



“MASTER’S DEGREE PROGRAMME IN BUSINESS  
ADMINISTRATION”

“Development and innovation in public procurement in the Greek  
government. The potential of Artificial Intelligence (AI) on  
developing a more ethical and effective procedure”

“Ioannis Melidonis”

Supervisor: “Bitzenis Aristidis”

Patras, Greece, “September” “2021”

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“Ioannis Melidonis”

Supervising Committee

Supervisor:

“Bitzenis Aristidis”

Co-Supervisor:

“Chatzoglou Prodromos”

Patras, Greece, "June" "2021"



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This is dedicated to my beloved partner for getting behind me throughout this journey

*“Acknowledgments and / or Dedication”*

## **Abstract**

Technological transformation through AI in all aspects of society and economy including public procurement has become possible over the last years. This follows the development of digitalization, data management and computer process capabilities. In Greece in the field of the public spending, procurement functions as a mean of improving services, satisfying internal and external stakeholders and on the same dealing with an estimating budget of around 7 B euros annually. Even more so in times of pandemic and rapid societal changes, the procurement organization needs to be agile to satisfy the emerging needs.

The literature suggests that AI technology has been more and more common over the last decade. Its area of applications is vast ranging from biometric identifying systems to data and optimization analysis for traffic patterns. Machine learning algorithms, chatbots and natural language processing are some of the tools that have been used. AI can offer among other things flexibility, improved efficiency, transparency, and speed. Procurement has not been at the forefront of the technological transformation like other fields; however, it is catching up. Big private corporations have already paved the way and many public organizations in EU and globally have started implementing AI technology to many projects, ranging from small to medium scale.

The national strategy of AI implementation in Greece has not made specific reference to procurement. On the other hand, EU reports have identified many gaps and areas of improvement for the Greek public procurement. Using extended bibliography and cases from other countries this report will seek to identify how the organization can move forward. Adaptation of this innovative technology can set the path for improved communication with the public, reduced corruption, compliance awareness and expedited procedures among other things. The hurdles to implement these systems and restrictions within this study, will also be analyzed, along with suggestions for future work.

## **Keywords**

Procurement



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Public Sector

Artificial Intelligence

Revenue Saving

Technology Adoption

“Ανάπτυξη και καινοτομία στις δημόσιες συμβάσεις στην ελληνική κυβέρνηση. Οι δυνατότητες της Τεχνητής Νοημοσύνης (TN) για την ανάπτυξη μιας πιο ηθικής και αποτελεσματικής διαδικασίας”

Μελιδώνης Ιωάννης

## Περίληψη

Ο τεχνολογικός μετασχηματισμός μέσω της τεχνητής νοημοσύνης σε όλες τις πτυχές της κοινωνίας και της οικονομίας, συμπεριλαμβανομένων των δημόσιων προμηθειών, έχει καταστεί δυνατός τα τελευταία χρόνια. Αυτό προκύπτει από την ανάπτυξη της ψηφιοποίησης, της διαχείρισης δεδομένων και των δυνατοτήτων ηλεκτρονικών διεργασιών. Στην Ελλάδα στον τομέα των δημόσιων δαπανών, οι δημόσιες προμήθειες λειτουργούν ως μέσο βελτίωσης των υπηρεσιών, ικανοποίησης των εσωτερικών και εξωτερικών «πελατών» έχοντας να διαχειριστούν έναν προϋπολογισμό περίπου 7 δισ. ευρώ ετησίως. Ακόμη περισσότερο σε περιόδους πανδημίας και ταχέων κοινωνικών αλλαγών, οι δημόσιες προμήθειες για να ικανοποιούν τις αναδυόμενες ανάγκες.

Από τη βιβλιογραφία προκύπτει ότι η τεχνολογία του AI είναι όλο και πιο διαδεδομένη την τελευταία δεκαετία. Ο τομέας των εφαρμογών της είναι τεράστιος και κυμαίνεται από συστήματα βιομετρικής ταυτοποίησης έως την ανάλυση δεδομένων και τη βελτιστοποίηση των της κυκλοφορίας. Οι αλγόριθμοι μηχανικής μάθησης, τα chatbots και η επεξεργασία φυσικής γλώσσας είναι μερικά από τα εργαλεία που έχουν χρησιμοποιηθεί. Η τεχνητή νοημοσύνη μπορεί να προσφέρει μεταξύ άλλων ευελιξία, βελτιωμένη αποδοτικότητα, διαφάνεια και ταχύτητα. Οι δημόσιες προμήθειες δεν ήταν στην πρώτη γραμμή του τεχνολογικού μετασχηματισμού όπως άλλοι τομείς- ωστόσο αυτό φαίνεται να αλλάζει σιγά σιγά. Μεγάλες ιδιωτικές εταιρείες έχουν ήδη ανοίξει το δρόμο στον τομέα των προμηθειών

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και πολλοί δημόσιοι οργανισμοί στην ΕΕ και παγκοσμίως έχουν αρχίσει να εφαρμόζουν την τεχνολογία ΑΙ σε πολλά έργα, από μικρής έως μεσαίας κλίμακας.

Η εθνική στρατηγική εφαρμογής της ΑΙ στην Ελλάδα δεν έχει κάνει ειδική αναφορά στις δημόσιες προμήθειες. Από την άλλη πλευρά, εκθέσεις της ΕΕ έχουν εντοπίσει πολλά κενά και τομείς βελτίωσης για τις ελληνικές δημόσιες προμήθειες. Χρησιμοποιώντας εκτεταμένη βιβλιογραφία και περιπτώσεις από άλλες χώρες, η παρούσα έκθεση θα προσπαθήσει να προσδιορίσει πώς ο οργανισμός μπορεί να προχωρήσει μπροστά. Η προσαρμογή αυτής της καινοτόμου τεχνολογίας μπορεί να θέσει το δρόμο για την βελτίωση της επικοινωνίας με το κοινό, τη μείωση της διαφθοράς, την ευαισθητοποίηση σε θέματα συμμόρφωσης και την επιτάχυνση των διαδικασιών μεταξύ άλλων. Τα εμπόδια για την εφαρμογή αυτών των συστημάτων και οι όποιοι περιορισμοί στο πλαίσιο αυτής της μελέτης, θα αναλυθούν επίσης, μαζί με προτάσεις για μελλοντικές εργασίες.

### **Λέξεις – Κλειδιά**

Mention 3 to 6 key words for the indexing of your thesis / dissertation in Greek.

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## **List of Abbreviations & Acronyms**

AI Artificial Intelligence

GDP Gross Domestic Product

HSPPA Hellenic Single Public Procurement Authority

SME Small Medium Enterprises

PP Public Procurement

...

....

...

...

## **1. Introduction**

### **1.1 Dissertation background**

Public Procurement in the European Union according to (European Commission, 2020) refers to the process by which public authorities, such as government departments or local authorities, purchase work, goods or services from companies, i.e. the building of a state school, purchasing furniture for a public prosecutor's office, contracting cleaning services for a public university etc.

Regarding the public procurement market in EU as per (Karachaliou, Giagtzoglou, & Stroikos, 2017)

- Every year nearly 2 trillion euros are paid in Europe for public contracts, i.e. 14% of EU GDP.
- At least 250.000 public authorities conduct public procurements annually.
- Public authorities are the major buyers in sectors such as energy, transport, waste management, social protection and the provision of health or education services.
- The estimated value of general government expenditures on works, goods, and services -excluding utilities- has increased by 4,2% in 2015. Almost all EU Member States increased their expenditure on public contracts between 2014 to 2015.
- The estimated value of tenders published in 2015 was 450.21 billion euros which stands for 6.9% more than it was in 2014.

The latest directives regarding procurement policies set by the European Union were; 2014/23/EU, 2014/24/EU and 2014/25/EU. These had to be implemented by member states by 2016 into national legislation. According to (European Commission, 2020) those rules seek to ensure greater inclusion of common societal goals in the procurement process. Environmental sustainability, social accountability, creativity, climate change mitigation, jobs, public health, and other social and environmental concerns are among these objectives. The effects of those were expected to benefit all stakeholders including governments and suppliers.

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According to European Commission (European Commission, 2020) the implementation of the new policy will help develop the following 3 principles.

- equal treatment
- non-discrimination
- transparency

According to (European Commission, 2020) e-procurement and the use of technology is an important parameter to follow the aforementioned principles. Increasing use of digital procurement provides faster access to procurement opportunities, makes more information available, and improves traceability. Furthermore, new innovations can significantly alter the procurement life cycle, resulting in substantial benefits for both buyers and suppliers. As described by (Allal-Cherifa, Simon-Moyab, & Ballestero, 2020) although still much less digitalized than other business functions, procurement is turning towards artificial intelligence. Decision support, strategic monitoring, prediction, and collaboration tools are increasingly being used by buyers in intelligent information systems. Some large groups (e.g., TOYOTA), considered as pioneers in the field, already use AI which widely enables them to design and adopt AI-based systems to undertake various tasks in parallel with, or instead of, their buyers, and to accomplish missions that could not be undertaken without these emergent digital technologies. From a procurement point of view any software that includes algorithms, self learning can fall in the AI category.

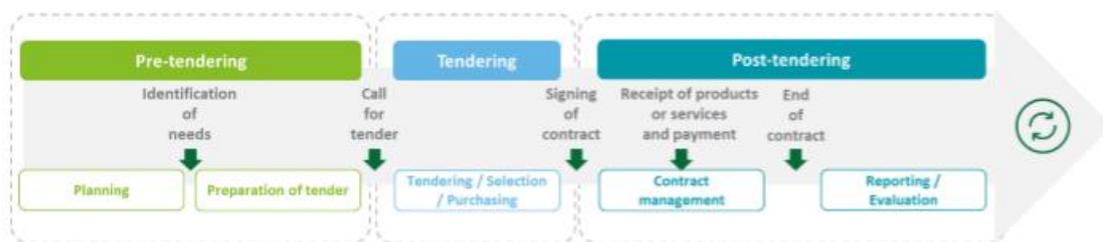
Compared to 2008 GDP of Greece was reduced by 100 b \$ (from 318 \$ B in 2008 to 218\$ B in 2018). Despite the relative growth achieved over the last few years the recent Covid-19 has hampered this trend. The recession for the 2020 was around 8,2%. Cutting expenses is an imperative issue.

In Greece in 2019 the total cost of public procurement was estimated to be 19,7 B Euros of which around 6,5 B euros went through the public procurement contracts process. The law which followed the European Directive in Greece was (4412/2016) was put in place in 2016. The Hellenic Single Public Procurement Authority (HSPPA) is the key institution and the main authority for public procurement. As described in their website (HSPPA, 2020) their role is.

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- develop and promote national public procurement strategy, policy, and action,
- ensure transparency, efficiency, cohesion, and compliance in the implementation of public procurement procedures and contracts with national and European law,
- constantly contribute to the improvement of the legislative framework on public procurement
- control the proper application by government bodies and contracting authorities.
- serve as a single point of contact for exchanging views, information, and data on the national public procurement policy, legal structure, and procedures for tendering for, awarding, and performing public contracts with EU institutions and international public procurement organizations

The following diagram shows a very concise picture of the procurement process to get a better understanding of the key steps followed.



**Figure 1; The typical public procurement process as published by (Peijl, O’Neill, Doumbouya, & Howlett, 2020)**

## 1.2 Dissertation Objectives

After the implementation of the 4412/2016 there has been improvement in many issues. The implementation of electronic procurement through the Prometheus electronic system (N.S.E.P.P, 2020) has resulted in reducing the procure to pay time by 50-80% due to the automation of the procurement process. In addition, with the use of electronic procurement, new practices have been applied as for example the electronic bidding and the use of e-catalogues. In addition, this system allows much quicker invoicing, increase of competition and due to that price reduction by 5% of the cost of participation for potential suppliers. Other indirect benefits are the improvement of order monitoring, better governance of order, suppliers’ assessment and other. Clarity of transaction can help in reducing corruption,

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modernize the system thus creating an eco-system of trust between key stakeholders (the public, government, and the suppliers).

Nevertheless, Greece still lags other European countries as determined by (European Commission, 2020). More specifically its overall performance was deemed as unsatisfactory. Artificial intelligence - a deeply technical family of cognitive technologies is recognized as an area of strategic importance and a key driver of economic growth (Kuziemska & Misuraca, 2020) in the public sector.

This dissertation sets the objective of portraying the landscape of the AI implementation for the Greek Public Procurement system. It will examine the advantages of an AI system for the public authorities, emerging paradigms and practices of other countries, and literature and regulatory review. In addition, there will be a forward-looking analysis of setting the goals, drivers, barriers, and risk for the AI system in the Greek Procurement Sector. Can the AI set a governmental procedure which would best support trust and therefore set the standards holding high standards? In addition, how can AI system drive automation thus providing a more cost-efficient method?

### **1.3 Importance of the topic**

Much research in Greece has been conducted in the public procurement system after the implementation of the 4412/2016 law as mentioned in (Foundation for Economic and Industrial Research, 2020). Those are focused on Green procurement, supply chain development, digitalization of invoicing system and the harmonization of the procurement systems across member states. On the other hand, regarding AI there have been reports for its implementation on the Greek industrial sector, the health sector, the HR sector, and its relevance on the Greek legal framework (Ministry of Digital Governance, 2020). Regarding AI on the public procurement there have been reports on countries like in Canada, Japan, Finland, and Poland (Peijl, O’Neill, Doumbouya, & Howlett, 2020) and others but none for Greece.

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There has been a lot of progress regarding collection and digitalization of purchasing data. Statistics regarding number of contracts, publication time, decision speed, total spends, and others are now widely available. On the other hand, there has also been a lot of research and application of AI systems on commercial issues such as e-commerce which focus on identifying prospects, how to create more efficient processes, chatbots and others (Gartner, 2021). Hence this is an important and fresh topic for the Greek system which can utilize established experience in other fields or other regions using data already available.

The results of this study would be of interest to those who participate in the public procurement process (i.e. suppliers) and of course initiators of public procurement reform i.e. public authorities.

## **1.4 Structure of the dissertation**

The following section will be a literature review which will provide insight on digitalisation of big data, artificial Intelligence technologies, application of AI on big data, application of AI on other countries, structure of Greek public procurement system, financial size of Greek public procurement and applications. This will include expected effects, drivers and hurdles of implementation. The next chapter will be an analysis of the methodology used and the various options in hand. It will give a clearer insight why the literature review was chosen compared to other tools. The 4<sup>th</sup> chapter will provide an assessment of AI on the Greek procurement system based on previous analysis. The last chapter will be the conclusion for the case study of AI for Greece. There will be a summary of the landscape in Greece and potential areas where more insight is needed.

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## **2 Literature review of Public Procurement and AI implementation**

### **2.1 Public Procurement in Greece**

#### **2.1.1 Legal framework**

As was explained above the law 4412/2016 has been an implementation of the European directive. 4412/2016 has set a uniformed platform for all public procurement activities. It is applied to all public procurement contracts irrespective of its total cost. The principal aims were to ensure transparency, a standard set of procedures and a level playing field for all stakeholder whether internal or external. In addition is has made clear which authorities are in charge for each field and what are the boundaries of control.

The following table shows a concise picture of tools, authorities and system involved in central Greek public procurement as published by (Karachaliou, Giagtzoglou, & Stroikos, 2017)

	Name	General Scope
Authority	Hellenic Single Public Procurement Authority (ΕΑΑΔΗΣΥ)	<ul style="list-style-type: none"> <li>• Responsible for development and promotion of national guidelines on public procurement</li> <li>• Assures the transparent execution of a tender as well as the better harmonization of national legal framework with EU directives</li> </ul>
Integrated Information System	National Electronic Public Procurement System NEPPS (ΕΣΗΔΗΣ)	<ul style="list-style-type: none"> <li>• Process and follow up the entire tender procedure electronically</li> </ul>
Electronic Registry	Central Electronic Public Procurement Registry CEPRR (ΚΗΜΔΗΣ)	<ul style="list-style-type: none"> <li>• Includes all pertinent information in awarding a contract</li> <li>• Provides ways in which an offer is submitted</li> <li>• Publishes all tenders (irrespective of their value)</li> </ul>

**Table 1; Authorities and electronic tools for Public Procurement Greece published by (Karachaliou, Giagtzoglou, & Stroikos, 2017)**

Law 4412/2016 is an intricate piece of legislation to achieve the goals - conditions set by the European Union for the in-depth reform of public procurement. It was in the obligations of Greece arising from its participation the transposition into Greek law of Directive 2014/24 and Directive 2014/25 / EU.

Law 4412/2016 and the European directives main targets according to (Georgakopoulos, 2020) are to:

1. The simplification and flexibility of the procedures and rules
2. The expansion and generalization of electronic media as a way of communication in public procurement, as it is a key player in simplifying public procurement in the short term.
3. Reduction of administration burden due to the number of certificates required by participants hence facilitating the participation of SMEs.
4. The modernization of procedures (e.g., reduction of deadlines for submission of tenders and requests to participate, flexibility in distinguishing between the selection of tenderers and the award of the contract, revision, and clarification of reasons for exclusion of candidates and tenderers, possibility of "self-cleaning", provisions for the modification)

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5. Facilitation of a better quality and strategic use of public procurement by incorporating social and environmental criteria, whether it be the cost of life cycle or the inclusion of vulnerable and disadvantaged people and strengthening innovation.
6. The adoption of a special framework for social, health and educational services.
7. The introduction of improvements to existing warranties in order to ensure greater integrity of procedures taking into account the financial challenges
8. The introduction of obligations in the Member States relating to good governance in the field of public procurement (supervision, monitoring, implementation and control of public procurement, support for contracting authorities and economic operators, statistical reporting and administrative cooperation between the competent authorities of the Member States.

### **2.1.2 Fields of application**

After discussing the key traits of the law it is worth delving more into the field of application of the public procurement system. What are the fields of the public procurement system, how these are defined and what are the exceptions? Based on much information from (N.S.E.P.P, 2020) the following definition can be given.

1. Public works contracts are contracts whose object is the execution or at the same time the study as well and the implementation by any means of a project that the contracting authority has a decisive influence on the nature of its nature. The execution of the works requires in particular the application of a study using technical knowledge and methods and concerns new constructions, extensions, renovations, repairs during operation, infrastructure demolition, especially in the categories of road construction, building, hydraulic, electromechanical, port, industrial green, water purification and treatment, liquid, solid and gaseous waste, drilling, special insulation, elevators, electronic equipment, floating works and installations, shipyards, mining revelations and infrastructure or a combination of the above categories.

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2. Public procurement contracts. Public procurement contracts are defined as purchase contracts which deal with the purchase, leasing, or leasing-sale, with or without the right of purchase, of products.

3. Public service contracts "Public service contracts" and "service contracts" means contracts that have as their object the provision of services, other than works.

(a) "public contracts for the preparation of studies and the provision of technical and other related scientific services" means those for the preparation of studies and the provision of technical and other related scientific services.

