Cultural currents: A statistical exploration of Inglehart-Welzel dimensions and artificial intelligence perceptions in Eurobarometer Surveys

George Nadoleanu[1]
Emanuela Bran[2]
Ana Rodica Stăiculescu[3]

Abstract
This paper explores public attitudes towards the social impact of artificial intelligence in the European Union. The premises of the study are that the cultural dimensions, as outlined by Inglehart-Welzel, have an intricate relationship with the way people perceive technology. The analysis aims to explore how national-level data from the Eurobarometer aligns with culture and explain the relationship drawing on concepts derived from the sociology of technology. The results show that public attitudes towards AI are multifaceted and influenced by various cultural mechanisms, highlighting the importance of taking a holistic approach to the implementation and regulation of artificial intelligence. Our findings can guide policymakers, tech developers, and educators alike, in promoting, respecting, and shaping deep-rooted cultural beliefs and values among the European nations.

[1] Doctoral School of Sociology, University of Bucharest, Bucharest, Romania, gheorghe.nadoleanu@s.unibuc.ro.
[2] Doctoral School of Sociology, University of Bucharest, Bucharest, Romania; Faculty of Automatic Control and Computers, National University for Science and Technology Politehnica Bucharest, Bucharest, Romania, emanuela.bran@s.unibuc.ro.
[3] Doctoral School of Sociology, University of Bucharest, Bucharest, Romania; Romanian Academy of Scientists, Bucharest, Romania; Faculty of Psychology, Behavioral and Legal Sciences, Andrei Saguna University of Constanta, Constanta, Romania, ana-rodica.staiculescu@fsas.unibuc.ro.

Introduction

The public discourse surrounding the social impact of artificial intelligence (AI) frequently presents a tapestry of contradictory opinions (Budeanu et al., 2023). There are also online public debates around the social and moral status of AI (Bran et al., 2023; Obreja and Rughiniş, 2023). These perspectives may be deeply anchored in local cultures, developmental priorities, and various individual, community, and national factors (Rughiniş et al., 2024a). By discerning which factors influence these opinions and understanding their interplay, we can promote a harmonious society by aligning global and local values in technology management (Nadoleanu, 2022; Nadoleanu, 2023).

In our increasingly globalized world, technological advancements, particularly in artificial intelligence (AI), are reshaping every aspect of life. These technologies offer significant benefits but also present complex trade-offs across psychological, sociological, economic, and ethical dimensions. Notably, the distribution of these benefits and drawbacks is uneven across different communities. On one hand, AI has the potential to bridge the digital divide, as seen in initiatives like Wikipedia, which democratizes knowledge and promotes broad public participation. However, AI also poses significant challenges (Sartori and Theodorou, 2022) including the concentration of power among entities controlling large AI models, potential disruptions in the job market, biases embedded in data, and a gradual shift toward a more synthetic environment.

Such challenges highlight the need for careful consideration of how we deploy and govern AI technologies to ensure they serve as tools for improving human life in all aspects. With the help of Eurobarometer data regarding public perception of AI, we delve into the sociology of futures and the sociology of anticipation. The first one analyses what the future will look like through the eyes of the respondents. Is it an AI eutopia or a dystopian horizon? The second explores a wider range of matters that tackle how we prepare and expect things to unfold. What kind of regulation is needed when we develop AI-based systems or how do we protect users by providing information that these services are powered by synthetic intelligence? In what life areas do we think that AI would bring the most benefit and what are the costs of AI integration?

Ulrick Beck, a German sociologist, talked about the risk society which refers to man-made risks, particularly those arising from technological advancements. He highlighted the ambivalent nature of technology which produces global threats while simultaneously helping detect and mitigate the negative effects. AI also embodies this duality, having the potential to significantly enhance our quality of life, yet also posing risks of social disruption and falling into malevolent hands. The negative consequences of AI can attract substantial media attention, prompting government and public intervention. However, some of its

effects might be more subtle and insidious, necessitating careful evaluation by social scientists to fully understand their impact (Joyce et al., 2021).

Sociology plays a crucial role in deciphering how different local cultures adopt and adapt AI and other new technologies for their benefit (Nadoleanu, 2022). Misguided approaches can be seen at both ends of the spectrum: the absence of digital literacy in underdeveloped regions hinders progress, while an excessive reliance on technology, as exemplified by transhumanism, may lead to the neglect of essential human elements. The former approach risks leaving communities behind in a rapidly advancing digital world, while the latter could lead to a detachment from intrinsic human values and experiences (Nadoleanu et al., 2023).

Our study adopts the Inglehart-Welzel cultural model to thoroughly examine the diverse range of societal values in relation to economic and institutional development. This two-dimensional model is instrumental in evaluating how societies evolve. Central to our investigation is the question: 'How do the cultural dimensions of self-expression, survival, secular-rational, and traditional values, as outlined in the Inglehart-Welzel framework, correlate with country-specific differences in perception, trust, and eagerness towards AI?' This question forms the core of our research, guiding our analysis and interpretations.

The outline of this paper comprises a literature review around the cultural model of Inglehart-Welzel followed by explanations regarding the methodology of our quantitative data analysis. The statistically significant results of variable frequencies, bivariate correlations, and linear regression are presented and briefly explained in the results section. The discussion section focuses on describing four societal types based on the Iglehart-Welzel model by interpreting the linear regression results, analyzing characteristic strengths, weaknesses, opportunities, and threats, and proposing suitable solutions.

Literature review

The World Values Survey (WVS) with its European component (EVS), represents a collection of transversal and longitudinal data from multiple countries around the world. The first surveys were carried out in 1981, and now we are at the 7th wave, which started in 2017 and ended in 2022, covering around 90 countries. These surveys helped Ronald Inglehart and Christian Welzel to plot a two-dimensional cultural map, where societies are neatly clustered by factors such as geography, language and religion, economic development, and history and politics (Inglehart and Welzel, 2005).

The horizontal dimension is linked to the prioritization of needs. Survival societies, due to their poor socio-economic infrastructure, are focused on physical and material security. This includes an ethnocentric look and aversion towards taking risks. Inglehart's theory proposed that as economies grow stronger and social systems develop, these primal needs are met and the focus shifts towards post-material values such as environmental protection, tolerance towards minority groups, gender equality as well as the subjective well-being of the citizens, and their free search for happiness. This theory of emancipative values resembles that of Maslow which put material needs at the bottom of

the pyramid, while the top was exactly linked to self-realization, personal growth, and expression of the self through hobbies, arts, and lifestyle choices.

