Ethics and Information Technology (2025) 27:26
https://doi.org/10.1007/s10676-025-09832-7

ORIGINAL PAPER

# AI regulation: maintaining interoperability through value-sensitive standardisation

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Accepted: 15 April 2025


**Abstract**
Artificial intelligence (AI) regulatory frameworks are being used to emphasise specific values in previously purely technical areas. One clear example is the European Union's (EU) AI Act regulation, which sets rules on AI while relying on technical standards to guide compliance and strengthen global cooperation. However, it also states that regulatory efforts have to be in accordance with Union values. Hence, we analyse the EU's approach as an example of the importance that values have gained in AI regulatory frameworks and standards. Therein, we argue that diverse conceptions of values could prevent interoperability between AI systems across regulatory contexts. To illustrate our argumentation, we identify values stated in AI regulatory frameworks from the EU, the United States and China and compare them according to the Theory of Basic Values. The comparison highlights that maintaining interoperability is crucial for regulatory frameworks and standards aiming to advance AI-based systems' successful deployment and function in and across different regulatory contexts. Consequently, we propose a value-sensitive AI standardisation approach based on our analysis of AI regulatory values, a previous ISO/IEC/IEEE standard's approach and value sensitive design. Our approach aims to relate AI regulatory values to requirements in AI regulations and provide suggestions for value-based configurability in AI standards. While we find there is no harmonised approach for the embedment of value-based consideration in AI standardisation, this could be a tool used to maintain the interoperability of AI systems that have global reach. Our proposed approach aims to address this shortcoming within the interplay of global AI markets and regulatory strategies.

**Keywords** AI standards · AI regulation · AI Act · Values · Interoperability

## Introduction

Governmental authorities are keen on establishing their own artificial intelligence (AI) rules through various regulatory frameworks (Mäntymäki et al., 2022; Gonzalez Torres et al., 2023). Leading examples can be seen in the European Union's AI regulation, the White House's Executive Orders on AI, and China's Interim Measures for the Management of Generative Artificial Intelligence Services (Annex I). These frameworks have a commonality. They explicitly mention values and even exhibit a willingness to protect specific values (Gonzalez Torres & Ali-Vehmas, 2024). This can be seen as an attempt to dictate the values that guide the development, deployment, and use of technology (Nissenbaum, 2005); from the values of privacy, democracy, and the rule of law to values like harmony and opportunity for all to pursue their dreams. Due to the diversity in AI regulatory values, we argue that different conceptions of values can impact the communication and functioning of AI-based systems across borders. Thus, ignoring the interplay between values, standards, and global regulatory frameworks could jeopardise the maintenance of AI systems' interoperability between regulatory contexts.

In practice, the effects of the mismatched interplay can already be observed across borders. One example is social scoring, which is the practice of using algorithms to rank individuals based on social, reputational and behavioural attributes (Packin & Lev Aretz, 2019). In China, social credit systems are a lawful and common practice (Ahl et al., 2024). Meanwhile in the European Union (EU), social scoring is a prohibited practice due to the unacceptable risk it poses to non-discrimination or the right to dignity (Regulation 2024/1689, recital 31; article 5). Furthermore, this

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Published online: 19 May 2025

mismatch has been exacerbated by AI developments, such as general-purpose models (Bommasani et al., 2022). For instance, consider the case of OpenAI, a United States AI company and its ChaptGPT AI model, which was temporarily blocked both in Italy due to privacy concerns (GPDP, 2024) and in Chinese social media applications due to fears of disinformation (Ray, 2023). Similarly, Chinese company DeepSeek's AI model was blocked in Italy due to privacy concerns in the processing of personal data (GPDP, 2025), whilst the United States (US) considers banning its use in government devices due to national security concerns (Duffy, 2025). These examples show the importance of addressing different value conceptions.

Unaddressed differences could lead to a future where internationally deployed AI systems will not be able to function or communicate across borders due to a lack of *interoperability* on the basis of different value conceptions (Leese, 2024). This scenario could become the norm leading to the loss of availability and service continuity. An example of this scenario can be seen in the case of Apple Intelligence (an AI-based system), deployed in 2024 to iPhones in the US while being unavailable in Europe and China. The lack of availability in the EU was justified under the grounds of "regulatory uncertainties" and the belief "that the interoperability requirements of the [European Digital Markets Act] could force [Apple] to compromise the integrity of [Apple's] products in ways that risk user privacy and data security" (Chee, 2024).

