

AI in Istria from an Industrial Perspective

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Abstract

Artificial Intelligence (AI) is a transformative technology with immense potential to drive innovation and sustainability across diverse industries in Istria, Croatia. This study examines the industrial applications of AI in key industrial sectors such as tourism, agriculture, logistics, renewable energy, creative industries, and manufacturing. The research employs a systematic literature review and qualitative content analysis of expert interviews, involving stakeholders from various industries, to assess AI's impact and identify strategies for its implementation. Results highlight that AI can enhance operational efficiency, personalize customer experiences, and enable sustainable practices, particularly in tourism and agriculture. For instance, AI-driven predictive analytics and smart farming can improve resource allocation and productivity. In logistics, smart port systems optimize cargo handling, while creative industries benefit from AI-enabled content creation and digital preservation. Key challenges include limited infrastructure, skill gaps, and high initial investments, particularly for small and medium enterprises. Opportunities lie in fostering collaborations with European initiatives, developing innovation hubs, and leveraging Istria's strategic position as a pilot region for AI-driven projects. The findings emphasize the importance of integrating AI into regional strategies to bolster economic growth, sustainability, and global competitiveness, positioning Istria as a leader in AI-driven regional development.

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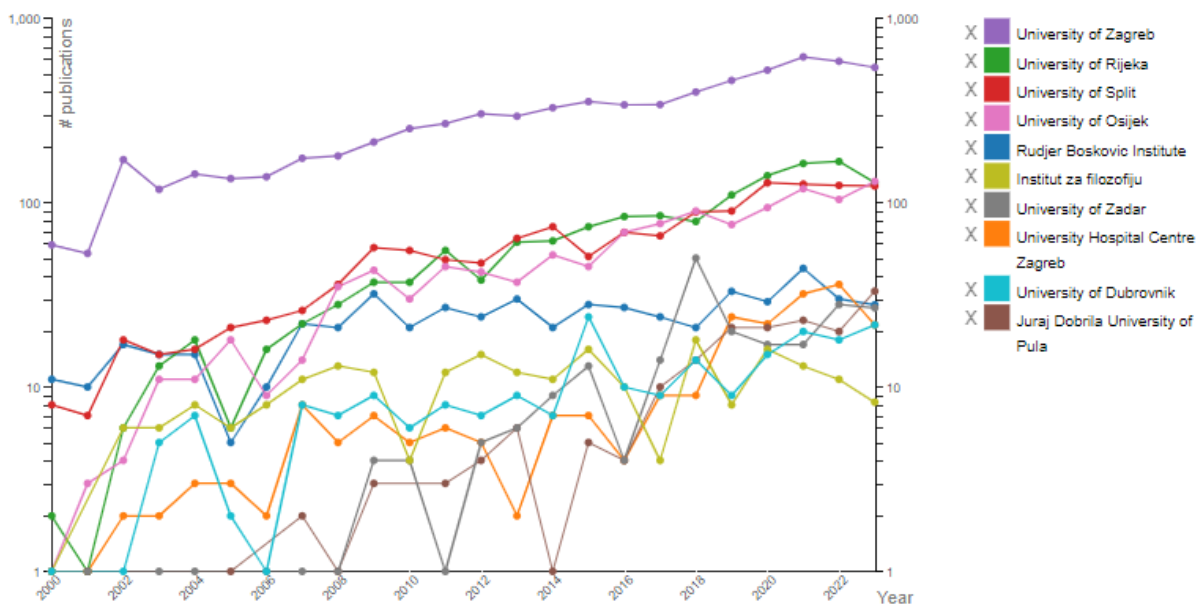
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Introduction

Artificial Intelligence (AI) is emerging as a transformative force across industries and regions, with significant potential for enhancing economic growth, sustainability, and innovation. For Istria, a region renowned for its rich cultural heritage, thriving tourism industry, and growing tech ecosystem, AI offers invaluable opportunities to optimize existing sectors while fostering new ones. The integration of AI into Istria's diverse economy can streamline agricultural practices, enhance tourism experiences, and improve local governance through data-driven decision-making. Moreover, AI-driven solutions in education and healthcare could address regional challenges, improving quality of life for residents and visitors alike. By embracing AI, Istria can position itself at the forefront of innovation, drive sustainable development, attract investment, and enhance its competitiveness on the global stage. (Vojnovic, 2015)