(b) "Public service contracts" means contracts which have as their object the provision of services other than "public design contracts and the provision of technical and other related scientific services" including consulting services (with a planning, organization, management, monitoring, control and evaluation of business and development programs and actions in all sectors of the economy, as well as in horizontal interventions, supporting their implementation by transferring the necessary relevant know-how, as well as providing outsourcing services for the implementation of the above programs and actions)

### **2.1.3 Importance and performance of public procurement in Greece**

In previous paragraphs the main legal framework of the application has been explained and the respective field of applications. It is worth exploring what is the total spend, how is Greece performing compared to other countries.

The following graph shows the allocation of expenses per category for 2019 as these were described above

**Συγκεντρωτικά στοιχεία συμβάσεων ετών 2017-2019**

Πηγή: ΚΗΜΔΗΣ ([www.promitheus.gov.gr](http://www.promitheus.gov.gr)) - Καταχωρίσεις έως 30/6/2020



**Figure 2; Allocation of public procurement per category in 2019 as published in (N.S.E.P.P, 2020)**

As it can be seen from the graph above.

- 2.5 B euros were spent on procurement contracts
- 2 B euros were spent on services
- 2 B euros were spent on work contracts

The following graph shows the performance of the Greek system compared to EU standards



**Figure 3; Performance Indicators of various member states in EU as published by (European Commission, 2020; European Commission, 2021)**

The indicators reflect according to (European Commission, 2021);

Indicator [1] – One Bidder; This indicator reflects several aspects of procurement, including competition and bureaucracy. More bidders are better, as this means the public buyers have more options, and can get better value for money. The "One Bidder" indicator measures the proportion of contracts awarded where there was just one bidder (excluding framework agreements, as they have different reporting patterns)

Indicator [2]: No Calls for Bids; This indicator reflects several aspects of procurement, including transparency and competition. Calling for bids (or "calling for tenders") before starting procurement negotiations is better, as it makes the bidder selection process more transparent and increases competition. This leads to better value for money. The "No Calls for Bids" indicator measures the proportion of procurement procedures that were negotiated with a company without a call for bids.

Indicator [3]: Publication Rate; This indicator shows the value of national public procurement advertised to businesses. A higher "Publication Rate" score is better, as it

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allows more companies to bid, bringing better value for money. It also means greater transparency, as more information is available to the public. "Publication Rate" measures the value of procurement advertised on TED as a proportion of national gross domestic product (GDP).

Indicator [4]: Cooperative Procurement; This indicator shows how often public buyers buy together. Buying in bulk often leads to better prices and offers an opportunity to exchange know-how. Although not all types of purchase are suitable for aggregation, excessively low aggregation rates suggest lost opportunities. The "Cooperative Procurement" indicator measures the proportion of procurement procedures with more than one public buyer.

Indicator [5]: Award Criteria; This indicator shows how public buyers choose the companies they award contracts to. This indicator, measures whether they decide based on price alone, or if they also take quality into account. While the choice of criteria depends on what is being purchased, over-reliance on price suggests better criteria could have been used – and thus a better purchase made. The "Award Criteria" indicator measures the proportion of procedures which were awarded only based on lowest price.

Indicator [6]: Decision Speed; This indicator reflects the speed of the public buyers' decision making. Very lengthy procedures are bad because they are expensive and cause uncertainty for both the public buyers and companies. "Decision Speed" measures the mean decision-making period. This is the time between the deadline for receiving offers and the award of the contract. To ensure comparability, only notices published under the open procedure and not including framework agreements are considered.

Indicator [7]: Missing Values; This indicator shows when, against the law, public buyers provide insufficient information about their procurement. A lower "Missing Values" indicator score is better, as it means companies can make better bidding decisions and citizens know how their money is being spent. The indicator measures the proportion of contracts awarded without information about the value (excluding framework agreements, as they have different reporting patterns).

Indicator [8]: Missing Calls for Bids; This indicator shows when, against the law, public buyers provide insufficient information about their procurement activities. A lower "Missing Calls for Bids" indicator score is better, because it means businesses and citizens

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can understand how contractors have been selected. The indicator measures the proportion of contract awards for which a call for bids took place, but it is not clear what the name of the call was or what the conditions were.

Indicator [9]: Missing Registration Numbers; This indicator shows when, against the law, public buyers provide insufficient information about their procurement. A lower "Missing Registration Numbers" indicator score is better, because registration numbers (e.g. those given by business registries) for buyers and sellers are crucial to understanding who is buying from whom across different procurement procedures. The indicator measures the proportion of procedures where the registration number was not included.

Greece is performing unsatisfactory on indicator 3 and from 5 to 9.

## **2.2 AI, public services, and procurement**

### **2.2.1 What is Artificial Intelligence**

Before delving more deeply on Artificial Intelligence (AI) and the link to Procurement more specifically, it is worth understanding what AI is about. According to (Gartner, Inc. and/or its affiliates, 2021) artificial intelligence applies advanced analysis and logic-based techniques, including machine learning, to interpret events, support and automate decisions, and take actions. In short, AI is mainly a computer engineering discipline. This discipline is made up of software tools aimed at solving problems, not replicating the human brain (let alone the mind). From that perspective, the AI discipline (and toolbox) comprises a series of mathematical or logic-based techniques — uncovering, capturing, coding knowledge, and using sophisticated and clever mechanisms to solve problems. AI has been recognized as one of the central enablers of digital transformation in several industries and functions. Before going more deeply into the techniques of AI it is useful to understand some of the most common terms used. These were analysed in the (Hussey, Taylor, & Murdoch, 2018) report. So, some of the most common components are;

- **Algorithm:** A set of instructions for carrying out a calculation or solving a problem, especially with a computer. They are the foundation for all a computer can do, and therefore are an essential component of all AI systems.

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- **Expert system:** A computer machine that mimics a human expert's decision-making ability by following pre-programmed rules like "if this happens, then do that." These systems fueled much of the early enthusiasm for AI in the 1980s, but have since fallen out of favor, particularly with the rise of neural networks.
- **Machine Learning:** One form of AI, which gives computers the ability to learn from and improve with experience, without being explicitly programmed. When provided with sufficient data, a machine learning algorithm can learn to make predictions or solve problems, such as identifying objects in pictures or winning at games, for example.
- **Neural Network:** This form of machine learning, also known as an artificial neural network, is loosely influenced by the structure of the human brain. A neural network is made up of basic processing nodes, also known as "artificial neurons," that are linked in layers. Each node will receive data from several nodes "above" it and send data to several nodes "below." Nodes assign a value to the data they obtain by assigning it a "weight." The data is not passed on to another node if it does not meet a certain threshold. When the algorithm is trained, the node weights and thresholds are modified until similar data input produces consistent outputs.

The following graph is concise picture of what AI is all about

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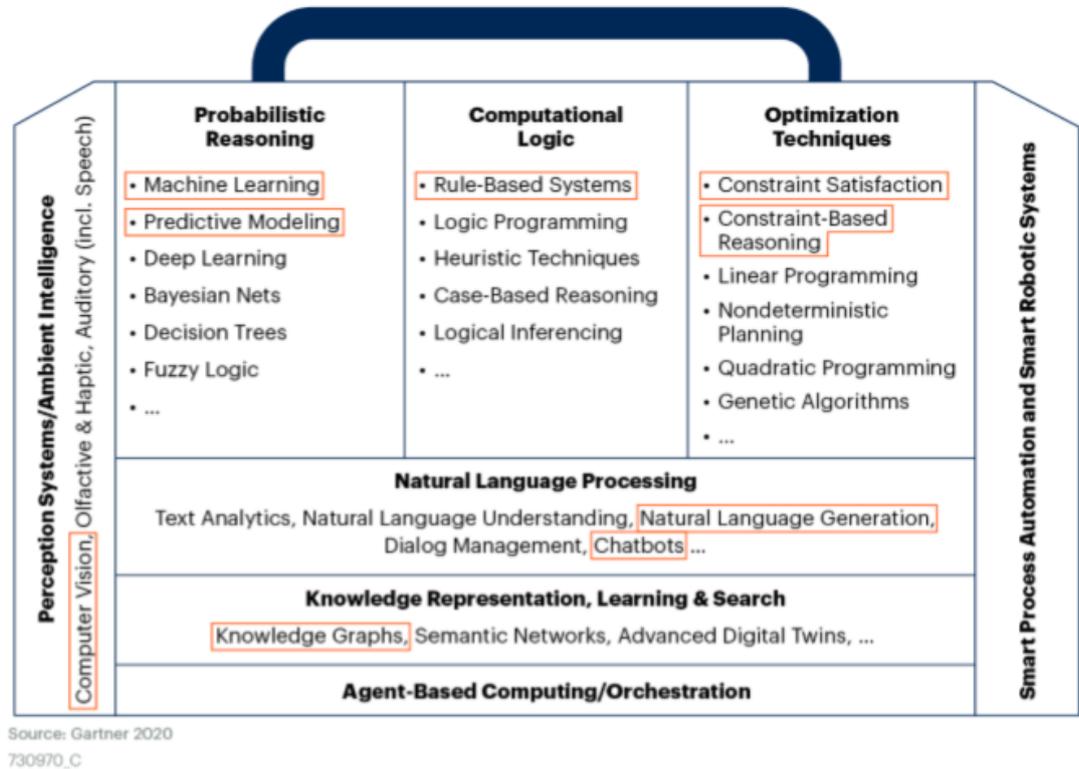


Figure 4; AI Techniques framework, published from (Gartner, 2021)

## 2.2.2 What are the main categories of AI

After discussing about the theory behind AI and its major components it worth focusing on the main categories of techniques of AI today. Today, three main categories of techniques form many cases in AI. These categories are distinct and embody very different approaches and techniques that are robust and mature:

- Probabilistic reasoning: As defined by (Java Point, 2021) probabilistic reasoning is a way of knowledge representation where we apply the concept of probability to indicate the uncertainty in knowledge. In probabilistic reasoning, the probability theory is combined with logic to handle the uncertainty. Probabilistic reasoning is used because it provides a way to handle the uncertainty that is the result of someone's laziness and ignorance. In the real world, there are lots of scenarios, where the certainty of something is not confirmed,

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such as "It will rain today," "behaviour of someone for some situations," "A match between two teams or two players." These are probable sentences for which can be assumed that it will happen but not sure about it, so here is the use of probabilistic reasoning. Some common applications include image recognition, diagnosis of health issues, decision support systems and others.

- Computational logic: As explained by (CLIMA, 2021) computational logic in multi agent systems are communities of problem-solving entities that can perceive and act upon their environment to achieve their individual goals as well as joint goals. The work on such systems integrates many technologies and concepts in artificial intelligence and other areas of computing as well as other disciplines. Over recent years, the agent paradigm gained popularity, due to its applicability to a full spectrum of domains, from search engines to educational aids to electronic commerce and trade, e-procurement, recommendation systems, simulation, and routing, to cite only some.

- Optimization techniques: According to (Gartner, 2021) optimisation techniques are traditionally used by operations research groups, optimization techniques maximize benefits while managing business trade-offs. They do this by finding optimal combinations of resources given several constraints in each amount of time. Optimization solvers often generate executable plans of action and are sometimes described as prescriptive analytics techniques. Operational research groups in asset-centric industries (such as, manufacturing and utilities) or functions (such as logistics and supply chain) have been using optimization techniques for decades.

Other emerging technologies in the field are. Most of the information were derived from (Gartner, 2021).

- Natural language processing (NLP); According to NLP allows humans and machines to communicate in a natural way. NLP encompasses both symbolic and sub-symbolic computational linguistic techniques aimed at identifying, decoding, interpreting, automatically tagging, translating, and producing (or summarizing) natural languages. Speech processing technologies, which are basically signal-processing systems, are often used to handle the phonetic component. As a result, various software systems are often used

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to provide speech-to-text and text-to-speech applications. NLP frameworks also provide additional information capabilities such as dictionaries and ontologies.

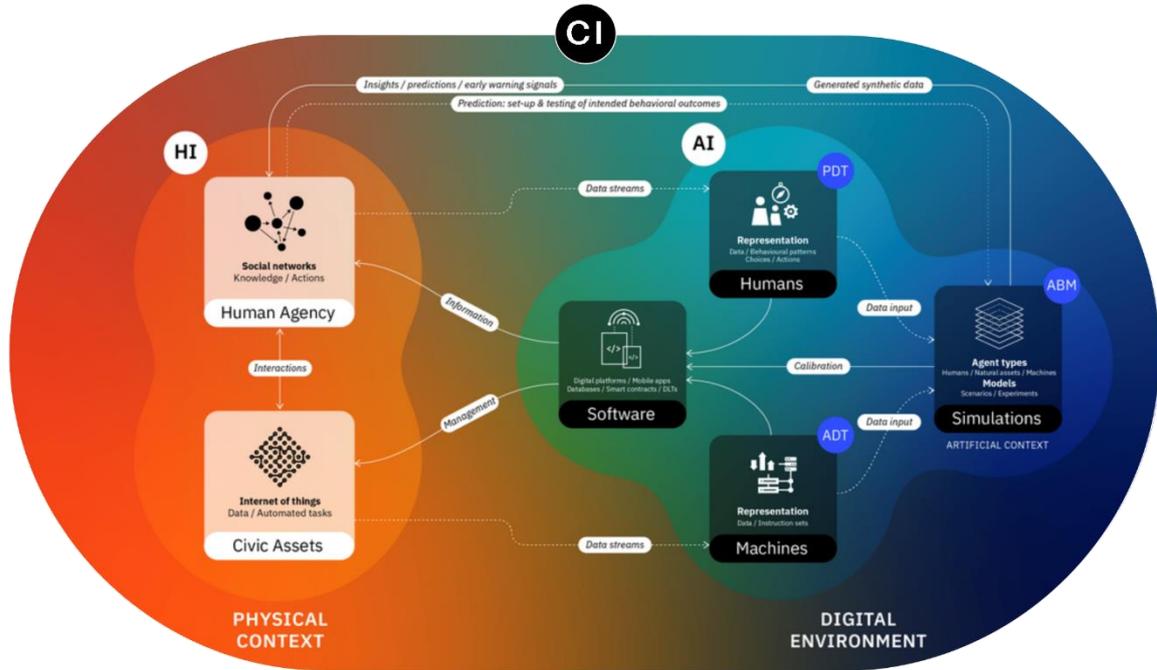
- Knowledge preparation: Information graphs and semantic networks are examples of capabilities that seek to make it easier and faster to access and analyze data networks and graphs. These processes are more intuitive for specific types of problems due to their information representations. New information representations, for example, provide fertile ground for AI techniques in situations where specific relationships among individuals must be mapped out (investigative research, process optimization or manufacturing assets management, for example). Graph traversal, memorization, and hybrid learning are examples of these strategies (while using composite AI systems).

- Agent based computing; This is the least developed of the AI techniques, but it is rapidly gaining popularity. Software agents are programs that operate on behalf of users or other programs and are persistent, autonomous, and goal oriented. Chatbots, for example, are becoming more and more common. There are five major types of agent systems, in order of the complexity:

- Reflex-based agents
- Model-based agents
- Goal-based agent
- Utility-based agents
- Learning agent

The following picture gives a good representation of an AI agent-based computation example

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**Figure 5; Augmented Collective Intelligence Framework as was published in (Lucidminds, 2021)**

Some of the most representative fields the AI can be applied are shown below as published in (Data Flair, 2021)

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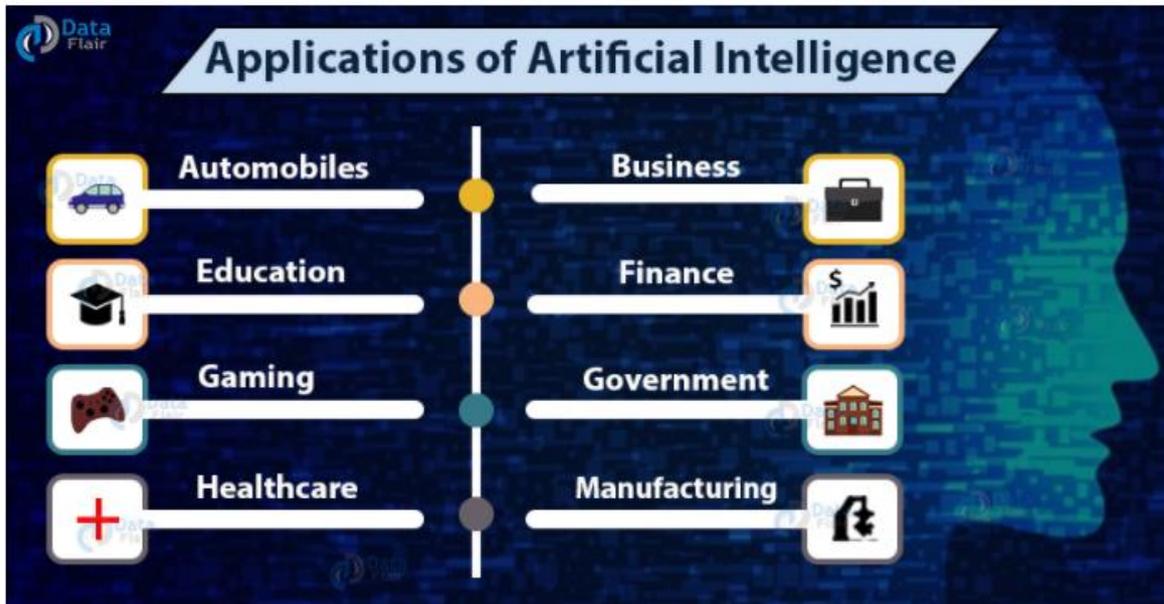


Figure 6; Application of Artificial Intelligence as published in (Data Flair, 2021)

### 2.2.3 What is the European Commission’s stand on AI?

The European Commission has developed a strong strategic path in the direction of ethical, human-centric AI.

As published by (Bertrand, Erwin, & Hartmann, 2020) to lead the next wave of AI, the European Commission's High-Level Expert Group (HLEG) on AI uses ethical criteria. Through a coordinated strategy and pan-European alliances, these guidelines enable the cohesive development of trusted AI solutions.

By putting humans at the core of technology growth, the Framework for Trustworthy AI aims to embed European values and gain public confidence. Centred on three foundations, the architecture operationalizes trustworthy AI:

- 1) ethical values such as justice and respect for human autonomy.
- 2) core criteria such as openness and accountability; and
- 3) technical and non-technical methods for evaluating trustworthy AI based on codes of conduct, standardization, and explanations of AI approaches.

Another approach set by the European Commission is the risk-based approach as analysed on (Directorate-General for Communications Networks, Content and Technology, 2021).

