How Can Spain Remain Internationally Competitive in AI under EU Legislation?

An Analysis of the Current Spanish AI Strategy and Recommendations to Drive Innovation

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1. Introduction

1.1 Contextual Overview

Artificial Intelligence (AI) has emerged as a transformative force in the global economy, with projections indicating it could contribute up to $15.7 trillion to the world economy by 2030 (PwC, 2023). The technology's impact spans across sectors, from healthcare and manufacturing to financial services and public administration, fundamentally reshaping business models and operational paradigms.

By 2027, spending on AI software will grow to $297.9 billion with a CAGR of 19.1%. Over the next five years, the market growth will accelerate from 17.8% to reach 20.4% in 2027. Generative AI software spending will rise from 8% of AI software in 2023 to 35% by 2027 (Gartner, 2024). This exponential growth reflects AI's increasing role in driving innovation, productivity gains, and competitive advantage across nations and industries.

In this rapidly evolving landscape, Spain has positioned itself as an emerging player in the European AI ecosystem. The country's AI market value reached €1.3 billion in 2022, representing approximately 13.4% of the European AI market (Telefonica Foundation, 2023). Spain's strategic geographical location, coupled with its robust digital infrastructure and highly skilled workforce, has created a fertile ground for AI development. The revenue generated by the AI market in the South European country is forecast to increase fourfold in the coming years, from around 2.5 billion euros in 2024 to over 11.5 billion euros in 2030 (Statista, 2024).

Spain's commitment to AI development is further evidenced by its national strategy, "Spain Digital 2026," which allocates [€600 million specifically to AI initiatives](#) (Government of Spain, 2023). This investment forms part of the broader digital European strategy, where Spain plays a crucial role in several EU-wide AI initiatives, including the [AI4EU project](#) and the [European Digital Innovation Hubs network](#). The country's participation in these collaborative frameworks highlights its strategic position as a bridge between European innovation ecosystems and Latin American markets, offering unique opportunities for international expansion and knowledge exchange.

However, Spain's position in the global AI landscape faces both opportunities and challenges. While the country ranks 18th in the Global AI Index (Tortoise Media, 2024), indicating significant potential, it has dropped from 11th position in the previous edition ranking. This highlights that Spain not only lags behind leading nations such as the United States, China, and European peers like Germany and France in terms of AI patent applications, research output, and private investment in

AI technologies, but against other rising countries such as Japan, and there is significant room for improvement. A similar view is provided in the Government AI Readiness Index where the country ranks 27th -in comparison France ranks 6th- (Oxford Insights, 2023). This positioning underscores the need for strategic initiatives to enhance Spain's competitive advantage while navigating the complex regulatory landscape emerging from the EU AI Act and related legislation.

1.2 Purpose of the Article

Spain stands at a critical crossroads as the EU AI Act reshapes Europe's technological landscape and could serve as a blueprint for other jurisdictions. We have witnessed firsthand how regulatory frameworks can either catalyze or slow innovation. This regulation presents unique challenges for Spain's burgeoning AI sector, particularly in Barcelona, Bilbao, Madrid, or Valencia's thriving tech hubs, where companies like Sherpa.ai are already pushing the boundaries of AI development while being compliant.

This article dissects how Spain can strike a balance between adhering to these regulations and maintaining an environment conducive to AI-driven innovation. The key to Spain's future success lies not in viewing the EU AI Act as yet another regulatory hurdle, but in leveraging its existing strengths. Spain's pioneering National AI Strategy already aligns remarkably well with several core requirements of the Act. Research institutions, such as the Barcelona Supercomputing Center (BSC-CNS), Valencian Research Institute for Artificial Intelligence (VRAIN) or the Artificial Intelligence Research Institute (IIIA-CSIC) are perfectly positioned to help bridge the gap between regulatory compliance and technological innovation.

The path forward isn't about choosing between innovation and compliance – it's about embracing both through pragmatic, forward-thinking policies. Drawing from Spain's successful digital transformation initiatives, we can create a model that other EU member states might follow.

By evaluating Spain's current AI policies and identifying areas for growth within the EU's regulatory framework, this article offers actionable recommendations aimed at fostering a robust, compliant, and forward-looking AI industry in Spain.

2. The European Union AI Legal Framework

2.1 Overview of the EU AI Act

2.1.1 Key Provisions and Regulatory Goals

The European Union Artificial Intelligence Act (EU AI Act) represents the world's first comprehensive regulatory framework aimed at governing artificial intelligence (European Commission, 2024). The Act's purpose is to ensure that AI technologies developed, deployed, and utilized in Europe align with the EU's values, especially in terms of human rights, transparency, and ethical standards. This regulatory framework introduces a risk-based approach and categorizes AI systems based on their potential impact on individuals and society, with special attention to "high-risk" AI and General Purpose AI (GPAI) applications.

EU AI Act is part of a wider European regulatory framework as it is reflected in the following table (Josep Curto, 2024):

Short Name	Code	Description	Status	Website	Legal text
Cyber Resilience Act (CRA) - horizontal cybersecurity requirements for products with digital elements	2022/0272(COD)	It introduces mandatory cybersecurity requirements for hardware and software products, throughout their whole lifecycle.	Published	Website	Source
Data Act	EU/2023/2854	It enables a fair distribution of the value of data by establishing clear and fair rules for accessing and using data within the European data economy.	Published	Website	Source

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Data Governance Act	EU/2022/868	It supports the setup and development of Common European Data Spaces in strategic domains, involving both private and public players, in sectors such as health, environment, energy, agriculture, mobility, finance, manufacturing, public administration and skills.	Published	Website	Source
Digital Market Act	EU/2022/1925	It establishes a set of clearly defined objective criteria to identify "gatekeepers". Gatekeepers are large digital platforms providing so-called core platform services, such as for example online search engines, app stores, and messenger services. Gatekeepers will have to comply with the do's (i.e. obligations) and don'ts (i.e. prohibitions) listed in the DMA.	Published	Website	Source

Digital Services Act	EU/2022/2026	It regulates online intermediaries and platforms such as marketplaces, social networks, content-sharing platforms, app stores, and online travel and accommodation platforms. Its main goal is to prevent illegal and harmful activities online and the spread of disinformation. It ensures user safety, protects fundamental rights, and creates a fair and open online platform environment.	Published	Website	Source
DMS Directive	EU/2019/790	It is intended to ensure a well-functioning marketplace for copyright.	Published	Website	Source
Energy Efficiency Directive	EU/2023/1791	It establishes 'energy efficiency first' as a fundamental principle of EU energy policy, giving it legal standing for the first time. In practical terms, this means that energy efficiency must be considered by EU countries in all relevant policy and major investment decisions taken in the energy and non-energy sectors.	Published	Website	Source

EU AI Act	EU/2024/1689	It assigns applications of AI to three risk categories. First, applications and systems that create an unacceptable risk are banned. Second, high-risk applications are subject to specific legal requirements. Lastly, applications not explicitly banned or listed as high-risk are largely left unregulated.	Published	Website	Source
General Data Protection Regulation (GDPR)	EU/2016/679	It strengthens individuals' fundamental rights in the digital age and facilitates business by clarifying rules for companies and public bodies in the digital single market.	Published	Website	Source

The EU AI Act establishes a governance framework for AI systems within the European Union, and incorporates a range of key provisions to shape a safe, transparent, and accountable AI ecosystem:

1. **Uniform Rules**: The Act creates a harmonized legal framework for the development, market placement, and use of AI systems across the EU. If regulatory requirements across countries or regions became more similar or aligned, then important innovations could move to the market in a more predictable and efficient way — as well as be more equally accessible. This approach is known as regulatory harmonization. This includes preventing individual member states from imposing conflicting regulations.