Seven meta-trends herald the research topic: (1) AI for and in sustainable tourism is a current research topic. (2) Research on AI in sustainable tourism has increased in the last decade, (3) AI research after the COVID-19 period has increased, (4) the topics used in research on AI in sustainable tourism revolve around consumer satisfaction and perceptions, (5) the topics used in research on AI revolve around the impact on employees and employee well-being, (6) the research shows that AI creates social, economic and financial value, and (7) there are differences in interest in AI research depending on academic institutions and countries. (Del Vasto & Castro, 2024)

Figure 1
AI research by institution – number of publications



Source: (OECD.AI, 2024)

Figure 1 shows the number of AI publications by universities in Croatia. The run-chart covers the period from 2000 to 2023 and uses a logarithmic scale for the number of publications. Most have come from the University of Zagreb, with almost 500 publications in 2023. Interesting is the intense catch-up of the Juraj Dobrila University of Pula, which is ranked fifth in 2023.

A comprehensive study for the period from 2023 to 2027 recommends for Croatia four objectives: (1) Attracting higher expenditure tourists, enlarging the season, and

reducing the geographical concentration of demand. (2) Increasing Croatia's brand power. (3) Helping the industry to do more and better marketing. (4) Supporting the national Strategy for the Development of Sustainable Tourism by 2030. Further, Smart Communication is mentioned as one of five themes, that encourages the usage of AI. It serves to improve the prediction system and modernize the monitoring of tourism satisfaction and the customer journey, thereby attracting locations "off the beaten track" in the off-season. Considering that Istria is the most visited tourist region and accounts for one-third of all arrivals in Croatia, the recommendations (1) to (4) for Croatia apply specifically for Istria as well. (THR et al., 2022)

The often controversial climate issue needs to be put in perspective, acknowledging that periods of cold and warmth, even warmer than those observed in recent years, occurred in Istria over the last 10,000+ years. It is fair to say that Istria enjoys, and will continue to enjoy, favorable climate conditions that promote distinct business opportunities. (Novellino et al., 2025)

Therefore, to learn more about the resilience of the Istrian economy by adopting AI the following two research questions are stated:

RQ (Research Question) 1: How can the systematic application of AI support the economy of Istria? This question aims to identify the potential of AI.

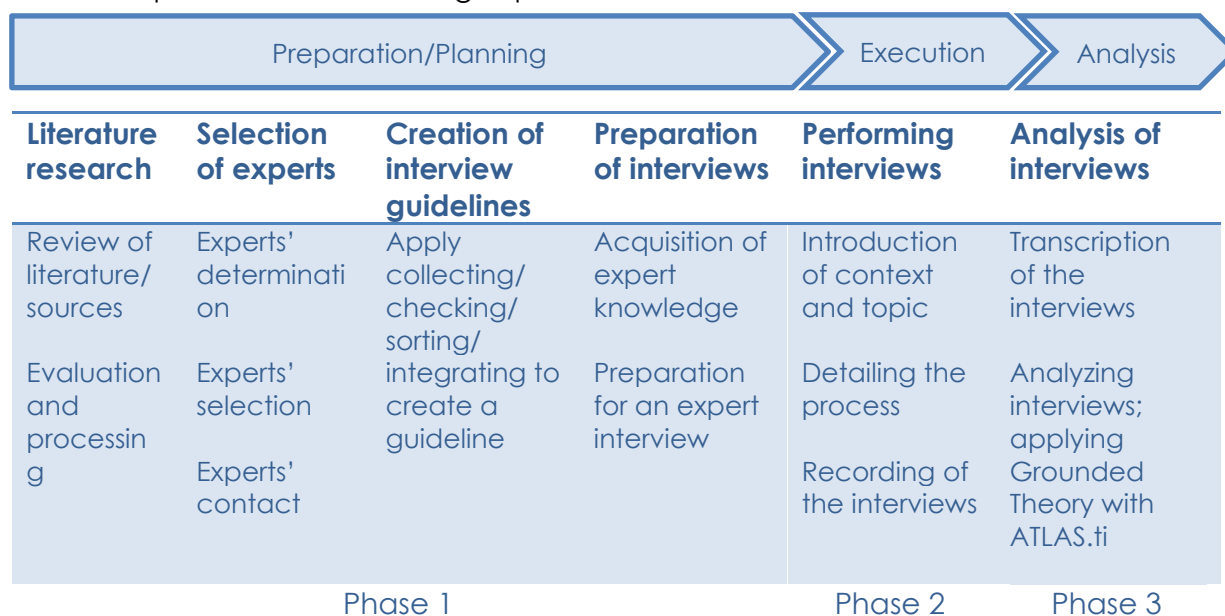
RQ 2: What are the challenges of implementing AI to increase resilience in terms of sustainable development? With this question, the investigation of concerns takes place and relates to RQ1.