In diverse market conditions, standardisation has been a powerful mechanism to solve interoperability problems (Lewis et al., 2020). However, there is a change in the standardisation paradigm brought by the EU's AI regulatory approach. Contrary to the previous paradigm, where standardisation was purely a technical endeavour, the EU's approach requests standards to cater for fundamental rights and Union values in their task of developing standards that support AI regulation. Thus, although standards can prove to be useful in addressing interoperability issues, they will have to face the underlying uncertainty surrounding the abstract nature of values and capture them in concrete standards. Moreover, this is challenging in light of the international landscape where, regardless of the regulator's expectations, one cannot expect standards to secure EU-specific values outside of the EU (Cantero Gamito, 2018).

In this set of affairs, we focus on value-based considerations in AI standardisation. Meaning how the (formal) processes behind the development of standards can conceptualise values as grounds for decision-making and within deliverables meant to support AI regulation (Abdelkaf et al., 2021). We analyse values in relation to the interoperability of AI systems in and across different regulatory contexts. In relation to regulatory contexts, we mean geographical areas governed by AI-specific regulatory frameworks, including various sources of law (e.g., binding regulations, executive orders, administrative measures) as established by governmental authorities within their competent regulatory borders. Whlist in relation to interoperability, we mean the capacity of AI systems to function in different geographies, and communicate with each other, across borders (Abdelkaf et al., 2021; Leese, 2024). In our conception, ideally, interoperability should happen even if regulatory contexts have different AI regulatory frameworks and values.

Our research questions (RQs) are:

**RQ1**: What are the implications of EU values to global AI standardisation?
**RQ2**: How can AI standards maintain interoperability between AI systems across regulatory contexts with different values?

To address *RQ1*, we analyse the issue of values in standardisation from the perspective of the EU's AI regulation (section "European AI regulation and standardisation"). Then, we compare values reflected in AI regulatory frameworks set by different governmental authorities (section "European Union values and beyond"). Our analysis is based on the Theory of Basic Values (Schwartz, 1992, 1994, 2012), which is used to exemplify how to navigate different value conceptions (Table 2). Based on the results of the analysis, we address *RQ2* by proposing a value-sensitive AI standardisation approach (section "Value-sensitive AI standardisation"). This is inspired by previous standardisation efforts (in ISO/IEC/IEEE), an analysis of value sensitive design (Friedman & Hendry, 2019; Friedman et al., 2006), Schwartz's Theory, and virtual home environments as an earlier example of standardised configurability. Finally, we discuss the practical implications of our proposed approach, our recommendations for future AI standards (section "Discussion: a way forward for future AI standardisation") and the broader impact of values in a polarised world (section "Conclusions").

## European AI regulation and standardisation

The EU governs the use of artificial intelligence in Regulation (2024/1689), "laying down harmonised rules on artificial intelligence" or "AI Act". In practice, it aims to bring regulatory considerations, like respect for values, to the forefront of AI research, development, and deployment (AI Act's recital (1);(6);(8)). We argue that through the AI Act, the EU is embedding specific value-based considerations into AI standardisation given the *harmonisation legislation* regulatory approach.

In the EU's context, harmonisation legislation aims to eliminate barriers and facilitate free trade in the single market (Veale & Borgesius, 2021). However, regulatory intervention is limited to only essential requirements in pursuit of the public interest or due to a product's risks (Tartaro, 2023). It does not extend to specifying the technical means needed to achieve regulatory goals. This specification task is understood to be the primary goal of formal standardisation by European Standardisation Organisations (ESOs), such as the European Committee for Standardisation (CEN), the European Committee for Electrotechnical Standardisation (CENELEC) and the European Telecommunications Standards Institute (ETSI).