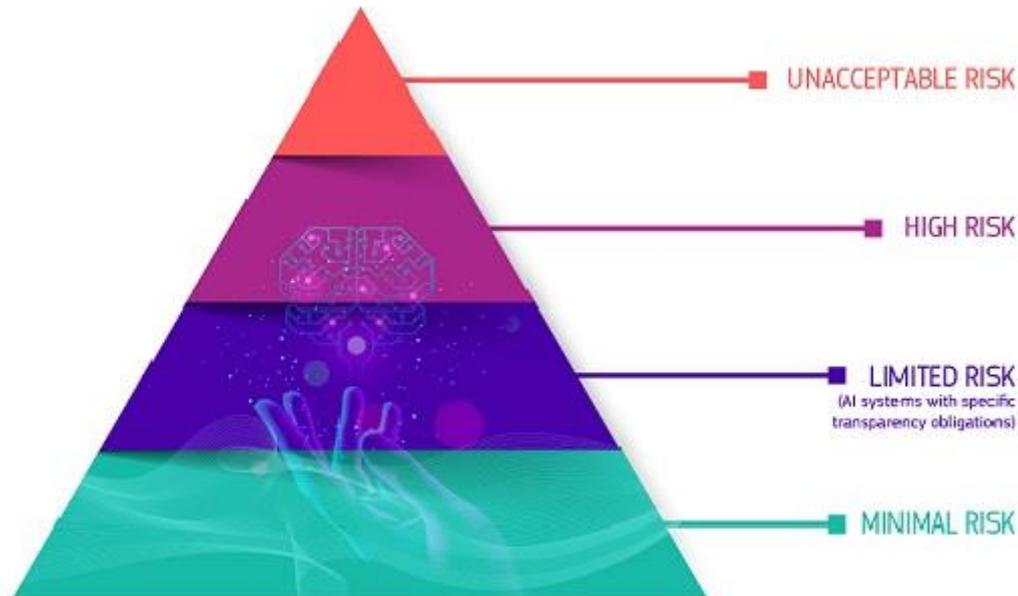
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The AI regulations proposed ensure the confidence of Europeans in what AI has to offer. Most AIs are risk-free and can be used to resolve many social challenges, but certain AIs are not risk-free and must be addressed to avoid undesirable results. For instance, why an AI system decided or predicted and reached a certain conclusion is often unable to be determined. So, it can be difficult to determine if someone has been disadvantaged unfairly, such as in a hiring decision or a public benefit application. Although there is some protection in existing legislation, there are still specific challenges that AI systems may pose.

Some of the rules proposed are:

- Address risks created by AI applications in particular
- Offer a list of applications at high risk
- Establish clear requirements for high-risk AI systems
- Specific obligations for high-risk AI Users and Providers
- Propose an evaluation of conformity before the AI system is commissioned or marketed
- Propose the implementation of a governance framework at European and national level after the introduction of this AI system on the market

The following image shows how the pyramid of the risk-based approach works



**Figure 7; A risk-based approach as published by (Directorate-General for Communications Networks, Content and Technology, 2021)**

According to (Directorate-General for Communications Networks, Content and Technology, 2021) there are certain types of risks associated with AI systems.

Unacceptable risk: all AI systems consider that a significant threat to the safety, livelihoods and rights of individuals is being prohibited, from government social scoring to toys that promote risky behavior through voice support.

High-risk: high-risk AI systems include AI technology employed in:

- Critical infrastructures (e.g., transport), which could jeopardize people's lives and health.
- Training or training which can determine access to education and the professional life of a person (e.g., the scoring of examinations);
- Product safety components (e.g., robotic AI application);
- Employment, employee management and self-employment access.
- Enforcement of law that could interfere with human rights (e.g., assessment of evidence reliability);

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- administration of migration, asylum and border control (e.g., authenticity checks of travel documents);
- Enforcement of law that could interfere with human rights (e.g., assessment of evidence reliability);

Before they are put on the market, high-risk AI systems undergo strict obligations:

- Adequate risk evaluation and systems of mitigation.
- High data quality feeds the system to reduce risks and discriminatory results.
- Activity logging to ensure results are traceable.
- Detailed documentation providing the authorities with all of the information needed for compliance with the system and for its purpose.
- Clear and sufficient user information.
- Adequate risk-minimizing human supervision measures.
- High degree of strength, safety, and precision.

All biometric remote identifying systems are considered high risk and are subject to strict requirements. Their live use for law enforcement purposes in publicly accessible rooms is in principle prohibited. Strictly defined and regulated are limited exceptions (such as where strictly necessary to search for a missing child, to prevent a specific and imminent terrorist threat or to detect, locate, identify, or prosecute a perpetrator or suspect of a serious criminal offence). Such use shall be permitted by a judicial or another independent body and shall have appropriate time limits, geographical reach, and the search data bases.

"Limited risk," i.e. AI systems with specific requirements for transparency: Users should be aware of interacting with a machine using AI systems like chatbots, so that they can make an informed decision to keep or step back.

'Minimum risk': The proposal permits the free utilization of applications like AI-enabled video games or spam filters. This category includes most AI systems currently used by the EU, which pose little or no risk.

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On another level the European Commission mission emphasizes the need for innovative strategies to address many of the most pressing social problems and global issues, and the development of the public sector is seen as a catalyst for long-term growth and innovation. This will be accomplished by leveraging European AI members to lead the way in innovation, science, and technology application to promote responsible action in the fields of sustainability, the environment, and the European Green Deal. To protect against cyberattacks and other security threats, technical robustness and security procedures are needed. The advancement of AI knowledge across Europe will be enabled by collaboration between the private sector, the public sector, academia, and civil society. This can be aided by the establishment and promotion of AI Centres of Excellence and testing centres that integrate investments from various sectors, as well as Horizon 2020/Horizon Europe grants for public-private partnerships in AI, data, and robotics.

#### **2.2.4 AI and National approaches**

Artificial intelligence (AI) can drive change, creativity, and economic development. As stated by (Bertrand, Erwin, & Hartmann, 2020) national AI Strategies, country visions, white papers, and recommendations have been published by European countries to explain their strategic approaches to AI. These national policies are like one another and to the European Commission's recommendations for developing ethical solutions that promote economic development and well-being.

One group of countries is concentrating their AI efforts on building a solid R&D base to ensure future AI growth. They detail unique programs aimed at fostering a vibrant ecosystem focused on start-ups, private businesses, and government. They hope to extend awareness and AI solutions across this dynamic creative ecosystem. As a result, they will become more attractive to talent and improve the necessary skills. This is supposed to spread to the government sector. Re-inventing the delivery of public services is driving public sector creativity.

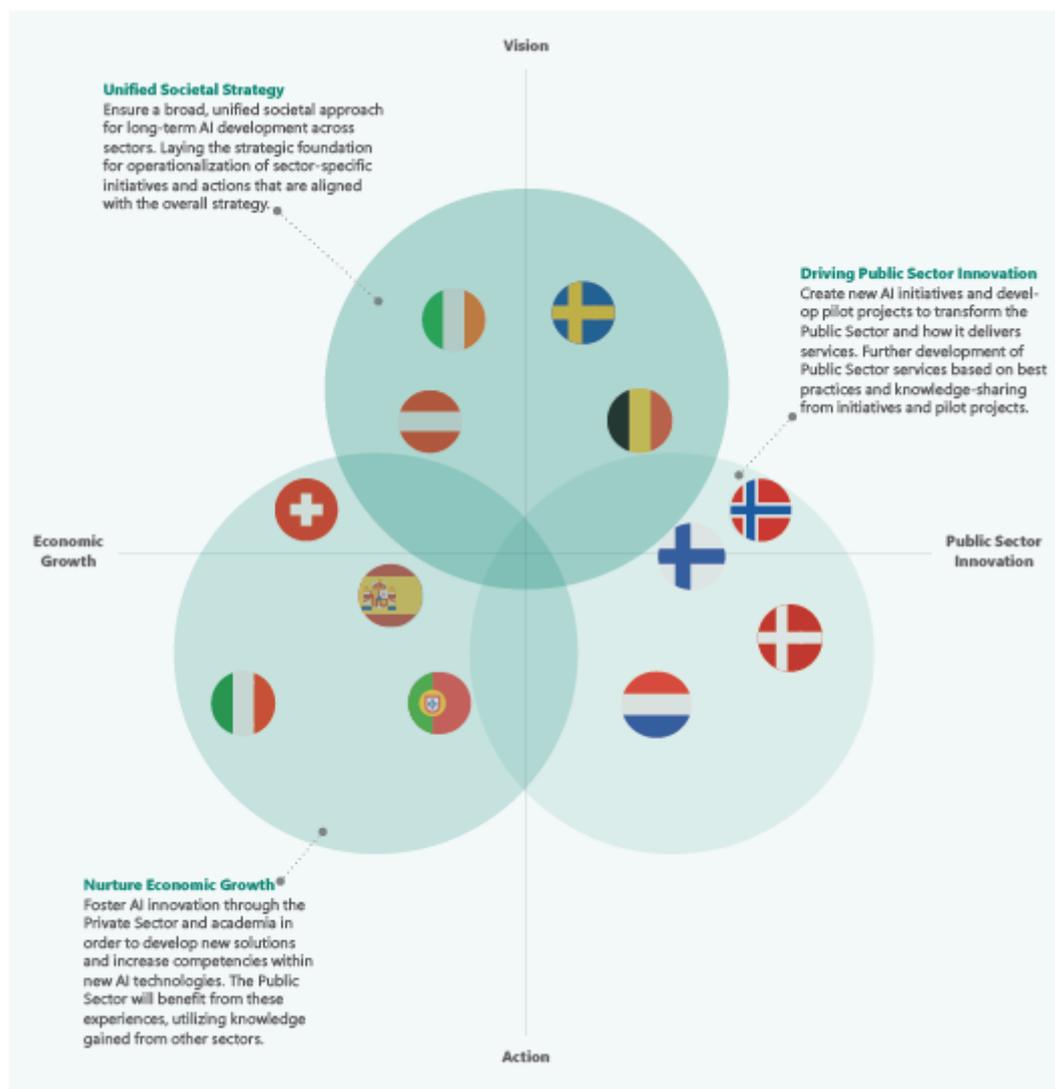
A group of countries with similar AI efforts are concentrating their efforts on defining and launching concrete programs to promote innovation through policies and pilot projects. Pilot projects and Proofs of Concept are being launched to experiment with AI and lay the

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groundwork for the implementation of innovative technologies as well as the future growth of AI-based public services.

The final group of countries has established broad approaches to AI that provide strategic guidance for the growth of society, while ensuring long-term support and acceptance through consensus. These countries are focusing on unifying AI growth, focusing on key aspects that can be formulated as specific initiatives and approaches for different areas and sectors, by setting a wide but consistent roadmap for the overall direction of AI.

The following figure shows the three clusters that were mentioned above



**Figure 8; What are the national AI approaches? By (Bertrand, Erwin, & Hartmann, 2020)**

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Not all countries, despite declared interest or stated importance, have emphasized the same profundity and scope of initiatives to encourage public sector adoption of IA. As can be seen from the overview, the action taken by the Member States in order to ensure the use of AI in the public sector differs substantially.

It is out of the scope of this dissertation to cover in more details all countries. However, it is worth investigating more the case of Portugal. A country with similar population and roughly at the same financial situation as Greece.

As analysed in a report by (Misuraca & van Noordt, 2020) in April 2019, the Portuguese Government submitted its national AI strategy. This document outlines the AI amplifying effect on the digitalisation process, which recognizes the growing effect and speed of technology on people's lives. This strategy aims therefore to prepare for the upcoming AI Revolution the Portuguese economic, social and cultural landscape. Further economic growth, scientific excellence and inclusive growth in the human development process are the major overall goals of the Strategy. Furthermore, there is a clear vision of AI's impacts to enhance social strength. The strategy consists of a specific section on modernizing the Portuguese government. In this respect, AI and Data Science are seen as important tools for providing better public services and adopting evidence-based public policy design approaches. Use and combine administrative data with other data. There are currently 19 research and development projects financed by the "Public Administrative AI Mobilization Programme" with four pilot projects in research and development community, and 15 additional projects selected from a scientific panel. More projects are planned for future financing.

### **2.2.5 AI and the Greek National approach**

Only in late 2020 did Greece develop a national AI strategy as published in the (Ministry of Digital Governance, 2020). The key tenets of this report are the following.

- The formulation of the National Strategy for the exploitation of artificial intelligence
- The creation of a national network of centres of excellence for AI.

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- The elaboration and formulation of the national data policy to incorporate the necessary provisions and requirements in relation to the possibility of using public data for AI education.
- Providing incentives to companies developing AI solutions, and supporting their scaling and networking.
- Developing the skills that will support the future of work, by training new scientists and retraining the existing workforce in new digital skills.
- Conducting educational programmes to build citizens' confidence in the use of AI. The aim is to develop the core of AI and the mechanisms by which it will be linked to related areas such as big data, robotics, ethics, and jurisprudence.

Hence as it can be seen from the previous article the ministry intends to follow a more unified approach. An approach where both the public and the private sector will reap the benefits of AI technology.

There was more insight on the report about the need to develop AI within public institutions. More specifically they emphasized that for the public administration to move forward on implementing AI the following parameters are required.

1. New types of cross-sectoral management and operational models, which generally ignore traditional borders between public players for data and digital resources.
2. A good understanding and risk of this technology to allow policymakers and public officials to properly appraise the integration of this technology into public policy areas.
3. The critical undertaking of all parties involved, including contractors, data providers and system operators, regarding the type of data that is to be used, with the aim to protect fundamental rights, such as privacy rights.
4. Building trust with the individuals or communities that will be affected by AI systems making decisions. The Department for Digital Government therefore considers a strategy of gentle, incremental introduction of AI systems into public administration, starting with pilot applications in specific sectors and policy areas that do not pose risks related to "personal data" or discrimination and bias in algorithmic decision making, to be the most appropriate approach. Such are, for example, systems that are 'trained' on open public datasets, ruled-

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based AI systems or systems that 'enforce' human supervision as a last step for automated legally binding decisions for the subject.

5. Build confidential relationships with persons or communities affected by AI systems. Therefore, a strategy of gradual introduction of AI systems into the public administration, starting with pilot applications in specific fields and policy areas that do not involve risks associated with 'personal data' or discrimination and partiality in algorithmic decision-making, is viewed by the Ministry of Digital Governance. These are, for instance, open-source systems, ruled-based AI systems, or systems 'enforcing' human surveillance as a last step towards automatically making legally binding choices.

Overall, the strategy would be, to slowly encompass the technology by introducing pilot projects in areas that do not involved risks relevant to “personal data” or system that could be biased on making specific decision due the algorithm setup. In addition according to the report there will be human monitoring in order to assess these decisions. The objective is to progressively 'friction' and prepare for the use and inclusion of this new technology by the administration on the one hand and to avoid risks associated with the 'false' use of new technology that can have negatives, including consequences that can be difficult to predict, detect or measure.

Some of the projects where there are plans already to implement AI technology are the following;

1. Artificial Intelligence and Machine Learning Platform. The aim of the platform is that the resulting applications and systems can use reliable components for their implementation, such as training datasets and algorithm libraries, and then be evaluated based on reliable test datasets.
2. Support mechanisms for public audit institutions to combat tax evasion and control of public procurement.
3. Implement monitoring of the input and output system in the fuel trade.
4. Support system of the public mechanism of collecting revenue.
5. Project for the automatic codification of legislation with using natural language processing technologies.

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6. Introduction of Robotic Process Automation technologies for reduction of repetitive administrative tasks.

7. System for the detection of arbitrary construction in forest areas and on the seashore.

As it can be seen from the specific measures mentioned above none is specifically targeted for the procurement function. However, a lot the actions and the projects mentioned above can be “transferred” to the procurement function.

### **2.2.6 AI and its social and moral aspect**

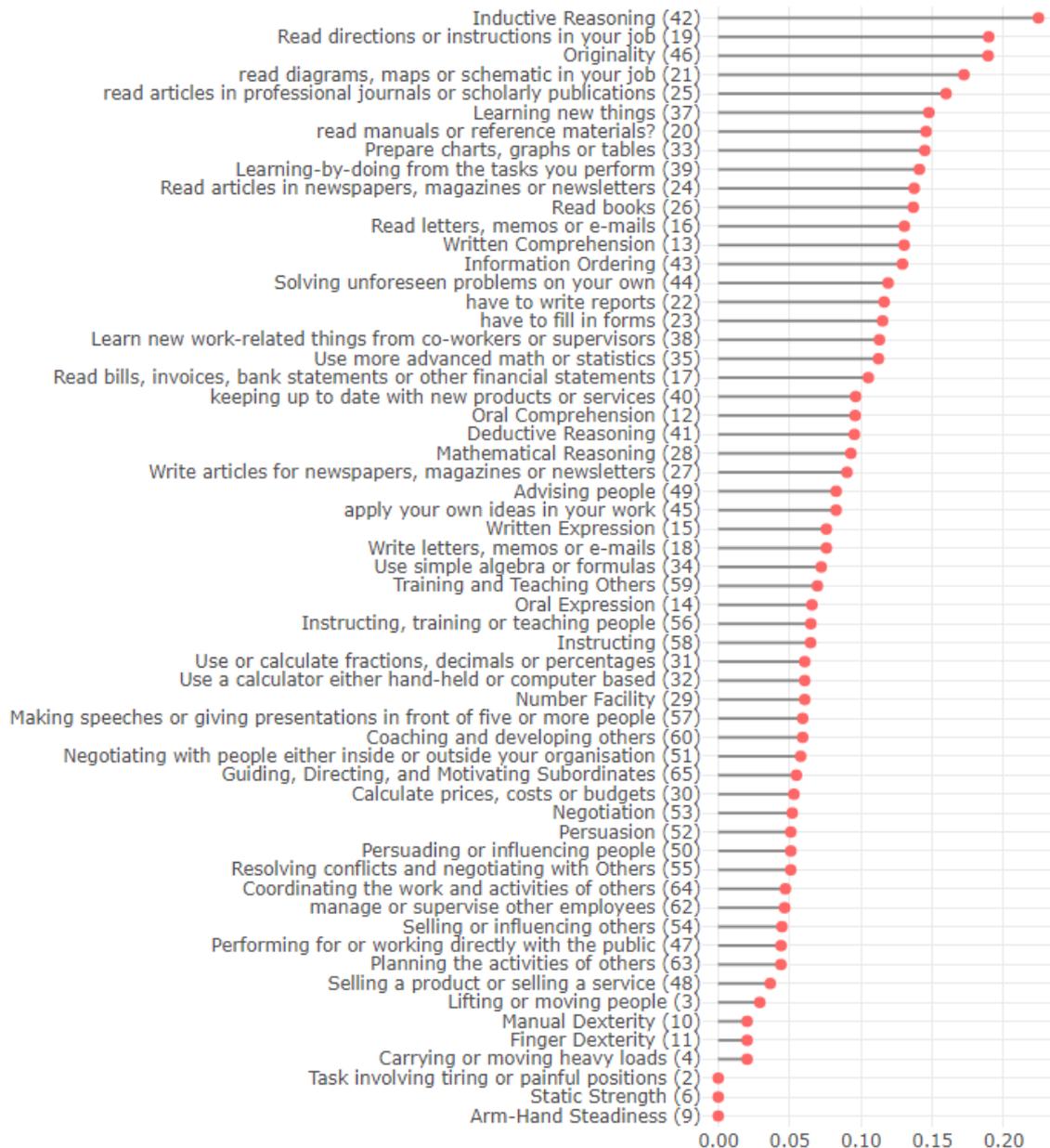
As mentioned by (Hussey, Taylor, & Murdoch, 2018) apart from people's lives as employees and users, AI may have a variety of social and political implications. AI makes processing and manipulating all types of digital data significantly simpler, which poses both opportunities and unparalleled challenges considering how pervasive digital data is in everyday life. There is an urgent need for public awareness and interaction with AI to evolve in tandem with the technology. In the coming months and years, public awareness and discussion of data manipulation will be particularly important.