Method

A Systematic Literature Review (SLR) has been conducted to understand the subject matter for the introduction of the paper. Systematic reviews of sources are focused on gathering and synthesizing evidence. Applying search on data bases (i.e., EconBiz, ScienceDirect, Scopus, and Web of Science), removing articles published before the year 2015, applying criteria-based inclusion/exclusion (i.e., inclusion for studies about Istria, not older than 2015, and published online; exclusion for non-peer reviewed material, not assessable in full-text, and duplicates of other studies), full-text reading, snowball sampling (i.e., backward snowball sampling for finding predecessors who influenced or contributed to their knowledge, behaviors; forward snowball sampling for involving hard-to-reach populations by identifying participants who meet the study criteria and then asking those participants to refer other individuals who also meet the criteria), quality assessment, and review of excluded articles (i.e., re-assessment of the once excluded to consider them based on the gained knowledge from the other sources) of the SLR led to the used sources listed in the bibliography. (Petersen et al., 2015)

The practical part of the research work was carried out using empirical social research, and the chosen research genre was qualitative. It started with the creation of an interview guide, which served as a guideline for subsequent discussions with experts in Istria with strong backgrounds in their fields. The material obtained from the interviews was systematically analyzed and evaluated using qualitative content analysis according to Grounded Theory, applying open, axial, and selective coding. Using inductive reasoning and anecdotal generalization, the findings were used to establish strong, cogent arguments to support a model to answer RQ1 and RQ2. Further, the data obtained was used as input for an analysis to derive strategies for action across six dimensions representing an industry, with an AI perspective and a time horizon up to 2030. (Mey et al., 2019; Strauss & Corbin, 1994)

Figure 2
Research process of conducting experts' interviews



Source: (Friese, 2016)

Figure 2 illustrates the three phases of the research process. The first phase consists of four elements: SLR, selection of experts, creation of the interview guideline, and preparation of the interviews. The second phase involves conducting the interviews, and the third phase involves analyzing the interviews. The interviews served as the primary source for the empirical part of the conducted study; secondary sources were government reports. Websites were consulted for triangulation and verification of the results.

The following table lists the interview partners. The eighteen interview partners were identified through serendipity and professional and scientific networks. All interviews took place in the second half of the year 2024. All of them happened personally, and follow-ups were conducted by telephone. The criteria are applied and explained in the table below.

Table 1
Interview partners of the empirical study

Dimension	Location	Position interviewee	Experience
Agriculture and wine	Buzet	Farmer	More than 15 years
	Labin	Project manager	10 to 15 years
		Quality manager	10 to 15 years
Creative industries	Hum	Artist	5 to 10 years
	Poreč	Owner of galleries	10 to 15 years
	Rovinj	Content creator	5 to 10 years
Manufacturing	Pula	Managing director	10 to 15 years
		SVP Purchasing	More than 15 years
		Plant manager	10 to 15 years
Maritime and logistics	Pula	Quality engineer	10 to 15 years
		Operations manager	More than 15 years
		Retired captain	More than 15 years
Renewable energy	Labin	Senior engineer	5 to 10 years
	Motovun	Plant manager	5 to 10 years
	Rabac	Owner of apartments	10 to 15 years

Tourism and hospitality	Labin	Hotel manager	10 to 15 years
	Pula	Tourism manager	5 to 10 years
	Rovinj	Resort manager	More than 15 years

