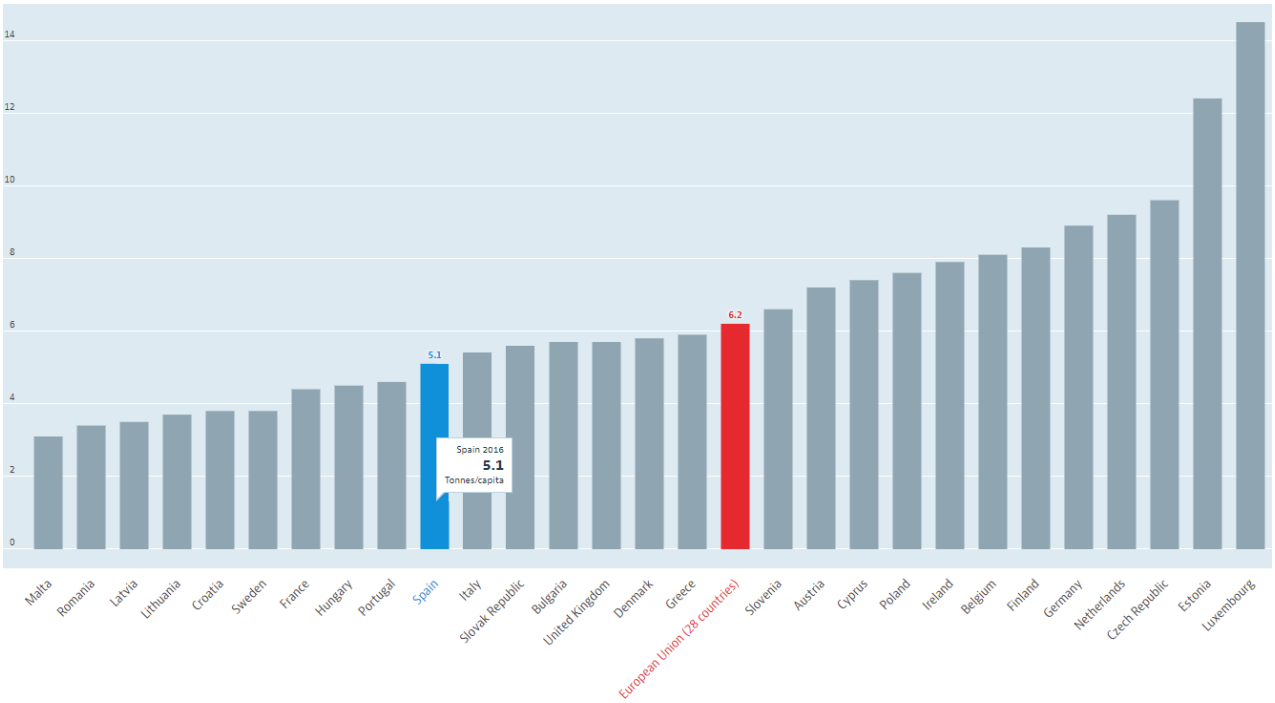


Figure 16: EU28 Carbon dioxide (CO2) emissions, tones/capita, 2016

Source: (OCDE data, 2018)

As shown in the graph, it is possible to state that Spain's position seems acceptable in comparison with the countries of EU 28. Spain emits 5.1 tones of CO2 per capita and the EU28 in average emits 6.2 tones per capita, which is 1.1 tones per capita less than the European countries average. So, within this matter, the application of AI in Smart cities is not that urgent in Spain as it may be in the case of Education or Citizen-PA interaction (which will be detailed in the lines below).

- Citizen-PA interaction: all administrations of the European countries have been assessed by the EC. Therefore, several strengths and weaknesses have been selected for this work as indicators of improvement need such as: access to government information, government transparency and corruption. Table 19 below, depict the situation of Spain regarding this indicators of the EU and its evolution from 2010 to 2016 (Parrado, 2018):

Table 19: Spanish PA indicators: government transparency, corruption and information delivery