The vertical dimension of the cultural values map captures the shift between traditional to modern societies. The first type of society is characterized by religion being at the core of the social system, a strong emphasis on family ties including that of parent and child, a general hierarchical organization based on deference to authority, traditional gender roles, and national pride. Modern societies tend to question authority and accept diversity in family systems and forms of spirituality. Inglehart proposed that cultural change precedes institutional change and that the shift is inter-generational. As children grow up in a more economically secure environment, they become engaged with self-expression and secular-rational values. This existential security in turn diminishes the role of religion in social life and ethical norms. Thus, several feedback loops push countries to move in a nonlinear pattern on their specific trajectory from tradition and survival values towards secular-rational and self-expression values.
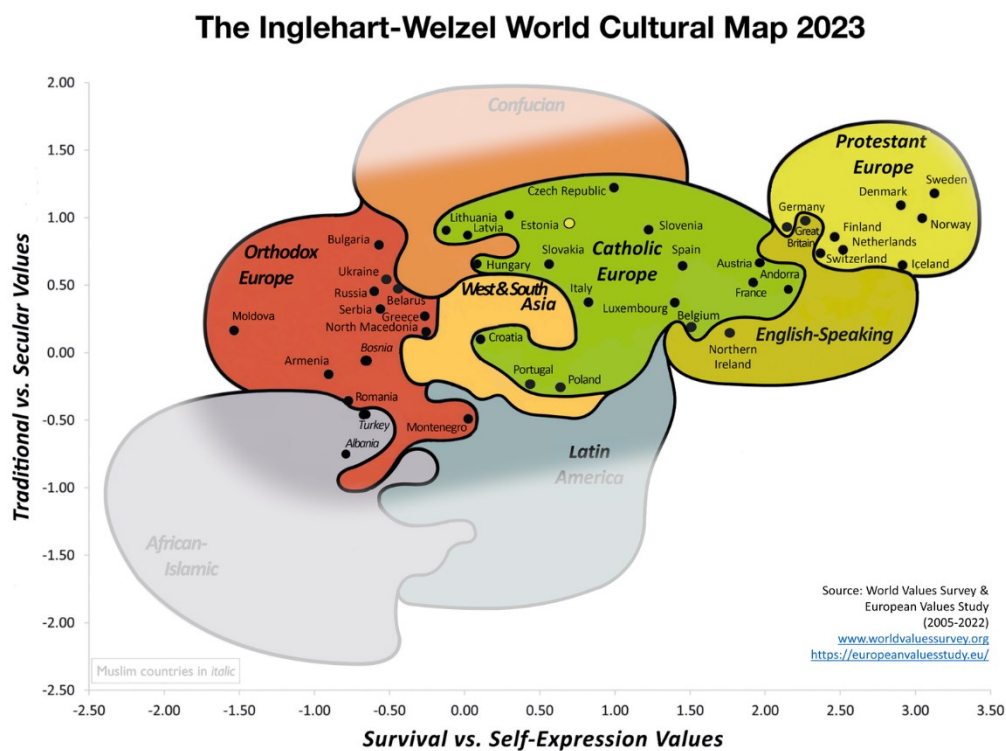

Figure 1. An edited version of the cultural map highlighting European countries. Source: https://www.worldvaluessurvey.org/WVSContents.jsp?CMSID=Findings, accessed 14.01.2024

A relevant observation regarding the European countries (see Figure 1) is that their distribution is wider across the survival vs. self-expression dimension (Borsci et al., 2023), and thus results of this study are expected to also exhibit a stronger link to this factor. This means that in terms of the factor loadings of the two cultural dimensions, the difference in the analyzed societies is linked more to responses to questions about the priority of

economic and physical security, subjective happiness, justification of homosexuality, civic engagement, and trust of people. This is the dimension across which the Orthodox, Catholic, and Protestant European societies are ordered. There is also some vertical variation within these religious worlds which is accounted for by another factor. Its loadings are related to the importance of God, learning obedience as a child, justification of abortion, level of national pride, and favoring respect for authority.

Although this study analyses the relationship between the bidimensional cultural values system of Iglehart-Welzel, any observations resulting from the survival vs. self-expression spectrum, might be linked to the religious systems and their respective cultural influence towards the non-religious aspects of life. This would have been a hypothesis put forward by Max Weber, which categorized religions by their focus on mysticism or asceticism and engagement with the world or rejecting it (Załęski, 2010). He explained that social systems such as capitalism are rooted in religious beliefs and their generated behavior. Thus, acceptance of AI-based systems might be influenced by how these denominations portray the relationship between the sacred and the profane.

Another six-dimensional cultural model devised by Geert Hofstede was used for analyzing technology acceptance (Straub et al., 1997). It comprises power distance, individualism vs. collectivism, polarization of gender roles, uncertainty avoidance, long vs. short-term orientation, and indulgence vs. restraint. Some of those dimensions, such as power distance, might be relevant to our study but we preferred the Iglehart-Welzel model due to its closer link to measuring the preference for tradition vs. modernity. Also, the distribution and religious grouping of countries along the material vs. post-material dimension seemed relevant.

The cultural dimensions outlined by Inglehart-Welzel could potentially resonate with concepts introduced by Ulrich Beck (Cottle, 1998). The self-expression vs. survival dimension might correlate with various perceived threats that are addressed in a risk society. For instance, survival societies may prioritize AI solutions that safeguard material well-being, particularly physical and economic security. The relationship between risk perception, genesis, and mitigation, however, remains intricate. As technological advancements surge, these perceived threats become palpable. Simultaneously, our capability to discern these threats and the methods to preemptively address them also evolve. Thus, distinguishing between heightened risk awareness and the increased likelihood of such risks impacting society becomes challenging. The preferred AI use cases could probably reflect a nuanced interplay between AI's potential role as a risk-mitigation tool and its perception as a risk.

Turning to the second dimension of Inglehart-Welzel provides further insights. In self-expression societies, there might be concerns about AI posing threats to human rights, such as equality and freedom of speech. These threats could manifest in the form of biased AI decisions or the proliferation of fabricated online identities and narratives. The reflexive nature inherent in modern societies, as described by Ulrick Beck, echoes the transition along the traditional to secular-rational dimension. Conservative societies may exhibit reduced reflexivity, while secularized, forward-looking societies might engage in continuous introspection and reevaluation. However, this dynamic could vary in Europe,

given its unique historical evolution. With a backdrop marked by shifts from Eastern communist rationale to Western liberalism, European societies have undergone substantial change. Consequently, a reflexive European society might even place significant value on religion, viewing it as a counterbalance to the challenges arising from rampant technological rationalization.

Robinson (2020) explored how values of trust, transparency, and openness, shared by the Nordic nations exhibiting a pattern of similitude on the Hofstede dimensions, are reflected in their national AI strategy. Bergdahl et al. (2023) researched how psychological needs of autonomy, competence, and relatedness affect the acceptance of AI, in a cross-cultural study with countries representative of each Inglehart-Welzel European cultural zone. Tao et al. (2023) audited three versions of chatGPT by asking questions for building the two cultural dimensions of the Inglehart-Welzel map and found that the large-language model is biased in values towards the English-speaking and Protestant European countries.

Thus far, we highlighted from multiple perspectives the importance of culture in shaping the way people might perceive their relationship to technology. However, regarding the European space, there are specific gaps in knowledge that need to be addressed regarding how cultural conditioning influences sentiments, attitudes, and perspectives on AI. We wish to test the following hypotheses that stem from the Inglehart-Welzel cultural model:

- H1: Self-expression societies are focused on post-material aspects of AI (such as using it for creativity and fearing biases)
- H2: Survival societies are focused on material aspects of AI (such as using it for medical purposes, and having concerns about job security)
- H3: Secular-rational societies are focused on how AI helps social and economic progress (such as envisioning positive outcomes)
- H4: Traditional societies are focused on how AI disrupts life and alienates people (such as fearing negative outcomes)

Methodology

This paper presents a quantitative data analysis of Eurobarometer responses on the subject of AI. We prepared our data by applying weights (w92), eliminating countries without responses, and uniting the two German groups. Our initial focus is on the Special Eurobarometer 95.2 from 2021 (Claessens, 2021). This survey includes an item of interest: "QA8a. The following is a list of areas where new technologies are currently being developed. For each of these, do you think it will have a positive, a negative or no effect on our way of life in the next 20 years?". Among the ten technologies listed, AI is featured at number 10. Respondents are asked to rate the impact, choosing between: "Very positive effect / Fairly positive effect / Fairly negative effect / Very negative effect / No effect". We recorded the responses to fit a 5-fold Semantic Differential Scale, placing the neutral "No effect" in the middle while treating "Don't know" as missing data. Additionally, we created a separate variable to capture whether a respondent provided an opinion or chose the "Don't know" option.