The increasing prevalence of AI raises concerns about how potential economic inequity will be handled. The labour market's polarization over the last thirty years, away from medium-skilled employment and towards low- and high-skilled jobs, is likely to reverse, as some low- and medium-skilled jobs are likely to be relatively immune to automation, while some highly skilled but relatively routine jobs may be automatable with AI. However, most experts believe that automation would result in an increasing share of income going to highly skilled employees, who are traditionally more adaptable and will have a greater stake in AI.

EU commission (Direction-Generale (DG) , 2021) has done extensive research on work tasks and the relevance of AI implementation the tasks which are higher on the list are more probable to be replaced by AI technology. The tasks which are lower on the list are less likely on the other and.

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## Labour tasks ranking



**Figure 9; Labour-related tasks ranked in descending order based on the AI research intensity/activity as published by (Direction-Generale (DG) , 2021)**

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From another point of view as analysed by (Perc, Ozer, & Hojnik, 2019) it is difficult enough to do the right thing in such situations; can the machines do the right thing with self-training. The key question is whether one can expect artificial intelligence to be pro-social or whether one can expect it to be focused on pleasing a single person, the owner, or the corporation that owns the land. The question is summed up in the meme "Is my driverless car allowed to kill me in order to save others?" It is relatively simple and honourable to respond yes without much thought, but who would want a car that could decide to kill you to save other strangers? Is economic development versus environmental issues a straightforward answer that should be left to machine? Of course, there are many other circumstances that share the hallmark characteristics of a social problem, and there is no simple or universally true solution to the issue of whether artificial intelligence should be prosocial or not. As is always the case, it depends on the circumstances, as well as the legal consequences of any decision. Without a doubt improving the digital skills of the workforce who will use the technology is a must.

A recent report in UK (Hussey, Taylor, & Murdoch, 2018) has delved more deeply into the topic of ethical implication of AI . Some bullet points from this report are the following.

- What does it mean to be human and the distinction between humans and machines?
  
- To what extent we will be content as a society to transfer responsibility and control in certain situations from a human to a machine?
  
- How do we ensure AI systems are doing what they are supposed to be doing?
  
- How are we able to verify AI systems safety and ensure they do not malfunction or are vulnerable to cyber-attacks?
  
- Are decisions made by AI auditable, challengeable, and ultimately understandable by humans?

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The focus on the above as stated in the report is not on the complex code and the algorithms of the program itself. This could be interpreted by a very few numbers of people thus making it difficult to assess and evaluate. Instead, the key point here is to ascertain that the right mechanism is in place so that any decisions which are being made are fully transparent, accessible, understandable, and quantifiable. More importantly they should be open to challenge by all parties, the suppliers, and the public of course.

### **2.2.7 Most impactful technologies of AI in the Public sector**

The public sector is expected to provide cheaper, quicker, and more personalized services to citizens. However, existing delivery models are being challenged by budget cuts, shifting demographics, security threats, and changing citizen preferences. AI has the potential to improve public service delivery and overcome these obstacles. AI technologies have the potential to change the public sector by inspiring staff and creating new ways of providing services, resulting in new positions, employment, and functions for these workers. For the public sector to innovate, it must undergo this transition.

According to (Bertrand, Erwin, & Hartmann, 2020) unique AI technologies vary from narrow AI that allows for specific tasks to wide AI that mimics human thought, with new solutions and applications being developed all the time. Most AI technologies currently in use by government agencies are focused AI solutions that boost productivity and quality while freeing up public workers to concentrate on higher-value tasks. Further creation of large AI solutions, which augment employees and allow new services that would not have been feasible without the use of these technologies, will be a part of AI's future. This emphasizes AI's ever-evolving essence, as well as its transformative potential for public services and society.

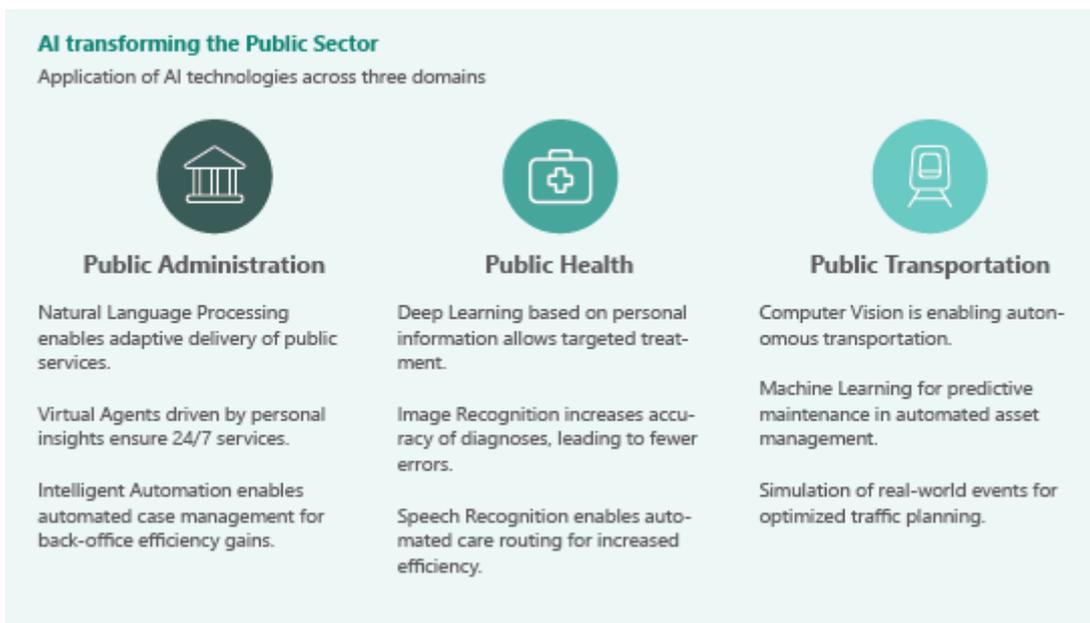
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services that would not have been feasible without the use of these technologies, will be a part of AI's future. This emphasizes AI's ever-evolving essence, as well as its transformative potential for public services and society.

Most government agencies are using artificial intelligence to automate routine activities, resulting in increased productivity, and enabling employees to concentrate on more important tasks. Some entities, on the other hand, have fully realized AI's ability, employing it to augment workforces and develop new products and services. AI is expected to become a central component of public sector organizations in the future, leading to society's improvement.

The following figure from shows the application of AI in three different sectors.



**Figure 10; AI transformation in the public sector as published by (Bertrand, Erwin, & Hartmann, 2020)**

There are some prominent cases of AI technology in the public sector. As analysed by (Bertrand, Erwin, & Hartmann, 2020) health organisations shows the highest commitment. Although some AI solutions have been widely embraced and are actively contributing to the improvement and transformation of health organizations, many others are still in their early stages and have yet to demonstrate effect. Medical Imaging is the most commonly adopted

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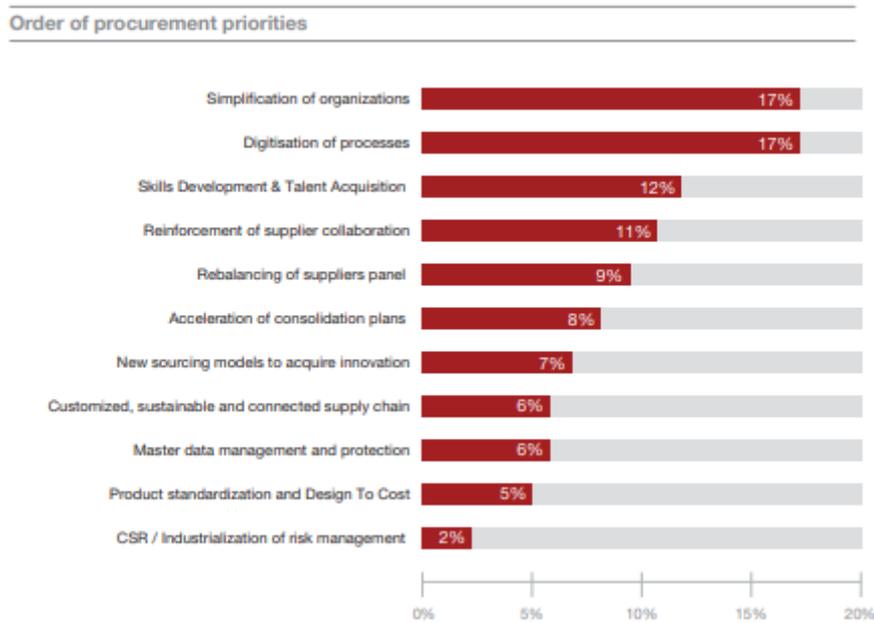
use case in health, and it uses historical and current radiology images to identify diseases and symptoms, such as early stage cancer detection. It is now actively contributing to the advancement of particular organizational fields, and in many cases, it is also having a transformative effect on the organization itself. Medical Imaging is expected to play a significant role in the transformation of the majority of authorities in the near future.

Another case from the same report (Bertrand, Erwin, & Hartmann, 2020), is the example of INAIL which is a non-economic Italian public body. INAIL has been able to easily grasp user intent thanks to the use of Virtual Agents such as chatbots on an external user portal. This expertise is used by the authority to directly respond to basic inquiries and to route more complicated inquiries to the appropriate organizational agency. This has resulted in a significant reduction in the amount of time spent by staff on interactions with basic requests, allowing them to concentrate on more difficult tasks. More than 300,000 documents were organized using Intelligent Automation on unstructured documents relating to technical advice on risk and prevention, increasing operational productivity in back-office processes. Finally, there is also the example of public transportation in Norway according to (Bertrand, Erwin, & Hartmann, 2020). Sporveien is a municipal corporation accounting for most public transportation in Oslo. Sporveien used a model to explore the use of Deep Learning to improve train switching in rail yards. The machine used a game-based algorithm to find the best solutions. This pilot was a huge success, and it will be implemented. Sporveien has also created a Machine Learning pilot that uses historical data to predict rail system errors before they happen. They found, however, that they could not use multiple maintenance systems at the same time because this would result in multiple maintenance procedures for the same piece of equipment. What the organisation discovered is that when it comes to AI growth, it's critical to concentrate on the importance of the solution's function, and that there's no point in introducing new systems and solutions without phasing out the old ones.

### **2.2.8 Artificial Intelligence and applications in procurement in general**

It is important first to understand what the current priorities of procurement are. Price water Cooper carried out an extensive research in 2019 regarding procurement (Gaugeois, Staquet, Roux, & Perrotin, 2019) in the European Region for big enterprises and their top priorities.

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**Figure 11; Order of procurement priorities as published by (Gaurois, Staquet, Roux, & Perrotin, 2019)**

It is obvious from the graph above that encompassing a simpler but more effective organisation is a top priority. The ability to collaborate better with external partners through a talented team and a new model which could enhance innovation are among the top priorities of senior stakeholders. These are as well the key pillars of the European Directive. So how can artificial intelligence be used in the procurement function? What are the trade-offs and the potential? What are on the other hand the limitations? There have been many research papers, studies, and business reports on this issue. The implementation of AI on the procurement function has been relatively slow.

Material, equipment and even service supply now works on a global scale. Even relatively small firms are now sourcing on a global scale. Hence professionals in the purchasing function need to consider dozens of suppliers. For larger corporation these can involve hundreds of different items among many suppliers. Hence this is a colossal and complicated task. In the tender stage purchasers need to set the criteria and evaluate the potential suppliers on features typical and even atypical sometimes. Time constraints, complications in the bidding process and the complexity of some tenders render it difficult to examine all

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the criteria and come up with a weighted objective decision. How can AI help in this case? As was described earlier AI techniques can be used to allow purchasing organisation to categorise, place and allocate orders on family of items or on a series of programs to manage a stream of different criteria. AI optimises purchasing decisions by making them easier to sort out and control in real time, by ensuring the objectives are real and transparent and on the same time avoid mistakes (Allal-Chérif & Maira, 2011). Hence without getting lost in an array of huge information the process can be simplified and a decision can be made much quicker. To be more specific this can simplify logistics, procurement of items, contract management while reducing risk and on the same time allowing innovative capacity.

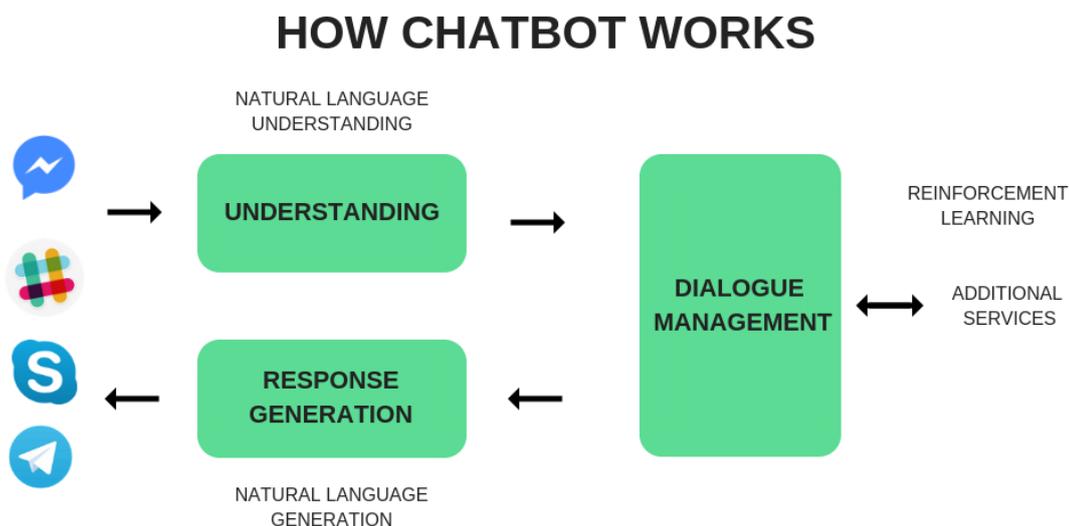
AI benefit is also valuable on a strategic scale as well. In the previous paragraph it was explained that AI can sort out information during a tender phase which would otherwise be very cumbersome. But what about global trends and macroeconomic issues which in effect could define the strategy of the procurement function? How would that work? This is very well explained in a review by (Smillie, 2020). There are tools which can be used to determine the efficiency of the procurement strategy by aggregating and interpreting thousands of data. These can be from many sources. For example data that are publicly available or data that is third-party licenced. By using econometrics these tools can provide a better picture of shift and patterns in the market, in the global supply trends, across many products or logistics routes. These in effect can help the procurement organisation into forming a clear strategy for different products and through different supply options.

Except cost another important facet as was mentioned earlier are supplier performance, quality, sustainability reputation, innovation. It is often the case that these must be considered when procuring supplies or services. By analysing data and information buyer can include in his assessment and final selection of the aforementioned criteria. Another aspect as explained by (Dauvergne, 2020) is the ability to share resources, to join other organizations, integrate and in the end innovate to be ahead of the market. AI can provide the underlying mechanism to reach consistent and dynamic information between different parts.

Another very important aspect is communication. The flow of communication replies to question, quick and open feedback on procedural questions. A very common tool is the

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chatbot. A very well known corporate software is SAP for example. SAP Ariba has developed a chatbot, which they have named “Procurement”, which can adapt to departmental, organization and individual characteristics to answer questions and provide the right member with the right information at the right time. This tool can be a huge help both for buyer and suppliers throughout the tendering process since it can warn bidders about mistakes, give options and in the end provide a more efficient tender process. Based on progressive conversations or increased learning the chatbot can give more concise and to the point information. The following schematic shows how a chatbot works as was published in (Nagar, 2019)



**Figure 12; Schematic of how a Chat bot works by (Nagar, 2019)**

Purchasing departments do not act in isolation. They collaborate with other functions to analyse the needs, to understand the requirement, to help in applying the policy and in the end comply with corporate governance. The term augmented buyer has been used in a research paper by (Allal-Cherifa, Simon-Moyab, & Ballestero, 2020). Signing a contract with a new partner entails a collaboration that extends beyond the sheer financial sphere. In terms of compliance organizations using an AI system as mentioned by (Smillie, 2020) can more easily identify discrepancies in contracts. In the context of a procurement function this technology can facilitate such mergers and acquisition and more specifically, the

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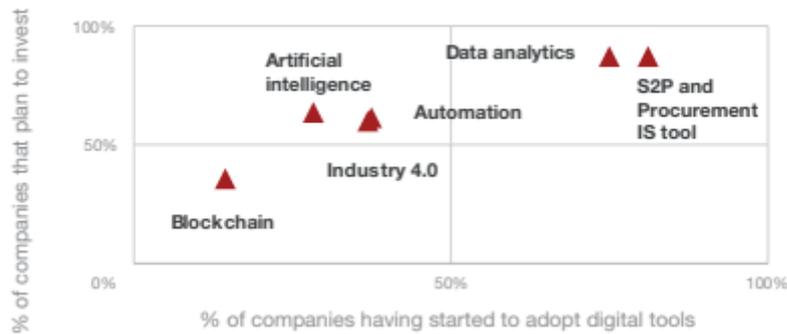
identification of assignment or termination rights and negotiation of corresponding consents.

Finally, procurement functions nowadays involve all the phases. From sourcing strategy to invoice data extraction. As mentioned in (Bagul, 2020) Intelligent Document Processing is a process which can capture domain specific data across document and streamline document routing activities. This means that regardless what kind of documents are processed whether these are PDF, word document or simple emails the AI technology serve the purpose to extract structured information. This can save valuable time and give better efficiency without the need of defined rules or templates.

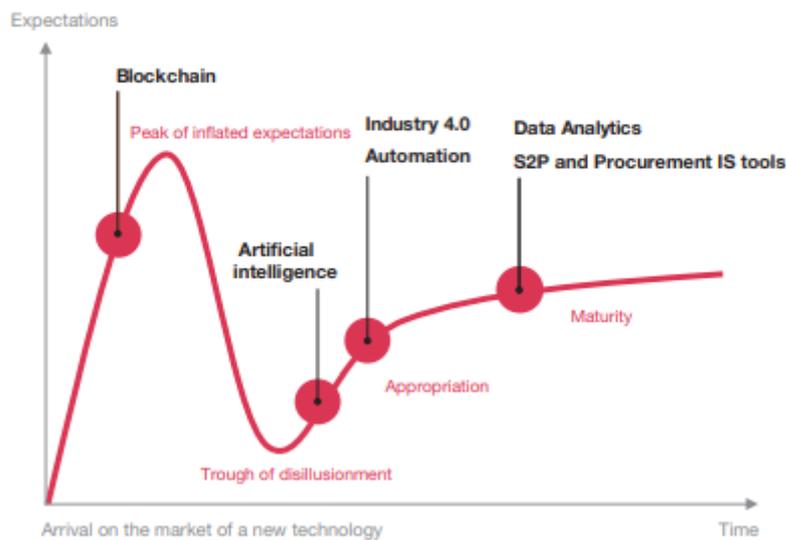
After delineating some of the key contributes of AI in procurement it is worth to understand what the level of implementation and maturity of these technologies in the European Region is. Again, the report by (Gaurois, Staquet, Roux, & Perrotin, 2019) will be used to show what has been achieved. The following two graphs shows the maturity of the digitalisation process across different technologies.