Indicator	**Value 2014**	**EU28 rank**	**Value 2016 (**)**	**EU28 rank**	**Δ Value**	**Δ EU28 Rank**
Access to government information (1-10)	5	26	6	23	+1	+3
Indicator	**Value 2013**	**EU28 rank**	**Value 2015 (**)**	**EU28 rank**	**Δ Value**	**Δ EU28 Rank**
Government transparency (1-100)	66	6	70.71	6	+4.71	+0
Indicator	**Value 2010**	**EU28 rank**	**Value 2015 (**)**	**EU28 rank**	**Δ Value**	**Δ EU28 Rank**
Control of corruption (-2.5, +2.5)	1.01	13	0.49	19	-0.52	-6
Perception of corruption (0-100)	61	15	58	18	-3	-3
Indicator	**Value 2010**	**EU28 rank**	**Value 2014 (**)**	**EU28 rank**	**Δ Value**	**Δ EU28 Rank**
(*) Gallup perception corruption (%)	75	17	84	22	+9	-5

Source: (Parrado, 2018) report with the EC

(*) It is an annual indicator concerning people perception. The ranking of the Gallup perception of corruption is based on 27 countries, and on the 2009 values for Estonia and Latvia.

(**) No information of major current importance has been found regarding the Spanish PA.

As shown in the table the only indicator that maintains Spain in the top 10 countries of the EU28 is government transparency, which is a remarkable grade. However, even if the reports of the EC comparing Publics Administrations consider plenty of indicators, the words AI does not appear neither (as it happened with the

Spanish general budget report), AI may be used so that these indicators could be improved.

In addition, another group of KPI concerning service delivery and digitalization which is an area that may be closely related to AI in the near future has been considered. This group includes e-government users and online service delivery. See in the following table its situation:

Table 20: Spanish PA indicators: service delivery and digitalization

Indicator	Value 2013	EU28 rank	Value 2015	EU28 rank	Δ Value	Δ EU28 Rank
E-government users (%)	23.55	13	29.99	13	+6.44	0
Pre-filled forms (%)	54.50	12	67.83	9	+13.33	+3
Online service completion (%)	90.86	3	91.43	7	+0.57	-4
Indicator	**Value 2013**	**EU28 rank**	**Value 2015**	**EU28 rank**	**Δ Value**	**Δ EU28 Rank**
Online services (0-1)	0.77	1	0.91	5	+0.14	-4

Source: (Parrado, Public administration characteristics and performance in EU28: Spain, 2018b) report with the EC

In contrast, Spain's development regarding these areas is quite advanced which indicates that having a strong online infrastructure the AI implementation should be much easier rather than otherwise.

In conclusion, the Citizen-PA interaction area has a very promising future in Spain, according to these indicators presented by the EC, so this is a potential area for introducing the AI in the first place.

- Security: this is a controversial area in terms of application due to safety is always a top priority for the human behavior and AI will provide significant improvements into this area. However, it is necessary to look at the immediate future. Data informs that Spain is a safe country, in average. Figure 17 illustrates the heat map of Europe in terms of crime and safety rates:

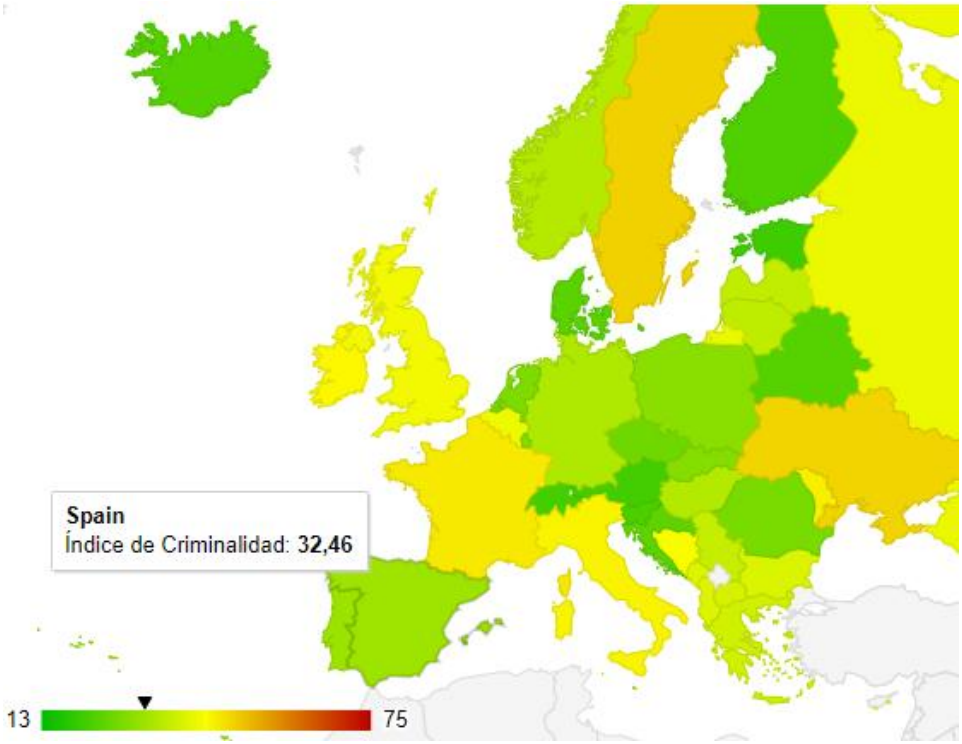


Figure 17: Crime rate in Europe 2019

Source: (Numbeo, 2019)

As shown in the map, Spain is significantly far from dangerous numbers in security. In fact, crime rate is showing a decreasing tendency in Spain:

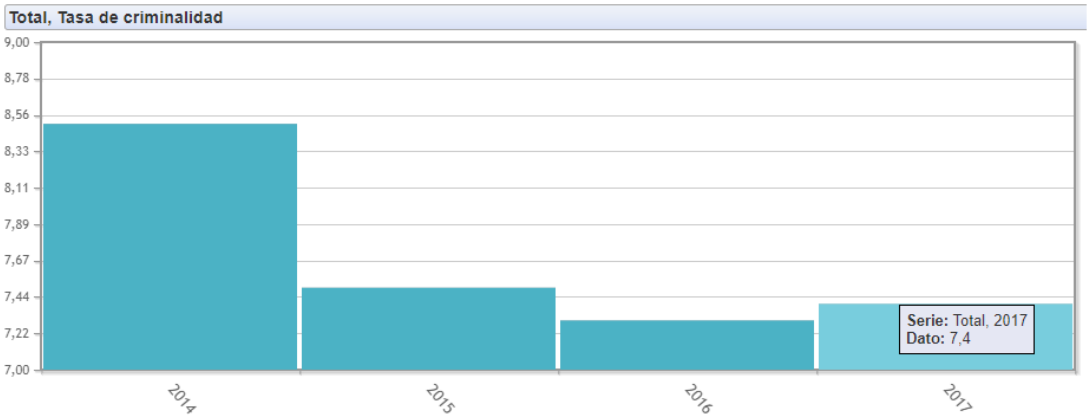


Figure 18: Crime tendency in Spain

Source: (INE data, 2019b)

In Figure 17 is depicted the tendency of crime rate in Spain which means that this area, even if it is important to work hard to maintain this numbers, is not in the first line for the AI application.

Nonetheless, there is a specific section of security that may be in danger and which is evolving uncontrollably. That is cybersecurity. Cybersecurity is an area that must be contained, and if AI will improve the safety in this matter, cybercriminals will also use AI systems in order to perform more powerful cyber attacks. In this line of analysis, Spain's current situation is not alarming. The danger level (measured in a percentage scale (0-100%) of Spain in 2019 is 13%, but it does not mean that few attacks are performed in Spain. See the picture below where this information is presented:

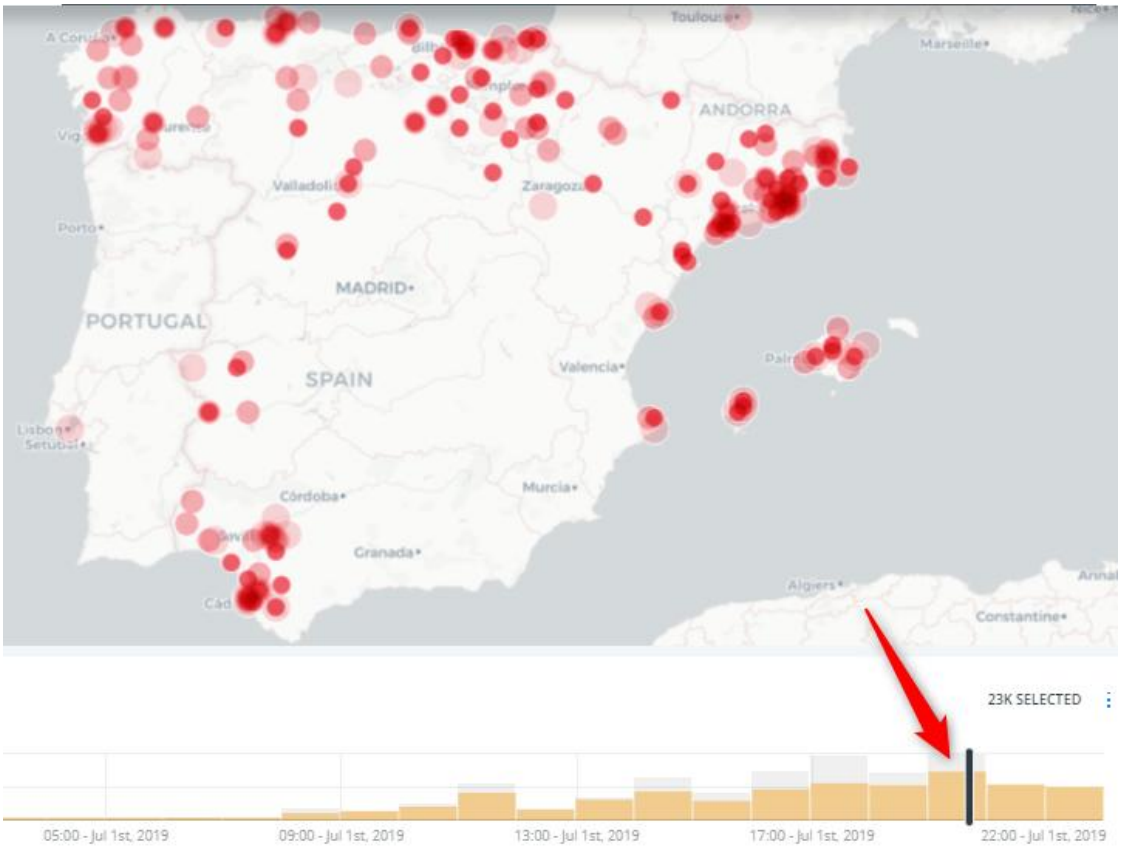


Figure 19: Cyber attacks in real time, 1st July 2019 (Spain)

Source: (INCIBE, 2019)

In Figure 19 is shown the peak number of attacks for the 1st July of 2019 in Spain, around 22:00 pm. The picture captures only those attacks performed in the second when the real time map has been frozen. And that is only for one day, so the information presented by the Cybersecurity National Institute of Spain endorses the aforementioned importance of implementing AI systems in the Cybersecurity area.

› **Ethics:** the ethical restriction is going to be crucial for AI development current and future. Concretely, the organism that controls that the ethical boundaries are respected is the Spanish Committee on Research Ethics

(CEEI). This organism must ensure that the aforementioned AI code of Ethics is complied by all AI systems. Within this context, a plausible problem (a part from the general ethical guidelines that must be respected, applied and monitored properly by the EC) that the AI implementation may cause within an ethical perspective in the Spanish PS might be the employment replaced by AI systems. It will be detailed as follows:

- Employment replacement: AI will change employment as it is known. The impacts of AI in the PS may be categorized in four areas associated to the specific tasks that intelligent algorithms perform (Sun & Medaglia, 2018):
  i. 1st category: Relieving: it is related to those mundane, repetitive and tedious tasks which will be carried out by AI and will relieve public workers for more important and valuable assignments.
  ii. 2nd category: Splitting up: AI helps to break up a job into smaller pieces, and takes over as many as possible of these, leaving humans do the remainder.
  iii. 3rd category: Replacing: this category references those tasks where AI will totally substitute humans.
  iv. 4th category: Augmenting: AI technologies will increase the efficiency and effectiveness of public workers by complementing their skills.

  Within this context, the 3rd category is alarming for the Spanish PA which has more public employees, in proportion, than countries such as Germany, Italy or Ireland. See the table below:

Table 21: Public employees per 1000 inhabitants

Country	Public employees per 1000 inhabitants
Spain	60.7
Germany	55.7
Italy	54.8

Source: (Alternatives Economiques, 2018)

In addition, the number of public employees in Spain is increasing each year, as illustrates Figure 20:

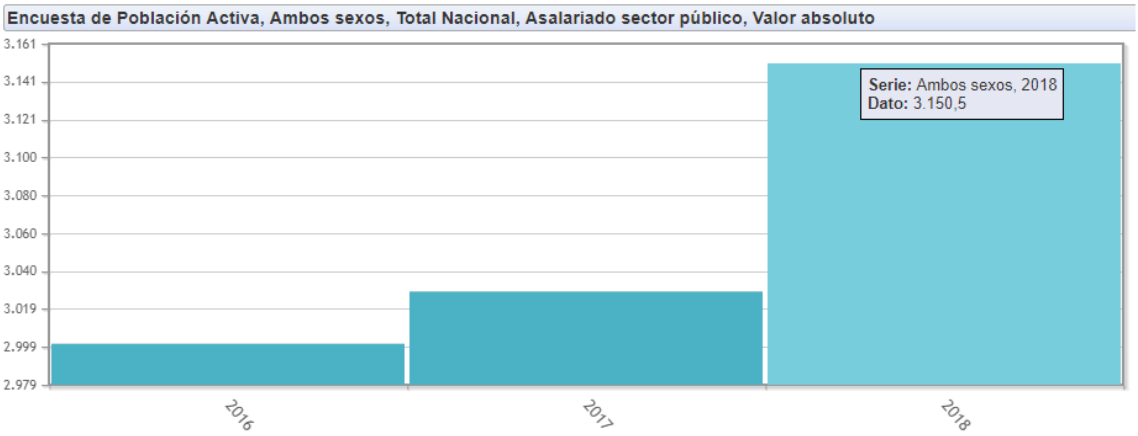


Figure 20: Public Sector employees in Spain, 2016, 2017 and 2018

Source: (INE data, 2019)

Above is shown the increasing tendency of public employment in Spain, which might be a critical ethic problem in the future whose existence may delay the AI implementation in the PS.

As a conclusion to this section, different potential barriers for the development of AI in the PS have been studied. As a result from this analysis, certain ideas for prioritizing the public areas in which AI will be applied have been extracted. First of all, according to the data considered, it seems that the priority number 1 areas to tackle might be Education and Citizens-PA interaction. Then, in second position might be the development of AI systems and algorithms that will protect Spain from cyber attacks. Finally, AI will be implemented in Healthcare, Smart cities and Security (excluding the cybersecurity field of action).

Naturally, every step of these stages must be monitored and data and ethics controls must be carried out for ensuring the proper performance of the implemented AI algorithms.

Finally, after having presented both the quantitative and qualitative analyses carried out concerning the AI capabilities to implement in the PS and the public areas where they will be applied. These results will serve as support for the AI implementation plan presented in the following chapter.

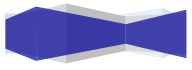
4.2. AI STRATEGY FOR THE SPANISH PUBLIC SECTOR

In the present chapter is detailed the proposal of this work regarding the implementation of AI in the Spanish PS. It is important to explain that the presented strategy is designed for being used as a general guideline of the AI implementation in Spain. Concretely, in the Spanish city councils that will be the actors of this disruptive transformation.

Following with the plan description, it contains three principal stages organized according the prioritization defined in chapter 4.1.3. Moreover, three levels of priority will be assigned to each stage for implementing all AI capabilities according to its defined area in the PACE prioritization matrix. First level of priority: implementation of the more prioritized AI capabilities (those located in the P area of the PACE decision matrix) into the more prioritized public areas (based on the conclusions extracted from the qualitative analysis). (2) Second level of priority: AI implementation using the following AI capabilities in the following public areas according to priority. (3) Third level of priority: AI implementation using the last AI capabilities in the last public areas, according to the already defined priority.

Of course, each stage will be subjected to both data controls (accessibility, quality and volume) and ethical controls, where privacy, public acceptance and plausible future problems will be monitored so that the correct performance of the AI implementation will be ensured. The following paragraphs describe more in detail each stage of this proposal.

In order to provide the rider with a better understanding of the presented strategy, see below in Figure 21 the representation of the AI implementation plan for the Spanish PS proposal:



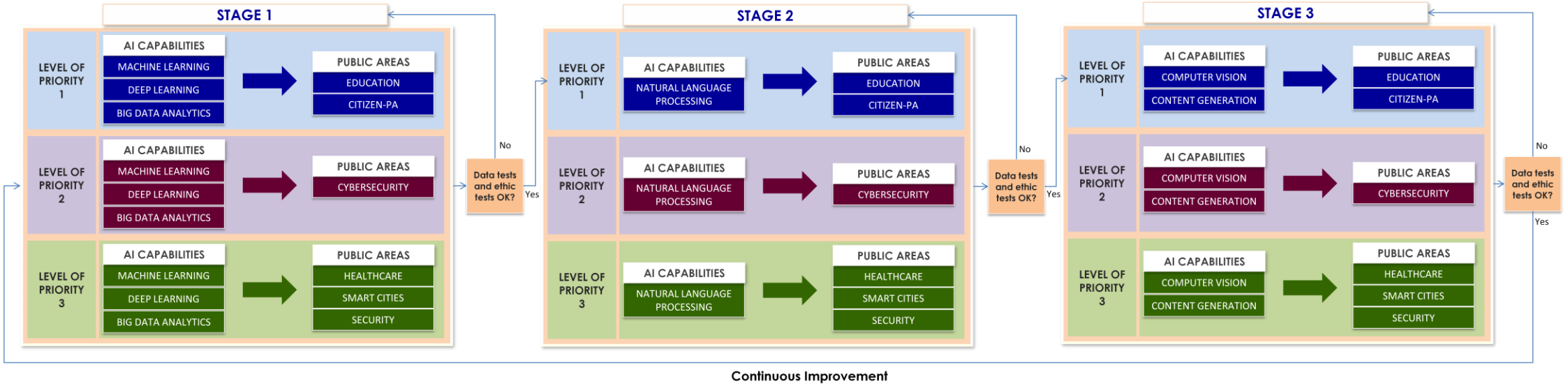


Figure 21: AI implementation plan for the Spanish Public Sector proposal

Source: own elaboration

As shown in Figure 20, this plan encompasses three stages involving the implementation of the AI capabilities situated in the Priority area of the PACE matrix into the public areas whose needs and current situation permit a proper application of AI systems. Notice that the stages are subdivided in 3 levels of priority. The below paragraphs detail thoroughly each stage.

4.2.1. Stage 1: ML, DL and Bid Data analytics in Spanish public areas

The objective of this first stage will be to accomplish the AI implementation in the three levels of priority defined above.

The first step will be to properly implement AI solutions by using ML, DL and Big Data analytics algorithms for approaching both areas Education and Citizen-PA interaction so that the current problems of these public areas will be improved. On the one hand, in terms of Education the main goal will be to decrease the early school leaving rate (18.3%) to the European average around 10.6%). On the other hand, in terms of Citizen-PA interaction the main objective will be to increase the accessibility of information and to decrease the corruption by exploiting with AI systems the robust online infrastructure of the Spanish PA.

The second step will be to improve the subarea of Cybersecurity with AI systems in order to decrease the potential vulnerability of Spanish entities if no action would be carried out regarding this matter.

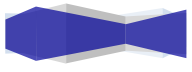
Lastly, the third step will be to perform the same implementation of AI capabilities but with different targeted sectors, in this case, Healthcare, Smart cities and Security (excluding the already tackled Cybersecurity area).

Then, when all priority levels will be tackled, the aforementioned controls in data and ethics will be performed. Within this context, several regulations may be updated for guaranteeing the constant and secure data sharing between institutions.

Finally, when an optimized functioning is ensured, stage 2 shall begin.

4.2.2. Stage 2: NLP in Spanish public areas

Stage 2 has the same format than stage 1. However, its main objective will be to achieve improvements by using AI systems based on NLP in all considered public areas, by respecting the priorities detailed. Concretely, in this stage will be exploited the potential that has NLP for the Citizens-PA interaction area which will be used for introducing reducing the response time of the public delivery service. Finally, tests will be effectuated and if the results are in line with expectations, then, the last stage of the presented plan, stage 3, will start.



4.2.3. Stage 3: CV and CG in Spanish public areas

Finally, stage 3 will follow an identical sequence of development but for the AI capabilities CV and CG. These capabilities are situated in the last stage due to the results obtained in the quantitative analysis which indicate that its maturity and impact in the PS will be smaller than the AI capabilities contained in stages 1 and 2. As in the other stages, when the testing matches the previsions the continuous improvement may start. That is, to evaluate again the status of the AI capabilities and the data, in order to verify the progress, or if changes should be carried out. The continuous improvement will be crucial in the long run, so it must be performed thoroughly.