2. **Risk-Based Approach**: AI systems are classified based on their risk levels: minimal, limited, high, and unacceptable risk. High-risk AI systems, which include those used in critical sectors like health, employment, and law enforcement, are subject to strict regulatory requirements. Unacceptable-risk AI systems, such as those used for social scoring by governments, are prohibited entirely.

3. **GPAI**: AI systems classified as GPAI have strict requirements (some of them similar to high risk AI systems).

4. **Governance Structure for Accountability and Oversight**: The regulation proposes the establishment of national supervisory authorities, a European AI

Office, and a European Artificial Intelligence Board (EAIB) to oversee and ensure compliance across member states.

5. **Transparency, Accountability and User Rights**: AI providers must ensure transparency, maintain technical documentation, and conduct conformity assessments for high-risk systems to promote accountability and trustworthiness. Additionally, the Act requires that users are informed when they are interacting with AI, especially in cases involving chatbots or biometric recognition systems. This aims to foster informed decision-making and to protect individuals' autonomy.

6. **Support for Innovation**: The regulation encourages innovation, particularly for small and medium-sized enterprises (SMEs), through AI regulatory sandboxes and other supportive measures.

The progressive deployment over the following periods requires every organization to follow up-to-date developments, analysis and summaries of the EU AI Act (Futures of Life Institute, 2024) and subscribe to activity trackers (Digital Policy Tracker, 2024).

2.1.2 Impact of AI Regulation on Innovation

The EU AI Act aims to balance the promotion of innovation with safeguards to prevent adverse impacts. By regulating the deployment of AI in high-stakes areas and GPAI systems, the Act seeks to establish a trustworthy ecosystem for AI, potentially increasing consumer and investor confidence in the technology. However, compliance requirements—particularly for high-risk and GPAI systems—pose challenges for smaller organizations and startups due to the increased costs associated with data, computing infrastructure, and compliance resources. The Act may inadvertently slow down AI development in these areas as companies adjust to the regulatory landscape.

The AI Triad framework (Buchanan, 2020) provides an effective lens to understand the EU AI Act's impact on AI technology:

- **Algorithms**: The Act emphasizes transparency, explainability, and auditability of algorithms, particularly for high-risk and GPAI applications. This emphasis encourages the development of algorithms that can be understood and verified, even as these requirements could slow down rapid algorithmic experimentation and iterative development cycles.
- **Data**: The quality and representativeness of data are central requirements in the Act, underscoring the need to reduce bias and ensure diversity in datasets. This focus promotes fairness in AI but imposes additional obligations on companies to manage data quality, maintain data provenance, and conduct bias audits. Data Governance becomes a mandatory requirement.

- **Computing Power**: The Act does not directly impose restrictions on computing power yet, but mandates appropriate capacity management to mitigate the risk of failure or misuse. For organizations, this could mean additional costs in maintaining secure and reliable infrastructure, which could become a barrier for companies with limited resources.

2.1.3 AI European Strategy Approach

The EU AI Act contributes to the European Union's strategic approach to AI, balancing goals across technological innovation, adversarial countermeasures, and values-driven deployment (Corrigan, J., Flagg, M. and Murdick, D., 2023):

- **Driving Technological Innovation**: While the Act's stringent requirements may slow down rapid AI experimentation, they aim to create an ecosystem of "trustworthy AI". The promotion of standardized, high-quality practices can encourage innovation that aligns with European values, fostering a sustainable AI industry.
- **Impeding Adversaries' Progress**: By establishing a comprehensive framework, the EU protects its citizens and markets from AI applications that could harm public trust. This impedes the deployment of unethical or adversarial AI applications within the EU, such as those based on opaque or manipulative algorithms. While not being the main goal, it may impede adversaries' progress as a by-product.
- **Promoting Safe, Values-Driven Deployment**: The EU AI Act's design is heavily focused on safe and ethical AI deployment, with extensive guidelines on transparency, data governance, and user protection. This commitment aligns with the EU's emphasis on human rights and public welfare, setting a global example in the values-driven deployment of AI.

The EU AI Act employs a mix of direct and enabling levers to enforce compliance and foster a responsible AI environment:

1. **Direct Levers**:
    a. **Prohibition of Unacceptable-Risk AI**: By outright banning AI applications deemed socially detrimental, the EU imposes a top-down directive that directly limits the scope of AI use cases.
    b. **High-Risk AI and GPAI Compliance Requirements**: The Act's mandatory compliance framework, requiring documentation, transparency, and fairness checks for high-risk AI and GPAI, serves as a strong regulatory control over AI development and deployment.
2. **Enabling Levers**:
    a. **Transparency and Accountability**: Requirements for transparency and algorithmic explainability foster a foundation of trust, enabling end-users and stakeholders to make informed decisions.

  b. **EU and National Regulatory Bodies**: By establishing a structured governance framework with both EU-wide and national bodies, the Act creates a collaborative regulatory environment that promotes consistent oversight and enforcement across member states.

  c. **Support for Research and Development**: The EU AI Act encourages innovation within defined ethical boundaries, facilitating the growth of trustworthy AI technology while ensuring that technological advances do not compromise safety or public welfare. For example, promoting the use of regulatory and operational sandboxes and data spaces.

2.1.4 AI Lifecycle Stages: Implications and Compliance Requirements

The EU AI Act affects all stages of the AI lifecycle, spanning from design and development to long-term deployment and diffusion (Janjeva, A., Mulani, N., Powell, R., Whittlestone, J. and Avin, S., 2023). The following table highlights some of the main implications per stage.

Stage	Design, Training, and Testing	Deployment and Usage	Long-term deployment and diffusion
Impact	- Risk Management - Data Governance - Transparency and Documentation - Testing for Compliance	- Conformity Assessment - Transparency Obligations - Human oversight - Prohibited practices	- Monitoring and Record-Keeping - Post-Market Surveillance - Adaptation and Retraining - Governance and Accountability

Here's a breakdown of how the regulation impacts each stage, particularly for high-risk and GPAI systems:

1. **Design, Training, and Testing**: This stage includes the conceptualization, development, data collection, and training of AI systems.
   a. **Risk Management**: During the design phase, developers must conduct comprehensive risk assessments for AI systems. This involves evaluating potential harms related to safety, discrimination, and violation of fundamental rights.
   b. **Data Governance**: The Act requires developers to ensure high-quality data that is accurate, relevant, and free from bias. This applies especially to the training, testing and validation data sets.
   c. **Transparency and Documentation**: AI providers must create and maintain technical documentation that describes the system's architecture, purpose, and functionality, ensuring it complies with the Act's transparency and accountability requirements.

    d. **Testing for Compliance**: Before deployment, high-risk AI and GPAI systems must undergo conformity assessments to verify that they meet the regulatory requirements for transparency, safety, and human oversight.

2. **Deployment and Usage**: This stage involves the AI system being put into service, used by businesses, governments, or consumers, and integrated into the operational environment.

    a. **Conformity Assessment**: Before AI systems can be deployed, they must pass a conformity assessment to demonstrate compliance with the Act's requirements (e.g., safety, transparency, and robustness).

    b. **Transparency Obligations**: When AI systems interact with humans, users must be informed that they are interacting with an AI. For instance, chatbots and AI-driven customer service must disclose their non-human nature.

    c. **Human Oversight**: High-risk and GPAI systems must allow for human oversight during deployment to ensure decisions or actions taken by the AI can be overruled by humans if necessary.

    d. **Prohibited Practices**: AI systems engaging in unacceptable practices, such as subliminal manipulation or systems that exploit vulnerable groups, are banned from being deployed.

