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Impact of Artificial Intelligence Research on Politics of the European Union Member States: The Case Study of Portugal

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Received: 24 July 2020; Accepted: 16 August 2020; Published: 19 August 2020

Abstract: Currently, artificial intelligence (AI) is at the center of academic and public debate. However, its implications on politics remain little understood. To understand the impact of the AI phenomenon on politics of the European Union (EU), we have carried out qualitative multimethod research by performing a systematic literature review and a case study. The first method was performed according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA), in order to report the state-of-the-art in the existing literature and explore the most relevant research areas. The second method contained contributions from experts in data science and AI of the Portuguese scientific community. The results showed that solutions such as intelligent decision support systems are improving the political decision-making process and impacting the Portuguese society at local, regional, and national levels. We also found that practitioners and scientists are currently shifting their interests from environmental and biological sciences to healthcare services, which is bringing new challenges in terms of protecting patient/citizen data and growing concerns about handling of critical information. Future research may focus on comparative studies with other EU States to obtain a comprehensive and holistic understanding of the AI phenomenon.

Keywords: artificial intelligence; decision-making process; healthcare services; intelligent decision support systems; politics; Portugal; society

1. Introduction

It is recognized that artificial intelligence (AI) has been an academic discipline since the 1950s and remained in scientific obscurity until it entered the field of business and the public sphere [1]. As AI permeated society, mainly due to the short cycles of technological innovation and means of digitalization, it has been transforming the production and services industries [2]. However, all indicators have shown that these transformations are more profound now and that perhaps the time has come for States and Public Administration to undergo major changes in AI [3].

Many definitions of AI can be found in the literature, but the most suitable for the scope of this research is perhaps the definition put forward by the European Commission. Therefore, AI is defined as "a collection of technologies that combine data, algorithms and computing power" (p. 2) to allow the European Union to become a global leader in innovation in the data economy, bringing benefits to the whole European society [4]. Political decisions are generally a reaction to social pressure and, in that regard, the European Union (EU) as a continent caught between two superpowers that

fight for supremacy has influenced Europeans to speak out for having a more effective government system, which includes global investments in technology, as well as long-term public investments [5]. The previous argument is particularly relevant because the technology of geopolitical actors, reinforced by weak regulatory oversight, has been expanded in their data collection and analysis capabilities. In that regard, Aho and Duffield [6] stated that this has created new dynamics of power and logics of accumulation, collectively referred to as surveillance capitalism. In this context, the authors reinforced that the EU and China have adopted important policies on the use of data with implications for future social and economic development, as evidenced by the adoption of the General Data Protection Regulation (GDPR) by Europe, while China has adopted a proactive strategy (i.e., social credit system) that combined surveillance architectures and AI technologies for state-craft purposes. With regard to the United States of America (USA), the country continues to attract talent and is strong in AI research, possibly due to its tradition in cross-sectorial joint labs [7], while business models based on mass data surveillance appears to be expanding [6].

Currently, in Portugal, there are also important areas of AI that can boost research and development in public administration, which, in turn, can justify the selection of this country as a case to study. In recent years, Portugal has had a notable evolution, well evidenced after the so-called migration from the watch out zone, i.e., low state of digitalization, low momentum, and slowly receding rate of change in 2008–2013 [8], to a break out zone in 2017, where current states are evolving rapidly with a potential to become a stand out country, such as Singapore and New Zealand, which are highly digitally advanced countries and exhibit great momentum [9]. This impetus is also supported by Scopus—a quick search on 11 July 2020 with the term "digital transformation" in the title-abs-key identified Portugal in 10th place in the world ranking (world ranking (top 10 countries): Germany, Russian Federation, United States, United Kingdom, Italy, Spain, France, India, Australia, Portugal) of scientific research, and is the 5th State among the 27 Member States of the EU, while Germany leads the group. On the same date, a search with the term "artificial intelligence" identified Portugal in 19th place among 159 countries worldwide, led by the USA, followed by China and the United Kingdom.

With regard to the aforementioned search in Scopus and in the context of the EU Member States (Figure 1), a more in-depth analysis places Portugal (in green) below the European average (in blue). Portugal is located in a central position between the great powers (left side of the figure) and the small powers (right side of the figure). Other metrics could be used to position Portugal, such as country size or the gross domestic product (GDP), just to name a few. A possible solution to address this issue would be to make an analysis from the political perspective, since in Europe of 27, Portugal occupies an intermediate position with 21 deputies, alongside Sweden, Hungary, and the Czech Republic [10]. However, even with the size of the population and political representation, which ultimately determines the weight of the number of members of the European Parliament [11], in many other institutional areas all Member States have an equal weight, regardless of their size [12]. With regard to GDP, it also does not tell us much about the influence of one State in relation to the others. For example, Luxembourg's GDP is only a very small fraction of the EU's total budget, but the country's economic challenges are different from those with similar GDP in Central or Southern Europe [13]. After a careful analysis, it seemed reasonable to position Portugal in accordance with the scientific research of AI in relation of each EU Member State, since it meets the research objectives of this article.

Portugal achieved this remarkable progression possibly due to the development of a set of funded programs that aim to streamline the use of big data, and whose specific objectives are [14]: (1) to make administrative data more easily accessible to research units (private and public); (2) to promote new and innovative solutions for administrative simplification, namely within the scope of the SIMPLEX program, with a positive impact on the lives of Portuguese citizens and companies, such as simplification of business information and the digital renewal of the citizen's card [15]; (3) to strengthen public sector skills and capabilities in relation to AI and data science; (4) to ensure the ethical use of AI in public administration and develop a national data infrastructure that will constitute a centralized repository of administrative data; and (5) to continue to finance collaborative projects

between the public sector and research units; among others. It is for these reasons that it is sensible to investigate the phenomenon of AI in Portugal.

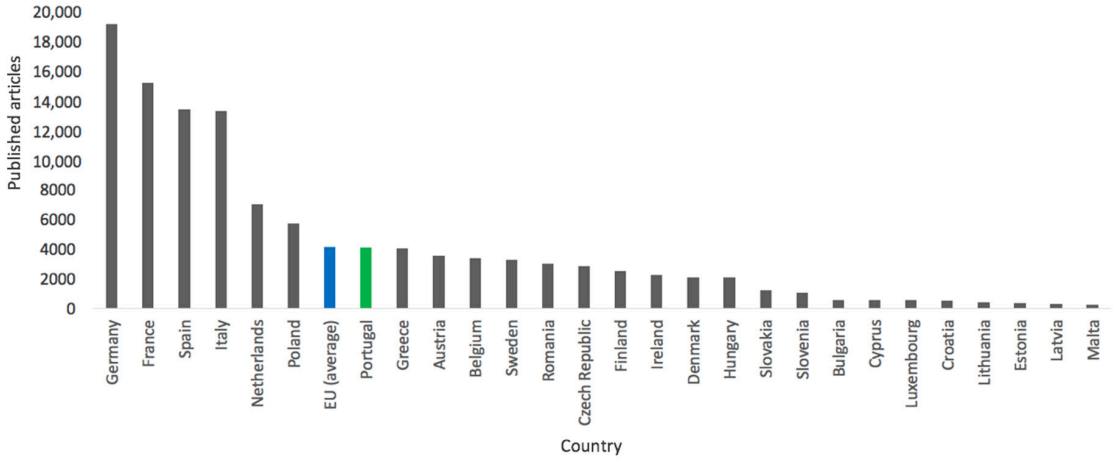

Figure 1. European Union research potential.