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Technology maturity



Technology maturity curve



**Figure 13; Technological maturity of different applications in Procurement (Gauois, Staquet, Roux, & Perrotin, 2019)**

The graphs above shows that the market’s adoption of different technologies is at a different level and stage. The technologies which are most widely deployed are the most mature like data analytics and Procure to Pay Solutions. On the other hand, technologies like Block Chain and AI still have a long way to go. The graphs reveal 4 levels of maturity which are defined from where the technologies are standing on the maturity curve. These four stages according to (Gauois, Staquet, Roux, & Perrotin, 2019) are.

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- a. Peak of inflated expectations
- b. Trough of disillusionment
- c. Appropriation
- d. Maturity

It is apparent that AI technology has a long way to reach the maturity and full implementation stage.

### **2.2.9 AI and application in Public Procurement**

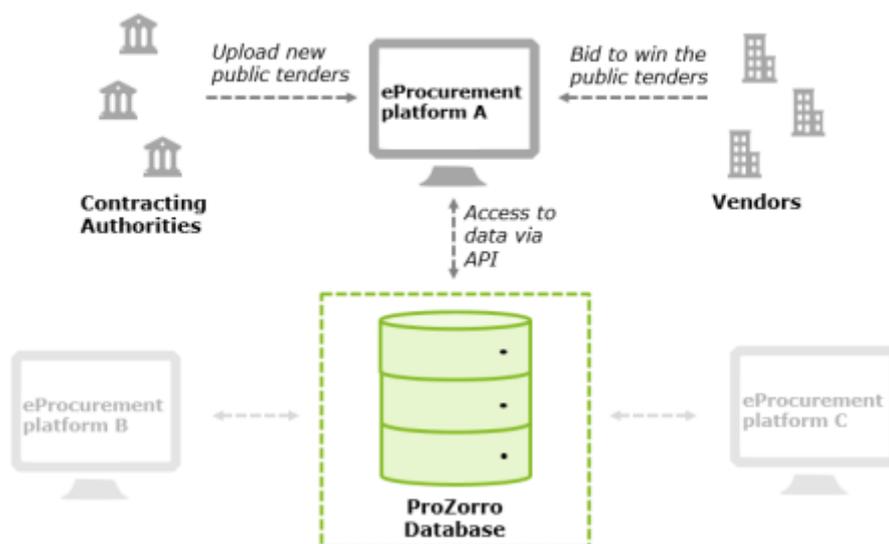
In the previous charter the AI technology was analysed and in parallel the benefits it can bring a procurement organisation. In the following chapter the implementation of AI on public services and more specifically on Procurement will be analysed. Has there been any case of AI in public procurement? Are there any initiatives from institutions or public bodies towards this technology? Are there research papers which have analysed its potential?

In relation to what was mentioned earlier there is a report by (Peijl, O’Neill, Doumbouya, & Howlett, 2020) where they analyse that AI can be used to monitor the tendering documents and information prepared by the public buyer for clarity and language. Hence this can be a valuable tool to provide a rigorous check on requirements and other text in the tender document. This can help to alleviate any misunderstanding of the tender material and reducing the bidder risk of any misunderstanding of the deliverables. The effect would be to lower the cost and improve the quality of the end deal.

Regarding some specific examples. As analysed by (Peijl, O’Neill, Doumbouya, & Howlett, 2020) in Ukraine ProZorro, the State organization behind the Ukrainian hybrid e-contracting system, a data science consulting firm (uData) has developed a machine learning solution predicting the correct product CPV code. This is based on textual information, including the product description and title. The algorithm developed is consists of many different CPV codes and is likely to be correct for each. If only one CPV code is provided for a good or a service, the first four digits of the CPV code can be predicted with 70 percent accuracy. The accessibility of appropriate education data for projects is a crucial success factor as is the case for all machine learning solutions. In this case, there was more than a sufficient level of training data available from the open ProZorro datasets, consisting of 4 million public

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tenders. The contracting authority has given each tender a CPV code. While the wrong code may have been provided, the sheer amount of available data makes it possible for the machine learning solution to establish an exact model for linking text descriptions with CPV codes to be properly classified. The impact so far however is expected to be limited as it has not been integrated into any front-end e-procurement platform. In terms of the future uData intends to integrate the tool into other broader offerings it develops – such as a service which, in the light of a description of the items and services it provides, updates private companies to new bonds of interest. The following picture shows a concise chain of how the system will work as published on the report by (Peijl, O’Neill, Doumbouya, & Howlett, 2020)



**14; ProZorro eProcurement ecosystem as published by (Peijl, O’Neill, Doumbouya, & Howlett, 2020)**

Again according to a report from (Peijl, O’Neill, Doumbouya, & Howlett, 2020) in Belgium, the Mobility and Public Works Department managed the procurement contracts and tracked these contracts using a digital system but lacked the tools to make historical goods and services price visible. The Ministry thus did not use its data fully to guide its procurement decisions. The MEDIAAN platform offers a searchable price database with a range of cost engineering and analysis applications. The Department's eDelta contract management system is the primary source of data, which included price data on 2001 contracts. These

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data are supplemented by information from other sources, including rules and parameters affecting Belgian law prices. Developed resources include price review applications, semi-automatic price estimates, and different unit and hourly rate calculation. One of the essential features of the solution was that it maintained separate databases and applications. This major advantage was that it reduced the costs of changing the functionality of the system. The development of the database entailed significant expenses and direct changes to the database structure which were expensive and difficult. However, applications could be added and transformed relatively easily in the solution created on top of this database. The associated advantage was that the application software provider was easier to switch off (i.e. Oracle). In future, plans are being made to expand and develop MEDIAAN over several dimensions – regarding tools, data and users. The following picture shows the costs and the requirement of the system



**Figure 15; Cost and requirements of the MEDIAAN system as published by (Peijl, O’Neill, Doumbouya, & Howlett, 2020)**

Another case from (Peijl, O’Neill, Doumbouya, & Howlett, 2020) is in Italy where they are developing a project to check whether the correct information is uploaded on the system thus if the correct codes/standards match the correct products. The authority - Consip believes that it could improve the accuracy of the algorithm if additional training data is provided. However, this would necessitate a substantial investment, and it has not yet decided whether it is willing to do this. In addition, Consip experiments with AI to better understand how platform users view it. A machine learning platform is being used to enable both buyers and suppliers to analyze their feelings through their platform. For users to react quickly to developments such as the publication of new tender, this pilot

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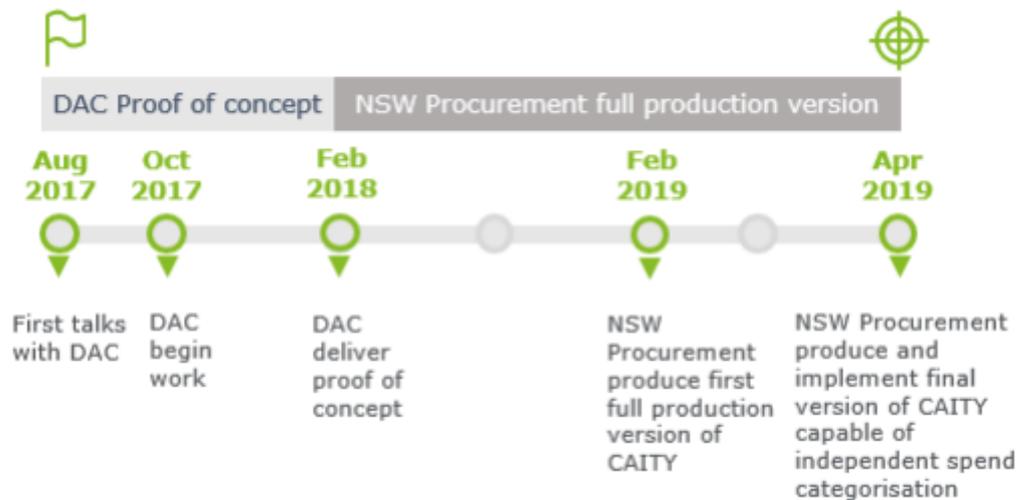
project draws on Twitter data. The relevant tweets are categorized as positive, neutral, or negative.

Another AI tool which can be used for public procurement data is the categorisation of different specs across organisation to provide visibility and understanding of how administrations are allocating their budget. Such a case is the Finish Explore State Spending according to (Peijl, O’Neill, Doumbouya, & Howlett, 2020). In this case the governmental body of Finland publishes data across different categories and public bodies to categorise across different types of spending. The machine learning solution categorized state e-Facturing information automatically in accordance with the UN Standard Products and Services Code (UNSPSC). The categorisation algorithm was developed and integrated by an IT consultancy. With the IT environment of Hansel Oy – Qlik Business Intelligence in particular. The overall accuracy of the categorization solution was only 51 percent, given the lack of machine training information. The organization has not yet made full use of the investment, as this would require a substantial investment in the delivery of the necessary data for training.

At the other part of the world in Australia, the New South Wales Data Analytics Centre is developing a neural network system which will categorise how the local government is allocating each annual \$30 billion budget according to (Peijl, O’Neill, Doumbouya, & Howlett, 2020). More importantly it will use this data to confirm whether the government is getting its best value for its money. According to the NSW the organisation is required to manually classify 2 million procurement transactions. This is a necessary task to instruct public expenditure, but it is a long-term and difficult process that uses up to 160 days every year. The machine learning instrument – CAITY – developed with support from the Data Analytics Centre, automatically categorizes different types of procurement expenditures based on data collected from the general record. The solution was developed using Microsoft Azure public cloud python-based machine learning tools. An accuracy rate of around 70% was observed in the previous manual classification. CAITY can categorize procurement spending with an accuracy of more than 90 per cent after training in over 45 million rows of pre-classified data. The cost was about 185.000 euros but the saving was about 160 employee days. There were some concerns about storing the data on external

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server. The solution has been fully employed and it is now completely functional. The following picture shows a concise timeline of how the system was deployed as published on the report by (Peijl, O’Neill, Doumbouya, & Howlett, 2020)



**Figure 16; Timeline for the development of CAITY as published by (Peijl, O’Neill, Doumbouya, & Howlett, 2020)**

Another example from the same report (Peijl, O’Neill, Doumbouya, & Howlett, 2020) is a case in United Kingdom. The Yorkshire Purchasing Organization (YPO) has a wide range from schools to local government, charities, emergency services and some private sector customers, including nurseries and care homes. There are also numerous public sector clients. It delivers the products and services that these customers need to carry out their tasks. YPO provided framework agreements through which their customers (public sector buyers) have access to and purchase products and services. However, the YPO website and the framework contracts that suit their needs have not been easier to navigate to customers. It has integrated a chatbot solution on its website – the provider of procurement information (PIP). The chatbot can interpret and direct written user queries to relevant parts of the YPO website. The Microsoft Azure bot framework was used to develop PIP. It allowed organizations to build and customize a chatboot according to their needs. In 3 months (May – July 2018), the initial version of PIP was developed. It has been updated and improved regularly since then, based on user feedback. The use of ChatboTech technology as a tool

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helped users to identify public procurement service that is appropriate to their needs. In addition, it can be relatively easy and cost effective. Due to the relatively small amount of knowledge and expertise on chatbot technology implementation, it was decided to approach these projects progressively and attempt to implement them in small scales before moving forward with more ambitious efforts. Focus was also required to ensure that the tool is kept up to date and maintained to ensure that the technology works properly. The expenses were about €5.780 (£5.000), fully covered by YPO personnel. The Microsoft Azure bot framework was provided for free.

A similar case to the above from the (Peijl, O’Neill, Doumbouya, & Howlett, 2020) report comes from the Purchasing and Strategic Sourcing (PSS) department of the City of El Paso which operated a call service to potential vendors with employees dealing with repeated and basic questions. The volume of these calls was increasing after internal restructuring as the new organization was not well understood by vendors. PSS wanted to find a way to reduce the worker's time. A chatbot solution – Ask Laura – was added to PSS department's website. The (proper) solution incorporates ability to translate and deal with natural language processing from open-source algorithms. The chatbot Ask Laura is a text and avatar box that offers a user interface, a knowledge base and an analytical platform for the council team to monitor and respond to user conduct. The City Council has repeated the approach of other departmental websites, following the successful implementation of the Ask Laura chat on the PSS website. First year annual subscription cost € 18,060 (\$ 20, 000), followed by annual subscription € 9,090 (\$ 10,140). In the future, PSS plans to replicate and increase the use of the software in other government departments further.

AI can be used to identify corrupt behaviour. Corruption is expensive problem for government around the world with an estimated worldwide annual cost of bribery around \$1.5 to \$2 trillion. How can AI contribute to anti-corruption methods? Again, AI can reveal patterns too complex for human and on the same time process large amounts of data so that people can focus on details. There are specific projects which have been developed in Europe. According to (Peijl, O’Neill, Doumbouya, & Howlett, 2020) in Ukraine the DoZorro initiative except predicting the correct product CPV code as described above, it has developed AI software which can find out which tenders have a high risk of corruption. The

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software tool produced some impressive results, identifying 26% more tenders with arbitrary winner selection and 37% more tenders with arbitrary disqualification. As reported by (Allal-Cherifa, Simon-Moyab, & Ballestero, 2020) in Spain a neural network was designed which could give an “early warning system” predicting public corruption. To estimate the likelihood of corruption in Spanish provinces, the tool combines data on economic and political variables such as economic development and the length of time a political party has been in power with data on actual corruption cases. In Colombia a research paper was recently published by (Callego, Rivero, & Martinez, 2021) where they developed a machine learning model in order to associate projects with certain variable which are important predictors of malfeasance such as for example time lag between adjusting the contract and nearest election. For this type of analysis, they developed early warning models using a unique dataset of more than two million public procurement contracts in Colombia between 2011 and 2015. They trained two representative models of machine training to identify those contracts which are likely to lead to undesirable results for the government as soon as possible. The authors believe that this kind of analysis is useful for public administration. Prediction of their models are risk scores that authorities can use when selecting which contracts to follow and audit. Their results vary from the most to the least serious cases, approximating various aspects of mishaps: proven corruption cases, breach of contract and inefficiency (which we approximated through extensions to the originally stipulated budget or to the duration of the contract). While these types of outcomes can reveal empirical correlations, they measure concepts which require government authorities to take various measures: contracts which can lead to corruption can trigger auditors being visited, whereas a contracting agency alert may be enough if they are predicted to request extensions. Using machine learning algorithms, AI can track vast amounts of public tender data and detect any irregularities, such as sudden increases in sales rates and allegations of fraud. Or on the other hand it can detect whether the authority that has concurred to this deal at the other end has been impartial on its judgement.

### **3 Methodology**

In this chapter the various approaches available for writing a dissertation will be presented. Moreover, the restrictions and potential of each methodology will be analysed. Based on this analysis the reasoning behind the end choice will be presented. The methodology that will be chosen will provide the main structure of this dissertation.

This dissertation specialises in the field of Artificial Intelligence and Public Procurement and how the innovation can be implemented for the case of Greece.

#### **3.1 Analysis of the most frequent research methods**

Research methods are broadly divided into two general approaches.

- Quantitative Research Methods
- Qualitative Research Methods

Of course, there is always the case that a research method can be a mixture of both.

Quantitative research method is based on data collection. As described by (Ali & Barliana, 2017) data are mainly related to research design, validity, experimental design, and analysis. Research designs on quantitative methods are descriptive, experimental, quasi-experimental or relationship based. The analytical data usually are related to the hypothesis testing, assumptions, and research result presentation. Data collection can be performed by experiments, questionnaires, polls, surveys, and others. The end purpose is to quantify the problem in question. Some typical tools are inferential statistics, mathematical modelling, and econometric analysis.

Qualitative method is more suited to open end questions. The qualitative method is focused on gaining a great understanding of a structure, technology, phenomenon, and any potential gap within a specific environment. The literature review can be used as tool to examine this gap. As explained by (Osanloo, 2016) the literature review can identify the gaps or paucity of information relevant to specific areas in the literature. Hence for this specific study, a qualitative method will be used. The foundation of the concepts will be presented.

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Specifically, for this dissertation the concept of AI will be laid down and the organisation and intricacies of the Greek Public Procurement system. Who are the key players on AI? What are the limitations? What are recent development of AI on procurement? What is the strategy of HSPPA? How is HSPPA organized? Analysis of the field developments through the literature review can provide answers to the subject.

There will also be analysis of cases which can illustrate the applications and benefits of AI on other countries. Hence an empirical evidence can support the data, interpret the findings, and underlie the recommendations for the Greek case.

### **3.2 Tool used in a research**

There are many tools that can be used for the methods mentioned above. Some the most important ones will be mentioned below

I. Comparative/case study analysis. The comparative method for the thesis consists of two things: two theories, texts, processes, historical personalities, etc. For comparative analysis, this is a sort of unifying idea. It may be an issue, an issue, a theory, etc. Case studies offer an excellent chance for innovation and challenge current theory. As reported by (Almeida, Faria, & Queirós, 2017) they can also be a good alternative to the focus group method or complement it. However, a connection between cause and effect can be difficult to draw and can be difficult to generalize, especially if a small number or case studies are considered.

II. Statistical analysis. A mathematical method for questioning data is statistical analysis. This is accomplished by looking for connections between various data sets. They can be used for econometric analysis for example to develop economic or finance hypotheses or theories. Econometrics is based on techniques like regression models and testing of null hypotheses. As reported by (Almeida, Faria, & Queirós, 2017) statistical analysis technique allows researchers, using the most appropriate methods for each situation, to investigate links between variables. In order to match the characteristics of the environment under analysis, the statistical process must be adjusted. Nevertheless, these

techniques are generally complex and require the use of specialized and generally costly statistical software.

III. Questionnaire analysis. The results of questionnaires are usually used to calculate average scores for questions or groups of questions. For example, students may request a five-point questionnaire, 5 of them being excellent, 4 good, 3 average, 2 poor and 1 very poor. As reported by (Almeida, Faria, & Queirós, 2017) surveys have many advantages. The high representativeness of the entire population and the low costs of the method in comparison to other alternatives are two of those most important advantages. On the other hand, depends heavily on the survey structure and the exact response provided by the respondents to assess the reliability of survey data.