In 2023, the European Commission published implementing decision C(2023) 3215, requesting CEN and CENELEC to draft new standards in support of the AI Act's essential requirements (EC, 2023). In accordance with the harmonisation legislation approach, *harmonised standards* developed by ESOs determine the technical means and detailed guidance on how to comply with regulatory requirements (Tartaro, 2023). In this regulatory setup, the role of harmonised standards is quite unique. On the one hand, standards are voluntary, but on the other hand, they offer a presumption of conformity. This presumption has important legal and economic consequences which make standards widely adopted. For instance, if manufacturers proceed according to harmonised standards, their product benefits from a presumption of conformity to applicable legislation, which leads to CE marking and subsequent commercialisation of a product in the EU single market.

While harmonisation legislation is a well established EU regulatory approach, the AI Act presents a unique challenge. It requires harmonised standards to be according to *Union values* when specifying how AI systems can technically conform to essential requirements (e.g., risk management, cybersecurity) (Baeva et al., 2023). This is explicit in the AI Act's article 40(3), "harmonised standards and standardisation deliverables", and in the European Commission's standardisation request, recital (14) (EC, 2023). Both establish, in a similar manner, that the standardisation process shall seek to promote *investment and innovation in AI*, *competitiveness and growth* of the Union market, contribute to *strengthening global cooperation on standardisation* and take into account existing international standards *that are consistent with Union values*. According to the AI Act's recital (6), these "Union values" refer to the values stated in Article 2 of the Treaty on European Union, meaning "*the values of respect for human dignity, freedom, democracy, equality, the rule of law and respect for human rights, including the rights of persons belonging to minorities*" (TEU, 2012).

Concretely, the AI Act employs a risk-based approach, stating four categories of AI systems, with the high-risk AI systems category being subject to the regulation's essential requirements and related harmonised standards (Ebers, 2024; Tartaro, 2024). This circumscribes ESOs' tasks within the development of harmonised standards. In fact, standardisation deliverables have been requested for ten items (risk management; governance and quality of datasets; record keeping; transparency and information provision to the users; human oversight; accuracy; robustness; cybersecurity; quality management system; conformity assessment) (Soler Garrido et al., 2023a, 2024). It is these items that will be impacted by the AI Act's stance in maintaining respect for Union values.

Therefore, we narrow the scope of our analysis to the phenomenon of technical standards, in their determination of a widely agreed way to technically comply with AI regulation (Abdelkaf et al., 2021) and their intersection with the complexity of values (Lewis et al., 2020; Polak, 2023; Winfield, 2019). However, in terms of values, it is important to be wary of potential underlying assumptions that certain values, such as Union values, are to be imposed in other contexts through standards. We do not attempt to further the assumption of European values' superiority as it can be harmful and build tensions in the global standardisation process. We focus on the EU because it is clear that while keen on Union values, the EU's AI standardisation efforts run the risk of not being accepted outside of Europe and even becoming an obstacle to the interoperability of AI systems due to the differences in value conceptions in different contexts.

Considering our *RQ1*, the implications of EU values to global AI standardisation are twofold. Primarily, it implies a need to understand *how* to approach the issue of values within AI standardisation. However, before approaching the issue of values, there is a need to understand *which* values drive AI regulatory frameworks. While overall, the underlying implication is that if left unaddressed, values could impact the ability to maintain AI interoperability due to different conceptions in EU standards and standards from different *foras*, like the Institute of Electrical and Electronics Engineers Standards Association (IEEE SA), the International Organisation for Standardisation (ISO) or the International Electrotechnical Commission (IEC).

We will address the primary implication in section "Value-sensitive AI standardisation" by proposing a value-sensitive AI standardisation approach inspired by the work of value sensitive design, which aims to embed value consideration in the development of technology (Friedman & Hendry, 2019; Friedman et al., 2006). Whereas the understanding of *which* value(s) will be addressed in the next section, based on an analysis and comparison of EU-specific values to the US and Chinese AI-related regulatory frameworks' values.

## European Union values and beyond

In order to demonstrate the underlying interoperability issues, derived from the interactions of different values, we have chosen to identify AI-related values from three different regulatory contexts: the European Union, the United States and China. In relation to AI, we aim to identify values that are considered important in governmental discourses due to their assertion in regulatory frameworks, such as treaties, executive orders or administrative measures (Foret & Calligaro, 2018). We consider that those values aim to incentivise AI development and deployment "towards desired goals" (Schwartz, 2012), mainly goals that are considered desirable by the EU, US and Chinese regulatory contexts. This aims to address the issue of *which values* could impact AI systems' interoperability and *how* to navigate values in the standardisation process and in standards themselves.