The second data collection is derived from the Standard Eurobarometer 92.3 from 2019 (Omrani et al., 2022), in which we examined four items related to AI. The first item is "QF1. Do you think that you should be informed when a digital service or mobile application is using artificial intelligence?". The answer choices are "Yes, in every case / Yes, in cases where it isn't obvious to you / Yes, in cases where artificial intelligence may pose a risk / No, it is not important for you to know / No, you trust that the rules in place already protect you in any event". We interpreted these responses in ascending order of trustworthiness and separately categorized "Don't know" in a distinct variable. Similarly, we processed the subsequent item that asks, "QF4. Which statement below do you agree with most to complete the statement: To ensure that Artificial Intelligence applications are developed in an ethical manner…". The available answers are "public policy intervention is needed / industry providers of Artificial Intelligence can deal with these issues themselves / no specific action is needed / other / none of the above". We grouped "Other" and "None of the above" under "Other opinions" in a separate variable and introduced an additional variable to indicate whether a respondent expressed an opinion.

From the same data collection, we also scrutinized two further items related to AI. The first is "QF2. Which statements below, if any, would you select to finish the statement: Artificial intelligence can be best used …" and the potential multiple-choice answers include "to improve medical diagnostics, develop personalised medicine, improve surgery / to improve traffic management, reduce congestion, improve air quality / to improve the monitoring of pollution, energy consumption levels / to power robots, improve productivity and job safety / to improve the safety and security of society / none of the above / all of the above". The next item probes the potential negative consequences of AI, asking "QF3. Which statements below, if any, would you select to finish the statement: You are concerned that the use of artificial intelligence could lead to …" and the offered multi-choice responses are "discrimination in terms of age, gender, race or nationality, for example in taking decisions on recruitment, creditworthiness, etc. / situations where it is unclear who is responsible, for example in case of accidents caused by self-driving cars / situations where there is nobody to complain to in case of problems / none of the above / all of the above". For our analysis, we transformed these responses into seven dichotomous variables: four representing attitudes of acceptance and three encapsulating anticipations of risk. The "Don't know" options from both items were managed through two distinct variables corresponding to AI use cases and potential risks. For both variables, the "All of the above" option was redistributed to every use case and risk.

In our paper, we used precomputed mean scores of secular-rational / traditional values and materialist (survival) / postmaterialist (self-expression) values at a national level (Source: https://www.worldvaluessurvey.org/WVSNewsShow.jsp?ID=467, accessed 14.01.2024). These dimensions are some of the iconic findings of the WVS & EVS studies, and they represent the result of an individual-level factor analysis over 10 indicators, five for each dimension. The indicators and their factors loadings are listed in Table 1. These items were chosen by Inglehart and Welzel primarily due to their availability in multiple waves and cross-cultural variability so that a comparative analysis might be carried out across nations and time.

Table 1. Two dimensions of cross-cultural variation: individual-level analysis. The first factor explains 26% and the second factor explains 13% of the total individual variation. Source: https://www.worldvaluessurvey.org/WVSContents.jsp?CMSID=Findings, accessed 14.01.2024

Factor 1 Traditional values emphasize the following (Secular-rational values emphasize the opposite):	God is very important in respondent's life.	0.70
	It is more important for a child to learn obedience and religious faith than independence and determination.	0.61
	Abortion is never justifiable.	0.61
	Respondent has strong sense of national pride.	0.60
	Respondent favors more respect for authority.	0.51
Factor 2 Survival values emphasize the following (Self-expression values emphasize the opposite):	Respondent gives priority to economic and physical security over self-expression and quality of life.	0.59
	Respondent describes self as not very happy.	0.59
	Homosexuality is never justifiable.	0.58
	Respondent has not and would not sign a petition.	0.54
	You have to be very careful about trusting people.	0.44

We also extracted data from the item that posed the question, "QC6. In the following list, which are the three most important values for you personally?". The answer choices included "The rule of law / Respect for human life / Human rights / Individual freedom / Democracy / Peace / Equality / Solidarity, support for others / Tolerance / Religion / Self-fulfilment / Respect for other cultures / Respect for the planet". However, both these values and the variables indicating AI use cases and potential risks were not examined at the individual level. The decision stemmed from the survey's data collection method, where respondents had a cap on the number of options they could choose. This might inadvertently fraction the frequency of observations representing analogous concepts.
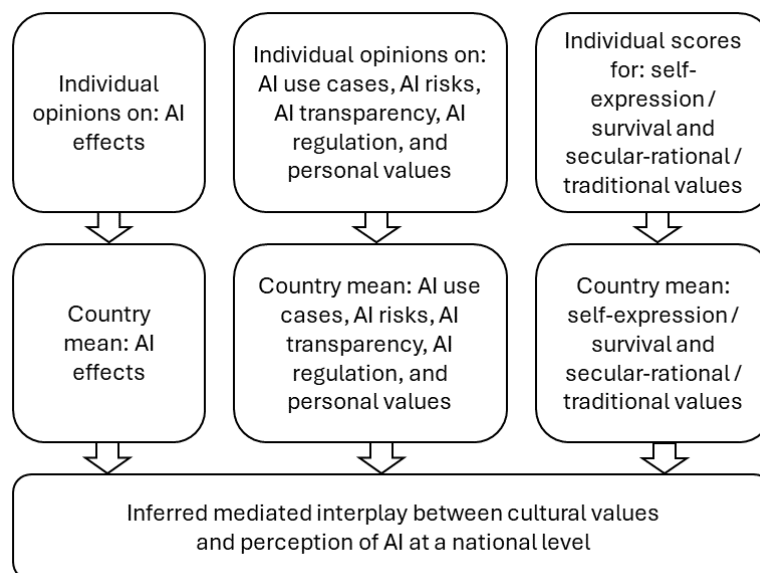

Figure 2. An outline of the methodology for the data processing, analysis, and interpretation.

Consequently, as seen in Figure 2, these variables representing personal values as well as all other variables discussed in this section, representing Eurobarometer items, underwent further processing to compute an average mean score at a national level for each country involved in the survey. Subsequently, for each nation, we recorded the latest scores for the two dimensions of the Inglehart-Welzel cultural map, which represent our main framework for studying cultural conditioning. Throughout our paper, all operations of analysis and interpretation are made at a national level, the unit of analysis being the country. We thus only revealed potential forces of influence at the national level. An individual-level perspective would have been of interest as a comparison, but we were limited by the available data because the subjects participating in the two Eurobarometer surveys and the WVS & EVS study are not the same individuals.