3. **Longer-term Deployment and Diffusion**: This stage refers to the continued use of AI systems over time, including updates, retraining, and adaptation to new contexts.

    a. **Monitoring and Record-Keeping**: Providers and deployers of high-risk AI and GPAI systems are required to maintain ongoing monitoring of the AI's performance, updating the technical documentation, and ensuring that the system continues to operate within the safety and transparency guidelines.

    b. **Post-Market Surveillance**: High-risk AI and GPAI systems must be subject to continuous surveillance by market authorities to ensure they continue to meet regulatory requirements. Providers are responsible for addressing any risks that arise during longer-term deployment.

    c. **Adaptation and Retraining**: Any modifications to the system (e.g., retraining with new data) require reassessments of conformity to ensure compliance, particularly for high-risk AI and GPAI systems.

    d. **Governance and Accountability**: National authorities, in coordination with the European AI Office and the European Artificial Intelligence Board (EAIB), will oversee the long-term deployment of AI systems, addressing any non-compliance, and ensuring that rights and safety standards continue to be met over time.

2.2 EU AI Governance: Challenges and Opportunities for Member States

2.1 Striking the Balance Between AI Safety and Competitiveness

The EU AI Act categorizes AI applications into different risk levels, applying strict requirements to high-risk AI systems, such as those used in healthcare, transportation, and law enforcement, while allowing lighter oversight for lower-risk systems. The goal is to ensure that AI systems deployed within the EU uphold high standards of safety, transparency, and ethical considerations. This "risk-based approach" is fundamental for managing AI risks but introduces several complexities.

On the one hand, stringent safety requirements foster public trust and uphold fundamental rights, contributing to the EU's long-standing values of transparency, fairness, and individual rights. The mandatory transparency and risk management standards aim to safeguard citizens against unintended consequences or harm from AI systems. However, achieving these regulatory goals requires compliance with rigorous standards across the AI lifecycle—from design and testing to deployment and monitoring—which can increase operational costs, scale maintenance costs, and potentially delay time-to-market. For EU-based companies, particularly SMEs and startups, these compliance demands may represent substantial barriers to entry and limit their ability to innovate rapidly.

In comparison, global AI competitors—such as the U.S. and China—operate with less regulatory oversight, allowing faster development cycles and greater risk tolerance. The U.S., for example, adopts a more hands-off approach, favoring innovation and industry-led best practices over stringent federal regulations. The AI Safety Institutes with a presence in the US, UK or Japan among others propose voluntary AI safety techniques to avoid hindering innovation (Araujo, 2024). This regulatory asymmetry poses a potential disadvantage for EU companies in competitive sectors, such as autonomous systems and generative AI, where speed and adaptability are crucial.

The challenge, therefore, lies in preventing "regulatory overreach" that could paralyze innovation while safeguarding core European values. Achieving this balance requires a flexible governance model that can adapt to emerging technological shifts and allow for safe experimentation, particularly in controlled environments or regulatory sandboxes. Such measures could help mitigate regulatory barriers without compromising safety, thus fostering both innovation and public trust.

2.2 Implications for Member States

The EU AI Act's impacts are not uniformly distributed, as each Member State faces unique socio-economic, technological, and regulatory landscapes.

This table summarizes some of the primary implications:

Economic Competitiveness and Innovation Gaps	Challenges for SMEs and Startups	Opportunities for Regulatory Harmonization and Ethical Leadership	Supporting Public Trust and AI Adoption	Need for EU and National-Level Support for Compliance
Varied Economic Capacities Investment in AI infrastructure and Talent	High Compliance Burden Stifling AI Entrepreneurship	Enhanced Trust and Market Access Ethical Leadership and Exporting EU Values	Fostering Citizen Trust in AI Localizing AI for Social Good	Funding and Technical Assistance Regulatory Sandboxes for Controlled Experimentation

Below are the details of the selected primary implications:

- **Economic Competitiveness and Innovation Gaps**:
  - **Varied Economic Capacities**: Member States with advanced economies and existing tech ecosystems, such as Germany and France, are better positioned to absorb the compliance costs and capitalize on EU AI Act provisions. Conversely, smaller or less-developed economies may struggle to meet these standards, risking a widening innovation gap between regions beyond GBP (ECB, 2024).
  - **Investment in AI Infrastructure and Talent**: Countries that already prioritize AI in their national strategies, such as France, may benefit from the Act's emphasis on ethical AI, attracting investments aligned with EU values (AI Watch, 2021). Others, however, may lack sufficient resources to build necessary AI infrastructure or retain high-skilled AI talent, especially where demand for compliance, data management, and risk mitigation expertise grows.
- **Challenges for SMEs and Startups**:
  - **High Compliance Burden**: SMEs form the backbone of the EU economy, but for many of these smaller players, the compliance costs associated with high-risk AI can be prohibitive. The requirement for extensive testing, documentation, and transparency measures can limit their ability to innovate, particularly in areas where regulatory compliance is resource-intensive.
  - **Stifling AI Entrepreneurship**: As a result, the EU AI Act might unintentionally discourage AI entrepreneurship in some Member States, driving local startups to relocate to countries with lighter regulatory frameworks to avoid complex compliance. For instance, highly innovative SMEs in digital health or fintech might prefer U.S. markets where entry barriers are comparatively lower.
- **Opportunities for Regulatory Harmonization and Ethical Leadership**:
  - **Enhanced Trust and Market Access**: Compliance with EU standards can increase trust and open up new markets within and beyond Europe, as ethical AI standards become an attractive differentiator in

the global market. For example, Germany's automotive and industrial sectors, already known for their stringent safety protocols, may gain a competitive advantage by emphasizing compliance with AI safety standards.

- ○ **Ethical Leadership and Exporting EU Values**: The EU AI Act enables Member States to collectively set global standards for ethical AI, influencing international norms. Countries like Sweden and Denmark, which have integrated ethical considerations into their national AI strategies, are well-positioned to promote EU-aligned ethical standards in their international partnerships, especially in areas such as data privacy and consumer protection (AI Watch, 2021).

- ● **Supporting Public Trust and AI Adoption**:
  - ○ **Fostering Citizen Trust in AI**: The EU AI Act's provisions around transparency and explainability can help Member States gain public confidence in AI technologies. For instance, countries with strong public sectors, such as France, could leverage compliance to foster greater AI adoption across public services, enhancing citizen trust in automated systems for healthcare, transportation, and education.
  - ○ **Localizing AI for Social Good**: Some Member States are using AI to address region-specific challenges, such as agricultural sustainability in Spain. By ensuring that these applications comply with the EU AI Act, Member States can assure the public of their commitment to safe and ethical AI while driving localized innovation.

- ● **Need for EU and National-Level Support for Compliance**:
  - ○ **Funding and Technical Assistance**: The EU's financial instruments, such as Horizon Europe, Digital Europe, and the European Investment Fund, provide funding that can help Member States develop AI infrastructure, promote talent retention, and support compliance efforts. However, there is an urgent need for Member States to proactively leverage these resources to reduce compliance costs, especially for high-risk AI.
  - ○ **Regulatory Sandboxes for Controlled Experimentation**: The EU AI Act provides a framework for regulatory sandboxes that allow controlled experimentation. Member States can benefit by establishing national sandboxes tailored to their unique economic sectors, such as Spain (Government of Spain, 2023). These environments encourage experimentation without the full compliance burden, thus supporting innovation while maintaining public safety.

3. Spain's National AI Strategy

The [Spanish Agency for the Supervision of Artificial Intelligence](#) (AESIA - Agencia Española de Supervisión de la Inteligencia Artificial-) is a comprehensive framework established to drive AI development while upholding Spain's commitment to ethical, human-centered AI. This strategy is part of Spain's broader Digital 2025 Agenda and aligns with EU guidelines to foster innovation, protect societal values, and position Spain as a competitive AI leader (Government of Spain, 2020). As a part of an update in 2024, the government aims to allocate an additional [€1500 million specifically to new AI initiatives](#). Below, we break down the key components and current strengths of Spain's AI strategy, analyzing them through the lenses of the AI Triad (algorithms, data, and computing power), the AI National Strategy Approach, and the AI lifecycle stages.