IV. Explanatory analysis/literature review. Explanatory research is indeed a type of design for research that focuses on the explanation of your study aspects. The scientist begins with a general concept and uses research as a tool for bringing the topics to be discussed in the future. This will be the main method used in this report. More details about the advantages and disadvantages of this method will follow below.

V. Interviews; Interviews may be defined as qualitative research that involves "intensive interviews with a small number of respondents to explore their views on a certain idea, programme, or situation." Three different interview formats exist: structured, semi-structured and unstructured. As mentioned by (Alshenqeeti, 2014) the interview is a powerful way to gain insight into the perceptions of people interviewed and can be combined with other methods and provide detailed information on the values and beliefs of participants. To investigate the external behavior and the internal beliefs of the participants, for example, the use of observation can be used as an addition to interviews. Thus, although it is a matter of research, using more than one data collection tool would make more information available and validate the findings of the research. On the other hand, interviews are costly in time for both participants and researcher, and therefore may have to be restricted in terms of the numbers undertaken during the study. Moreover interviews have the potential for subconscious bias and potential inconsistencies.

VI. Time series analysis. The analysis of time series may be helpful to see how an asset, security, or economic variable changes over time. It can also be used to investigate

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how changes related to the selected data point compare to shifts in other variables in the same period. As mentioned by (Bush, 2020) with the correlation coefficient in mind, observational data can easily be quantified. At the same time, one can collect a large number of information from many areas at once and the interrelationships between these variables can be studied. However, correlation does not indicate cause, as a third variable can possibly explain the association of two variables.

VII. Algorithm development and implementation. In computer science, an implementation means the production by computer programming and deployment of a technical specification or algorithm as a program, software component or another computer system. A certain specification or standard may contain many implementations. As reported by (Almeida, Faria, & Queirós, 2017) algorithm implementation is an appropriate method for analyzing a large and comprehensive practical problem when a mathematical model cannot be modeled beforehand. In addition, a time frame that can be used to rapidly investigate the effects of a real life change can be compressed. The simulation, however, also shows disadvantages, for example that model construction requires a profound knowledge of the field.

VIII. Field experiment. In real life settings, field experiments take place. One or more variables for the testing of the effect must be isolated and manipulated. It allows the researcher to observe more natural compatibility, but it will need to consider many more variables. In sociology and applied science, such as bioengineering and medicine, this approach is also common. As reported by (Almeida, Faria, & Queirós, 2017) compared to laboratory experiments, field experiments offer significant strengths. Instead of an artificial laboratory it offers a natural setting. It can be observed. Large groups of people that are more representative in general. On the other hand, control of variables is more difficult, and thus it is very difficult to replicate the same conditions. Moreover, unanticipated actions that can adversely affect subjects and participants may appear because it is difficult to control the environment.

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### **3.3 The purpose of this study and the selected analysis**

As mentioned earlier the purpose of this study is to portray the landscape of the AI implementation for the Greek Public Procurement system. From the various tools above the explanatory analysis/literature review was deemed as the most appropriate.

Due to the nature of the issue in question as this was portrayed in chapter 1.2 the investigative and explanatory method based on a literature review was selected. Hence a theoretical qualitative framework of the issues pertaining to the subject will be analysed. As explained by (Osanloo, 2016) without a literature review which can provide the theoretical framework, the structure and vision for a study is unclear, much like a house that cannot be constructed without a blueprint. Moreover, a comparative analysis with similar cases in other region will provide case by case analysis. In the end there will a critical analysis of the collected information.

Collection of information was not limited to a single source. The secondary data collected to answer the research problem came from scientific journals regarding the use of AI technology, reports from European and national authorities regarding its implementation in procurement, as well as from reports consulting firms of recognized value, such as Ernst and Young and Pricewater Cooper House. The focus was on AI use in procurement not so much in other areas. In addition, most up to date reports from public authorities were analysed spanning a period after 2016 when the European directive was put into place for member states. Only highly established reputable private companies research was taken into consideration so that they could bring added value to this research. Hence it is a collection of scientific rigor, public policies and links to the market. In addition, information from HSPPA can provide a scale of the market and up to date information of recent developments. Information analysis was carried out in two axes; collection and critique - discussion. The information was collected, analysed and presented after comparison between different sources. This comparison was made in the context of finding the most representative and relevant data, as the research field is evolving rapidly;

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### **3.4 Limitations of the selected analysis**

The purpose and the advantages of the selected analysis are described in section 3.2. Nevertheless, there are some limitations in this method.

A qualitative method using literature review as the key tool is based on previous knowledge to explain its findings. This itself places a limitation on coming up with a new field of knowledge. In addition, the availability of these studies using the method outlined in the search methodology (section 3.2) requires clear and intricate on the same time criteria. A misguided selection procedure can lead to wrong or vague conclusions.

Another issue as pointed out by (Theofanidis & Fountouki, 2018) is that most qualitative methodologies cannot be truly replicated as in controlled experiment and therefore are unable to verify per se.

As explained in (USC - University of Southern Carolina, 2021) there are also methodological limitations.

- Lack of data or of reliable data which likely to limit the scope of the analysis. On the other hand, this can be an opportunity to find gaps which can lead to future research.
- The direction taken to collect the information. It is usually the case after completing the study that in retrospect adding other dimension on the scope could provide a more solid conclusion. Again, this deficiency could lead to more open questions for further research.

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## **4 Assessment of AI in PP**

In the previous chapters the Greek public procurement system was reviewed as well as the AI technology in relation to procurement and public services. Hence this chapter will involve the the specific environment of the Greek Procurement system, its barriers and deficiencies and on the same time how AI can be used to overcome those.

### **4.1 Level of maturity and technological innovation of PP**

Technological maturity as this was described earlier goes hand in hand with a clear strategy for adopting innovation. According to the European Commission (European Commission, 2020):

*“Innovation procurement” refers to any procurement that has one or both of the following aspects:*

- buying the process of innovation – research and development services – with (partial) outcomes;*
- buying the outcomes of innovation created of others.*

As explained in an interview by (Zacharopoulou, 2021) most of the public procurement authorities do not use innovation procurement to fulfil their needs. Only just recently the center of innovation has been established in Greece. Hence there is a long way ahead.

Public Procurement in Greece is an adaptation of procurement Directives 2014/24/EU and 2014/25/EU. As reported by (Directorate General for Informatics; Directorate General for Communications Networks, Content & Technology, 2019) Promitheus, a public procurement platform, promotes and supports economic bodies participating in public tenders to participate and improve competition in tendering procedures. This is done in accordance with the principles of transparency and equal treatment, and to ensure compliance with the rules and principles of European and national legislation on public procurement. Greece passed Law 4601/2019, which governs the issuance of electronic invoices in public procurement. Only in 2021 has e-invoicing started to be implemented.

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## **4.2 Corruption case in Greek Public Procurement**

As was mentioned earlier AI can be used as a tool to tackle case of corruption. AI-based systems and solutions improves transparency in the planned AI model and its impact. So, what are the cases of corruption in Greek PP? Is it a systemic problem? Is this documented and what are the suggested solutions? How can AI technology be used to tackle specific corruption as this is presented in the Greek environment?

Corruption is defined as the abuse of entrusted power (Transparency International, 2021). Political corruption happens when a public official violates the rules of his or her position to favor a corporation or crony and is enticed to do so by the prospect of personal or partisan gain. According to the same site even if Greece has made some significant steps in the last few years its overall index is at 50 when the European average is 66. Anti-corruption laws for public and civil servants exist but on the other hand the control mechanisms to enforce them are not very effective.

It goes without saying that the best outcomes for the public will be achieved if there is open competition for contracts and decisions about how to allocate contracts are made impartially, based on the best value for money. When it comes to public procurement, corruption typically takes the form of policies that prevent free competition or grant contracts based on particularistic relationships, such as nepotistic or clientelist ties to relatives, kin, or political allies. Outright bribery may be a form of corruption in public procurement. On this chapter some of the systemic cases of corruption will be mentioned and how they are encountered in the Greek system.

According to (GAN INTEGRITY INC, 2021) some of the most common reasons were of corruption in the Greek system according to companies who have participated in public tenders are:

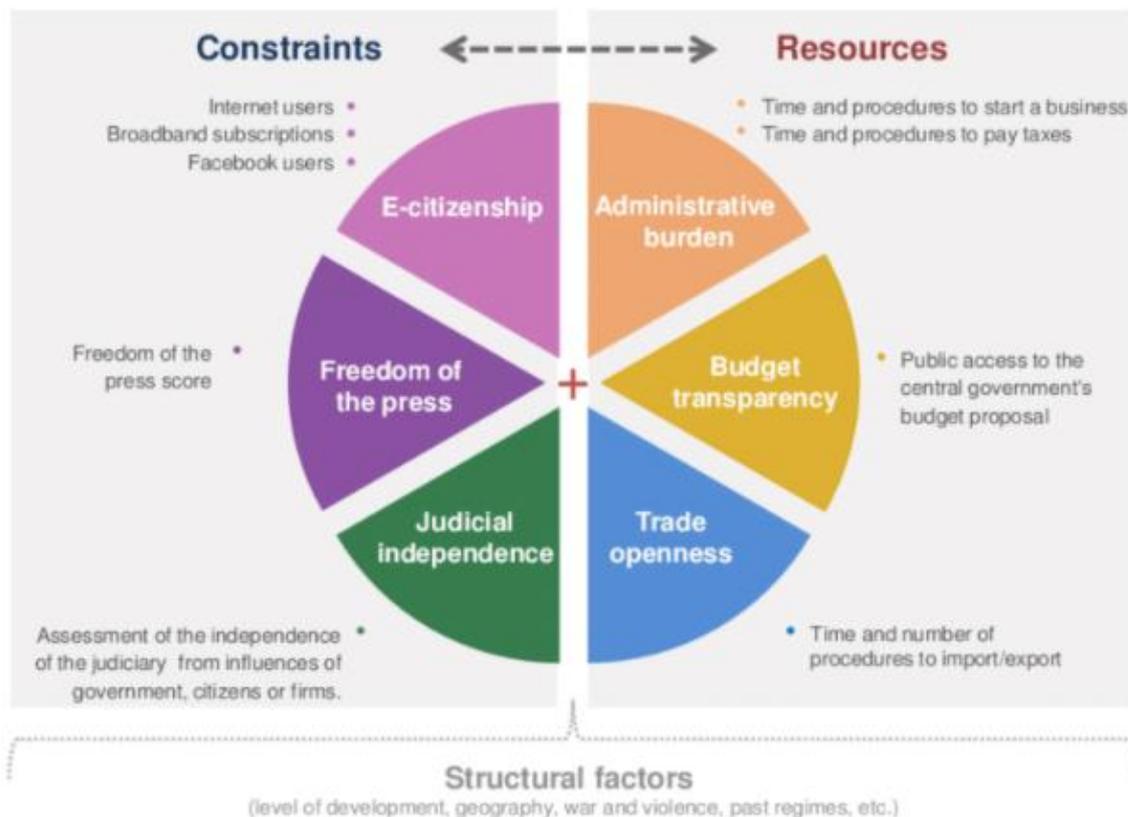
1. The criteria looked like they were tailor-made for certain participants.
2. The bidding was collusive.
3. The deal appeared done before the call for tender was published.

In terms of the view of the public more than half the Greeks believe that state officials who award the tender as corrupt. The evaluation for the award is not transparent and is subject

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to political influence. According the same site Greek state and companies included kickbacks amounting to 2-2.5 percent of the total contract. Considering public contract and procurement is around 8,5 B euros this amounts to 162 M euros.

So what are the key constraints and resources related to public corruption and how can AI be used?



**Figure 17; Control of corruption as interaction between resources and constraints as published by (Mungiu-Pippidi, 2018)**

As it can be seen from the figure above some of the key constraints to tackle systemic corruption is time and number of procedures that can be imported/exported. In addition, administrative burden can also be a critical factor. Both constraints could be alleviated with the use of AI tools and technology as will be explained in more detail below. It goes without saying the ease of access to internet resources also facilitates this. The rest of the criteria mentioned above are beyond the scope of this study.

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As was mentioned earlier in the literature review there certain projects implemented and research carried out which have focused on tackling corruption issues in public procurement. More specifically

- The research by (Callego, Rivero, & Martinez, 2021) where they developed a machine learning model to associate projects with certain variables.
- The case of Ukraine of a project called DoZorro initiative which identified suppliers who have won tenders based on “arbitrary” criteria.
- In Spain there was a research by (López-Iturriaga & Sanz, 2018) to develop a neural network was designed which could give an “early warning system” predicting public corruption.

Hence there are cases where AI has been deployed to tackle the corruption issue. Greater insight on how to make better decision on the public money and mitigate the corrosive effect of corruption is valuable. Moreover, it can be a huge step in establishing greater trust between public authorities and the public. The distrust between authorities and the public has been a long-standing issue.

On the other hand, the implementation on a large scale should be carried meticulously and with slow and established steps. The implementation of this technology on this application has not reached full maturity yet. Contested decisions taken by an AI application can be challenging and, even if the argument is to reduce fraud or corruption, are one of the most serious ethical issues that one should always bear in mind.

### **4.3 Missing registration number**

As was mentioned earlier in the literature review there are systemic cases of inefficiency in the Greek system. It is worth delving more into those to understand more its root causes and in addition their effects. In the end it is this a problem where AI can be of benefit? According to the report published by the (European Commission, 2020; European Commission, 2021) there is a problem in term of the delivered information by the potential buyers.

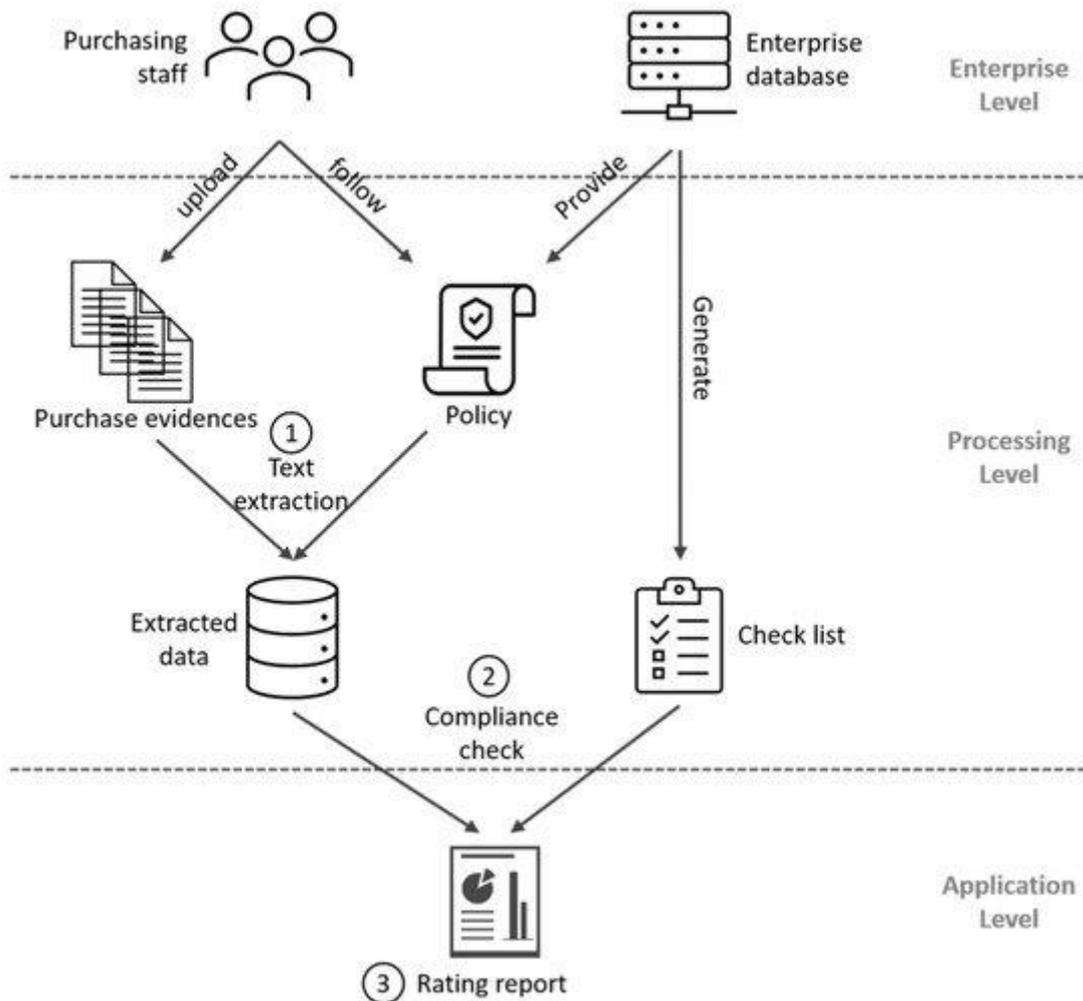
In terms of clarity and access of information as was mentioned by (Georgakopoulos, 2020) the registration numbers of the various tenders are not easy to locate. On the same time they

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are not synchronized with the DIAVGEIA system which is the public e-platform which publishes all decisions related to public services. As mentioned in this report the data base system is very much fragmented and the various decisions tasks are not aligned. Furthermore, many of the procedures are very much delayed due to lack of access to information or even more due to difficulty in getting the right info from the right stakeholder.

Another problem is the lack of the appropriate documentation from the bidders as well as the lack audit from the authorities. According to (Rozou, 2018) the contracting authorities do not thoroughly audit supporting documentation for the tenderers on several occasions and therefore illegally accept offers which do not satisfy the contract notice requirements. The main reason is that employees who make up the Contracting Authorities lack specialization and training and that all tender offers are legitimate unless otherwise determined by the Administrative Court. The second case will involve the cancelation of the relevant decision of the contracting authorities by lodging a preliminary objection with the Administrative authority if a competitor considers that he was illegally passed on to the next stage of the tender process. In addition, manual auditing is an arduous process with a low level of efficiency, speed and in many case accountability. Hence it is not uncommon that mistakes often occur.

So, does AI have the potential to support the Greek authorities in tackling this issue? A recent scientific study (Wang, Zipperle, Becherer, Gottwalt, & Zhang, 2020) has proposed a framework for automated auditing. More specifically this paper proposes a continuous compliance awareness framework (CoCAF). It is defined as an AI-based automated approach to conduct procurement compliance auditing. CoCAF is used to automatically and timely audit an organization’s documents by intelligently understanding compliance policies and extracting the required information using text extraction technologies, automatic processing methods and a report rating system. The CoCAF will include a regularly updated report based on the auditing findings, showing the organization's compliance level with graphs and diagrams. It is based on three stages whose workflow is shown on picture below and published by (Wang, Zipperle, Becherer, Gottwalt, & Zhang, 2020)



**Figure 18; The workflow of CoCAF as published by (Wang, Zipperle, Becherer, Gottwalt, & Zhang, 2020)**

The procurement function must take account of the potential of remote auditing by the adoption of advanced technologies, as traditional audit services, notably on-site visits, were significantly interrupted during the COVID-19 pandemic. CoCAF offers the possibilities for remote auditing and continuous auditing, using artificial intelligence and conducting compliance audits on an automatic basis. The CoCAF is tested using real-world data, and the results show that it can process 500 pieces of evidence in five minutes and provide 95.6 percent auditing accuracy, demonstrating its reliability, consistency, and assurance level in procurement internal audit.