We wish to stress that our interpretations of country mean scores describe national cultures and do not reflect patterns at the individual level, since inferring something about individuals that make up a group from the group's characteristics would be an ecological fallacy. Any words that seem to describe individuals should be understood from the perspective of a group of individuals. Taking the example of religion as a core value, we do not claim that religious individuals hold a uniform view of artificial intelligence. However, in a country where there are significant religious populations, certain recurrent themes in public discussions can influence a segment of the populace through mass media and specific institutions. This can, to some extent, sway the general sentiment towards AI.

The study incorporates data from 26 countries, namely: Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom. While Ireland and Malta were part of the Eurobarometer studies (opinions on AI), they were missing from the WVS & EVS study (cultural profile), and thus, we excluded them from our research. Furthermore, even if Eurobarometer and Iglehart-Welzel data were available for some European countries outside the European Union, we limited ourselves to those belonging to the EU in order to have a more politically homogeneous sample.

Using SPSS, we performed a comprehensive statistical analysis of our dataset, encompassing observations of variable frequencies, bivariate correlations, and the testing of linear regression models. Variable frequencies highlight preferred options and whether respondents provided an opinion. Next, we present bivariate correlations between the Inglehart-Welzel cultural dimensions and personal values from QC6 of Eurobarometer 92.3. Correlations further explore the prevalence of expressed opinions, AI use case acceptance, and anticipated adverse outcomes along with desired transparency level and regulatory frameworks. We initially investigate how these opinions correlate with cultural dimensions and subsequently with personal values.

The results section then proceeds to showcase the outputs of linear regression models where the predicted variable is the opinion on AI-related issues and the predictors are the two scores representing the Inglehart-Welzel cultural dimensions. Each regression model aims to decipher variance in country-level attitudes toward AI. We present the R-square for each predictive model and the Beta value for the dual cultural dimensions. Three

tiers of statistical significance were used for predictors. Numerical values were transposed to the corresponding cultural attribute names (self-expression, survival, secular-rational, traditional), with self-expression and secular-rational substituting the numerical values having a positive sign. Dependent variables were structured such that higher values consistently suggest a positive inclination toward good outcomes, low demand for transparency and regulation, high approval of use cases, high anticipation of risks, and the expression of opinions.

Furthermore, in the discussion section, we interpreted the linear regression results according to four society ideal types constructed using cultural attributes. The robust regression models were further processed in terms of reading the sign of each numerical value, to highlight attitude patterns that are characteristic of these society ideal types. Our study takes a nuanced exploratory approach while testing the outlined hypotheses, interpreting the multiple findings in the light of cultural conditioning. Whenever we refer to an ideal type, such as the traditional society, we describe one end of the spectrum along a cultural dimension, in this case, the secular-rational vs. traditional values dimension. As seen from the Inglehart-Welzel map in Figure 1, societies are characterized simultaneously along two dimensions. Nevertheless, we endeavored to deconstruct the dual cultural model in order to highlight the inclination observed in each typology.

An important limitation of our study is related to the temporality of survey data acquisition that reflects past correlation patterns with cultural values. This paper doesn't capture the present interplay between the fast-evolving AI landscape and culturally conditioned reactions. The landscape surrounding AI technological integration, regulation, and rising concerns present in the public discourse has shifted since 2019-2021. The latter part of the year 2022 was marked by the public recognition of the profound impact of generative AI (Bran et al., 2023) related to image (e.g. Stable Diffusion) and text models (e.g. ChatGPT). Prior to this, concerns centered more on the prospective and speculative consequences of AI, frequently motivated by a general aversion to the unknown, and universal ethical considerations. With the increasing prevalence and tangible nature of AI technologies, attention transitioned towards immediate and practical concerns, including but not limited to deepfakes, misinformation and algorithmic bubbles causing social polarization, surveillance technologies capable of emotional profiling leading to control and manipulation, along with autonomous weapons and other AI technologies that create a dystopian horizon (Rughiniș et al., 2024b).

Results

Individual-level variable frequencies

The Eurobarometer survey on science and technology assessed the perception of the effects of several new technologies that are currently being developed. AI occupied the place just before the last in terms of positive effects, the last being occupied by nuclear energy for energy production. From Table 2, we can observe that 21% of Europeans anticipate very positive effects in the next 20 years, 42% still think that effects fall on the

positive spectrum, while the rest are divided between no effect, negative effects and not expressing an opinion. Thus, the overall opinion is inclined towards anticipating positive effects.

Table 2. Long-term impact of AI. "QA8a. The following is a list of areas where new technologies are currently being developed. For each of these, do you think it will have a positive, a negative, or no effect on our way of life in the next 20 years?"

Very positive effect	Fairly positive effect	No effect	Fairly negative effect	Very negative effect	Don't know
21%	42%	2%	21%	9%	5%

The data from the Eurobarometer on AI detailed in Table 3 shows that 51%, which is the majority of Europeans, think that when an application or service is AI-based, they should always be informed. The rest of the responses are divided between positions that are laxer towards transparency. Summing up, a total of 80% are requesting to be informed in different circumstances, hence there is a strong desire towards transparency.

Table 3. Transparency regarding AI-based digital services. "QF1. Do you think that you should be informed when a digital service or mobile application is using artificial intelligence?"

Yes, in every case	Yes, in cases where it isn't obvious to you	Yes, in cases where AI may pose a risk	No, it is not important for you to know	No, you trust that the rules in place already protect you in any event	Don't know
51%	15%	14%	8%	5%	7%

Another item assessed which AI use cases seem more attractive for the responders who were given 5 options out of which they could choose a maximum of 2 answers. As seen in Table 4, the most desired use case, with 53% of responders choosing it, is "to improve medical diagnostics, develop personalised medicine, improve surgery", followed by environment management systems. It is not clear whether improving the security of society is not a priority, or if it scored lower due to requiring a tradeoff on privacy. The same could be affirmed by the productivity use case which could also imply a tradeoff linked to disruption of the job market.

Table 4. AI use cases. "QF2. Which statements below, if any, would you select to finish the statement: Artificial intelligence can be best used …"

Medical services	Traffic / Air quality	Monitoring pollution / Energy consumption	Safety / Security of society	Power robots / Productivity and safety	Don't know
53%	32%	28%	22%	19%	8%

Moving on to the risks posed by AI (see Table 5), the responders were given 3 types of negative outcomes out of which they could choose 2 at most. The greatest fear regarding AI-based systems is unclear responsibility. In the questionnaire, the item gave an example of the complex nature of accountability in case a self-driving car would produce an accident. The next fear revolves around biased decisions, with the last being linked to the absence of a human to complain to in case of system malfunction. The provided response options were quite restrictive since they didn't allow for choosing "Other" concerns, which might have obtained a greater weight and shifted the distribution of the already-mentioned fears. This item merely investigates from a comparative perspective which of the three negative outcomes worries Europeans the most. An additional open-ended question about AI-related concerns would have brought valuable insight into the nuances of negative perceptions. Future surveys would especially benefit from a larger array of available options representing risks of different magnitudes and timescales, as the impact of AI is now felt across multiple areas of life and society.