To the best of our knowledge, no such research has yet been carried out in Portugal. Our research was motivated initially by a study from Lytras and Visvizi [16], who examined how big data and big data-based services influence individuals and societies. Later, we identified another relevant study, conducted by Wirtz et al. [17], who proposed an integrated AI governance framework based on regulation theory, that showed the main elements of AI governance and regulation from the perspective of public administration. Thus, while the aforementioned authors guide the implementation of a comprehensive regulatory process, our study focuses on building the basis for the use of interdisciplinary practices in the context of Portugal's public administration. In short, we are following the recommendations for future research by Wirtz et al. [17], insofar as we apply their conceptual framework to the Portuguese context so as to improve our understanding of AI governance and regulation. That said, we developed two research questions (RQ), as follows:

RQ1: How is AI influencing Portugal's national policy as a Member State of the EU?

RQ2: What are the benefits of using AI to achieve political governance of the European Union?

Although this research concerns the EU and only focuses on Portugal, it is justified by the fact that the EU guidelines on AI are effectively applied to all Member States (e.g., the EU's General Data Protection Regulation) and, on the other hand, this research is part of a broader project involving other European countries. Thus, our perspective is to present an exploratory research that provides a knowledge base for carrying out comparative studies between several EU countries.

This article first describes the state-of-the-art of AI's impact on public policy, presenting a holistic view of opportunities and challenges. Based on the existing literature, we developed an empirical research, by collecting contributions from experts in the field to build a richer theoretical framework and provide a stronger contribution to the literature. The last section discusses the theoretical and practical implications, the research limitations, and recommendations for future studies.

2. Methodology

This article followed a qualitative multimethod research, since it involved combining data-gathering and -analyzing techniques from two or more methods [18]. Multimethod research has been experiencing a wave of popularity for some time, as this methodology produces integrative evidence [18–20]. In our research, the argument behind the selection of multimethod research is related to the combination of several qualitative methods that use complementarity as a strength, since one method makes it possible to support, improve, and elaborate the results of the other method [21–23]. That is, multimethod research can be appropriate, as the central idea of integrated research of various

methods is to use each method for what is especially good, minimizing inferential weaknesses, by using another method to test, review, or justify assumptions, while triangulation fully depends on both the strengths and weaknesses of each method [18].

Within the wide variety of possible combinations of qualitative methods, we selected a systematic literature review, as it provides the best conceptual basis, while the process is "replicable, scientific, and transparent" at the same time [24]; and a case study, as it creates the opportunity to explore and explain a contemporaneous phenomenon that is not clear and that is technically difficult to define [25]. Both strategies complemented each other, since the systematic review provided the conceptual basis on the state-of-the-art of AI in Portugal, and the case study provided the empirical foundation to validate and adjust the theoretical framework to reality. More details on using each method are provided below.

2.1. Method 1: Systematic Literature Review

The first method was performed according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) protocol [26]. The PRISMA Statement included a 27-item checklist and a four-phase flow diagram (Table 1), with the aim of improving transparency and replicability [27]. In the identification phase, we analyzed the research scope [28] and identified the most appropriate keywords. This phase made it possible to define the subsequent steps, as well as the inclusion and exclusion criteria. Following, eligibility is mainly related to the issue of accessibility, and the inclusion criteria is concerned with the relevance of the manuscripts to this research. More detailed information is provided in the following subsections.

Table 1. Four phases and criteria of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) protocol.

SCOPUS	*n*
Identification	
"Artificial intelligence" AND "Portugal"	
Article title, abstract, keywords	180
Screening	
Articles	69
Journals	67
Affiliation country (Portugal)	54
Language (English and Portuguese)	54
Eligibility	
Full-text articles	53
Included	
Studies included (+6 articles)	59

2.1.1. Selection Criteria

The data search was conducted on 5 August 2020, and featured peer-reviewed articles from Scopus, which is one of the largest international multidisciplinary research databases. Typically, a truly systematic literature review includes more than one database, but given that our priority was transparency and easy reproduction of results, this choice seemed sensible. Scopus was chosen from a number of pre-selected databases, such as Web of Science, B-on, and EBSCO, as it has a broader data coverage; and search engines, such as Google Scholar, were also excluded, as our priority was to select peer-reviewed articles. In addition, the relevance of Scopus is also justified, since it indexes a wide range of AI journals. In that regard, Reis et al. [29] found, in March 2019, 127 journals indexed in Scopus that publish research in AI, a surprisingly high number of sources when compared to other databases.

We started the inclusion criteria using the terms "artificial intelligence" and "Portugal" in the title, abstract, and keywords. To get a holistic view over time, we decided not to include any time constraints; however, the systematic review is already limited, as it provides a snapshot of the reality over a

given period. In addition, no filters were used in relation to the language, since the selected articles used English and Portuguese; thus, language sorting in Table 1 shows that it had no implications for the results.

The process included the selection of journal articles, as, in our view, these publications are of higher quality; therefore, we excluded book chapters, conference proceedings, among others, although we know that in some situations we can find relevant evidence about the latter. After collecting a record of 54 articles, we did not have access to the full text of one of them, which was excluded. The process ended with the inclusion of six articles, also retrieved from Scopus, which served to corroborate some arguments used in the framework for the implementation of AI in Portugal (see Section "Theoretical Framework for AI in Portugal"). After applying the PRISMA protocol, the final result was 59 articles.

2.1.2. Data Synthesis and Analysis

Of the 59 collected articles, we carried out a descriptive and a thematic analysis (see Section 3.1), very similar to that of Paschou et al. [30]. In the descriptive analysis, we used a deductive approach to classify the articles according to the date of publication and their evolution over time, as well as a characterization by subject areas. This analysis was supported by the graphs extracted directly from Scopus, together with the reading of the articles to justify the trends and the interpretation of the bibliometric results. We also performed an inductive analysis to characterize Wirtz et al.'s [17] framework in the light of the Portuguese reality, that is, to relate the framework of integrated AI governance structure with studies in Portugal.

2.2. Method 2: Case Study Research

This research was qualitative, exploratory, and descriptive, with the objective of investigating a phenomenon that involves the development of AI technologies to optimize services in the public administration of a Member State of the EU. Through the collection of data from specialists who lead AI projects that seek to deepen knowledge about the impact of AI on Portuguese public administration, we sought to understand the relationship from top to bottom, that is, the relationship between Politics and the adoption of AI by the Public Administration. To achieve the proposed objective, a case study was designed, which incorporated several units of analysis, and where each unit of analysis was a project in the areas of AI and Data Science (Appendix A).

2.2.1. Case Design

We considered specialists the senior researchers who obtained a national grant from the Foundation for Science and Technology (FCT) promoted by the Portuguese Government. FCT supports the Portuguese scientific community through various funding instruments to support scientists, research teams, and research and development (R&D) centers [31].

In 2018, the FCT promoted an AI and Data Science program to support R&D projects that involved partnerships between Public Administration and Scientific Institutions. The program aimed to gather relevant knowledge based on the analysis of large amounts of data available in the public administration so as to improve service delivery to citizens and to support decision-making [32].