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To sum it up some of the indicative ways AI can help in reducing the missing registration numbers are:

- Through an automated compliance awareness framework
- Through a machine learning solution of allocation, the correct CSV codes and number
- Automated tools to provide more clarity and substance on public tenders.

Again, the main challenge in this case is

- This application is still in the development stage. There are no clear data of respective cost or proof of concept on a wide scale.

#### **4.4 Missing Calls for Bids**

This indicator is a clear indicator against the clarity of the bid and the selection criteria. In other words, it is a measure of transparency of the bidding procedure. It showcases what the name of the call was, and under which condition the end supplier was awarded the tender. This is another section where the Greek system has scored low.

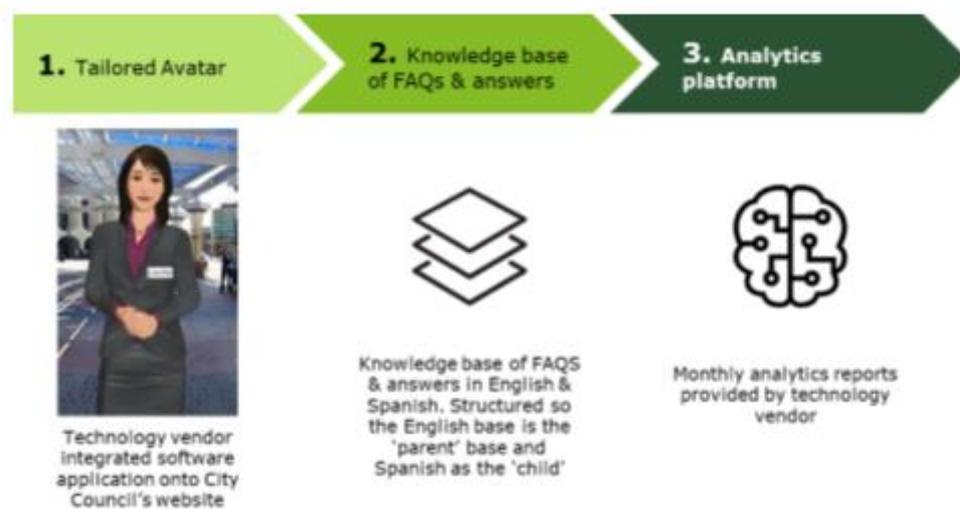
Only just recently Microsoft (Langston, 2020) is making its AI-powered writing assistance tools more widely available to enterprise and consumer customers around the world. With new features Microsoft Editor will give writers the option to use intelligent tools to craft more polished prose in documents, emails, and posts across the web on sites such as LinkedIn, Gmail, Facebook, Twitter and more. The new tools are available in Word, Outlook, and a new Editor in the browser plugin, and they can help users catch errors and write more confidently.

In addition, the application of the chatbot which was mentioned earlier can also be a very useful tool as was described earlier. This tool can be a huge help both for buyer and suppliers throughout the tendering process since it can warn bidders about mistakes, give options and in the end provide a more efficient tender process. Based on progressive conversations or increased learning the chatbot can give more concise and to the point information. An actual case is coming from UK according to (Peijl, O’Neill, Doumbouya, & Howlett, 2020). The

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public sector procurement organization (YPO) in UK integrated a chatbot solution onto their webpage – the Procurement Information Provider (PIP). The chatbot will decipher written user requests and guide them to the appropriate sections of the YPO website. The Microsoft Azure bot system was used to build PIP. The initial version of PIP was developed in 3 months (May – July 2018). Since this time it has been regularly updated and improved on the basis of user feedback. Customer support is available 24/07.

Another case of the implementation of the Chatbot technology was in the United States. More specifically in El Paso the program Laura managed to resolved much of the queries made by bidders much more efficiently and on the same time saving the local employees a lot of valuable time. According to the information provided more than 300 standardized question were inputted into the knowledge base which is maintained and update by the state employees. The components of the system are shown below.



**Figure 19; Component of the "Ask Laura" system as published by (Peijl, O'Neill, Doumbouya, & Howlett, 2020)**

Hence overall the Chat bot technology can offer.

- Reduced man hours required by employees.
- A fully tested system which has been implemented in other countries.
- A low-cost application
- There is no need to integrate with other software application.

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- It can be easily transferrable to other departments as well.

On the other hand, the challenge is

- Employees must be trained on using and assessing the technology.
- The knowledge base must be regularly updated to keep up with any changes.

### **4.5 Decision Speed**

This indicator reflects the speed of the public buyers’ decision making. Very lengthy procedures are detrimental because they are expensive and cause uncertainty for both the public buyers and companies. "Decision Speed" measures the mean decision-making period. This is the period that elapses between the deadline for receiving bids and the contract's award.



Just like the eagle catching its prey speed in decision making is an absolute virtue in a rapid changing society. As explained by (Francioni & Clark, 2020) as competitive environments are increasingly competitive, or even hypercompetitive, the ability to make decisions

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quickly can enable organisation to better exploit opportunities reduce pre-emption cost and ultimately to increase performance. The advantages of a quick decision speed could be of a primarily and directly financial nature (e.g., lower costs, consistent cost levels) and/or of a non-financial nature (e.g., quick and reliable delivery). The main logic in this argument particularly in a competitive and changing environment, that a slower sourcing decision process reduces the chance of selecting the best or most appropriate supplier, thus foregoing both financial and non-financial benefits. This is even more poignant during a COVID pandemic when authorities need to act and react fast and efficiently.

So how can AI be a useful tool on this issue? AI can automate to save time and optimize spend. According to (Pickup, 2019) the first point is automation and speeding to deliver low to medium value and market risks. The AI auction and bargaining bots, for example. They will be further advanced in the future. The second – and more important – usage relates to AI-enabled instruments that help quickly collect, update and analyze commodity, market and intelligence supplies to inform market strategies. Early users report that they can react far more quickly with regard to buying decisions, reducing time from weeks to days and implementing statistical analyzes to recommend the number of inviting suppliers, the best price day of the week, etc. Even for more complicated purchases where contracts have to be drafted, approved and signed AI can also be a useful tool. As explained in the report by (Peijl, O’Neill, Doumbouya, & Howlett, 2020) authorities can maintain consistency in the terms and usage in all of their contracts and to speed up manual tasks from “identification of requirements, to creation and approval of critical contracts, to their eventual renewal.

Hence to sum it up these the main methods that AI can help improve the decision speed of Greek Purchasing

- Setting up an algorithm that can easily sort out and grade the received bids
- Use automated procedures for low risk, commoditized items. Particular examples are e-auctions
- Contract development and management can also help in speeding up manual tasks

#### **4.6 Award Criteria**

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The key objective of a procurement organization is to deliver value to its internal stakeholders. Value can be defined not only in terms of cost but the other parameters as well. This can include delivery of service, product quality, delivery time, performance. Even other societal factors can be considered as well. Like whether the supplier perform well on sustainability indices or they are part of an underprivileged group. Especially for public procurement is part of the social policy of the state these factors cannot be neglected but they should be included in the award criteria wherever this is possible. Hence awarding a tender solely based on cost fails to consider other parameters as well. Unfortunately, in this field the Greek PP has scored quite low.

As explained in the report by (Peijl, O’Neill, Doumbouya, & Howlett, 2020) AI tools set out examples for decision criteria to include in a risk assessment of any potential solutions that contain AI capabilities. AI tools available outline some of key questions that should consider when deciding the procurement strategy, considering what questions to ask in you’re the tendering stage and assessing the solution. AI based procurement frameworks can prescribe the terms and conditions that to any subsequent contract and allow the pre-vetting of providers against a set of predefined criteria that can include ethical requirements. Leading AI-solution providers have begun to create internal frameworks for the ethical design, development, and deployment of AI, which cover processes to ensure accountability over algorithms, avoiding outputs of analysis that could result in unfair and/or biased decision- making, designing for reproducibility, testing the model under a range of conditions and defining acceptable model performance. Bidders should be able to not only explain their approach to the above, but also include examples of projects where these considerations were followed, along with client references. The AI system may also include a set of requirements such as a set of skills and qualifications.

#### **4.7 Publication rate**

Publication rate refers to the value of national public procurement advertised to businesses. The more companies allowed to bid the more value is going to reach the table In addition greater competition is destined to bring more offers thus increasing the chances of a better end price. Except the price each supplier can bring his own proposal to the table thus giving

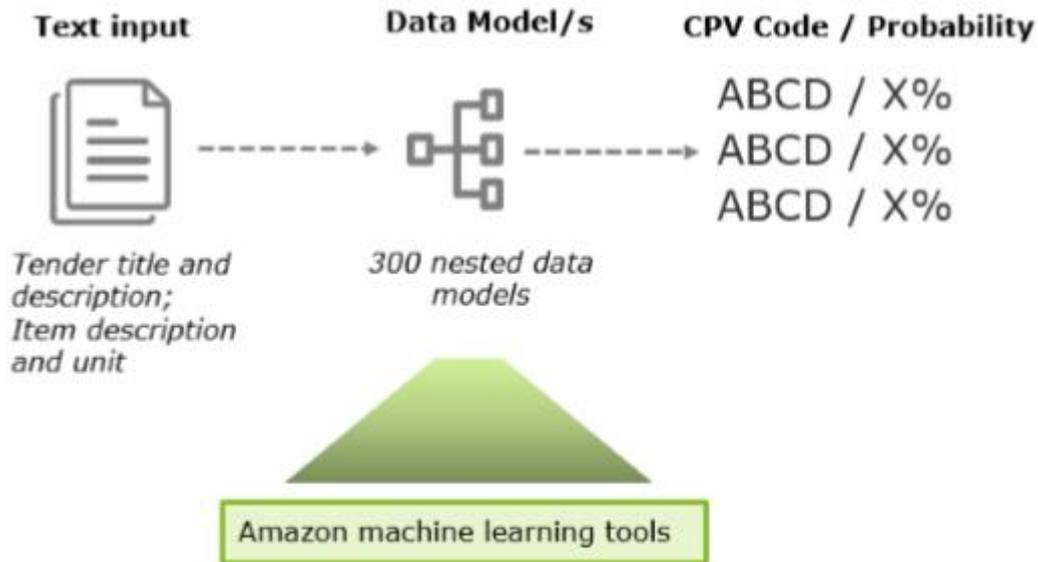
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the end authorities more option to choose not only in terms of price but to include other criteria as these were mentioned above. That also means more accountability as more data is open to the public.

AI can be used to source potential supplier which are more suitable for the tender. In addition, using evidence from past events AI can collect, recognize and design the process and documents to support the tender. On the same time, it can provide support so that the tender reaches suppliers which are already included in a white list which meet the required criteria. Of course it is very important that new supplier can access new calls. A very important factor in this case is that the call is that the goods and services are categorized under the correct procurement vocabulary. Such a case was dealt in Ukraine as explained in the report by (Peijl, O’Neill, Doumbouya, & Howlett, 2020). For ProZorro, the State organization behind Ukraine's hybrid e-Procurement scheme, a data science consultancy (uData) created a machine learning solution that predicts the correct CPV code for a product. The algorithm developed does this based on textual input including the description and title of the product. The output of the algorithm is several different CPV codes, together with a probability for each one that it is correct. If restricted to just providing one CPV code for a good or service, it can predict the first four digits of the CPV code with an accuracy of 70%. The cost was around 10,000 euros. The future expectation is that the tool is available for integration into a front-end eProcurement platform. uData itself plans to integrate the tool into other broader offerings that it is developing – for example a service that updates private companies on new tenders of interest to them on the basis of a description of the items and services they provide.

The prediction model worked as shown below

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**Figure 20; CPV prediction solution as show by by (Peijl, O’Neill, Doumbouya, & Howlett, 2020)**

Overall, the solution mentioned above offer the following advantages.

- They are relatively straightforward.
- Availability of data is already part of the Greek PP which is essential for accurate implementation.
- Costs are relatively small; around 10.000 euros.
- There is proof of concept in other countries.

Some of the challenges could be

- Categorization of data needs to be re-organized in some cases and it needs to be consistent.

#### **4.8 Barriers of implementing AI in the Greek PP**

In the articles above some of the main advantages of AI in the Greek ecosystem were analyzed. These were based on the key benefits of AI technology and the key challenges of the Greek system. On the same time project cases from other countries were referenced and research models. On the other hand implementing AI on the Greek PP system entails many

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difficulties which in turn should be identified and acknowledged in order to have a more complete assessment.

Overall widespread adoption of AI in the public sector has been slower than in big private corporations. The diagram below from (Santeli & Gerdon, 2019) gives a very concise picture of the key barriers.



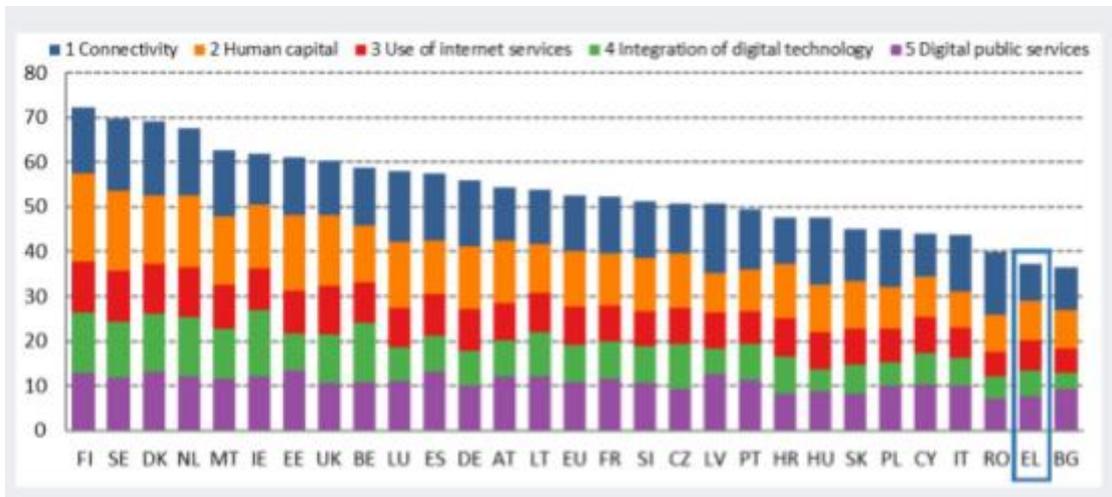
**Figure 21; Barriers to AI adoption as presented in (Santeli & Gerdon, 2019)**

So what do the above mean and how relevant are they on the Greek ecosystem?

Effective use of data; This refers to the digitalization of data within an organized database management system. As was mentioned above the Greek system is quite developed in this field. The Central Electronic Public Procurement Registry CEPRR has the purpose the last few years of collecting, processing, and publishing data on public procurement, services and procurement, for projects with a budget value of € 1,000 or more. Hence all aspects related to public procurement from tendering to proposal and in the end the allocated spend are registered there. According to the latest law 4782/2021 regarding public procurement it is proposed that all suppliers will need to provide an electronic calendar for all their activities during the implementation of a public contract. This is a first step in evolving into AI technology that could utilize some of that data.

As was mentioned earlier AI is a relatively new computer engineering discipline. To fully utilize organization as a whole need staff that can fully comprehend the concept and utilize the technology. In Greece there are only a few big private corporations that have started to dig into AI technology like Vodafone, Papastratos, Cosmote, TITAN Cement and others. As mentioned by a report from (Foundation for Economic and Industrial Research, 2020) the country's connectivity infrastructure and level of digital skills lags those of its EU peers. The graph below as presented on this report shows some key indicator regarding the digital economy among EU states.

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**Figure 22; Digital Economy and Society Index (DESI) ranking of EU member states in 2020 by (Foundation for Economic and Industrial Research, 2020)**

In addition, regarding the provision of online public services, Greece made progress in 2019, with 25/100 pre-filled forms, though this remains well below the EU average of 59/100. In terms of human capital on digital skills Greece continues to rank only to 25<sup>th</sup> in the EU. Hence there is big questions regarding the ease of implementing such a transformative technology. On the other hand, there is some hope for change. Only recently e-gov has been introduced. In addition, according to the same report at the beginning of 2020, Greece had 9 fully operational Digital Innovation Hubs covering various sectors such as agriculture, fishing, construction, manufacturing, transport, and electricity through a wide spectrum of advanced technologies such as additive manufacturing, AI and cognitive systems, cybersecurity and blockchain, big data and photonic.

The legacy structure is also a big issue. AI is a transformative technology. It requires a new way of working, organization change, time to adapt and common consensus among all employees. Public entities have established practices and processes, they usually go through a lot of scrutiny and they tend to be less agile than private companies. It is also much more hierarchical. Hence every new process requires authorization and approval. There is no sense of autonomy or direct accountability which in effect often leads to stagnation. Moreover, any changes are based more on direct financial gains or cuts. Only just recently as was explained above did innovation come into play. It remains to be seen if the strategic

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direction for AI would be successful. Thus, the overall culture is not fruitful for transformation technologies like AI to be adopted on a large scale.

Finally, also the nature of the procurement mechanism of AI technology could a problem. As discussed by (Santeli & Gerdon, 2019) governments who purchase off-the-shelf AI algorithms may want to be able to understand and edit them as required throughout the lifecycle of the tool – customization is very common in software procurement – yet AI providers are likely to object to this. A parallel discussion is the inability of government to avoid vendor lock-in where algorithms are treated like IP, given the original provider would most likely not consent to other AI developers accessing their algorithm. For most technologies this affects maintenance, but AI also affects the government's ability to refresh the algorithm with new data on a regular basis to keep it current, reducing the application's lifetime.

#### **4.9 Concerns regarding AI**

In the articles above the key advantages of AI technology for the Greek ecosystem were analyzed. In addition, some of the hurdles of implementing AI were mentioned. Nevertheless, there are certain constraints and precautions one has to take bear in mind before implementing AI technology.

There is the debate that AI technology can and will replace human labor. This is long debate over century ago that first rose during the Industrial Revolution. As every transformative technology there is a high possibility that some tasks will be performed by machines or technology. Another key point is how this development will be distributed? Thus, this is a more general topic related to technology development vs human employment and should not be considered only within the boundaries for the public procurement sphere in Greece. Overall, more deterministic tasks which involve process oriented and quantitative reasoning skills. On the other hand, humans are much better on cross sector tasks or human reasoning skills. AI technology cannot replace creativity, emotional intelligence, social skills, and critical thinking. Hence education and jobs will need to place emphasis on that so that human skills can augment AI. On a strategic level, key stakeholders need to redesign their systems

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and processes so that machines and people work hand in hand rather than one competing the other.