3.1 Key Components of Spain's AI Strategy

Spain's AI strategy has six primary strategic pillars that address AI across various sectors, emphasizing the need for responsible development and deployment. Each pillar contributes to the advancement of the AI Triad by enhancing algorithmic research, data infrastructure, and computing capabilities. Additionally, these components align with Spain's objectives to drive technological innovation, protect against misuse, and promote values-driven AI deployment.

- **Scientific Research and Technological Innovation**: This pillar focuses on building a robust R&D environment that encourages scientific excellence in AI and technological advancement. It emphasizes fundamental and applied research, collaborative projects, and the development of advanced algorithms. This aligns with the design, training, and testing stages of the AI lifecycle, ensuring robust, fair, and reliable AI models. Direct government levers here include increased R&D funding and establishing partnerships between universities and industries to support basic and applied research while enabling levers include fostering public-private innovation ecosystems and reducing bureaucratic obstacles to collaboration.
- **Digital Skills and Talent Development**: Spain aims to empower its workforce with digital skills, especially in AI, to foster national talent and attract global expertise. The emphasis is on interdisciplinary training that addresses technical and ethical considerations. This focus on skills development supports safe and values-driven deployment, preparing talent for stages from design to deployment. Direct levers of power in this area involve national educational reforms, funding for STEM and social science integration, and specific programs to close the digital divide, particularly for marginalized groups.
- **Data Platforms and Technological Infrastructure**: This component seeks to build the foundational data and computing resources necessary for AI innovation. By prioritizing secure data platforms, high-performance computing, and interoperable systems, Spain's strategy strengthens the data and computing power aspects of the AI Triad. These infrastructure enhancements are crucial for the immediate deployment and long-term diffusion of AI, enabling large-scale data-driven projects across sectors. The Spanish government employs direct levers like investments in supercomputing

facilities and regulatory standards for data governance, alongside enabling levers such as collaborative data-sharing platforms that enhance interoperability between public and private datasets.

- **AI in Economic Transformation and Value Chains**: To integrate AI across various sectors and elevate Spain's economic productivity, this pillar encourages AI adoption in critical areas such as healthcare, transportation, and agriculture. Spain is working to embed AI into value chains to drive sustainable growth, align with environmental goals, and improve economic resilience. This initiative supports the deployment and diffusion stages of AI, as it enables continuous use and improvement of AI systems in operational environments. Government levers here include incentives for AI adoption in businesses, tax benefits, and grants for green AI initiatives.
- **AI in Public Administration and Strategic National Missions**: The strategy incorporates AI into government operations to improve transparency, efficiency, and service quality in areas like healthcare, education, and justice. This promotes a values-driven deployment approach by applying AI to enhance public welfare. Direct government levers include mandates for AI use in public administration and establishing regulatory frameworks for responsible AI in government services, with enabling levers such as digital transformation funds and technical assistance for public agencies.
- **Ethical and Regulatory Framework**: To ensure AI's ethical deployment, Spain emphasizes a regulatory approach that protects fundamental rights, fosters transparency, and ensures accountability. This framework aligns with the AI National Strategy Approach by promoting safe deployment that is grounded in Spanish and European values. Direct regulatory levers here include the development of a national AI ethics code while enabling levers to involve educational initiatives and creating forums for public discourse on AI ethics.

3.2 Current Achievements and Strengths

Spain's AI strategy has already generated meaningful progress, particularly in fostering human talent, implementing the EU AI Act and leveraging the country's assets.

Following the EU AI Act mandate, the government created AESIA. This organization was established in September 2023 as an autonomous agency of the Spanish Department of Digital Transformation. It is the relevant authority to supervise AI systems in the country. Additionally, it has been established that the [Spanish Central Bank](#) will be the relevant authority for high-risk AI systems in the financial sector (Spanish Central Bank, 2024).

In terms of policies targeting primary and secondary education, the national AI strategy foresees the following actions (Government of Spain, 2021):

- Introducing the foundations to understand computational thinking, critical and creative thinking;
- Strengthening the orientation towards Information and Communications technologies (ICT) and AI of early education cycles and training of teachers;

- Promoting and adapting education in science, technology, engineering, math and humanities (STEM), also within the tertiary education.

At higher education levels, such as tertiary education, the following initiatives aim to strengthen the technological content towards AI:

- Expanding postgraduate studies, Master's and doctoral programmes that offer AI training;
- Promoting an inter-multidisciplinary approach in all educational disciplines.

As a result, the number of programs with content related to AI has increased across Universities and Business Schools in Spain.

In terms of the AI Triad:

- **Algorithms**: Spain has made progress in AI algorithm development through its research initiatives, particularly in fields such as generative AI creating [specific models for the languages in Spain such as Catalan or Spanish](#) using training data sets with balanced distribution (in terms of the local languages).
- **Data**: Spain has invested in creating high-quality datasets representing the local languages. This data set has been the key to creating the localized Large Language Models (LLMs).
- **Computing Power**: High-performance computing (HPC) capabilities are expanding in Spain through investments in supercomputing facilities. In particular, the BCN-CNS has been the key computing resource to create some localized LLMs.

The Spanish government leverages both direct and enabling measures to drive AI development while ensuring compliance with ethical and regulatory standards:

- **Direct Levers**:
  - **Regulatory Compliance Mandates**: Enforcing ethical AI through legal frameworks, including data governance standards and the establishment of a national AI ethics code.
  - **Public Funding for Research**: Direct government funding for AI research projects, data infrastructure, and HPC facilities.
  - **Mandated AI in Public Services**: Requiring the integration of AI in public administration, ensuring AI adoption in areas such as healthcare, education, and social welfare.
- **Enabling Levers**:
  - **Innovation Ecosystems**: Developing Digital Innovation Hubs to support businesses with AI resources, training, and data access, promoting broader AI adoption.
  - **Talent Development Programs**: Funding education and training programs to cultivate a digitally skilled workforce, with a focus on attracting diverse talent into AI.
  - **Public-Private Partnerships**: Facilitating collaboration between academia, industry, and government to advance interdisciplinary AI research and foster ethical innovation across sectors.

The Spanish Government has implemented in a short period of time [28 AI policies](#) (some of them have no budget or are still pending to start).

4. Challenges to Spain's AI Competitiveness

Spain's journey toward becoming a leading AI player in the EU faces significant barriers that may be high to overcome. This section examines the primary challenges to Spain's AI competitiveness, focusing on the tension between regulatory compliance and innovation, and identifying structural and economic barriers impacting AI growth.

4.1 Regulatory Compliance vs. Innovation

4.1.1 Potential frictions between the EU AI Act and Spain's AI Growth

Spain's AI ecosystem, while promising, is still in a nascent stage compared to other leading European countries such as Germany and France. This creates several potential frictions between Spain's AI growth ambitions and the compliance demands imposed by EU legislation.

- **Compliance Costs and Resource Limitations**: For Spain, where the majority of AI companies are SMEs and startups, the high cost of compliance represents a formidable barrier. Many smaller companies may struggle to meet the transparency and risk management requirements outlined by the EU AI Act. As these companies often operate on limited budgets, diverting resources to compliance rather than innovation can slow down Research and Development (R&D) efforts and reduce Spain's overall competitive edge.
- **Impact on Speed of Innovation**: Spain's AI innovation initiatives may be hindered by the slower pace required to ensure full compliance with EU standards. In sectors such as healthcare and transportation, where the potential for high-risk applications exists, the need to navigate complex regulatory hurdles could delay AI deployment. Compared to AI competitors operating in countries with less stringent requirements, Spanish firms may lose valuable time-to-market advantages, impacting their capacity to scale internationally.