In 2019, 13 projects were proposed for funding in the 2nd AI/Data Science call, which received 69 eligible applications, distributed in the areas of AI (5 projects) and Data Science (8 projects). For 2019 projects, the budget is expected to be allocated in mid-2020.

The 2018 projects were our object of study, because these grants are currently under execution; in that regard, 49 eligible applications were submitted and 15 projects were selected for funding in various areas of Public Administration (Appendix A). For the global grant (three-year grant: 2018/2019/2020) the budget is €4 million, fully financed by national funds from the Ministry of Science, Technology, and Higher Education. The approved projects of 2018 involved partnerships between the R&D units, companies, and public administration entities on topics such as health, public transport, water resources management or the use of data from the European Space Agency's IPSentinel system [33].

2.2.2. Data Collection and Analysis

This study reports on the contributions of 15 specialists involved in R&D projects that focus on AI technologies in Portuguese public administration. The study gathered scientific evidence through semi-structured interviews with members of the project, in addition to the cross-check and analysis of information from official project documents available on the FCT's official website. We used convenience sampling, which is a common type of nonprobability sampling technique [19] used in most qualitative research [20], and which aimed to keep the focus on projects approved by the FCT. In convenience sampling, respondents are usually selected because they are accessible and therefore relatively easy to recruit [19]. The interviews were focused on informants with high knowledge and able to observe the phenomenon from different perspectives, as they were chosen according to the different areas of the projects. The interviews continued until theoretical saturation was reached [34]. Unlike probabilistic sampling, in which representation is sought, with the nonprobability sampling technique we sought depth and, as a result, we prioritized the selection of project leaders, as they work closely with all team members and have a deeper knowledge of the research conducted. In general, the semi-structured interviews allowed to address a number of predetermined questions that were prepared in advance (i.e., interview protocol—Appendix B) to ensure reliability. In that regard, the protocol served to formulate questions and establish the general procedures and standards to be followed [25]. Overall, the aforementioned technique helped the researchers to compare the participants' responses while simultaneously seeking to fully understand their unique research experiences [35]. To ensure validity, a post-interview questionnaire was carried out in order to clarify the answers where doubts persisted, which made it possible to obtain a greater degree of depth and avoid misunderstandings. As for the official documents, they helped us in two different ways. First, in the exploratory phase, they made it possible to access all the information about the projects, as they contained the names, references, and exact details of the research teams (an excerpt can be found in Appendix A). In the subsequent phase of the empirical investigation, they also helped the researchers in the extent that they made it possible to cross-check some information identified by the interviewees, serving as a means of corroboration, but also as a means of improving the validity of this research.

The data from the case study were analyzed according to the content analysis technique, well known in qualitative research [36]. Therefore, we started by reading the text from all data collection sources and integrated it into a data analysis software known as NVivo. Then, we identified the most interesting phrases and ideas, followed by coding both the words and phrases mentioned by the interviewees. After this process, it was possible to identify the categories. In the next phase, we had to find the patterns in the codes to identify the most relevant topics and, finally, we generated a map that provided an overview of the data. In general, the selected data analysis technique made it possible to integrate, code, and analyze the large volume of qualitative data, in order to hierarchize categories and subcategories to identify emerging patterns and ideas. These ideas enabled us to draw conclusions and chart paths for future research that may be relevant for both academics and practitioners in the field of AI.

Table 2 presents a brief summary of the methodology section for an easy visual analysis of the entire process. As can be interpreted from Table 2, dividing this research into two independent articles could be an appropriate methodological approach for the reader due to its simplicity [37]; however, recent studies [38,39] are aligned with the adopted research strategy, arguing that the combination of two or more data-gathering and -analysis techniques can generate wider and richer knowledge, offsetting the weaknesses inherent in individual methods.

Table 2. Summary of the methodology.

Multimethod Qualitative Research		
Methodology	Qualitative	
Research strategy	Multimethod	
Approach	Systematic literature review	Case study research
Sources of data collection	Scopus database	Semi-structured interviews Project documents
Data analysis techniques	Descriptive and thematic analysis	Content analysis

3. Findings

This section presents the results of the systematic literature review. First, it shows the state-of-the-art of the existing literature on AI in Portugal, making an analysis over time and exploring the most relevant areas of AI; then, it intersects known frameworks [17] with the Portuguese context. This section also includes the analysis of the case study that contains the contributions of specialists who carried out scientific research in the areas of AI and data science in Portugal; lastly, we present a discussion where the data from both methods are combined in order to provide a holistic and integrated view of the phenomenon.

3.1. Theoretical Background

The scientific research in Portugal on AI is far from being straightforward, as it reached peaks (the articles of the identified peaks can be found in Appendix C) in 2009, 2014, and 2019 (Figure 2). Thus, in our perspective it can be relevant to understand why the AI phenomenon has not grown steadily along with the digital transformation phenomenon. Previous research has found that in the context of digital transformation, the government sector was responsible for only 1% of world research, which led the authors to argue in previous articles that this theme was one of the most promising to be developed in the future [40]. Therefore, we found that AI in Portugal may be reaching an inflection point, albeit slight and not constant over time. In that regard, the publication peaks highlight the application of AI technologies to mitigate social and climate issues, instead of looking for industrial solutions, contrary to the trends today [41–44].

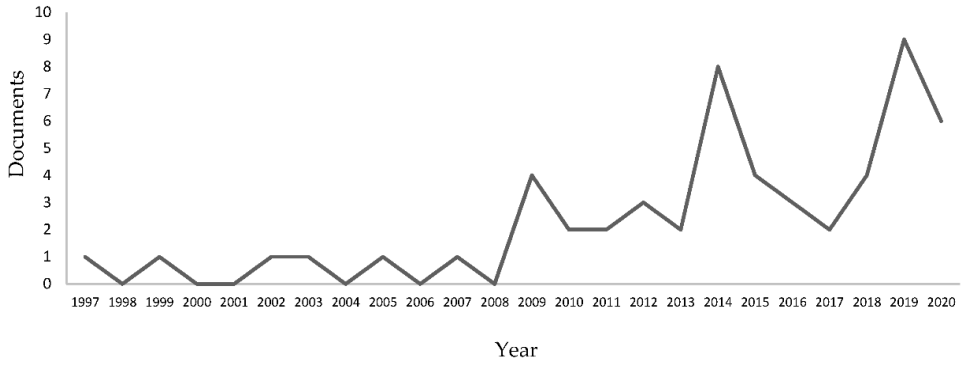

Figure 2. Documents by year.

In light of the above, the social and climate issues to which AI has offered relevant solutions, and which, in turn, are of interest to Portuguese policy, are related to population aging [45], climate change [46,47], green energies [48], and water resource management/planning [49–53]. Most of these articles have used decision-making applications, enhanced by engineering tools and computational technologies, in the fields of environmental sciences, agricultural and biological sciences, energy, and social sciences (Figure 3).