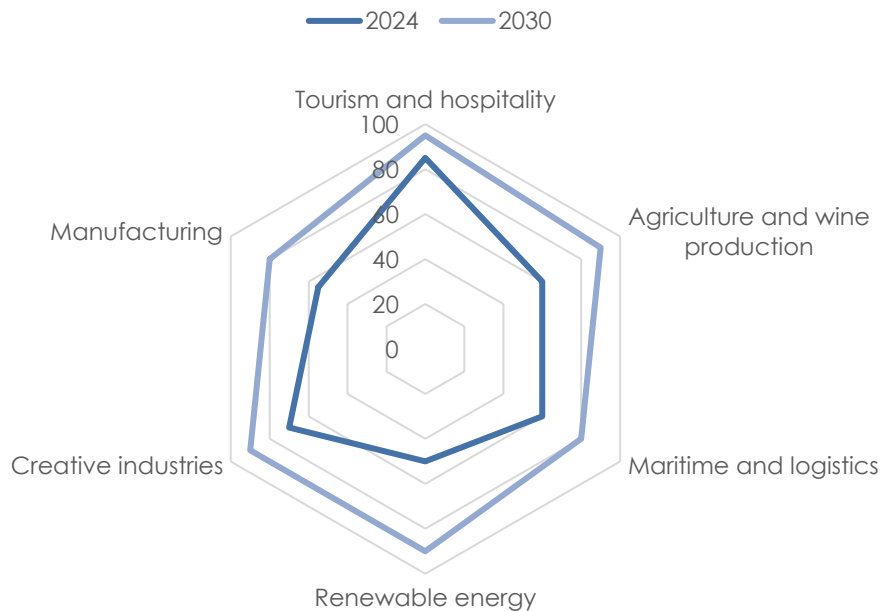
Source: Author's Illustration

Table 1 lists the 18 experts in Istria, including their place of residence, position, and experience. All of them have longstanding, relevant experience, stated in the fourth column, with a minimum of five years. Five interviewees have more than 15 years of experience, and one 74-year-old winemaker has 60 years of professional experience. The number of interview partners is considered sufficient, as qualitative saturation has been reached. Although, as always, a weak point in qualitative research, the three interviewees per dimension is the bare minimum considering triangulation. Nevertheless, the responses across each dimension were consistent in the independently conducted interviews. No additional inputs are expected, but they may be requested or required in any further interviews. Therefore, achieving qualitative saturation, an important validation criterion in qualitative research, is considered fulfilled.

Results

The application of Artificial Intelligence (AI) in Istria, from an industrial perspective, can focus on critical industries in the region, leveraging AI to drive efficiency, innovation, and sustainability. The perceived coverage of the AI potential in Istria is sorted clockwise by the perceived importance of these industries in Istria:

Figure 3
Coverage of AI potential by 2030



Source: Author's Illustration

Figure 3 shows the results for six industries across six dimensions: tourism and hospitality, agriculture and wine production, maritime and logistics, renewable energy, creative industries, and manufacturing. The inner hexagon represents the current situation as of 2024. The scale of 0 to 100 reflects the perceived percentage of

AI coverage in the respective industry. The outer hexagon forecasts the situation by 2030. For each dimension, further details were detected:

Table 2

Details for AI exploration

Tourism and hospitality	Agriculture and wine	Maritime and logistics	Renewable energy	Creative industries	Manufacturing
Personalized experiences	Precision farming	Smart ports	Solar and wind energy	Cultural heritage	Automation
Predictive analytics	Winemaking optimization	Sustainable fisheries	Energy efficiency	Content creation	Quality control
Smart destinations	Supply chain management				

Source: Author's Illustration

Table 2 lists for each dimension the key findings of the empirical research. They are described further in the following sub-chapters.

Tourism and Hospitality

Personalized experiences: AI can analyze tourist preferences to provide personalized travel packages, dining recommendations, and event suggestions.

Example: Chatbots for booking queries and virtual tour guides.

Predictive Analytics Using AI to forecast tourist numbers, optimize resource allocation, and manage seasonality.

Smart destinations: Integrating AI into innovative city initiatives, such as dynamic crowd management at popular sites like Pula Arena or Rovinj Old Town.

Agriculture and Wine Production

Precision farming: AI-driven systems for monitoring soil health, weather patterns, and crop conditions to improve yields and reduce waste.

Winemaking optimization: AI can assist in monitoring fermentation processes, predicting optimal harvest times, and enhancing quality control.

Supply chain management: Streamlining logistics for local olive oil and wine producers, ensuring product freshness and traceability.

Maritime and Logistics

Smart ports: AI-powered systems for port management in locations like Pula and Trget, optimizing cargo handling, ship scheduling, and energy consumption.

Sustainable fisheries: AI can help monitor fish populations, prevent overfishing, and improve aquaculture practices.

Renewable Energy

Solar and wind energy: Leveraging AI to predict energy generation from solar and wind farms in the region, ensuring efficient grid integration.