4.1.2 Examples of bottlenecks caused by regulatory constraints

- **Data Governance and Access**: One bottleneck is the EU AI Act's strict guidelines on data handling and usage, which are meant to prevent bias and protect data privacy. Spanish AI firms, particularly in data-intensive sectors like fintech or healthcare, may face additional administrative challenges in ensuring data governance compliance. Even with the support of the Spanish Government, these requirements can slow down project timelines and increase operational costs.
- **Limited Testing Opportunities**: Another regulatory constraint is the challenge of finding opportunities for controlled experimentation. The EU AI Act emphasizes extensive testing for high-risk AI, yet Spain's limited access to advanced infrastructure, such as AI sandboxes or high-performance computing centers, can complicate testing and validation phases. As a result,

firms face challenges in demonstrating compliance and establishing proof-of-concept within reasonable timeframes. While there are existing facilities such as the BSC-CNS and the Spanish Government offers an AI Sandbox, more testing facilities are needed.

4.2 Structural and Economic Barriers

Beyond regulatory challenges, Spain's AI ecosystem is also constrained by structural and economic factors, including infrastructure limitations, gaps in AI funding, and issues with talent retention. These barriers further complicate Spain's ability to keep pace with AI innovation leaders both within and outside the EU. We want to highlight some of the gaps in infrastructure, funding, and talent:

- **Inadequate Infrastructure**: While Spain has made strides in developing digital infrastructure, it still faces gaps in HPC and cloud resources essential for large-scale AI projects. There are some private initiatives that could alleviate this situation but more work needs to be done: [Microsoft is planning to invest €6.69 billion ($7.16bn) in developing new data centers in the northeastern region of Aragon, Spain](#).
- **Limited AI-Specific Funding**: Spain's current funding allocations for AI lag behind those of other EU nations like Germany and [France -The President reaffirmed that artificial intelligence is a strategic priority for France, dedicating nearly €2.5 billion of France 2030](#)–, impacting both private sector and academic research. Though there are national initiatives to support AI R&D, these funds are limited, and competition for grants is high. Smaller firms and research institutions may lack the financial backing required to remain competitive, while limited public funding hampers the development of foundational AI research, essential for long-term competitiveness.
- **Brain Drain to Tech Hubs**: One of Spain's persistent challenges is retaining highly skilled AI talent. Spanish professionals often move to countries offering more lucrative opportunities, such as the U.S. or Northern European nations, where funding is more abundant, and AI job markets are more mature. This "brain drain" weakens Spain's ability to develop a robust AI workforce, affecting both industry growth and academic contributions to AI research. If we combine this endemic problem with the expected retirement of 60% of professors in Universities in 2030, the country is facing a major crisis.
- **Insufficient Support for Career Development**: While there are programs in place to develop AI talent domestically, these efforts often lack the incentives needed to retain high-skilled professionals. Many AI practitioners and researchers encounter barriers in accessing competitive wages, cutting-edge research opportunities, and career advancement, prompting them to seek positions abroad. In the long run, this talent loss limits Spain's ability to foster an AI-literate workforce capable of innovating within a compliant framework.

5. Recommendations for Strengthening Spain's AI Competitiveness

To fully capitalize on AI's potential while remaining compliant with EU legislation, Spain can proactively leverage regulatory frameworks and target investments to create a robust, innovation-driven AI sector. This section outlines fifteen strategic recommendations that Spain could adopt to strengthen its AI competitiveness.

Each one of these recommendations can contribute to the Spanish AI Strategy, balancing goals across technological innovation, adversarial countermeasures, and values-driven deployment (Corrigan, J., Flagg, M. and Murdick, D., 2023):

Goal	Recommendation	Driving technological innovation	Adversarial Countermeasures	Promoting safe, values-driven deployment
Leveraging the EU AI Act for Innovation and Safety	Using Regulatory Frameworks to Enhance Responsible AI	✔		✔
	Pushing for Open Source AI Model Regulation and Fair Use Licensing	✔		✔
	Regulatory Sandboxes and Innovation-Friendly Interpretations of the EU AI Act	✔		✔
	Regulation of Small Frontier Models	✔		✔
	Regulation on Computing Governance			✔
	AI Safety Unit	✔		✔
	Pushing beyond Human Oversight for additional AI Safety Measures			✔
	Help organizations to adopt AI ISO/IEC standards to increase EU AI Act Compliance	✔		✔
	Expand AI literacy efforts to explain AI systemic risks and copyright rules	✔		✔
Increasing Investment in AI Infrastructure	Expanding AI Research Centers and Innovation Hubs	✔		✔
	Co-Investing in Data Centers	✔		✔
	Securing More Funding from Public and Private Sectors	✔		

Introducing New AI Policy Levers for Innovation	AI Visas for Talent Acquisition	✔	✔	
	AI Programs for Talent Retention	✔	✔	
	AI Diplomacy with Latin America	✔	✔	✔

5.1 Leveraging the EU AI Act for Innovation and Safety

Although the EU AI Act imposes stringent regulations, Spain can harness these frameworks to bolster innovation in a responsible, values-driven AI landscape. By adopting a proactive approach to EU compliance, Spain can create a differentiated AI ecosystem that emphasizes ethical AI while fostering competitiveness.

5.1.1 Using Regulatory Frameworks to Enhance Responsible AI

Spain can establish itself as a leader in responsible AI by supporting compliance initiatives that promote transparency and accountability. Implementing guidelines aligned with the EU AI Act can position Spanish firms as trustworthy and ethically aligned with European values, which may enhance their marketability across the EU and globally. Moreover, by promoting responsible AI practices - for instance EU model clauses for AI procurement -, Spain could attract international partners and investments from companies looking for compliant AI solutions. For example, Spain should actively pursue the publication of the AI Liability Directive, which aims to improve the functioning of the internal market by laying down uniform rules for certain aspects of non-contractual civil liability for damage caused by the involvement of AI systems.

5.1.2 Pushing for Open Source AI Model Regulation and Fair Use Licensing

Spain could advocate for EU regulations that specifically address the use of open-source AI models and open models (such as Llama by Meta), focusing on fair use licensing. Because of the lack of centralized control, open models present distinct governance challenges, but the gap in performance between closed and open AI models is getting smaller (Cottier, 2024). Through frameworks like Fair.io, Spain could support licenses that ensure transparent, ethically aligned uses of open-source AI, promoting interoperability and accountability while controlling the diffusion of open source AI models. Encouraging open-source contributions could enhance Spain's AI ecosystem by making models more accessible to startups and researchers, thereby stimulating innovation at lower costs.

5.1.3 Regulatory Sandboxes and Innovation-Friendly Interpretations of the EU AI Act

Spain can lead the charge within the EU to establish regulatory sandboxes that allow firms to test innovative AI applications in a controlled environment, reducing the time and cost of compliance. By encouraging innovation-friendly interpretations of the EU AI Act, Spain can foster experimentation, accelerate testing cycles, and promote agile compliance processes. These sandboxes could specifically target high-growth

areas like healthcare and fintech, where rapid deployment of compliant AI solutions could provide substantial benefits, or can be created in some specific regions (such as has been done in [Canton](#) - Zurich-).

5.1.4 Regulation of Small Frontier Models

Spain should push for the EU AI Act to consider separate regulatory frameworks for Small Frontier Models, distinct from the large-scale foundation models. Since Small Frontier Models often operate at a scale that mitigates some high-risk issues associated with foundation models, tailored regulations could ease compliance burdens for smaller companies. However, capability is not correlated with scale and policies related to training and derived data sets may be more efficient. (Gupta, 2024). This approach would allow Spain to incentivize trustworthy innovation among SMEs while adhering to EU safety standards.