Table 5. Risks posed by AI. "QF3. Which statements below, if any, would you select to finish the statement: You are concerned that the use of artificial intelligence could lead to …"

Unclear responsibility	Discrimination in decision-making	Nobody to complain to	Don't know
47%	40%	36%	9%

The survey also assessed desired regulation frameworks of AI development that would ensure products respect human ethics (see Table 6). The majority of Europeans (51%) believe that state institutions should overwatch and regulate the development process. Another 23% think that the business sector is trustworthy, or that everything is good as it is. While some answered "Other" and "None of the above", it is not clear what kind of solution the 14% of the responders had in mind. Some possible options might include collaboration between the government and the private sector, international standards, or third-party audits.

Table 6. Regulation of AI development. "QF4. Which statement below do you agree with most to complete the statement: To ensure that Artificial Intelligence applications are developed in an ethical manner…"

Public policy intervention is needed	Industry providers of AI can deal with these issues themselves	No specific action is needed	Other	None of the above	Don't know
51%	16%	7%	4%	10%	12%

Country-level bivariate correlations

We analyzed through bivariate correlations how personal values align with the cultural dimensions proposed by Inglehart-Welzel (see Table 7). Post-materialist (self-expression) values include democracy, tolerance, and respect for the planet, which align with the idea

that people who have already fulfilled their most basic material needs would expand their attention toward diversity and the environment. Traditional values seem oriented towards equality and solidarity - probably between the members of the group - which could in turn cause unrest with other groups, resulting in a negative relationship with peace. Religion represents a core value characteristic of both traditional and materialist (survival) cultural dimensions, as it provides a set of moral norms and a feeling of protection against perceived immediate physical dangers.

Table 7. Personal values correlated with cultural dimensions. Personal values were derived from "QC6. In the following list, which are the three most important values for you personally?" and their values represent country-level means. Self-expression/survival and secular-rational/traditional values were extracted from the Inglehart-Welzel study. Only statistically significant results were tabulated.

	Self-expression values (invert sign to read for survival values)	Secular-rational values (invert sign to read for traditional values)
Individual freedom	-0.34*	
Democracy	0.48**	
Peace		0.44**
Equality		-0.39**
Solidarity		-0.45**
Tolerance	0.47**	
Religion	-0.63***	-0.62***
Self-fulfilment	-0.36*	
Respect for cultures	0.33*	
Respect for the planet	0.75***	0.35*

Table 8 presents whether respondents presented an opinion on a particular subject, which is indicated by a positive correlation with the specific personal value or set of cultural values. Even if we might interpret the correlations in this section using words such as Europeans or individuals, we always consider the cultural impact at a national level, as all processed numbers are country mean scores. We observe that individuals of post-materialist societies, which value self-expression, democracy, and respect for the planet, provided an opinion more often than those with other cultural typology backgrounds. Also, individuals from secular-rational societies and those who value individual freedom were inclined to choose another option of an ethical framework for AI regulation than those provided by the questionnaire. Those valuing equality and solidarity accepted one of the listed regulation frameworks. Furthermore, values such as respect for human life and religion align with not providing opinions so often.

Table 8. Expressing an opinion or not correlated with values. For values of AI effect see Table 2, for AI use case see Table 4, for AI risks see Table 5, for transparency see Table 3, and for regulation & other ethics see Table 6. Only statistically significant results were tabulated.

		Expressing an opinion on					
		AI effect	AI use case	AI risks	Transparency	Regulation	Other ethics
Importance assigned to:	Self-expression	0.38*	0.48**	0.60***	0.55***	0.60***	
	Secular-rational						0.46**
	Respect for human life		-0.44**	-0.46**	-0.37*	-0.45**	
	Individual freedom						0.55***
	Democracy		0.53***	0.52***	0.52***	0.58***	
	Peace						0.37*
	Equality						-0.54***
	Solidarity						-0.44**
	Religion	-0.47**					
	Self-fulfilment					-0.34*	
	Respect for the planet	0.39**	0.54***	0.62***	0.57***	0.53***	

Table 9 provides correlations between different personal values and AI-preferred use cases. Traditional values align with choosing to approve AI-based pollution and energy management systems and having a lower preference for automating productivity. This might be explained by the prevalent first and second-sector economic activities which are linked to energy and emission issues and represent manual job opportunities that financially sustain the community. Furthermore, societies that don't highly regard individual freedom, solidarity, and self-fulfillment but respect religion, seem to be inclined towards desiring AI solutions for managing traffic, energy, and emissions while avoiding factory automation. This might be explained due to the poor infrastructures that are in place where communities have more traditional lifestyles. Other observations include the respect for human rights and life which are aligned with desiring AI-enhanced medical services and respect for the planet and cultures which are aligned with AI solutions for achieving the safety and security of society. The latter might be due to the link between open society values, global sustainable development, and digital social surveillance. Furthermore, it is interesting to note that respect for the planet is not aligned with any of the AI use cases that could indeed protect the environment, while religion is slightly aligned with such solutions, as environmental stewardship and community welfare are closely connected.

Table 9. Preference for AI use cases correlated with values. Only statistically significant results were tabulated.

	Medical services	Traffic / Air quality	Monitoring pollution / Energy consumption	Power robots / Productivity and safety	Safety / Security of society
Secular-rational			-0.39**	0.44**	
Respect for human life	0.39*				
Human rights	0.43**				
Individual freedom			-0.44**		-0.34*
Peace		0.35*	-0.36*		
Equality			0.38*		
Solidarity				-0.45**	
Religion			0.35*		
Self-fulfilment	-0.41**				
Respect for cultures					0.38*
Respect for the planet					0.47**

The data presented in Table 10 delineates various perception categories pertaining to the potential risks associated with AI systems. One critical risk under scrutiny is the propensity for biased decisions leading to discriminatory practices against specific groups of individuals. It is apparent that those valuing self-expression exhibit a heightened concern for this risk, likely stemming from a broader emphasis on diversity and inclusion. A parallel can be drawn with the emphasis placed on environmental values, where from a harmonious perspective animals and nature should be treated as entities holding equal significance to humans, fostering a unified stance against discrimination. In the same light, respect for cultures is slightly aligned with bias concerns. On the flip side, the diminished concern observed among individuals focused on self-fulfillment could potentially be attributed to a survival-centric mindset. These individuals, often residing in less developed societies, may prioritize meeting personal necessities over addressing broader societal and environmental issues, thus reflecting a more self-centered approach to navigating the complexities of life.

Examining the risk associated with unclear responsibility, we find a strong positive correlation with both adherence to the rule of law and holding religion as a personal value. This relationship can be understood by considering the fundamental principles of each domain. Religious doctrines, generally rooted in divine law, frequently emphasize personal responsibility as a moral imperative. Similarly, the rule of law, as a state-driven mechanism, operates to maintain social order through a structured system of responsibilities. Therefore, individuals guided by these values are likely to perceive unclear responsibility with heightened concern, given the weight they attribute to defined roles and duties within a society. There exists a negative correlation between unclear responsibility and a value for environmental stewardship. This tendency may originate from a heightened focus on other types of risks, or perhaps a leaning towards the championing of rights over assuming responsibilities. The perception of having no one to complain to emerges as a significant risk for individuals primarily concerned with respect for human life. This perception likely

stems from a fundamental belief that only fellow humans can fully comprehend and respond to human difficulties and dilemmas with empathy and understanding.