Energy efficiency: AI-based systems for monitoring and optimizing energy usage in industrial facilities and public infrastructure.

Creative Industries

Cultural heritage: AI applications for digital preservation of Istrian cultural assets, such as 3D modeling of historical landmarks or virtual reality experiences.

Content creation: AI tools for generating marketing materials to promote Istrian products globally.

Manufacturing

Automation: Implementing AI-driven robotics in manufacturing processes for industries like shipbuilding or food processing.

Quality control: Using AI for real-time monitoring of production lines to detect defects and ensure high standards.

Discussion

AI has great potential to transform regions worldwide. Istria, with its rich cultural heritage and growing economy, benefits significantly from the integration of AI capabilities. AI technologies can be pivotal in optimizing industries such as tourism, agriculture, and logistics, which are central to Istria's economic landscape. By enhancing operational efficiency, improving decision-making, and fostering innovation, AI can help businesses streamline processes and address challenges more effectively. Furthermore, AI's ability to analyze vast amounts of data can provide valuable insights for sustainable development, ensuring Istria's growth while preserving its cultural and natural resources. As Istria seeks to position itself as a forward-thinking region within Croatia and Europe, AI has the potential to drive both local and global competitiveness, making it an essential tool for future progress.

In industrial engineering, the SWOT analysis, which stands for strengths, weaknesses, opportunities, and threats, originated in the field of business administration. It is an important tool in many different disciplines, contexts, and industries. The SWOT analysis makes important internal and external aspects visible. The input data from the empirical research was used to focus on challenges and opportunities from an AI perspective. (Cf. Bajzek et al., 2021).

Challenges

- Limited infrastructure for advanced AI adoption.
- Skill gaps in AI expertise.
- Initial investment costs for small and medium enterprises (SMEs).

Opportunities

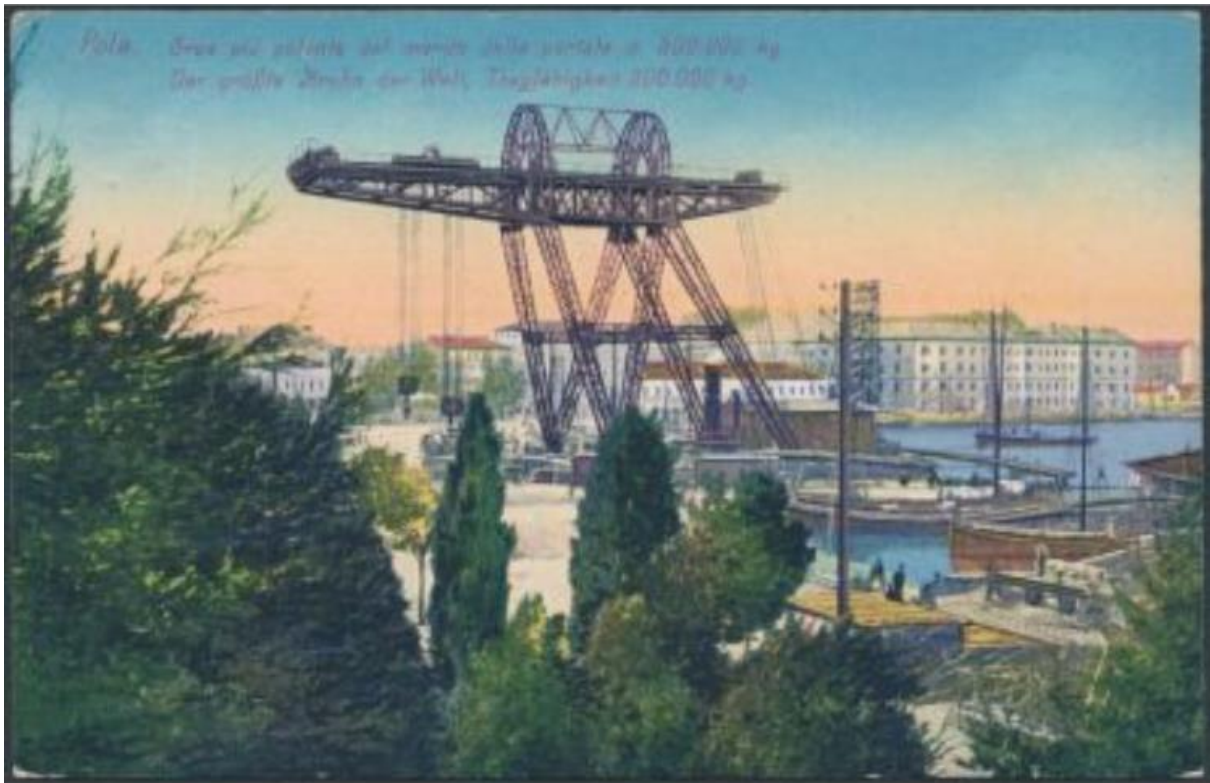
- Collaboration with European AI initiatives and funding programs.
- Leveraging Istria's strategic position for piloting AI projects in tourism and agriculture.
- Developing AI hubs or innovation centers in partnership with local universities and research institutions.