There are two main reasons behind our comparison. First, the US and China are considered the world leaders in AI (Hine, 2023). It is, therefore, important to understand which values drive the AI-technology innovations that have a significant impact on the global AI industry (Ding et al., 2023; Hine & Floridi, 2022). Second, there is an observation that current leading AI actors tend to consider EU's regulations, and therefore its specific values, as an extra burden (Hacker, 2024). This is either because the legal burden is considered higher in the EU than in providers' home markets, as is the case for US technology companies, or because their home markets present different governmental guidance, as is the case in China (Ding et al., 2023; Hacker, 2024). Thus, when AI systems are deployed in the European context, there is a potential for conflict when AI technologies present their providers' own (distinct) set of values based on their home markets' regulatory frameworks.

## Methodology

The identification of relevant AI-regulatory contexts' values, Table 1, is based on the authors' initial identification of AI-regulatory documents in the EU, US and China according to references provided in academic literature. Subsequently, the authors conducted a qualitative analysis of the relevant AI regulatory frameworks, aiming to identified mentions of values and direct mentions of specific values. Therefore, the values displayed in Table 1 account for values over which there was an overlap in recognition, both in regulatory frameworks as well as in relevant literature. The values over which there was a discrepancy in recognition were excluded. Annex I provides a detailed account of the sources used for the identification of regulatory contexts' values. In a nutshell, the authors provide a comparison limited to a qualitative analysis:

- The identified values in the European Union are based on an analysis of the AI Act (Regulation, 2024/1689) and the Treaty of the European Union (2012), complemented by the work of Spieker (2023) on Union values.
- The identified values in the US are based on an analysis of Executive Orders (Administration periods 2017–2021 and 2021–2025) focused on AI.
- The identified values in China are based on the Interim Measures for the Management of Generative Artificial Intelligence Services (2023), complemented by the academic work on core socialist values by Miao (2020) and Chinese values in AI regulation by Sheehan (2023).
- The comparative analysis is complemented by reviewing Hine & Floridi (2022), which provided a comparative analysis of the US and Chinese governmental AI policies (2016–21), and Roberts et al. (2021), which compared the US and the EU approaches for "good AI in society". In both cases, we focused on their results on values.

**Table 1** Identified AI-related regulatory contexts' values

| United States | European Union | China |
|---|---|---|
| • Freedom<br>• Guarantees of human rights<br>• Rule of Law<br>• Stability in our institutions<br>• Rights to privacy<br>• Respect for intellectual property<br>• Opportunities to all to pursue their dreams | • Human dignity<br>• Freedom<br>• Democracy<br>• Equality<br>• Rule of Law<br>• Respect for human rights<br>• Rights of the persons belonging to minorities | • Prosperity<br>• Democracy<br>• Civility<br>• Harmony<br>• Freedom<br>• Equality<br>• Justice<br>• Rule of law<br>• Patriotism<br>• Dedication<br>• Integrity<br>• Friendship |

## Limitations in value analysis

In account of our analysis, and to the best of our knowledge, there is no previous academic work that compares the *values* of *all three* selected *regulatory contexts* (EU, US and China) in relation to AI. Therefore, our work addresses this gap through a comparative qualitative analysis. However, we limited our analysis to *values* explicitly mentioned in AI regulatory frameworks because our aim is to identify the values that governmental authorities consider important and, therefore, are likely to impact AI standardisation. In our view, this approach provides more stable grounds for a comparative analysis. In relation to our identification of values, we recognise, there might be different opinions and disagreements about the exact values that are important in the selected regulatory contexts. However, that is precisely our point; it is the (inevitable) differences in the conceptions of values that poses an issue that could hinder interoperability between AI systems.