Anticipating favorable outcomes from AI integration is characteristic of individuals who value respect for human life and equality, as well as those less concerned with preserving individual freedom. The first correlation can be rationalized by noting that nations placing a high premium on respect for human life and equality tend to be more developed, setting a precedent for relying on advancements that AI promises to foster in the coming years. The second correlation is logical when considering the frequent portrayal of AI as a tool for enhancing societal safety, albeit potentially at the expense of Infringing upon personal privacy. Furthermore, we observe that religious beliefs, deeply ingrained in one's core values, could intensify apprehensions about AI and its potential negative impacts in the near future. This unease might stem from a concern over the disruption of traditional lifestyles and a heightened sensitivity towards influences that profoundly affect the human essence, beyond mere material prosperity. Nevertheless, other explanations based on a mediated impact and complex relationships between religion and societal narratives that shape worldviews are not excluded.

Table 10. Anticipation of risks, effects, and desired transparency and regulation levels correlated with values. The positive sign means a heightened concern (columns 1-3), anticipated positive effects, and a lower demand for transparency and regulation. Only statistically significant results were tabulated.

	Discrimination in decision-making	Unclear responsibility	Nobody to complain to	AI effect	Transparency	Regulation
Self-expression	0.45**				-0.53***	-0.67***
Secular-rational						-0.34*
Rule of law		0.43**			-0.43**	-0.39*
Respect human life			0.60***	0.36*	-0.41**	
Human rights					-0.43**	-0.44**
Individual freedom				-0.36*	0.51***	0.55***
Democracy						-0.35*
Equality				0.34*		
Religion		0.41**		-0.44**	0.37*	0.45**
Self-fulfilment	-0.59***	0.35*			0.58***	0.44**
Respect for cultures	0.36*				-0.46**	-0.47**
Respect for the planet	0.48**	-0.38*			-0.56***	-0.73***

In querying Europeans about their desired degree of transparency regarding AI-based digital services, including the specific circumstances under which they wish to be notified of AI involvement, we find that the responses strongly correlate with a variety of deeply held values. Notably, a demand for heightened transparency aligns with values centered on self-expression, adherence to the rule of law, upholding human rights, and a profound respect for human life, cultures, and environmental conservation. Conversely, a tolerance for reduced transparency resonates more with individuals prioritizing individual freedom, religion, and the pursuit of self-fulfillment. This trend can be comprehensibly delineated through the lens of cultural dimensions, which inherently intertwine with several of the cited values. Notably, post-materialistic societies exhibit a stronger inclination towards safeguarding human rights, insisting on being adequately informed about the AI nature of digital platforms and necessitating consent prior to engagement in digital endeavors.

We further note a pronounced correlation between individual personal values and preferences regarding the extent of regulatory mechanisms overseeing AI development, with the identified trend regarding transparency continuing on the subject of regulation. Those advocating for stringent regulatory frameworks tend to prioritize self-expression, secular-rational values, adherence to the rule of law, championing of human rights, support for democracy, and respect for cultures and the planet. Meanwhile, individuals favoring more lenient regulations typically value individual freedom, religious principles, and the pursuit of self-fulfillment. Values tethered to self-expression consistently advocate for rigorous product regulation, asserting a necessity for consumer protection and transparency. In contrast, proponents of individual freedom are often less supportive of restrictive regulations, potentially perceiving them as impediments to entrepreneurial liberty and preferring a business landscape where developers are not obliged to disclose exhaustive details of their products' inner workings to users and submit to governmental overwatch and control.

Country-level linear regression

In our analysis, we utilized the two cultural dimensions outlined in the Inglehart-Welzel model as predictors for the country-level means related to perceptions of AI-related topics. Below, we distill the findings to highlight those predictors that achieved statistically significant scores. To facilitate a more intuitive understanding of emerging patterns, we have translated the sign of the beta values into their corresponding societal traits.

We discern that the self-expression versus survival dimension is pivotal in elucidating a larger share of the variance in responses. Nevertheless, the secular-rational versus traditional dimension holds merit as well, accounting for a noteworthy segment of the statistical data distribution. In the subsequent section of this article, we will endeavor to interpret these findings through the theoretical framework delineated in the literature review section.

Table 11. Summary of regression models for the perception of AI effects, trust in transparency and regulation, approved used cases, feared outcomes, and opinion articulation.

	Self-expression (Beta)		Secular-rational (Beta)		R-square
Perceive: positive effects	0.05		0.06		0.01
Accept: low transparency	− 0.62	***	0.16		**0.30**
Accept: low regulation	− 0.68	***	0.01		**0.45**
Approve: healthcare	0.05		− 0.05		0.00
Approve: traffic	− 0.02		− 0.14		0.02
Approve: energy	0.21		− 0.50	**	**0.19**
Approve: robotics	− 0.08		0.48	**	**0.20**
Approve: society	0.14		− 0.13		0.02
Fear: discrimination	0.59	***	− 0.27		**0.26**
Fear: responsibility	− 0.34		0.21		0.09
Fear: accountability	− 0.29		− 0.04		0.10
Opinion: effects	0.32		0.12		0.16
Opinion: use cases	0.56	***	− 0.16		**0.25**
Opinion: risks	0.63	***	− 0.05		**0.37**
Opinion: information	0.60	***	− 0.09		**0.31**
Opinion: ethics	0.66	***	− 0.11		**0.38**
Opinion: other ethics	− 0.45	**	0.70	***	**0.36**

In Table 11 we present a summary of the regression models for a set of dependent variables that are listed in each of the 17 rows. We used as predictors the two cultural dimensions proposed by Inglehart-Welzel, and their Beta coefficient and statistical significance along with the model's explained variance (R-square) are shown on each row. Table 12 presents only those models that had at least one statistically significant predictor, and instead of a numerical value, the name for each cultural dimension was used. Thus, as devised by the cultural dimensions in the Iglehart-Welzel study, positive Beta values of the first predictor are associated with self-expression and negative ones with survival values. Similarly, positive Beta values of the second predictor are associated with secular-rational values, while negative ones with traditional values.

Table 12. Summary of statistically significant predictors and models with higher R-square

	Self-expression (Beta)	Secular-rational (Beta)	R-square
Accept: low transparency	Survival		0.30
Accept: low regulation	Survival		0.45
Approve: energy		Traditional	0.19
Approve: robotics		Secular-rational	0.20
Fear: discrimination	Self-expression		0.26
Opinion: use cases	Self-expression		0.25
Opinion: risks	Self-expression		0.37
Opinion: information	Self-expression		0.31
Opinion: ethics	Self-expression		0.38
Opinion: other ethics	Survival	Secular-rational	0.36

Discussion

The motto of the European Union encapsulates the idea of nations functioning together harmoniously despite cultural differences. "Unity in diversity" is a highly relevant principle in establishing common technological standards while respecting diversity when discussing the strategy for AI development and deployment (Pacces and Weimer, 2020). The aim is to develop an AI strategy that is sensitive to the underlying values of different societies, without compromising on essential ethical and technical standards. By tailoring the approach based on these value systems, it is more likely that the AI implementation will be successful and less socially disruptive (Ulnicane, 2022). The shared attitudes towards certain AI use cases and risks can be understood as universal or near-universal concerns and aspirations. Issues like health, safety, traffic, and concerns over accountability in AI may be universally recognized as critical, irrespective of cultural dimensions. However, we will focus on what distinguishes each cultural type and explore potential avenues for AI deployment that harmonize with their unique set of values and principles.