5.1.5 Regulation on Computing Governance

Spain should consider pushing for the EU AI Act to consider separate regulatory frameworks for Computing Governance. Policies and levers can be structured in terms of visibility, allocation and enforcement (Sastry, 2024):

Visibility	Allocation	Enforcement
- Using public information about compute quantities to estimate actors' AI capabilities (now and in the future) - Required reporting of large-scale training compute usage from cloud providers and AI developers - International AI chip registry - Privacy-preserving workload monitoring	- Differentially advancing beneficial AI development - Redistributing AI development and deployment across and within countries - Changing the overall pace of AI progress - Collaborating on a joint AI megaproject	- Enforcing "compute caps" via physical limits on chip-to-chip networking - Hardware-based remote enforcement - Preventing risky training runs via multiparty control - Digital norm enforcement

Spain should champion the adoption of computing governance not only for data centers and HPCs in Spain but for the rest of the supercomputers (as listed in [EuroHPC JU](#) (European High-Performance Computing Joint Undertaking)) and data centers in Europe.

5.1.6 AI Safety Unit

As the industry is moving to [compound AI systems](#) and [Agentic AI](#), AI safety research is key as these new paradigms pose new safety challenges. Spain should consider creating an AI Safety Unit as part of AESIA, although it can be considered an independent institute. This new unit should be part of the AI Safety Institute Network.

So far the International Network of AI Safety Institutes is constituted by the United States, United Kingdom, European Union, Japan, Singapore, South Korea, Canada, France, Kenya and Australia (although some of the members are still lagging behind in the constitution of its national safety institute). The following table provides an organizational overview of AISI Network Members (CSIS, 2024):

Country	Name	Establishment
United States	US AISI	February 2024
United Kingdom	UK AISI	November 2023
European Union	EU AI Office	May 2024
Japan	Japan AISI	February 2024
Singapore	Singapore AISI	May 2024
South Korea	Korean AISI	May 2024 (Announced)
Canada	Canada AISI	April 2024 (Announced)
France	AI Evaluation Center (INRIA/LNE)	July 2024

This could position the country as a relevant player in the global arena, and align the research to the EU AI Act. As AI systems are advancing rapidly in sensitive domains like cyber or biological, governments should urgently take action on AI safety in the next eighteen months introducing direct levers such as conducting and publishing risk evaluations and developing and publishing AI Safety preparedness plans. Some interesting recommendations about evaluation safety points (JAISI, 2024a) and red teaming (JAISI, 2024b) have been published by members of the network.

5.1.7 Pushing beyond Human Oversight for additional AI Safety Measures

One mechanism that has become a centerpiece of global efforts to regulate government algorithms is to require human oversight of algorithmic decisions. However, human oversight policies provide a false sense of security in adopting algorithms and enable vendors and agencies to shirk accountability for algorithmic harms as evidence suggests that people are unable to perform the desired oversight functions. Spain should propose a shift from human oversight to institutional oversight as the central mechanism for regulating government algorithms (Green 2022). Additionally, Spain must advocate for the following measure in the future GPAI Code of Practice: Implementing a multi-layered framework of safeguards for model evaluation, combining technical, physical, and legal measures to protect proprietary information while enabling meaningful assessments.

5.1.8 Help organizations to adopt AI ISO/IEC standards to increase EU AI Act Compliance

At this time, the [GPAI Code of Practice](#)'s first draft has been published, but organizations cannot wait for the final version to comply with the regulation. For those organizations or institutions that still do not have any AI governance framework (for example, [AIGA](#)), AESIA can promote a trustworthy framework based on ISO/IEC standards that covers high risk AI systems as well (Piattini, 2024). The framework proposes the following mapping between organizational needs, standards and requirements and we have extended to consider additional organizational needs.

Organizational needs	Regulatory Requirement	Standard
Adopt AI Governance	AI Governance	[ISO/IEC 38507 Information technology — Governance of IT — Governance implications of the use of artificial intelligence by organizations](#)
Adopt Data Governance	Data Governance	[ISO/IEC 8183 Information technology — Artificial intelligence — Data life cycle framework](#)
Manage AI systems efficiently	AI Management	[ISO/IEC 42001 Information technology — Artificial intelligence — Management system](#)
Ensure quality in AI systems	Data Quality	ISO/IEC 5259 Artificial intelligence — Data quality for analytics and machine learning (ML) ([1](#) - [2](#) - [3](#) - [4](#) -[5](#) - [6](#))
	Software (product)	[ISO/IEC 25058 Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Guidance for quality evaluation of artificial intelligence (AI) systems](#) [ISO/IEC 25059 Software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Quality model for AI systems](#)
	AI Quality: Software (process)	[ISO/IEC 5338 Information technology — Artificial intelligence — AI system life cycle processes](#) [ISO/IEC 24970 Artificial intelligence — AI system logging](#)
	Security and Privacy	[ISO/IEC 27563 Security and privacy in artificial intelligence use cases — Best practices](#) [ISO/IEC 27090 Cybersecurity — Artificial Intelligence — Guidance for addressing security threats and failures in artificial intelligence systems](#) [ISO/IEC 27091 Cybersecurity and Privacy —](#)

		Artificial Intelligence — Privacy protection
	Safety	ISO/IEC 5469 Artificial intelligence — Functional safety and AI systems
Ensure that AI systems are fair, trustworthy, robust, transparent, sustainable and unbiased	Robustness	ISO/IEC 24029 Artificial Intelligence (AI) — Assessment of the robustness of neural networks (1 - 2) ISO/IEC 42119 Artificial intelligence — Testing of AI ISO/IEC 17847 Information technology — Artificial intelligence — Verification and validation analysis of AI systems
	Fairness	ISO/IEC 12791 Information technology — Artificial intelligence — Treatment of unwanted bias in classification and regression machine learning tasks ISO/IEC 24027 Information technology — Artificial intelligence (AI) — Bias in AI systems and AI aided decision making ISO/IEC 24368 Information technology — Artificial intelligence — Overview of ethical and societal concerns
	Sustainability	ISO/IEC 20226 Information technology — Artificial intelligence — Environmental sustainability aspects of AI systems
	Performance	ISO/IEC 4213 Information technology — Artificial intelligence — Assessment of machine learning classification performance To be replaced by: ISO/IEC 4213 Artificial intelligence — Performance measurement for AI classification, regression, clustering and recommendation tasks
	Transparency	ISO/IEC 12792 Information technology — Artificial intelligence — Transparency taxonomy of AI systems
	Trustworthiness	ISO/IEC 24028 Information technology — Artificial intelligence — Overview of trustworthiness in artificial intelligence
	Human Oversight	ISO/IEC 42105 Information technology — Artificial intelligence — Guidance for human oversight of AI systems
	Explainability and Interpretability	ISO/IEC 6254 Information technology — Artificial intelligence — Objectives and approaches for explainability and

		interpretability of ML models and AI systems
Manage risk in AI systems	Risk Management	ISO/IEC 23894 Information technology — Artificial intelligence — Guidance on risk management ISO/IEC 8200 Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems ISO/IEC 42005 Information technology — Artificial intelligence — AI system impact assessment

It is important to note that other ISO/IEC standards may be developed in the future and this table should be updated to reflect the latest developments.

5.1.9 Expand AI literacy efforts to explain AI systemic risks and copyright rules

The first draft of the GPAI code of practice introduces rules for systemic risks and copyright (Hendricks, 2023). Spain, through AESIA and other institutions, should broaden AI literacy programs to address rising AI systemic risks (MIT, 2024) and copyright issues in the context of high-risk AI systems, GPAI and frontier models.