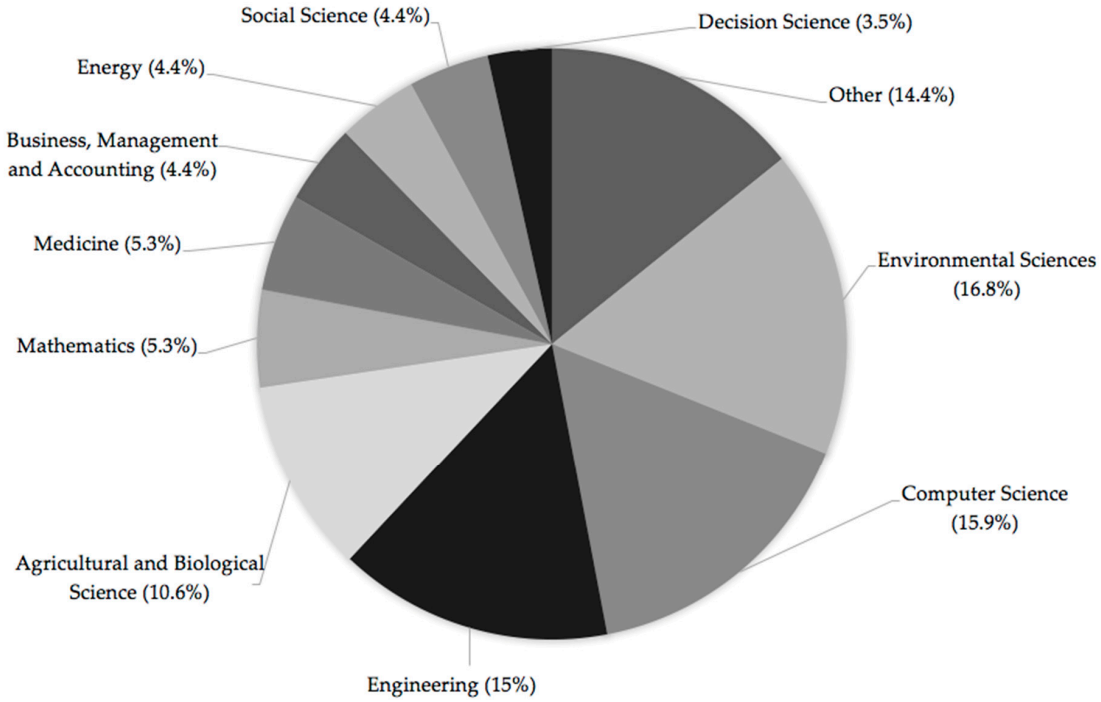

Figure 3. Documents by subject area.

In fact, decision-making applications have shown great relevance to local, regional, and national political leaders, as they usually involve the management of complex situations, that is, the mediation of beliefs between different pressure groups, which usually requires the analysis of logical and well-structured processes for assertive and fair decisions [54,55]. Examples of the previous arguments were published by Cortes et al. [53], who performed research about water resource planning and decision-making applications. The authors argue that in all areas of the Mediterranean, the longitudinal dimension of rivers' connectivity is interrupted by barriers (e.g., dams), in order to compensate for water demand in long periods of water scarcity; on the other hand, with the intensification of agriculture, there is pressure to increase hydroelectric energy production, especially in recent decades. According to Cortes et al. [53], this pressure in Portugal is associated, for instance, with the Douro River, where it is difficult to find a stream segment that is not virtually obstructed by at least one dam or weir. Therefore, the authors proposed better spatial planning for sustainable water reservoirs to reconcile the management of water resource and the protection of biodiversity through intelligent decision-making systems. However, they also claim that the implementation of connectivity makes complex social and political decisions a challenge, especially if there is a need to re-dam, which is often highly contested by the local population, while the regional and national population calls for ecological and sustainable political measures. Similar research was carried out by Fernandes et al. [51] in the Douro region, which aimed to plan and manage water resources through the use intelligent decision support systems (IDSS) and geographical information in order to assess whether the availability of water will be enough to meet the current and future agricultural needs. Finally, an article that is worth mentioning was published by Serrano-Jiménez et al. [45], who developed a method based on interdisciplinary decision support systems to renew buildings in order to promote sustainable urban regeneration while ensuring aging in the local area residence and solving a major social issue in Portugal's capital city. The authors argue that the government continues to promote national renovation policies to adapt residential buildings to normative requirements and contemporary social needs and, at the same time, is contributing to increasing technological research so that they can respond to citizens' demand.

In short, we note that AI-enabled technologies are used to assist local, regional, and national policies, by developing IDSS solutions that address societal concerns. Instead of analyzing large volumes of private data, which can generate citizen distrust, the studies focused on data that are not

directly in the personal sphere of the Portuguese citizens. Moreover, AI in Portugal is seen by the scientific community and the political leaders as a necessary tool that deserves to be explored, as Portugal is experiencing increasingly frequent periods of extreme drought and severe forest fires during the summer periods [56–58]. Indeed, the use of these technologies is beginning to be well-accepted by the Portuguese society, dispelling general fears, such as the use of personal data or the replacement of jobs by machines.

If, on the one hand, political power is expected to intervene to allow human and AI technologies to collaborate; on the other hand, in Portugal, AI presents challenges such as protecting privacy and maintaining citizens' rights and freedoms. In that regard, political leaders restrict and regulate the use of technologies that involve the use of information about their citizens. In view of the above, it is worth mentioning two articles from Portugal that addressed privacy issues. For instance, the article by Ferreira et al. [59], who focused on teaching intercultural design thinking for health, realized that in relation to AI in medicine, medical students were little aware of data privacy issues, stressing the need to consider the effect of AI on healthcare professionals. Moreover, these authors reinforced that most scientists, engineers, and clinicians are not prepared to contribute to the AI revolution in healthcare. Moreover, Cruz-Jesus et al. [60] (research from the FCT grant (vide Appendix A—DSAIPA/DS/0032/2018)) also conducted a study in the area of education, namely with regard to academic performance, which is one of the most global challenges. They presented an innovative approach, using cutting-edge AI techniques, to predict the academic performance of practically all high school students in Portugal. In the context of the developed application, the possibility of obtaining explainable models was highlighted, which may allow the Portuguese Ministry of Education to make informed decisions to promote academic performance. At European level, the importance of achieving an explainable AI model is motivated by the recent introduction of the General Data Protection Regulation (GDPR), which prohibits the use of exclusively automated decisions.

In short, awareness of privacy in Portugal is still low, both on the side of professionals and academics. In contrast, political leaders have paid particular attention to citizens' rights and freedoms, particularly at European level. These policy decisions are restricting and regulating the use of advanced AI technologies or at least those that are exclusively automated, which can delay the development of certain applications that use customer or citizen data.

Theoretical Framework for AI in Portugal

In the previous section, it was clear that the implementation of AI in Portugal has made considerable progress with regard to the AI applications and technology layer; the acquisition of data is carried out by research units and, consequently, the data processing is performed scientifically according to a pre-established program approved by the FCT (Figure 4); further on, the implementation of the AI technologies is carried out by partners (i.e., companies and/or public entities) who test and validate the tools in the field. In turn, the country is experiencing a momentum of change, where the legal issues of AI, social privacy, and ethics are becoming important.