Societies based on self-expression

The self-expression society is characterized by a high preoccupation with transparency and regulation, an accentuated fear of discrimination, a frequent expression of opinions, and a choice for established ethical methodologies, as seen in Table 14. Our findings are aligned with the main idea of our hypothesis: "H1: Self-expression societies are focused on post-material aspects of AI". The significance of individual autonomy, voice, and rights in self-expression societies might be connected to the emphasis on transparency and regulation in these cultures. The need for transparency stems from the strong notion that people should be informed, protected, and empowered. Additionally, a concern for non-discrimination and equal rights is consistent with the principles of self-expression. There are worries about potential biases in AI choices because of how highly these cultures value equality and diversity. This is consistent with the focus on having a voice in public discourse, participation, and free expression. The predilection for traditional ethical procedures can indicate that these cultures resonate more with established ethical norms than with other approaches.

Table 14. Summary of statistically significant predictors and models with higher R-square, with dependent variable names adjusted (in italics) and beta coefficients (in italics) in order to reflect self-expression values (positive beta coefficient in column 1).

	Self-expression (Beta)		Secular-rational (Beta)		R-square
***Demand*: high transparency**	Self-expression	*0.62***			0.30
***Demand*: high regulation**	Self-expression	*0.68***			0.45
Fear: discrimination	Self-expression	0.59***			0.26
Opinion: use cases	Self-expression	0.56***			0.25
Opinion: risks	Self-expression	0.63***			0.37
Opinion: information	Self-expression	0.60***			0.31
Opinion: ethics	Self-expression	0.66***			0.38
Opinion: *listed* ethics	Self-expression	*0.45***	Traditional	− 0.70***	0.36

Some of the strengths and opportunities of self-expression societies are the following. Their civil society has a high interest in ethical governance and has increased flexibility in adapting to new technologies. This ethically mature environment fosters innovation, public-private partnerships, and robust governance frameworks. There are also weaknesses and threats associated with self-expression societies. People may prioritize personal freedom at the expense of collective well-being, and there is an increased possibility for fragmentation and polarization of public opinion. Furthermore, societies that value freedom of expression and only focus on individual liberties might resist top-down forms of governance, reducing their ability to tackle broader societal issues.

These societies prioritize individual freedoms, diversity, and the right to voice one's own opinion. To accommodate these society's needs and values, it is essential to prioritize public engagement and democratic oversight such as running awareness campaigns and organizing public referendums on critical AI issues in order to assess the pulse of society. Other priorities include developing ethical guidelines in accordance with individual privacy, autonomy, and freedom of choice and creating innovation hubs where developed AI solutions cater to individual needs and preferences.

Societies based on survival

The survival society has antagonistic traits with respect to the self-expression society, as seen in Table 15. Again, our findings reflect the developed hypothesis for this cultural typology: "H2: Survival societies are focused on material aspects of AI". In communities that depend on survival, pressing problems like regulation and transparency may be overlooked. There is frequently a greater dependence on established processes and institutions. Therefore, a decreased worry about discrimination may be explained by the priority placed on survival issues rather than potential AI biases. Furthermore, it may be an indication that conventional or generally recognized ethical methodologies don't properly address the particular issues or viewpoints of these cultures if "other" regulating methods are preferred.

Table 15. Summary of statistically significant predictors and models with higher R-square, with dependent variable names adjusted (in italics) and beta coefficients (in italics) in order to reflect survival values (negative beta coefficient in column 1).

	Self-expression (Beta)		Secular-rational (Beta)	R-square
Accept: low transparency	Survival	– 0.62***		0.30
Accept: low regulation	Survival	– 0.68***		0.45
No **fear: discrimination**	Survival	– *0.59***		0.26
No **opinion: use cases**	Survival	– *0.56***		0.25
No **opinion: risks**	Survival	– *0.63***		0.37
No **opinion: information**	Survival	– *0.60***		0.31
No **opinion: ethics**	Survival	– *0.66***		0.38
Opinion: other ethics	Survival	– 0.45**	Secular-rational 0.70***	0.36

Survival societies exhibit the following strong points and potentials with regard to the deployment of AI-based technologies. Due to being more accepting of strong governance, there are more opportunities for state-driven initiatives and investments focusing on practical solutions and applications. Priorities include improving public services such as healthcare and safety along with enhancing economic operations. These societies also exhibit vulnerabilities related to the impact of rapid changes on the job market and social stability. Resistance might also be due to lower digital literacy rates and skepticism towards technologies that are perceived as non-essential. Moreover, if the job market is disrupted due to job opportunity losses, social unrest might occur. Also, acceptance of strong governance brings about challenges such as authoritarian misuse of AI for surveillance and control.

These societies focus on economic and physical security, often at the expense of civil liberties, and resist change. An emphasis should be put on job security by developing reskilling programs to address job losses due to AI. Transparency of clear governance structures will promote trust in AI as a tool for an increased quality of life as opposed to a threat to survival. As such, AI should be leveraged for healthcare, disaster management, and public safety which are directly tied to survival needs. Prioritizing local governance will ensure that AI technologies directly address the survival-related concerns of the community.

Societies based on secular-rationality

A secular-rational society distinguishes itself through a lower emphasis on implementing AI for use cases regarding energy management and a higher desire for job safety through automation, as seen in Table 16. The findings are in line with our stated hypothesis: "H3: Secular-rational societies are focused on how AI helps social and economic progress". These choices might reflect skepticism or the workings of the secular-rational dimension which values logic, reason, and science. One reason automation is preferred in such societies is that it can enhance efficiency and reduce human error in various fields, aligning with a pragmatic approach that favors systematic, data-driven solutions. The expression of alignment in terms of regulation with the conventional ethical methodologies is expected as such procedures were created through rational thinking which is its core value.

Table 16. Summary of statistically significant predictors and models with higher R-square, with dependent variable names adjusted (in italics) and beta coefficients (in italics) in order to reflect secular-rational values (positive beta coefficient in column 2).

	Self-expression (Beta)		Secular-rational (Beta)		R-square
Disapprove: energy			Secular-rational	*0.50***	0.19
Approve: robotics			Secular-rational	0.48**	0.20
Opinion: other ethics	Survival	− 0.45**	Secular-rational	0.70***	0.36

On the other spectrum, secular-rational societies may benefit from AI-powered data-driven decision-making, while also displaying a strong focus on scientific and ethical higher standards that might become globalized. The highly educated citizens represent an ideal human capital resource for fostering R&D environments. At the same time, the downside of data-driven rationalization and overreliance on technological advancements is a neglect of human factors. This may lead to ethical lapses and a risk of elitism and inequality between the regular citizens and the technocrats who hold the power of AI governance.

These societies emphasize logic, scientific inquiry, and evidence-based decision-making. Thus, the preferred way of AI governance and oversight is through using data analytics and evidence-based approaches for policymaking and establishing independent bodies for auditing and monitoring the ethical implementation of AI. Educational programs should focus on introducing AI and technology education in schools and universities, emphasizing its rational benefits and ethical considerations. Other suitable strategies include international collaboration through engaging in partnerships that prioritize scientific research and global best practices in AI development and deployment.