AI initiatives provide a solid base for strengthening cooperation between EU countries. In a time of global geopolitical restructuring and deglobalization, the EU should focus on its own policies and initiatives to develop and promote AI. Such policies should motivate AI investors, public or private, to include as many components produced in EU countries as possible.

Related anecdote: More than 100 years ago, Pula had the biggest crane in the world. The official name of this extraordinary floating crane was P 240 (pontoon crane

with a lifting capacity of 240 tons). It was commissioned in 1907 and accepted in 1910 as the future pride of the Pula naval arsenal. The crane was mainly used for installing turbines and heavy guns, as well as for harbor construction and the recovery of sunken submarines. The crane itself was built by Prager Maschinenbau AG, formerly Ruston & Co, and by Bromovsky, Schulz & Sohr in Prague and Königgrätz from 1907 to 1909, while the pontoon was built by Danubius in Kraljevica from 1907 to 1908.

Figure 4
Crane in Pula



Source: (Donko, 2020)

Figure 4 displays the crane in Pula in 1913. The current level of foreign investment in Rijeka is in stark contrast to past European innovation, which needs enabling in Europe, especially in the context of AI. Indeed, critical Chinese infrastructure equipment does not foster the local and European capabilities to prevail in a global economy. On top of the concern is enemy espionage, potentially disabling and, most certainly, tracking critical infrastructure by a foreign power to the disadvantage of European interests. (Bloomberg, 2024; Mäder, 2024)

AI holds significant potential for Istria, a region known for its rich cultural heritage, tourism, and diverse economy. By leveraging AI technologies, Istria can drive economic growth, enhance efficiency, and improve the quality of life. AI can revolutionize industries, including agriculture, a vital part of Istria's economy, by enabling more innovative farming practices through predictive analytics, precision farming, and automation. This can lead to increased crop yields, reduced resource usage, and more sustainable farming methods.

In tourism, AI can personalize travel experiences, optimize resource management, and predict tourist trends, thereby enhancing both the visitor experience and operational efficiency for businesses. Additionally, AI-powered tools can improve

healthcare systems in the region by enabling faster diagnostics, personalized treatment plans, and efficient healthcare delivery.

The region's strong focus on environmental sustainability can benefit from AI applications in smart energy grids, waste management, and conservation efforts. By analyzing large datasets, AI can help monitor environmental changes and manage natural resources more effectively. Specific policy recommendations for AI adoption in Istria, such as startup incentives, AI education programs in universities, and government-supported AI initiatives, would strengthen the region.

Conclusion

AI has the potential to transform Istria's industrial sectors while preserving its cultural and natural heritage. Strategic investments in technology, education, and partnerships can position the region as a leader in sustainable AI-driven development.

Answer to RQ1: The systematic application of AI supports Istria's economy by driving innovation, enhancing operational efficiency, and fostering sustainability across key industries. In total, 14 distinct proposals across six sectors were unveiled, ranging from personalized experiences in tourism and hospitality to quality control in manufacturing.

Answer to RQ2: The challenges of implementing AI in Istria for sustainable development include (1) inadequate advanced technological infrastructure to support widespread AI adoption, (2) shortages of local expertise in AI and digital skills among the workforce, (3) SMEs face financial barriers to adopting AI technologies, (4) concerns over reliance on foreign technologies, such as Chinese-manufactured infrastructure, which may compromise local and European capabilities and security, and (5) ethical and social considerations in terms of balancing AI-driven efficiency with the preservation of cultural and natural heritage and addressing public concerns about AI's impact on employment and privacy.

Overall, AI can position Istria as a leader in innovative and sustainable development, fostering innovation across industries and ensuring long-term prosperity for its economy and residents.

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