Systemic risk in AI refers to the potential for AI systems to create cascading failures, amplify vulnerabilities, or exacerbate risks that affect entire sectors, economies, or society at large. Unlike isolated incidents where an AI system might malfunction in a single context, systemic risks involve widespread and interconnected effects that can disrupt critical systems and social functions. Copyright and intellectual property topics include data provenance, legal restrictions on using copyrighted materials in model training, fair use, and intellectual property implications of AI-generated content.

5.2 Increasing Investment in AI Infrastructure

5.2.1 Expanding AI Research Centers and Innovation Hubs

Spain has a unique comparative advantage over large foundation labs, such as lower operational costs and proximity to markets in Latin America. Spain can capitalize on this by investing in specialized AI research centers that focus on fields relevant to its economic and industrial landscape, such as agritech, energy, and tourism. These areas represent Spain's economic strengths and potential for AI applications, allowing for specialized, applied AI research that may not be prioritized by larger labs focused on generalized AI.

5.2.2 Co-Investing in Data Centers

To address the increasing data demands of AI, Spain could co-invest in data center facilities in partnership with private-sector firms and other EU countries. By establishing joint ventures, Spain could reduce infrastructure costs while expanding access to computational resources. Additionally, these centers could support

Spanish firms working with high-compliance data applications, such as healthcare and financial services, reducing reliance on external cloud services.

5.2.3 Securing More Funding from Public and Private Sectors

To bridge existing funding gaps, Spain should prioritize attracting both public and private investment into its AI ecosystem. At the public level, Spain could work with the EU to secure grants specifically targeted at emerging technologies and infrastructure. On the private side, tax incentives and R&D credits could attract venture capital and private equity investments. Further, collaborations with global tech companies for AI initiatives in Spain could help bolster funding sources, infrastructure support, and knowledge sharing.

5.3 Introducing New AI Policy Levers for Innovation

To foster innovation and improve Spain's AI competitiveness, targeted policies and programs can attract international talent, build diplomatic ties, and elevate Spain's influence in the AI space.

5.3.1 AI Visas for Talent Acquisition

Spain could adopt an AI visa program similar to Singapore's Tech Pass, targeting top AI researchers, engineers, and professionals worldwide. Such a visa would allow high-skilled professionals to live and work in Spain with attractive benefits and residency options, helping to fill local talent gaps. Given the competitive nature of global AI talent acquisition, an AI visa program could be an effective tool for bringing in the expertise necessary to develop Spain's AI sector.

5.3.2 AI Programs for Talent Retention

Spain could adopt an AI Talent retention program similar to the US Optional Practical Training (OPT) Program, which allows international students on F-1 student visas to work temporarily in the United States after graduating. This could be an effective tool to retain young talent in the country.

5.3.3 AI Diplomacy with Latin America

Spain's cultural and linguistic connections with Latin America provide a natural advantage in establishing diplomatic and business relations in the AI domain. By forming AI partnerships and knowledge-sharing agreements with Latin American countries, Spain can build an extended AI ecosystem that encourages mutual growth. Initiatives could include collaborative research centers, AI ethics seminars, multilateral agreements, and investment programs that bridge Spanish and Latin American AI firms, fostering innovation while expanding Spain's influence in global AI markets.

6. Conclusions

6.1 Key Findings

As Spain seeks to establish itself firmly in the AI industry amidst an evolving European Union regulatory landscape, both the strengths and challenges inherent in its national strategy come into focus. The EU AI Act has introduced a unified, risk-based governance framework for AI systems, emphasizing transparency, respect for human rights, and accountability. While this regulation bolsters public confidence and aligns with Spain's values-driven approach to artificial intelligence development and deployment, it also imposes significant compliance costs, particularly on small and medium-sized enterprises (SMEs) and startups, which may impede the rapid advancement and application of AI technologies.

Spain's National Artificial Intelligence Strategy, built upon foundations such as scientific research, talent cultivation, data infrastructure, economic transformation, integration of AI into public administration, and adherence to ethical standards, underscores a dedication to nurturing responsible AI development. Spain's accomplishments in algorithm design, data management, and investments in computing power place it in a strong position within the European Union, particularly in sectors where ethically aligned AI can provide competitive advantages. Nonetheless, structural and economic obstacles—including shortages of funding specifically dedicated to AI initiatives, challenges in retaining skilled talent, and deficiencies in testing infrastructure—pose substantial impediments to maintaining competitiveness both within Europe and globally.

6.2 Call to Action for Policymakers, Industry Leaders, and Academic Stakeholders

To fully harness AI's potential while staying compliant with the EU AI Act, Spain's leaders and stakeholders must adopt targeted initiatives that align regulatory compliance with AI innovation:

- **For Policymakers**: Introduce adaptive regulatory frameworks, such as sector-specific innovation sandboxes, to allow controlled experimentation within the boundaries of the EU AI Act. Greater investment in digital infrastructure and AI-specific R&D funding will also be critical. Policymakers should advocate for EU-wide adjustments to support smaller frontier AI models, OpenSource AI Models, and computing governance that align with Spain's unique market needs.
- **For Industry Leaders**: Embrace the ethical and transparency requirements of the EU AI Act as a competitive advantage. By embedding robust data governance practices and transparency measures into AI systems, Spanish companies can gain consumer trust and access new markets. Industry

leaders should also actively engage in public-private partnerships to drive R&D and facilitate knowledge sharing between academia and industry. Last but not least, industry leaders must invest in upskilling and reskilling programs that empower the workforce with the knowledge and tools to thrive in an AI economy.

- **For Academic Stakeholders**: Researchers, universities, and educational institutions must focus on talent retention by enhancing AI-related programs and offering career development pathways within Spain. Furthermore, engaging with international partners, especially within the Latin American AI ecosystem, can bolster Spain's influence and create collaborative AI opportunities that align with Spain's ethical values.

By aligning efforts across policy, industry, and education, Spain can lead in building a values-driven, competitive AI ecosystem. This collective approach will position Spain as a model for responsible AI that fosters both compliance and innovation in an increasingly complex global AI landscape.

7. Glossary

AESIA	Agencia Española de Supervisión de la Inteligencia Artificial
AI	Artificial Intelligence
BSC-CNS	Barcelona Supercomputing Center - Centro Nacional de Supercomputación
CAGR	Compound Annual Growth Rate
EAIB	European Artificial Intelligence Board
ENIA	Estrategia Nacional de Inteligencia Artificial
EU	European Union
EUHPC JU	European High-Performance Computing Joint Undertaking
GBP	Gross Domestic Product
GDPR	General Data Protection Regulation
GPAI	General Purpose Artificial Intelligence
HPC	High-Performance Computing
ICT	Information and Communications
IIA-CSIC	Instituto de Investigación en Inteligencia Artificial - Consejo Superior de Investigaciones Científicas
ISO/IEC	International Organization for Standardization/International Electrotechnical Commission
LLM	Large Language Model
R&D	Research and Development
SMEs	Small and Medium-sized Enterprises
STEM	Science, Technology, Engineering and Mathematics
VRAIN	Valencian Research Institute for Artificial Intelligence