We did not aim to engage in the debate around the differences between rights, principles and values (Kochenov, 2016; Raz, 2005). However, we align with the consideration that values are broader stances that inform both principles and rights (Dworkin, 2001). In this sense, while there might be different conceptions of values, the results in Table 1 are consistent with our goal of comparing values for the purposes of interoperability, not to question governmental discursive assertions.

In relation to the identification of relevant AI regulatory documents, we excluded regulatory frameworks focused on rights and principles. For instance, in the European Union, we excluded the EU Charter of Fundamental Rights and Ethics guidelines for trustworthy AI (HLEGAI, 2019). In the US, we excluded the Blueprint for an AI Bill of Rights (The White House, 2022). In relation to the Chinese regulatory context, we limited our review to literature written in the English language by academics who focus on Chinese values and AI regulatory frameworks. In broader terms, we excluded OECD (2019) values-based AI principles because we wanted to focus on comparing values recognised in specific regulatory contexts.

## Comparing key values of three regulatory contexts

The comparison of regulatory context values is based on our analysis of the Theory of Basic Values (Schwartz, 1992, 1994, 2012). This theory concerns the basic values that people in various cultures around the world implicitly recognise (Schwartz et al., 2012). Schwartz's work emerges from studies in the field of psychology, aiming to provide a common understanding of values across cultures. It suggests that there is a potential for a universal organisation of values, even if there might be different priorities or hierarchies. We choose Schwartz's theory because it is supported by survey evidence showing that certain values are recognised across cultures and for its applicability, beyond individual values, in the policy domain for comparative analysis (Schwartz, 1994).

We employ the theory's four "high-level order values" to categorise Table 1 values. The four categories are *self-transcendence*, *conservation*, *self-enhancement*, and *openness to change*. Each category encompasses a series of basic values (universalism, benevolence, tradition, conformity, security, power, achievement, stimulation, self-direction) contributing to the achievement of their corresponding higher-level value. The categories are characterised by having distinctive goals. For instance, self-transcendence pursues goals related to welfare; conservation pursues goals related to culture, social expectation or safety; self-enhancement pursues goals related to dominance or personal success; openness to change pursues goals related to novelty or independence. We used the theory in its description of high-level values to categorise previously identified values from the EU, China, and the US.

Concretely, we use the four high-level values as a model for abstraction, similar to a generalising lens, to structure Table 2. This table is an example we have constructed to demonstrate a potential way to categorise values. To each high-level value corresponds certain values (hereafter "basic values") from the selected regulatory contexts (e.g., to the high-level value of "openness to change" correspond the US's "basic values" of freedom and opportunities to all to pursue their dreams as well as the EU's and China's "basic value" of freedom). This was done based on our analysis and interpretation of values in AI-related regulatory frameworks, literature review of value, and Schwartz's conceptions on the high-level order of values. To validate the results, the authors discussed the correspondence until they reached an agreement and consultated external stakeholders during the development of Table 2 as well as during the review process.

From Table 2, we highlight three observations:

First, we see there is an alignment when following a "high-level order values" categorisation. For instance, values like the rule of law and freedom are present in all three analysed regulatory contexts. Therefore, in some areas, a *minimum threshold* of agreed-upon values could be defined. This threshold could be a heuristic list of values (Friedman & Hendry, 2019), useful as a starting point to ground the navigation of different values in relation to the interoperability of AI-based systems.

Second, even under a generalising lens, there are high-level values where cross border recognition might not be possible. For instance, the EU and the US have no recognition for *self-enhancement* as there are no regulatory contexts' basic values that could be categorised as such, similarly for China and *self-transcendence*. In a sense, one