With regard to the AI challenges cycle in Portugal (Figure 4), we noted that it started to migrate from a lower level of concern with privacy, to the establishment of laws and regulations; despite the measures taken by the Portuguese government and the initiative for greater control over the use of AI technologies, the key regulation is still supranational, as is the case with the European Union General Data Protection Regulation (EU GDPR). Moreover, as the AI is integrated in many areas of daily life, it has a major impact in today's society. One of the main impacts that concerns the society is the fear of replacing jobs due to the increasing automation of industrial processes and services, as evidenced by Huang and Rust [61]. Another relevant issue is the ethical challenge that has been widely discussed in the literature [62] and, therefore, a large number of ethical guidelines have been produced in recent years [63]. In addition, although extant research has been mainly conducted at the corporate level, the governmental level is of equal importance [64]. Reinforcing the arguments mentioned above, the complexity is also increasing, since the various challenges start to be discussed

in a transversal way, as is the case of the debate between ethical and legal concerns [65]. With regard to the AI collaboration cycle, the granted projects, as mentioned earlier, were approved by a governmental agency (i.e., FCT) that has the responsibility of monitoring the projects (regulatory mechanism); subsequently, the awarded projects are led by a university research team and/or a research unit, called the "proposing institution"; the project may also include one or more institutions from a public administration institution, private organizations, non-governmental organizations (NGOs), or other stakeholders that are essential to test and validate the AI technology or application. With respect to the assessment of regulatory success, it is necessary to establish indicators to measure the risks and benefits of planned regulation, as well as to determine milestones to study the effects on the different stakeholders and society in general; the next step is to evaluate and implement further actions, i.e., to regulate or not regulate.

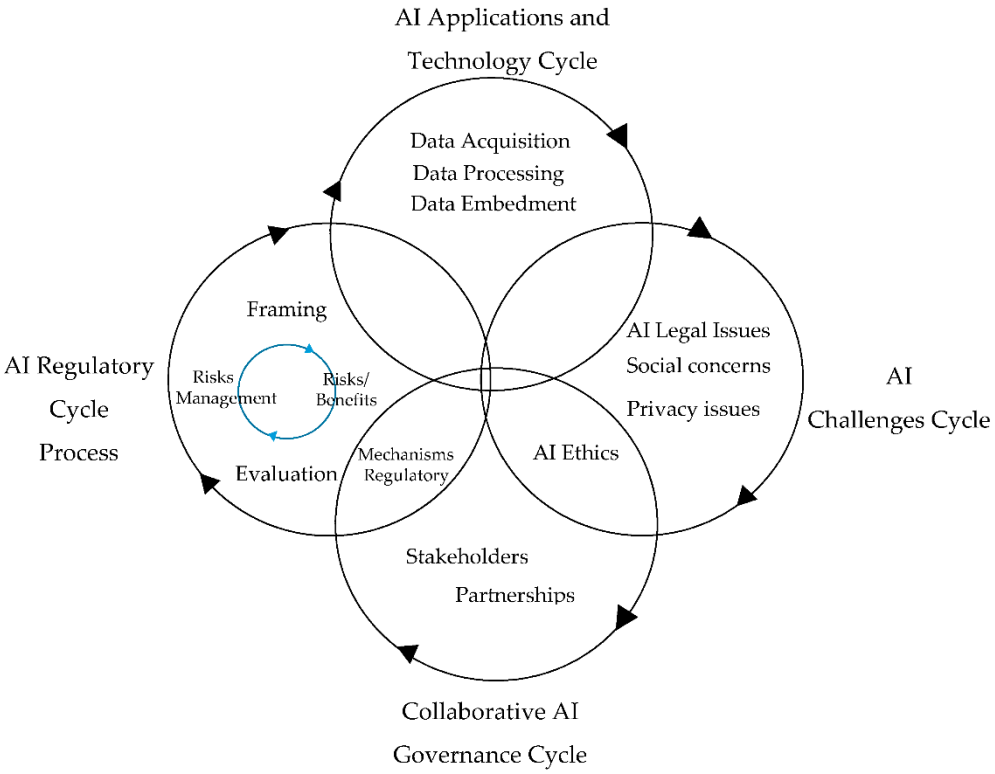

Figure 4. Framework for artificial intelligence (AI) implementation. Adapted from Wirtz et al. [17].

3.2. Case Study Research

The EU has been a pioneer in defining good practices and creating new regulations for responsible use of data and AI. In Portugal, the State is also concerned with regulating the use of AI technologies, while encouraging, valuing, and supporting scientific research through the FCT. In fact, it is widely accepted that the regulation of AI technologies is essential, since the Portuguese government does not have the full control over the use of data from private companies. Cases such as the Cambridge Analytica scandal [66] have raised fears in many States, and Portugal is no exception to this. Consequently, the State is, on the one hand, taking small steps towards obtaining scientific knowledge on how to improve public services, since it is the legitimate owner of large amounts of public data; and, on the other hand, trying to ethically monitor how data are used on the private sector. It should be noted that the Portuguese State has a great advantage when storing large volumes of data in critical areas of management, such as the health, education, and public sectors, so that they can be analyzed by AI tools, making the process faster and more efficient.

As academics and professionals migrate research perspectives to domains that have been secondary so far, concerns about data privacy and data protection are also increasing and getting closer to the

European standards. However, it is not clear that new regulations will restrict or delay the development and implementation of new AI technologies.

We found other interesting evidence, such as the migration of AI specialists to private companies, which offer better working conditions and higher salaries. Contrary to the UK [67], Portuguese universities and research units are still an exception, offering privileged conditions, namely with regard to the retention of talents who complete their higher education courses and end up working in the same team or looking for working groups with similar characteristics and profiles. We realized that, with the exception of universities and IT companies, the lack of retention of scarce human resources, specialized in AI, is hurting public administration, producing a knowledge deficit in the public sector. One of the possible causes for such deficit stems from a divestment by successive governments, and this does not only apply to the technological sector. Therefore, we found that the data corroborated Wirtz et al. [17], who mentioned that an option to mitigate the previous effect is to encourage governments to collaborate with private companies to benefit from their advanced knowledge. In this regard, the respondents were in line with the literature, as they considered that society in general is suspicious of the use of private data by private companies, which raises questions about how to create and cultivate trust in data processing practices [68]; second, universities and research units are somewhat instrumentalized by public policy with regard to the development of IDSS solutions. Thus, it is necessary to bring universities closer to private companies and public administration to encourage open innovation, test and validate new technological developments in AI. This situation is not new and has also been verified in other areas, such as the manufacturing industry, which is well evidenced in other scientific articles [69,70].

With regard to public employment, the perspective of integrating new AI systems to improve the execution of tasks, increase in productivity, and profitability must be seen as a win-win situation and never as a zero-sum game. Thus, if some tasks are obsolete, companies and governments should focus on the creation of new and stimulating jobs for humans in other areas of interest. What the theory tells us is that for tasks of high analytical and cognitive complexity, it is likely that robotics and AI will start to replace human employment, while for social-emotional tasks humans still have a very relevant role [61,71]. Furthermore, it is likely that for human-robot collaboration (HRC) situations, employees will become more specialized, and that requires more training and continuing education [72], while robots will only need to be (re)programmed [73] and, in some cases, AI will be responsible for learning autonomously and adapting to circumstances. In that regard, the respondents were unanimous, as it does not make sense, with the current technologies available, to continue to process data manually, as is still done in many healthcare services in Portugal; thus, with due investment and research, the use of AI technologies may support patient prioritization, reduce service times, optimize medical resources, and reduce costs, just to mention a few advantages listed by the respondents. Another different issue is how the Portuguese and European society decides to socially manage the work issue (i.e., number of working hours, type of working relationship, etc.). In the public debate, the question of reducing working hours, among other relevant social issues related to this topic, almost never arises.