Another key point is the ethical aspect of AI programming and transparency of implementation. People are often worried about the ethical standards that a machine is using to make decision. How can people critique, complain or raise an argument about a choice that an algorithm is making when this highly complex and not transparent? As highlighted by (Hussey, Taylor, & Murdoch, 2018) full technical transparency is hard to achieve. In certain cases, it can be impossible. In other instances, it may not be helpful. In case where a technical transparency is necessary regulators must set rules so that other expert on this field can have access. An alternative approach is not so much on providing the programming code but explain how that works. That means that AI frameworks are created so that they can clarify the data and rationale used to show up at their choices. There are several specialized arrangements which are presently being developed, which could help clarify AI frameworks and their choices. An assortment of organizations and associations are as of now dealing with clarification frameworks, which will assist with solidifying and interpret the cycles and choices made by AI calculations into structures that are conceivable to human administrators. Many organizations, including Google, IBM and Microsoft, have submitted interpretable AI frameworks, such as Google's 'Glassbox' structure for interpretable AI, and Microsoft's improvement of best practices for a more clear AI framework. On a broader level it is a case of building trust between the organization that provide AI solutions and people who get affected by it.

#### ***4.10 Limitations of the existing dissertation***

As stated above there have been many cases identified which could add value on the case of public procurement in Greece. On the same time there are some barriers which have been identified in this research. However as stated above there are some limitations on this kind of analysis.

The work analyzed was based on research by other writers. The research was based actual cases on other countries or research studies still trying to develop the proof of concept. What were their criteria on each case for choosing a specific sub-application? Were all evidence

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and issues equally valid? Much of the work was also focused on the budgetary and organization changes required on each case. Specifically, about actual cases on other countries the writers focused a lot on the training and the manhours required by personnel. Unfortunately, there were no cases of AI development in other Greek Public authorities to evaluate the intricacies of this technology on the Greek eco-sphere. A central tenet of a scientific method is that the case in question can be replicated. Also much of the works was descriptive. To make the decision to invest a cost benefit analysis would provide the basis for any scope of work. It is unknown whether key stakeholders of PP are engaged on applying such a transformative technology. In terms of strategic support however Greek National Strategy clearly elaborates that AI should be developed across all functions. More suggestions on how to overcome some of the limitations mentioned above will be provided on the conclusion stage.

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## **5 Conclusion about in Greek PP**

### **5.1 Conclusions regarding AI**

Procurement organizations are currently under pressure from both the domestic and the international but also from global competition. Achieving efficiency, increased productivity, and quality optimization is hampered by the recent pandemic and the instability of the economic environment. These factors lead to the need to find new technologies, systems, and human resource management skills. The efficiency of an organization depends directly on its ability to adapt to these constantly changing circumstances.

Recent circumstances, such as the Covid19 health crisis have demonstrated the importance of digital maturity for organization, as all those that already had an adequate digital background were able to adapt and switched to a remote working model specifically for administrative staff. Without compromising the efficiency of each employee, and without compromising the effectiveness of each employee

AI can be a strategic choice for Greek Public Procurement system to gain the competitive edge in the advantage in the global market. The main benefits of AI are cost reduction, reduction of the probability of error and increase in productivity. The implementation of AI can be done in stages, starting from simple processes in key parts of the organization and then extend to more complex processes. The most importantly, in this way, employees become familiar with the use of new technologies and the company culture changes.

The review of the literature produced important findings. In general, the interest for this transformative technology is constantly growing. The interest around the benefit of AI technology in procurement and more specifically in procurement for public services is following the same trend. Referring to the research problem the conclusions address these aspects of the research problem:

"... it is expected to identify the expected benefit and raising the ethical standards of Greek Public Procurement system."

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Overall, the European Commission has set the direction of introducing the AI based on the criteria of openness, ethical justice, accountability, and technological advancement. EU countries have followed different approaches either by nurturing economic growth or driving public innovation or a unified societal strategy or a even a hybrid of all those. Social aspects like human accountability, jobs’ closure are other parameters that need to be included in the discussion. Grece has only recently published an AI strategy focusing on fostering growth across the public and private sector.

Private organizations have been relatively ahead on this field. The level of maturity is still relatively low however there are cases and the potential to grow further. Most important AI fits with many of the priorities set out by procurement function such as simplification of menial tasks and digitalization of processes. This of course needs to go hand in hand with skills’ development and appropriate training. Lessons from the private sector of course are easily transferable to the public sectors as well.

The dissertation highlighted how various technological achievements such as those of evolution of artificial intelligence combined with lessons from the success of other countries, can be used to drive the technological transformation of public services. In addition, it emphasized how various technological achievements such as those of evolution artificial intelligence and the development of data collection and communications, combined with lessons from the success of social media, can be used to drive the technological transformation of public organizations by considering public opinion.

More specifically, the implementation of AI tool on data management and in general the various functions of procurement, can provide PP with the basis for transforming its organization and the way it works giving procurement a competitive advantage.

Some characteristics applications mentioned above are.

- The chatbot application for improved communication
- Algorithm to detect and protect against corruption cases.
- Machine learning methods to create a homogeneous and more transparent items coding.
- Optimization criteria to include a more expanded and integrated approach considering other factors such sustainability and innovation.

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- Automation tools to expedite and standardize tenders and contract management.
- Continuous compliance awareness framework to automate auditing and avoid errors.

Overall the goal of this dissertation was to highlight how AI technology can add value on the Greek PP. To assess that two pillars were analyzed. What are the idiosyncrasies of the Greek PP system? Are there areas where there is major room for improvement? Does it align with the strategy set by key stakeholders? i.e. the government and the European commission. The other major pillar was the AI technology, its features, and relevant applications. Can AI add value to procurement? Are there cases in other countries? At which stage is the technology? What are the benefits that were derived? What should be the path forward?

Many of the questions set above have been answered. There is indeed a lot of space for improvement and AI can be a tool for that. What has been missing is direct feedback from stakeholders within the public authority. The implementation of such a transformative technology can be a major hurdle as will be described below.

It goes without saying that there are many hurdles before such a transformative technology is implemented. Regarding the barriers to digital transformation there is still significant dependence on existing infrastructure, lack of knowledge and experience, but also the alignment and willingness of the public service culture towards its technological transformation.

Some of the most salient ones are.

- Overall Greece still lags in the digitalization of doing business compared to other European countries.
- No prior cases of AI implementation in public services even more so in procurement.
- The legacy culture and the more rigid organization of the public services can make it difficult for the implementation of such a transformative technology.

The Greek system specifically has developed a lot over the recent years in terms of digitization of processes and electronic storage of data. In addition, more and more tenders are now carried out electronically. Only recently a new authority which oversees fostering

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innovation has been established and the overall trend is for more and more processes to be digitized. Moreover, the fact that there is a single authority that oversees the processes and set out a strategic direction in terms of moving things forward can add to the prospect of encompassing new technologies. There are clear areas which were mentioned above where improvements need to be made. These were emphasized by the European commission as well. According to literature review and considering the cases from other countries the implementation of AI can bring huge benefits.

## **5.2 Suggestions for future research**

AI transformation need to follow clear and well-designed steps. In the literature review there is no single method that one can follow to implement the technology. It is dynamic, agile and need to be adjusted to the needs of the key stakeholders. The level of maturity differs for each specific application and subsequently the cost of implementation.

Therefore, there are many issues that need to be considered for the implementation of AI in the Greek environment. In terms of suggestion below follow some general issues that should be considered for the adoption of AI technology

- Adopting a new direction in education at all levels of staff so that everyone becomes a strong advocate for change, innovation and in this case technological transformation.
- Creation of a dedicated IT department team operating within the procurement department and listening to the needs of the concerns of the executives, identifies errors and room for improvement of the systems and takes the necessary corrective action.
- Ongoing evaluation of the performance and benefits of new systems and their continuous improvement where feasible

Finally, regarding the proposals for future research, these are listed below:

- Conducting a survey by means of questionnaires among the authority executives on existing situation and nuances of the current situation in PP.

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- The current situation and perception in Greece concerning change, change management, innovation, and transformation technology.
- A business model to measure the benefits accurately and quantitatively for specific projects.
- What are the skills and education required to develop AI technology in PP. Should the focus be on out sourcing or developing in house talent?

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## References

- Ali, D. M., & Barliana, M. S. (2017). The use of quantitative research method and statistical data analysis in dissertation: an evaluation study. *International Journal of Education*, 46-52.
- Allal-Chérif, O., & Maira, S. (2011). Collaboration as an anti-crisis solution: the role of the procurement function. *International Journal of Physical Distribution & Logistics Management*, 860-877.
- Allal-Cherifa, O., Simon-Moyab, V., & Ballestero, A. C. (2020). Intelligent purchasing: How artificial intelligence can redefine the purchasing function. *Journal of Business Research* , 69-76.
- Almeida, F., Faria, D., & Queirós, A. (2017). Strengths and Limitations of Qualitative and Quantitative Research Method. *European Journal of Education Studies*, 3. 369-387.
- Alshenqeeti, H. (2014). Interviewing as a Data Collection Method: A Critical Review . *English Linguistics Research*, Vol. 3, No. 1.
- Bagul, Y. J. (2020, June 18). *How to Use AI for Invoice Data Extraction and Processing?* Retrieved from KlearStack: <https://www.klearstack.com/how-to-use-ai-for-invoice-data-extraction/>
- Bertrand, A., Erwin, T., & Hartmann, M. (2020). *Artificial Intelligence in the Public Sector; European Outlook for 2020 and Beyond*. Paris: Microsoft.
- Bush, T. (2020, June 8). *Time Series Analysis: Definition, Benefits, Models*. Retrieved from Pestle Analysis: <https://pestleanalysis.com/time-series-analysis/>
- Callego, J., Rivero, G., & Martinez, J. (2021). Preventing rather than punishing: An early warning model of malfeasance in public procurement. *International Journal of Forecasting*, 360-377.
- CLIMA. (2021, February 19). *Computational Logic in Multi-Agent Systems*. Retrieved from CLIMA: <https://userweb.fct.unl.pt/~jleite/events/clima/index.html>
- Data Flair. (2021, May 1). *Artificial Intelligence Tutorial – It’s your time to innovate the future*. Retrieved from Data Flair: <https://data-flair.training/blogs/artificial-intelligence-ai-tutorial/>

“Ioannis Melidonis”, “Development and innovation in public procurement in the Greek government. The potential of Artificial Intelligence (AI) on developing a more ethical and effective procedure”

- Dauvergne, P. (2020). Is artificial intelligence greening global supply chains? Exposing the political economy of environmental costs,. *Review of International Political Economy*.
- Direction-Generale (DG) . (2021, April 24). *Impact of AI on labour market: beyond automation*. Retrieved from European Commission; Knowledge4Policy: [https://knowledge4policy.ec.europa.eu/ai-watch/impact-ai-labour-market-beyond-automation\\_en](https://knowledge4policy.ec.europa.eu/ai-watch/impact-ai-labour-market-beyond-automation_en)
- Directorate General for Informatics; Directorate General for Communications Networks, Content & Technology. (2019). *Digital Government Factsheet - Greece*. Brussels: European Commission.
- Directorate-General for Communications Networks, Content and Technology. (2021, April 25). *Regulatory framework proposal on Artificial Intelligence*. Retrieved from Shaping Europe’s digital future: <https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai>
- European Commission. (2020, December 28th). *EU public procurement directives*. Retrieved from European Commission - Environment: [https://ec.europa.eu/environment/gpp/eu\\_public\\_directives\\_en.htm](https://ec.europa.eu/environment/gpp/eu_public_directives_en.htm)
- European Commission. (2020, December 27th). *Public Procurement*. Retrieved from Internal Market, Industry, Entrepreneurship and SMEs: <https://ec.europa.eu/growth/single-market/public-procurement/>
- European Commission. (2021, February 17). *Single Market Scoreboard*. Retrieved from Single Market Scoreboard: [https://ec.europa.eu/internal\\_market/scoreboard/performance\\_per\\_policy\\_area/public\\_procurement/index\\_en.htm](https://ec.europa.eu/internal_market/scoreboard/performance_per_policy_area/public_procurement/index_en.htm)
- Foundation for Economic and Industrial Research. (2020). *Greece 2020 – Factsheet on Digital Transformation*. Athens: IOBE.
- Francioni, B., & Clark, K. D. (2020). The mediating role of speed in the global sourcing decision process. *Journal of Purchasing and Supply Management*, Volume 26, Issue 2.

“Ioannis Melidonis”, “Development and innovation in public procurement in the Greek government. The potential of Artificial Intelligence (AI) on developing a more ethical and effective procedure”

- GAN INTEGRITY INC. (2021, March 10). *Greece Corruption Report*. Retrieved from Risk and Compliance Report: <https://www.ganintegrity.com/portal/country-profiles/greece/>
- Gartner. (2021, February 17). *Define Your Artificial Intelligence Roadmap*. Retrieved from Gartner: <https://www.gartner.com/en/information-technology/insights/artificial-intelligence>
- Gartner, Inc. and/or its affiliates. (2021, February 17). *Gartner Glossary*. Retrieved from Gartner: <https://www.gartner.com/en/information-technology/glossary/artificial-intelligence>
- Gaurois, P., Staquet, N., Roux, A., & Perrotin, E. (2019). *EMEA Digital Procurement Survey 2019*. Paris: PricewaterhouseCoopers.
- Georgakopoulos, T. (2020). *Ο Νόμος 4412 Και Η Εφαρμογή Του Ανάλυση Αστοχιών Και Προτάσεις Για Τη Βελτίωσή Του*. Athens: Dianeosis.
- HSPPA. (2020, December 30). *Mission & responsibilities*. Retrieved from Hellenic Single Public Procurement Authority (HSPPA): <https://www.eaadhsy.gr/index.php/en/hsppa/mission-responsibilities>
- Hussey, L., Taylor, D. B., & Murdoch, H. (2018). *AI in the UK: Ready, willing and able?* London: the Authority of the House of Lords.
- Java Point. (2021, February 17). *Probabilistic reasoning in Artificial intelligence*. Retrieved from Java Point: <https://www.javatpoint.com/probabilistic-reasoning-in-artificial-intelligence>
- Karachaliou, E., Giagtzoglou, K., & Stroikos, K. (2017). *Guide to country specific elements on public procurement: Greece*. Athens: Q-PLAN INTERNATIONAL.
- Kuziemska, M., & Misuraca, G. (2020). AI governance in the public sector: Three tales from the frontiers of automated decision-making in democratic settings. *Telecommunications Policy*, 101976, 44(6).
- Langston, J. (2020, March 30). *New AI tools help writers be more clear, concise and inclusive in Office and across the web*. Retrieved from Microsoft/ The AI blog: <https://blogs.microsoft.com/ai/microsoft-365-ai-tools/>

“Ioannis Melidonis”, “Development and innovation in public procurement in the Greek government. The potential of Artificial Intelligence (AI) on developing a more ethical and effective procedure”

- López-Iturriaga, F., & Sanz, I. (2018). Predicting Public Corruption with Neural Networks: An Analysis of Spanish Provinces. *Soc Indic Res*, 140, 975–998.
- Lucidminds. (2021, April 24). *Augmented Collective Intelligence* . Retrieved from COMPLEX SYSTEM DESIGN AND ANALYSIS: <https://lucidminds.ai/>
- Ministry of Digital Governance. (2020). *The bible of digital transformation 2020-2025*. Athens: Ministry of Digital Governance.
- Misuraca, G., & van Noordt, C. (2020). *Overview of the use and impact of AI in public services in the EU*. Luxembourg: Publications Office of the European Union.
- Mungiu-Pippidi, A. (2018). Seven Steps to Control of Corruption: The Road Map. *Daedalus*, 147(3):20-34.
- N.S.E.P.P. (2020, December 30th). *National System of Electronic Public Procurement (N.S.E.P.P)*. Retrieved from N.S.E.P.P: [http://www.eprocurement.gov.gr/webcenter/faces/oracle/webcenter/page/scopedMD/sd0cb90ef\\_26cf\\_4703\\_99d5\\_1561ceff660f/Page119.jsp?\\_afLoop=9663912804753521#%40%3Fwc.contextURL%3D%2Fspaces%2Fprod\\_ministry%26\\_adf.ctrl-state%3D11c1ub8pzt\\_4](http://www.eprocurement.gov.gr/webcenter/faces/oracle/webcenter/page/scopedMD/sd0cb90ef_26cf_4703_99d5_1561ceff660f/Page119.jsp?_afLoop=9663912804753521#%40%3Fwc.contextURL%3D%2Fspaces%2Fprod_ministry%26_adf.ctrl-state%3D11c1ub8pzt_4)
- Nagar, S. (2019, January 19). *How to Make a Chatbot With AI*. Retrieved from DZ Zone AI Zone: <https://dzone.com/articles/how-to-make-a-chatbot-with-artificial-intelligence>
- Osanloo, A. &. (2016). Understanding, selecting, and integrating a theoretical framework in dissertation research: Creating the blueprint for your “house”. *Administrative issues journal: connecting education, practice, and research*,. *The Administrative Issues Journal*, 12-26, 4(2), 7.
- Peijl, S. v., O’Neill, G., Doumbouya, L., & Howlett, V. (2020). *Study on up-take of emerging technologies in public procurement*. European Union: Deloitte.
- Perc, M., Ozer, M., & Hojnik, J. (2019). Social and juristic challenges of artificial intelligence. *Palgrave Commun*, 5, 61.
- Pickup, O. (2019, January 31). *Getting to Work: Where AI Can Make a Difference*. Retrieved from HICX: <https://www.hicx.com/where-ai-can-make-a-difference/>

“Ioannis Melidonis”, “Development and innovation in public procurement in the Greek government. The potential of Artificial Intelligence (AI) on developing a more ethical and effective procedure”

- Rozou, A. (2018). *Public e-Procurement (Tendering) Services in Greece*. Retrieved from Rozou & Associates: <https://www.nomikosodigos.info/en/services/for-companies/918-public-procurement>
- Santeli, J. T., & Gerdon, S. (2019, August 19). *5 challenges for government adoption of AI*. Retrieved from World Economic Forum: <https://www.weforum.org/agenda/2019/08/artificial-intelligence-government-public-sector/>
- Smillie, E. H. (2020). *The AI opportunity in sourcing and procurement - Opportunities in the market today*. Ontario: Deloitte.
- Theofanidis, D., & Fountouki, A. (2018). Limitations And Delimitations In The Research Process. *Perioperative nursing (GORNA)*, 155–162, VOLUME 7, ISSUE 3.
- Transparency International. (2021, March 3). *WHAT IS CORRUPTION?* Retrieved from Transparency International: <https://www.transparency.org/en/what-is-corruption>
- USC - University of Southern Carolina. (2021, January 21). *Research Guides*. Retrieved from USC Libraries: <https://libguides.usc.edu/writingguide>
- Wang, K., Zipperle, M., Becherer, M., Gottwalt, F., & Zhang, Y. (2020). An AI-Based Automated Continuous Compliance Awareness Framework (CoCAF) for Procurement Auditing. *Big Data and Cognitive Computing*, 4(3):23.
- Zacharopoulou, A. (2021, February 2). Greek competence centre for innovation procurement. (P. 2. Innovate, Interviewer)

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