**Table 2** Comparison of regulatory contexts' values according to the Theory of Basic Values

| | | | Regulatory Contexts' Basic Values | | |
|---|---|---|---|---|---|
| | | | **United States** | **European Union** | **China** |
| High-Level Order Values | Self-Transcendence | Contribute to pursuing goals geared towards maintaining welfare for all (universalism value) as well as for those in the "in-group" (benevolence value). | • Guarantees of human rights<br>• Rights to privacy<br>• Respect for intellectual property | • Human dignity<br>• Respect for human rights<br>• Rights of the persons belonging to minorities | |
| | Conservation | Contribute to pursuing goals of commitment to customs and ideas of one's culture or religion (tradition value), restrain of actions and impulses likely to violate social expectations or norms (conformity value) as well as safety, harmony, and stability of society, of relationships, and of self (security value). | • Rule of law<br>• Stability in our institutions | • Democracy<br>• Equality<br>• Rule of law | • Democracy<br>• Civility<br>• Harmony<br>• Equality<br>• Justice<br>• Rule of law<br>• Integrity<br>• Friendship |
| | Self-Enhancement | Contribute to pursuing goals of status, control or dominance over people or resources (power value) as well as personal success through competence according to social standards (achievement value). | | | • Patriotism<br>• Dedication<br>• Prosperity |
| | Openness to Change | Contribute to pursuing goals of novelty, and challenges in life (stimulation value) as well as independent thought and action or choosing, creating and exploring (self-direction value). | • Freedom<br>• Opportunities to all to pursue their dreams | • Freedom | • Freedom |

can interpret that certain high-level value categories are not considered important in certain regulatory contexts. Therefore, in those categories no agreement on the content of a minimum threshold's basic values will be achieved.

Third, for some regulatory contexts, there is a high emphasis on some high-level values, like *conservation* in China, as seen by the number of basic values in that category. Thus, certain categories will have extended recognition in some contexts, while in other regulatory contexts, there will be no recognition or only a disregardable level of interest.

We find that Table 2 provides a concrete example of how to navigate values by exhibiting how they are diversely prioritised in the three regulatory contexts. This is relevant for AI standardisation as global standardisation efforts will need to contextualise values in a broader international landscape. In our view, and specifically in the EU, AI standards could be developed according to a generalising lens with high-level categorisations instead of focusing on specific basic values. Thus, avoiding situations where values suffer from a general lack of recognition (jeopardising interoperability).

Overall, the importance of using a generalising lens to categorise values, as stated in Table 2, is that it can help to assess and disclose preferences in values. Ultimately helping navigate different values and maintain the interoperability of AI-based systems. However, this cannot extend to holding a "universalism" in values (Kaiser, 2024). It is clear that in some geographical contexts, certain values may include aspects that are not allowed in other regions due to regulations or culture. It might be the case where values that are not considered *Union values* play a significant role in global AI standardisation or EU's regulations might not recognise the values guiding the original development and deployment of non-European AI-based systems. For instance, when an EU entity uses (or develops) AI-based services outside the EU, in China or the US, and there is no alignment with those regulatory contexts' values. This happened in the case of voice privacy, which, at an early stage of the technology, was not allowed in all markets. In such instances, the ciphering status (active/not) was indicated to the users. Similarly, in the case of children's data protection, privacy considerations vary in different regulatory contexts (Bischoff, 2023).

While it is evident that values are important in all regulatory contexts, some commonalities and differences will have to be navigated. Thus, there is a need to *facilitate* interoperability across borders in relation to recognised values and *maintain* interoperability when values do not seem to gain recognition across regulatory contexts (e.g., when a minimum threshold cannot be achieved). Based on our analysis and interpretation, there is potential for a proposition of *three levels*. *Level 0*, where there is no recognition of values. *Level 1*, a minimum threshold alignment. *Level 2*, extended recognition of basic values. This *three levels proposition* could support AI standards and guide the process of embodying values, depending on the agreed level. For instance, for Level 1, developing standards that guide the design of AI features that cater to values under a minimum threshold (e.g., rule of law and freedom). For Level 0 of non recognition (e.g., in the cases of patriotism, dedication, prosperity) and for Level 2 of high recognition (e.g., in the cases of China's extended recognition of self-enhancement with extended basic values), developing standards that allow for configurability by guiding the design of AI systems with alternatives. In this realisation, the next section will be devoted to our proposed *value-sensitive AI standardisation* as an approach suitable to address the differences between regulatory contexts' values in standardisation and standards.

## Value-sensitive AI standardisation

In practice, the prioritisation of values varies in different regulatory contexts. Therefore, when standards support AI regulation, some flexibility is needed (Hanseth et al., 1996). To address various conceptions of values, a high-level categorisation is needed (e.g., Table 2) which then allows choosing a value-sensitive approach. In relation to the *how* of our *RQ2*, we envision that a combined approach of minimum threshold and configurability could provide a fruitful way to maintain interoperability when facing regulatory contexts with different conceptions of values. This can be achieved by what we call a *value-sensitive AI standardisation* approach.