The purpose of this case study was twofold: reinforcing the findings of the systematic review, and obtaining more solid and consistent results. It is also important to note that the case study was exploratory and needs further development. Due the topic complexity, the authors will continue to investigate in order to deepen knowledge and provide a stronger contribution.

3.3. Discussion

From the fifteen approved projects, seven are being developed in the fields of healthcare, computer science, and engineering. Their objectives are to develop solutions so as to improve processes of the national healthcare services. This result is in line with the main subject areas of AI in Portugal (Figure 3), such as computer sciences (15.9%), engineering (15.9%), and medicine (5.3%). The aforementioned statement is well evident in the granted projects, including the following: (1) Derm.AI, that aims to use AI to enhance teledermatological screening, and, thus, increasing the efficiency of the teledermatology

process in the primary healthcare and dermatology services of the national health services [74]. The objective of the project is to develop a mobile application for the acquisition of macroscopic images of skin lesions that allows dermatological tele-screening through the use of machine learning methods and computer vision; (2) DSAIPA 087 project has the objective to identify significant changes in the search for emergency units so as to assist the decision-making process in public health, both at the local (emergency unit) and national level [75]; or (3) Data2Help has the objective of creating tools to optimize resource allocation, improving the quality and response time to medical emergencies in mainland Portugal [76].

In relation to the agricultural and biological science (10.6%) and environmental science (16.8%) research streams, only one project was approved for each area. The IPSentinel program applies AI techniques (i.e., active learning technique and fuzzy logic) to process satellite images, with the aim of providing free access to data that are essential in the planning and management of land and water resources [77]. In addition, the WISDom program hopes to improve decision-making in urban water infrastructures, assisting to detect, locate, and resolve breaks through advanced AI techniques and optimization algorithms [78].

Finally, the mobility in large cities is also starting to be more prominent in AI research. This is a new field of research that was not previously identified as a research stream in Portugal (Figure 3), but is already studied in other countries. Here, we highlight the work of Musolino et al. [79], who proposed an evaluation method integrating Data Envelopment Analysis and Multi Criteria Decision-Making for transport planning, and Croce et al. [80] who proposed a decision-making framework in the context of sustainable mobility. Therefore, the aforementioned scientific research can be seen as a framework for future research for implementing IDSS in the context of sustainable mobility. Albeit related to the environmental sciences (16.8%), the main objective of FCT projects is to reduce pressure in large cities by optimizing routes [81], reducing road accidents [82], and early detection of damages in public transport vehicles [83]. Thus, the idea is to enable the Portuguese State to use digital decision support tools to optimize and manage resources, reduce road accidents, and prevent public transport breakdowns.

In summary, we can draw from this analysis that FCT grants are aligned with most of the disciplinary areas in Portugal (Figure 3). However, our interpretation is that there is a clear political interest in financing scientific development in the national healthcare services, so that these services could be more efficient. This shift in the research paradigm, which we identify as an inflection point, i.e., research migration from the environmental and biological sciences to healthcare services, is going to create new challenges in terms of the establishment of new protocols for patient data protection and will raise ethical concerns regarding the handling of critical information by machines, which are, for example, more susceptible to cyberattacks.

Regarding the universities and research centers that hold the AI project grants (in black color), three of them are at the top of the most innovative in scientific research in Portugal, namely the University of Lisbon, the University of Minho, and the Instituto Superior Técnico (Figure 5).

In light of the above, it is worth mentioning that national universities and research centers are instruments of national policy, as they develop scientific knowledge and new AI tools to address emerging social issues and public needs. In addition, it is relevant to note that universities that fall into this sphere also have the opportunity to develop joint research along with companies and public administration. For instance, in the Data2Help project the responsible institution is the Institute for Systems and Computer Engineering, Technology and Science (INESC-TEC) and collaborates with the National Medical Emergency Institute (INEM), which provides emergency services available through a phone call (number 115); or in the DSAIPA 0090 project [82], which is led by the University of Évora and includes as participants the National Republican Guard (i.e., Portuguese gendarmerie force), just to name a few.

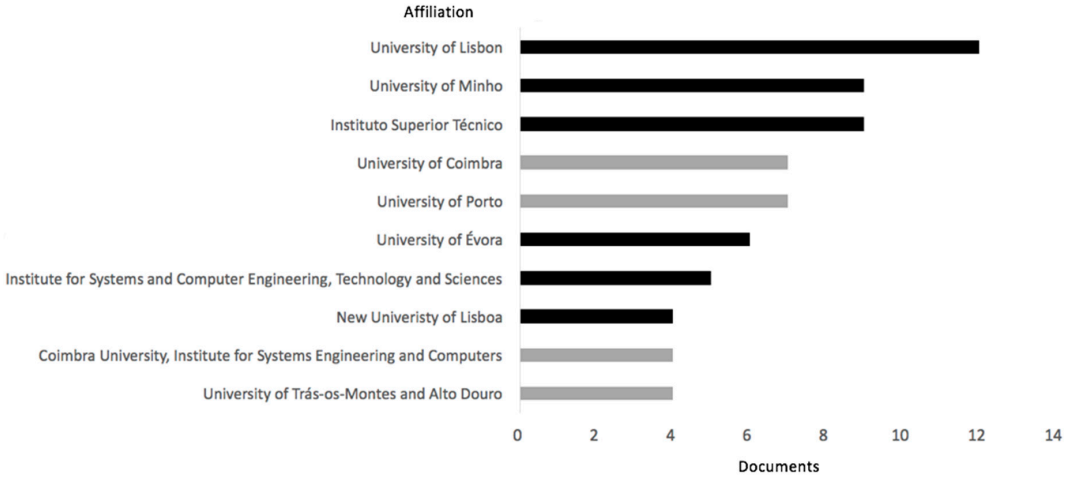

Figure 5. Documents by affiliation (top 10 universities/research centers).

4. Concluding Remarks

With this article, we analyzed the influence of AI on Portuguese and European politics in general.

With regard to the practical contributions, we found that the IDSS solutions have a significant impact on policy, as they offer solutions that react to social issues and, consequently, allow a better political response to local, regional, and national needs. In that respect, we mentioned some examples, such as the development of methods based on IDSS for the rehabilitation of buildings with a view to sustainable urban regeneration in the Portuguese capital; this is one of the main priorities of the city hall of Lisbon, which is seeking a better planning and management of public space through the use efficient decision support systems (local impact). Or, for example, we also made reference to solutions with national impact that met the requirements of the EU—the use of AI that predicts academic achievement in public high schools. In general, the identified FCT projects have practical implications, as they aim to have a social impact. In this last example, the research project intended to establish a set of suggestions to improve the database system of the Ministry of Education of Portugal and, for the EU, the underlying objective was to implement the Europe 2020 strategy in terms of academic performance. In short, this article advocates the need for IDSS to improve the political decision-making process and to expand public investment in scientific research, with a view to develop new knowledge and stimulate the implementation process of AI in public administration.