4.3. CONCLUSION AND FUTURE RESEARCH

In the present work has been analyzed the current situation of AI in both scenarios Europe and Spain, which has permitted the elaboration of an AI implementation guideline for the Spanish PS. Since, in Spain, governments and city councils will have to manage the disruptive transformation that AI will cause in the near future, it is crucial to anticipate the circumstances and decide what is needed to be done first. The performed analysis has served, precisely, for prioritizing not only the AI capabilities to be applied in the PS, but also the public areas where AI systems should be installed first. The results obtained are supported on the one hand, by quantitative parameters, in the case of AI capabilities, and on the other hand, by a qualitative analysis conducted by studying tendencies in information that could impact AI, in the case of public areas where AI will be applied.

The results confirm that there are three AI capabilities supposed to be the main actors of the AI application in the PS in the short-midterm, which are: ML, DL and Big data analytics due to its capacity of evaluating enormous amounts of data both structured and unstructured for making decisions that permit the optimization of the variables defined in their algorithms. Also, another reason why these three AI techniques are in the top of the presented analysis is their current development, that is, the amount of research papers in the field of applying AI in the PA concerning these technologies is much higher than for the other AI capabilities considered. As a matter of fact, the potential of these capabilities remains in their transversal capacity of being applied in all areas of the PS.

In second place, it is situated a very promising AI capability, which is NLP. It has plenty of potential in the Citizen-PA interaction area, where NLP is intended to change radically communication between citizens and public institutions due to its capacity of parsing and interpreting human languages, an ability highly valuable in Spain which has more than 5 different languages and dialects. Nevertheless, as confirmed in the quantitative analysis, its complete productivity is envisioned in a 5 to 10 years horizon which has provoked the decision of tackling the application of intelligent systems based on NLP in the second stage of the presented implementation plan. Then, the obtained results for CV and CG are coherent regarding their narrower framework of application in comparison with the aforementioned AI capabilities. So it seems logical to approach them in stage 3, as the results have confirmed. Finally, the RL application has to be removed for this strategy proposal because, even though this AI capability has an enormous potential in other areas such as games, due to its capacity of grading the results perceived by the algorithm in order to learn from them, when considering its applications in the PS, only Healthcare is mentioned. Moreover, its maturity is in a nascent state yet.

In addition, the presented results concerning the priority of the AI application in the public areas may be very controversial due to the subjectivity to which it is subjected. This is because of the vast amounts and different types of data that could be

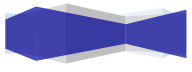
considered arguing that a given decision is better than another. An actual fact is that plenty of different paths could be proposed if they are properly supported by data. It only depends on which data you are looking. Within this context, a critical factor needed to achieve the adaptation of the Spanish PS is to have a defined succession of actions to conduct. The order presented in this work, supported by the detailed qualitative analysis, is based on public Spanish information related to AI that has marked a specific order of approach:

I. Education and Citizen-PA interaction
II. Cybersecurity (as a part of Security)
III. Healthcare, Smart cities and Security (excluding Cybersecurity)

This prioritization is coherent according to the data used in the conducted study which is based on several indicators that describe the current situation on Spain within these concrete areas. In this line of analysis, it is also concluded that there is an important lack of perception in a regional level concerning the enormous technological change that is just around the corner. There are no allusions to AI neither in the national budget report of the Spanish government, nor in the regional budgets of the most influent city councils (Madrid, Barcelona and Valencia), when the EU has set a deadline for presenting an AI national strategy (presented on march 2019 for a plan to be perform for the 2030 horizon) that will affect 11 ministries, which, apparently, it is not contemplated in the Government General Budget (PGE for its Spanish acronym). So, which is critical for the current situation is to integrate a transversal plan between the public institutions in Spain for collaborating in this difficult common goal.

Finally, future research might be related to talent attraction regarding the AI topic. One of the most important problems of this transformation is that AI systems are very difficult to not only understand them, but also to control them. Therefore, it is crucial to embrace new technologies by promoting bachelor and master studies related to AI and by open new fields of research in AI related topics, because the only way to benefit from AI systems and being totally safe at the same time is to truly understand them and being capable of predicting the future problems that AI may cause in order to eradicate them.

Nevertheless, the future is promising regarding AI implementation in the PS. According to Makridakis (2017) humans perceive the AI transformation from four different perspectives: optimists, pessimists, pragmatists and doubters. As mentioned before in this section, every path is respectable if properly argued. Well, I am a pragmatist, "our view is that we could learn to exploit the power of computers to augment our own skills and always stay a step ahead of AI, or at least not be behind it".



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