Societies based on tradition

Traditional societies, as seen in Table 17, favor AI applications that align with their established customs and norms while avoiding those that could disrupt existing social structures and job roles, a reason why there is a general aversion to automation technologies. These findings were envisioned within our hypothesis: "H4: Traditional societies are focused on how AI disrupts life and alienates people". These societies appreciate their historical working methods, seeing them as rich and meaningful. However, they are open to leveraging AI for managing energy and emissions, as this doesn't replace human roles but enhances them, facilitating better stewardship of natural resources and helping protect the environment for future generations, thus fostering a harmonious blend of traditional values and modern technology for the greater good of the community.

Table 17. Summary of statistically significant predictors and models with higher R-square, with dependent variable names adjusted (in italics) and beta coefficients (in italics) in order to reflect traditional values (negative beta coefficient in column 2).

	Self-expression (Beta)	Secular-rational (Beta)		R-square
Approve: energy		Traditional	− 0.50**	0.19
Disapprove: robotics		Traditional	− *0.48***	0.20
Opinion: _listed_ ethics	Self-expression *0.45***	Traditional	− *0.70****	0.36

Traditional societies represent the other end of the spectrum in contrast with secular-rational ones and may offer unique ethical perspectives. Strong community cohesion fosters collective decision-making and community leaders can be leveraged for smooth AI implementation. Solutions would most likely focus on solving community-level issues while caution for wide technology adoption would reduce the risk of rapid failures.

Nevertheless, this prudence and resistance to change might also lead to marginalization if these societies fall behind in adopting AI. Other risks include that the focus on communities might override individual freedoms and rights. Furthermore, lower levels of digital literacy and exposure to diverse viewpoints might lead to ethical risks if community norms are not compatible with broader human rights frameworks.

These societies value religious beliefs, historical continuity, and societal norms over radical change or individual freedom. Cultural sensitivity should be addressed through AI systems by respecting local customs, social structures, and religious beliefs. Ethical guidelines should be formulated by taking into account respect for tradition, family values, and community cohesion. AI systems should be designed for inclusivity, meaning that they can be customized to align with traditional values and norms. Altogether, community leaders and traditional institutions should be involved in the decision-making processes related to AI for a sustainable future.

Conclusion

This study leverages the insightful framework of the Inglehart-Welzel cultural value system to analyze and understand the heterogeneous perspectives towards AI development and deployment at a country level. By utilizing the extensive Eurobarometer dataset as the foundation for our analysis, we successfully deconstructed the complex network of expectations, perceived risks, and preferred regulatory approaches regarding artificial intelligence. This was accomplished primarily through the lens of survival versus self-expression dimension, while also acknowledging the significant contributions of the traditional versus secular-rational spectrum.

We constructed four societal archetypes according to attributes that delineate the extremes of the two dimensions in the Inglehart-Welzel model. Each archetype clarifies unique inclinations and apprehensions linked to AI technologies. By adopting this perspective, one could gain an understanding of the imagined futures shaped by various cultural frameworks, wherein certain individuals predict that AI will contribute to enhancing the quality of life, while others foresee possible exacerbating of pre-existing disparities. The diverse array of expectations exhibited by various cultural groups highlights the need for a nuanced strategy toward the integration of artificial intelligence, one that carefully balances the dual imperatives of unity and diversity.

Our strategic outline serves not just as a roadmap for AI deployment but as a compass guiding societies to leverage the strengths and opportunities inherent in their unique cultural landscapes, while conscientiously averting potential pitfalls. Our objective is to promote a harmonious cohabitation of artificial intelligence and the diverse array of European cultures by advocating for a strategy based on "unity in diversity." This will lead to a future in which technology exemplifies how contemporary innovation and deeply ingrained cultural values can coexist in harmony, thereby fostering a sustainable and inclusive future that benefits all.

This development signifies a progression towards a future in which the cultural values of Inglehart-Welzel not only provide insight into the intricate dynamics of AI

acceptance but also serve as a compass for the seamless incorporation of technology into various societal structures. It establishes a precedent for a future in which diversity is esteemed and celebrated while collectively striving towards shared objectives. The present approach not only fosters a more profound comprehension of the complex mechanisms that govern the acceptance of artificial intelligence but also guarantees that the technological path is controlled by reverence for the diverse tapestry of European societal values. This creates an environment in which innovation and tradition coexist in a harmonious manner, promoting a sustainable and inclusive future.

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Gheorghe Nadoleanu is a Ph.D. student in the field of Sociology at the University of Bucharest, researching the connection between religion and society, with a focus on the perception and impact of advanced digital technologies such as Artificial Intelligence. He has a profound understanding of humans, being a priest with over 25 years of experience, and having a multidisciplinary study background comprising theology and psychology. After graduating in Theology at the University of Bucharest and Psychology at the Ovidius University of Constanta, he obtained a master's degree in Theology and one in Law and Administration and further continued his research at the Pontificio Orientale Institute in the Vatican. He coordinated several institutions such as a center for preventing family abandonment created from European funding, an NGO for vulnerable people, the theological seminary of Cocosu Monastery from its foundation, and the Department of Development Programs in Tomis Archiepiscopate. He is currently working as a priest, as a school psychologist, and as an itinerant teacher for children with special needs.

Emanuela Bran is a Ph.D. student at the National University of Science and Technology Politehnica of Bucharest in the field of Computers and Information Technology and a PhD student at the University of Bucharest in the field of Sociology. She worked as a research assistant at the Institute of Security and Development at the Black Sea, which is affiliated with Ovidius University of Constanta, where she researched and developed distributed multimodal systems used for enhancing the driving experience and museum environments. She is currently working as a teacher assistant at the National University of Science and Technology Politehnica of Bucharest. Her areas of expertise include ubiquitous computing, multimodal interfaces, human-computer interaction, mixed reality, user experience, artificial intelligence, blockchain, and connected subjects. Her aim is to understand and create technology that brings a positive change in people's lives, society, and the environment.

Ana Rodica Stăiculescu worked as a university professor at the Ovidius University of Constanta and is currently working as a university professor at Şaguna University of Constanta, and furthermore, as a Ph.D. coordinator at the University of Bucharest. She graduated in Sociology at the University of Bucharest and received a scholarship from the ONU-CEDOR, continuing her postgraduate studies at the University of Paris I – Panthéon-Sorbonne, where she obtained her Ph.D. in Demography with the "très honorable" distinction - the highest grade. Her area of expertise comprises Sociology and Social Psychology, with subfields such as demographical research, transdisciplinary studies of social identity, the impact of technology on society, cultural differences in international negotiation, sociology of deviance, and sociology of organizations. She has been affiliated for over 10 to 15 years with several renowned institutions and organizations, namely as a council member responsible for coordinating the Romanian

branch of the OLA Observatory of Local Autonomy of the EU European Committee of the Regions, as an ARACIS evaluator for the C4 Commission on Social, Political and Communication Sciences, as a reviewer in the Editorial Board of Journal of Politics and Law of Canada ISSN 1913-9047 (Print) ISSN 1913-9055 (Online), and as a reviewer in the Editorial Board and associate editor of Public Administration Research Canadian Center of Science and Education (PAR) of Canada, ISSN 1927-517X (Print) ISSN 1927-5188 (Online).