With regard to the theoretical contributions, similar to other developed countries [84], we found that the awareness of privacy in Portugal is still low, not least because the IDSS (being) developed focus mainly on the analysis of data that do not use personal information from citizens, which, to some extent, inspired popular confidence in the use of AI technologies in Portugal. On the other hand, European politicians are more aware of the need to protect the rights of their citizens, and have been doing so by restricting and regulating the use of advanced AI technologies. It is also expected that political leaders in Portugal will intervene more and more, since academics are witnessing an inflection point involving the migration of public funding from the environmental sciences and biological resources to health services. This shift is creating new challenges in terms of establishing new protocols for patient data protection and increasing ethical concerns related to the handling of clinical information by autonomous systems. In order to help the Portuguese State to better understand the AI phenomenon and to establish measures that can minimize the possible negative impact of the inappropriate use of AI, it seems sensible to establish close relations with universities and private companies, so that the State can benefit from their advanced knowledge. From the sustainability point of view, it is essential (1) for governments in partnership with the industry, academia, NGOs, and general public to improve and interactively adapt their policies that govern the digital economy to balance technological gains [85]; and (2) that the Member States of the EU join forces for the development of common technologies, not only developing applications of AI at local, regional, and national level, as we refer in this article,

but also at the supranational level, so that the EU becomes more competitive at the international level. With regard to the benefits of using AI to achieve political governance at the EU level, our article shows that Portugal is starting to take significant steps in storing large volumes of data, especially in critical areas of management, such as health, education, and the public sector. However, the infrastructures required in the EU to share secure and reliable information between Member States is still a vision. In other words, in our understanding, it is necessary to boost the EU's strategies to aggregate individual efforts and, thus, achieve an expected impact far in excess of the current sum of its parts. In addition, AI research and innovation also contributes to a better EU governance, as it promotes the development of reliable AI and increases public and private investments, which ultimately results in a positive impact on the EU society and economy as a whole [86].

Although this research provides the theoretical basis for improving the understanding of AI governance and regulation in the EU domain, it is not free of limitations. This work is limited to the Portuguese reality, and, therefore, does not comprise any generalization perspectives. However, as an exploratory research, it provides the first known basis for understanding the AI phenomenon in similar EU Member States and its impact on policy.

Future research can address the issue of generalization through a more comprehensive research in all States of the EU, an investigation that may, eventually, be conducted by the European Commission itself or through funds to stimulate research in the public sector context. More limited research can also focus on a comparative study between equivalent European States with similar AI research ranking, as is the case between Portugal and Greece (8th place), Austria (9th place), and/or Belgium (10th place). This analysis can be very relevant from the point of view of the technological sustainability and EU governance in AI, as it allows the identification of the technological strategies of each country and, at the same time, makes it possible to find common trends between them, including the identification of possible strategic partnerships to improve resource management, both at the infrastructural (e.g., development of shared technologies and systems) and human resource (e.g., enhance intellectual sharing by means of education and training) levels. Finally, and reinforcing the previous argument, unless the EU's research and development programs (e.g., Horizon 2020) are the tip of the iceberg, a supranational sustainability strategy in terms of AI research and technological development in the EU should be a priority. This is well evidenced by the analysis of the eligible articles (Table 1), where we identified several partnerships between Portuguese and international researchers (e.g., Spain, USA, Germany, Australia, Brazil, Denmark—data retrieved from each author's affiliation), but could not find consistent research collaborations between Portuguese researchers and other Member States' counterparts, that is, apparently, solid transnational research groups have not yet been established. Perhaps, this is why the European Commission recently launched a call for the development of a European Network of Centers of Excellence in AI to bring together scientists and research infrastructures, in order to face greater scientific and technological challenges, enhancing the implementation of AI-based solutions [14,87].

Author Contributions: Conceptualization, J.R.; methodology, J.R. and N.M.; software, J.R.; validation, P.S. and N.M.; formal analysis, J.R.; investigation, J.R.; resources, J.R.; data curation, J.R.; writing—original draft preparation, J.R.; writing—review and editing, J.R., P.S. and N.M.; supervision, P.S. and N.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: We would like to acknowledge the support given by the invited researchers through the better clarification on the projects they are developing, as well as their view on the relationship between artificial intelligence and political science in Portugal.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Research and development (R&D) projects approved by Foundation for Science and Technology (FCT).

Project	General Purpose	Research Objective(s)	University/Research Center	Funding	Team	Area
Artificial Intelligence						
Derm.AI DSAIPA/AI/0031/2018	Use of artificial intelligence to enhance Teledermatological screening	Increase the efficiency of the Teledermatology process between primary health care and dermatology services of the National Health Service	Fraunhofer Portugal Research	€299,156 Approved	7 elements	Healthcare
Data2Help DSAIPA/AI/0044/2018	Data science for medical emergency services optimization	Create tools to optimize resource allocation, improving quality and response time to medium emergencies in mainland Portugal	Institute of Systems and Computers Engineering, Research and Development in Lisbon (INESC ID/INESC/IST/ULisboa)	€294,036 Approved	10 elements	Healthcare
DSAIPA/AI/0087/2018	Identification and forecasting demand for hospital emergency	Identify in due time significant changes in the demand for emergency units	Calouste Gulbenkian Foundation	€283,103 Approved	4 elements	Healthcare
IPSTERS DSAIPA/AI/0100/2018	IPSentinel terrestrial enhanced recognition system	Apply AI techniques for processing satellite images available on the IPSentinel platform for an optimized generation of added-value maps (e.g., Land-cover land-use maps, level-3 products)	Institute for the Development of New Technologies (UNINOVA/FCTUNL/UNL)	€124,600 Approved	10 elements	Land and use planning
Data Science						
DSAIPA/DS/0022/2018	Detection of addition patterns in online game	To propose a tool based on AI that can capitalize on the large amount of data collected and analyze the online behaviour of users to model and detect the behaviours associated with gambling addiction	New University of Lisbon (UNL)	€295,291 Approved	8 elements	Healthcare

Table A1. *Cont.*

Project	General Purpose	Research Objective(s)	University/Research Center	Funding	Team	Area
EPISA DSAIPA/DS/0023/2018	Inference of entities and properties for semantic files	Incorporate national archives into the Semantic Web and give new uses to cultural content	INESC TEC—Institute of Systems and Computers Engineering, Technology and Science	€299,237 Approved	19 elements	Archives and museology
DSAIPA/DS/0032/2018	Understanding the determinants of academic performance: evidence from the Portuguese high school education system	This project aims to analyze the background of academic performance, on a national scale, using micro data from public high schools.	New University of Lisbon (UNL)	€157,737 Approved	5 elements	Education
ModEst DSAIPA/DS/0039/2018	Modelling the flow of students in the Portuguese education system	Use of AI in the production of knowledge for the definition of organizational policies in the education system and for taking specific corrective measures	FCiência.ID—Association for Research and Development of Sciences	€246,950 Approved	6 elements	Education
DSAIPA/DS/0042/2018	Identification of surgical risk patterns in cancer patients	Predict the risk of health issues from surgical treatment and definition of the prognosis in cancer patients by integrating clinical and pathological data	Institute of Mechanical Engineering (IDMEC)	€247,056 Approved	18 elements	Healthcare
DSAIPA/DS/0065/2018	Diagnosis of neurological diseases	Neuroimaging biomarkers for the diagnosis of Neuropsychiatric diseases using AI	FCiência.ID—Association for Research and Development of Sciences	€299,925 Approved	10 elements	Healthcare
ICDS4IM DSAIPA/DS/0084/2018	Intelligent clinical decision support in intensive care medicine	Support real-time clinical decision-making in the field of intensive care	University of Minho	€264,888 Approved	15 elements	Healthcare