8. References

- AI Watch. (2021) "National strategies on Artificial Intelligence: A European perspective" AI Watch. https://ai-watch.ec.europa.eu/publications/ai-watch-national-strategies-artificial-intelligence-european-perspective-2021-edition_en (retrieved on 04 Nov 2024)
- Araujo, R. (2024) "Understanding the First Wave of AI Safety Institutes: Characteristics, Functions, and Challenges". Institute for AI Policy and Strategy (IAPS) https://www.iaps.ai/research/understanding-aisis (retrieved on 04 Nov 2024)
- Buchanan, B. (2020). "The AI triad and what it means for national security strategy". Center for Security and Emerging Technology. https://cset.georgetown.edu/wp-content/uploads/CSET-AI-Triad-Report.pdf (retrieved on 29 Oct 2024)
- Cottier, B. et al. (2024) "How Far Behind Are Open Models?" Epoch AI. https://epoch.ai/blog/open-models-report (retrieved on 13 Nov 2024)
- Corrigan, J., Flagg, M. and Murdick, D. (2023). "The Policy Playbook: Building a Systems-Oriented Approach to Technology and National Security Policy" CSET (Center for Security and Emerging Technology) https://cset.georgetown.edu/publication/the-policy-playbook/ (retrieved on 29 Oct 2024)
- Curto, J., et al. (2024) "Awesome Responsible Artificial Intelligence". *GitHub*, 2024. https://github.com/AthenaCore/AwesomeResponsibleAI (Accessed 7 Nov 2024)
- CSIS. (2024) "The AI Safety Institute International Network: Next Steps and Recommendations" CSIS (Center for Strategic and International Studies), 2024. https://www.csis.org/analysis/ai-safety-institute-international-network-next-steps-and-recommendations (Accessed 22 Nov 2024)
- Digital Policy Tracker. (2024). "Europe Policy Tracker". Digital Policy Tracker. https://digitalpolicyalert.org/activity-tracker?offset=0&limit=10&jurisdiction=1049&period=2020-01-01,2024-11-13 (Accessed 13 Nov 2024)
- European Central Bank (ECB). (2024). GDP and expenditure components. European Central Bank https://data.ecb.europa.eu/main-figures/macroeconomic-and-sectoral-indicators/gdp-and-expenditure-components (retrieved on 04 Nov 2024)
- European Commission. (2024) EU AI Act. "Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797

and (EU) 2020/1828 (Artificial Intelligence Act)". European Commission.
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401689
(retrieved on 29 Oct 2024)

- Future of Life Institute. (2024) "The EU Artificial Intelligence Act. Up-to-date developments and analyses of the EU AI Act". Future of Life Institute. https://artificialintelligenceact.eu/ (retrieved on 29 Oct 2024)
- Gartner. (2023). "Forecast Analysis: Artificial Intelligence Software, 2023-2027, Worldwide" Gartner. https://www.gartner.com/en/documents/4916331 (retrieved on 29 Oct 2024)
- Green, Ben. (2023) "The Flaws of Policies Requiring Human Oversight of Government Algorithms". Computer Law & Security Review, Volume 45, 2022, Available at SSRN: https://ssrn.com/abstract=3921216 or http://dx.doi.org/10.2139/ssrn.3921216 (retrieved on 7 Nov 2024)
- Government of Spain (2019). Spanish RDI Strategy in Artificial Intelligence. Ministry of Science, Innovation and Universities. http://www.ciencia.gob.es/stfls/MICINN/Ciencia/Ficheros/Estrategia_Inteligenc ia_Artificial_EN.PDF (retrieved on 07 Nov 2024)
- Government of Spain (2021). "Digital Competences Plan". Ministry of Economic Affairs and Digital Transformation. https://www.lamoncloa.gob.es/presidente/actividades/Documents/2021/27012 1-PlanCompetenciasDigitales.pdf (retrieved on 07 Nov 2024)
- Government of Spain. (2023). "Spain Digital 2026". Ministry of Economic Affairs and Digital Transformation. https://portal.mineco.gob.es/es-es/digitalizacionIA/Paginas/ENIA.aspx (retrieved on 29 Oct 2024)
- Government of Spain. (2020) "Digital Spain 2025". Ministry of Economic Affairs and Digital Transformation. https://portal.mineco.gob.es/RecursosArticulo/mineco/ministerio/ficheros/2102 04_Digital_Spain_2025.pdf (retrieved on 07 Nov 2024)
- Gupta, Ritwik, et al. (2024). "Data-Centric AI Governance: Addressing the Limitations of Model-Focused Policies." arXiv preprint arXiv:2409.17216 https://arxiv.org/pdf/2409.17216 (retrieved on 13 Nov 2024)
- Hendrycks, D., Mazeika, M., & Woodside, T. (2023). "An overview of catastrophic AI risks. Center of AI Safety". arXiv preprint arXiv:2306.12001. https://arxiv.org/pdf/2306.12001 (retrieved on 15 Nov 2024)
- JAISI. (2024a) "Guide for Evaluation Safety Points Regarding AI Safety" JAISI (Japan Artificial Intelligence Safety Institute) https://aisi-go-jp.translate.goog/effort/effort_information/240918_2/?_x_tr_sl=a uto&_x_tr_tl=en&_x_tr_hl=es (retrieved on 13 Nov 2024)
- JAISI. (2024b) "Read Teaming Methodology for AI Safety" JAISI (Japan Artificial Intelligence Safety Institute) https://aisi-go-jp.translate.goog/effort/effort_information/240925/?_x_tr_sl=aut o&_x_tr_tl=en&_x_tr_hl=es (retrieved on 13 Nov 2024)

- Janjeva, A., Mulani, N., Powell, R., Whittlestone, J. and Avin, S. (2023). "Strengthening Resilience to AI Risk. A guide for UK policymakers" CETaS (Centre for Emerging Technology and Security) https://cetas.turing.ac.uk/sites/default/files/2023-08/cetas-cltr_ai_risk_briefing_paper.pdf (retrieved on 29 Oct 2024)
- MIT (2024) "AI Risk Repository". MIT. https://airisk.mit.edu/ (retrieved on 15 Nov 2024)
- OECD. (2024) "AI in Spain". OECD. https://oecd.ai/en/dashboards/countries/Spain (retrieved on 29 Oct 2024)
- Oxford Insights. (2023) "Governance AI Readiness Index 2023" Oxford Insights. https://oxfordinsights.com/ai-readiness/ai-readiness-index/ (retrieved on 7 Nov 2024)
- Piattini, M. and Fernández C.M. (2024) "Marco Confiable". Revista SIC 162 https://revistasic.es/revista-sic/sic-162/colaboraciones/marco-confiable/ (retrieved on 14 Nov 2024)
- PwC. (2023). "Global Artificial Intelligence Study: Exploiting the AI Revolution". PricewaterhouseCoopers. https://www.pwc.co.nz/insights-and-publications/2023-publications/artificial-intelligence-study.html (retrieved on 29 Oct 2024)
- Telefonica Foundation. (2023). "Sociedad Digital en España 2023". Telefonica Foundation. https://www.fundaciontelefonica.com/cultura-digital/publicaciones/sociedad-digital-en-espana-2023/780/#close (retrieved on 29 Oct 2024)
- Sastry, G., Heim, L., Belfield, H., Anderljung, M., Brundage, M., Hazell, J., … & Coyle, D. (2024). Computing Power and the Governance of Artificial Intelligence. arXiv preprint arXiv:2402.08797. https://arxiv.org/pdf/2402.08797 (retrieved on 07 Nov 2024)
- Spanish Bank. (2024) "¿Qué puede hacer el Banco de España para apoyar los restos de la revolución tecnológica que afrontamos?". Banco de España. https://www.bde.es/f/webbe/GAP/Secciones/SalaPrensa/IntervencionesPublicas/Gobernador/Arc/Fic/IIPP-2024-10-07-escriva-es-or.pdf (retrieved on 07 Nov 2024)
- Statista. (2024) "Artificial intelligence market size in Spain 2020-2030". Statista. https://www.statista.com/forecasts/1491196/artificial-intelligence-market-size-spain (retrieved on 29 Oct 2024)
- Tortoise Media. (2024). "The Global AI Index". Tortoise Intelligence. https://www.tortoisemedia.com/intelligence/global-ai/#rankings (retrieved on 29 Oct 2024)