Table A1. *Cont.*

Project	General Purpose	Research Objective(s)	University/Research Center	Funding	Team	Area
WISDom DSAIPA/DS/0089/2018	Water intelligence system data	The intention is to support water management entities in decision-making and improve the operational management of systems (e.g., reducing water losses, improving energy efficiency, and optimizing rehabilitation interventions)	Polytechnic Institute of Setúbal (IPSetúbal)	€288,450 Approved	15 elements	Water management services
FailStopper DSAIPA/DS/0086/2018	Early detection of damage to public transport vehicles in an operational environment	Create a system that automatically identifies the existence of a malfunction in development Application—Metro do Porto vehicles, compressed air production system	INESC TEC—Institute of Systems and Computers Engineering, Technology and Science	€95,147 Approved	3 elements	Public transports
DSAIPA/DS/0090/2018	Modelling and prediction of road accidents in the district of Setúbal	Obtain, based on the adjusted models, a digital tool to support decision-making in real time, with the ability to re-estimate the parameters and update the predictions whenever new data is obtained	University of Évora (EU)	€299,986 Approved	14 elements	Mobility
iLU DSAIPA/DS/0111/2018	Advanced Learning in Urban Data with Situational Context for Optimizing Mobility in Cities	Intermodal management of public transport and support circulation in the city	Institute of Systems and Computers Engineering, Research and Development in Lisbon (INESC ID/INESC/IST/ULisboa)	€299,725 Approved	20 elements	Public transports

Appendix B. Interview Protocol

1. Introduction

   - Brief explanation of the research;
   - Explanation of the confidentiality decorum;
   - How was the interview conducted? We started by placing some topics for discussion and the subsequent questions were added according to the initial contribution of the interviewees. These topics essentially served to break the ice and stimulate discussion. Given its practical relevance, we think it is more important to present topics instead of an extensive list of questions.

2. Research questions for discussion

   Topic 1. Full automation or decision support system?

   Fully automated decision-making will result in more harm than benefit to society. It is, therefore, acceptable to conceive AI as a tool to support decision-making, while the idea of fully automated systems that overlap with human decision is still a vision of the future.
   The previous paragraph was followed by a discussion and intermediate questions.

   Topic 2. Change of paradigm

   AI in Portugal is experiencing an inflection point, clearly visible by the migration of scientific research from the area of Environmental Sciences (16.8%), Computer Science (15.9%), and Engineering (15%) to a greater preponderance in the area of Healthcare Services, which currently holds 5.3% of national research. In this regard, it is foreseeable that the paradigm shift will create new challenges in terms of establishing patient data protection protocols, as well as handling of critical information more susceptible to, for example, cyber-attacks.

   The previous paragraph was followed by a discussion and intermediate questions.

   Topic 3. Deceleration in the development and implementation of new AI technologies and applications
   While academics and professionals migrate research perspectives to domains that until now were considered secondary (for example, health: 5.3%), concerns about privacy and data protection at the national level are still low, considering supranational initiatives (i.e., general data protection regulation). The implication of greater regulation may, consequently, restrict or delay the development and implementation of new AI technologies.
   The previous paragraph was followed by a discussion and intermediate questions.

   Topic 4. Approaching Higher Education to the Private Sector and Public Administration

   Universities and research units are, to a certain extent, instruments of support local, regional, and national politics, namely with regard to the development of DSS (Decision Support Systems) solutions. It is therefore necessary to bring universities closer to private companies, as well as to the public administration (for example, security forces, hospitals, etc.), to test and validate new technological developments in AI.
   The previous paragraph was followed by a discussion and intermediate questions.

Topic 5. Approaching the State to the Private Sector

Due to higher wages and better working conditions, AI specialists have joined private companies and, unintentionally, produce a knowledge deficit in the public sector, slowing down and worsening the regulatory process at the same time. Therefore, governmental institutions must collaborate with private companies to benefit from their advanced knowledge.
The previous paragraph was followed by a discussion and intermediate questions.

Topic 6. Human unemployment

One of the main concerns of contemporaneous society is the fear of replacing jobs with AI, which is mainly due to the increasing automation of industrial processes and which are likely migrate to services and public administration. The previous paragraph was followed by a discussion and intermediate questions.

Appendix C

Table A2. Research peaks over time.

Author	Title	Year	Source
Sangiorgio et al.	Structural Degradation Assessment of RC Buildings: Calibration and Comparison of Semeiotic-Based Methodology for Decision Support System	2019	Journal of Performance of Constructed Facilities
Tato and Brito	Using smart persistence and random forests to predict photovoltaic energy production	2019	Energies
Serrano-Jiménez et al.	Promoting urban regeneration and aging in place: APRAM—An interdisciplinary method to support decision-making in building renovation	2019	Sustainable Cities and Society
Ferreira et al.	Effectiveness assessment of risk reduction measures at coastal areas using a decision support system: Findings from Emma storm	2019	Science of the Total Environment
Cortes et al.	Undamming the Douro river catchment: A stepwise approach for prioritizing dam removal	2019	Water (Switzerland)
Fonseca and Santos	A new very high-resolution climatological dataset in Portugal: Application to hydrological modeling in a mountainous watershed	2019	Physics and Chemistry of the Earth
Marujo et al.	Prioritizing Rubble-Mound Breakwater's Repairs Using a Multicriteria Approach	2019	Journal of Performance of Constructed Facilities
Naderi et al.	Sustainable operations management for industry 4.0 and its social return	2019	IFAC-PapersOnLine
Naderi et al.	Improving operational management of wastewater systems. A case study	2019	Water Science and Technology
Prieto et al.	Twitter: A good place to detect health conditions	2014	PLoS ONE

Table A2. *Cont.*

Author	Title	Year	Source
Silva et al.	Biogas plants site selection integrating Multicriteria Decision Aid methods and GIS techniques: A case study in a Portuguese region	2014	Biomass and Bioenergy
Fernandes et al.	Decision support systems in water resources in the demarcated region of Douro—Case study in Pinhão river basin, Portugal	2014	Water and Environment Journal
Ruano et al.	Seismic detection using support vector machines	2014	Neurocomputing
Silva et al.	Development of a web-based multi-criteria spatial decision support system for the assessment of environmental sustainability of dairy farms	2014	Computers and Electronics in Agriculture
Pinto et al.	Mainstreaming Sustainable Decision-making for Ecosystems: Integrating Ecological and Socio-economic Targets within a Decision Support System	2014	Environmental Processes
Oliveira et al.	Decision support system for not urgent transportation of patients in shared vehicle	2014	RISTI—Revista Ibérica de Sistemas e Tecnologias de Informação
Sousa et al.	Risk assessment of sewer condition using artificial intelligence tools: Application to the SANEST sewer system	2014	Water Science and Technology
Gonçalves and Pereira	Decision support system for surface irrigation design	2009	Journal of Irrigation and Drainage Engineering
Maia and Silva	DSS application at a river basin scale, taking into account water resources exploitation risks and associated costs: The Algarve Region	2009	Desalination
Pinto et al.	Optimizing water treatment systems using artificial intelligence based tools	2009	WIT Transactions on Ecology and the Environment
Rodrigues et al.	Multi-dimensional evaluation model of quality of life in campus	2009	WSEAS Transactions on Information Science and Applications

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