This approach could guarantee functionality across borders by determining *essential functions,* as embodied by a minimum threshold of agreed-upon values, such that different devices or software exchange and use information from different contexts through shared common protocols (Abdelkaf et al., 2021; Leese, 2024). At the same time, a level of value-based flexibility can be ensured by producing standards aiming for *configurability* and providing guidance on *how* to use the various configurations in each regulatory context.

In diverse value contexts, striving for AI interoperability will require guiding the production of options and/or variations as well as allowing unique software configurations (Nitu, 2009). One simple and concrete example of successful interoperability while allowing configurability can be seen in the 15 types of domestic electrical outlet plugs currently available worldwide. They all present differences, but they are also unified by some essential functions and features that make it possible to build adapters and converters for appliances (Roberts et al., 2021).

In our view, standards could guide the development and design of AI-based systems towards *configurability*. For example, developing personalised features (e.g., furthering self-transcendence through degrees of privacy in data sharing), user interface (e.g., furthering conservation through degrees of democracy by developing an interface that provides a certain number of perspectives when generating texts through AI-based systems), customisation (e.g., furthering openness to change through freedom by enabling user's customised services based on information directly or indirectly gathered from a user's profile). These examples of configurability could be based on the specific values of the relevant regulatory context.

We emphasise the importance of *value sensitivity* because the *standardisation process* should also contemplate values when developing standards according to regulatory requirements. Our approach recognises that there are specific values that are considered important in relation to AI systems. Thus, s*tandards* aiming to maintain interoperability could use our proposed approach when guiding the navigation of values through the development and deployment of AI-based systems.

At the time of writing, CEN and CENELEC have a short list of published standards and a work programme for the development, draft and approval of new standards, none of which relate to interoperability. To address this overlooked aspect, we demonstrate the applicability of our proposed approach through a high-level example in section "Values in standardisation: ISO/IEC/IEEE 24748:2022 standard" and by discussing a concrete way to consider values in section "Value sensitive design in standards". Thereafter, in section "Standardised configurability: virtual home environments", we analyse a practical earlier example of configurability in a standard.

## Values in standardisation: ISO/IEC/IEEE 24748-700:2022 standard

ISO/IEC/IEEE, 24748–700:2022 standard was initially developed for ethically aligned autonomous and intelligent systems, according to a value-based engineering approach (Spiekermann & Winkler, 2022). It establishes a set of processes by which engineers and technologists can include consideration of ethical values throughout the stages of concept exploration and development. This process includes eliciting and understanding value implications and consequences, value priorities, values as system's requirements, and design alternatives.

The standard has been recognised as relevant in the context of the AI Act, given its consideration for values and its relation to risk management (Soler Garrido et al., 2023a, b). We consider this standard provides a high-level example for EU AI standardisation. In our view, standardisation could take into consideration the process in the ISO/IEC/IEEE standard while anchoring the initial values to a *minimum threshold* (e.g., rule of law, freedom) to favour interoperability with other regulatory contexts. A minimum threshold could be achieved, at least partially, based on high-level order values. This could lead to recognising the general applicability of certain regulatory requirements.

As an example, Table 3 shows how the Theory of Basic Values can be used to categorise the AI Act's essential requirements. In our example, regulatory requirements can embody value-based considerations starting from *high-level values*. In such a case, we could see a recognition of certain values in self-transcendence (e.g., contributing to maintaining respect for human rights) and conservation (e.g., contributing to maintaining the rule of law). Thus, requirements like human oversight and risk management (in relation to the prevention of harms posed to human rights) or transparency and data governance (in relation to compliance and documentation) could lead to developing standards that are value-sensitive. This could mean including in standards a process, like that of ISO/IEC/IEEE 24748-700:2022, guiding determinations of value priorities (e.g., between human rights and intellectual property rights or between rule of law and democracy). Especially in an international landscape, where requirements might not be the same, one of the tasks of standardisation will be to determine the values guiding requirements and, therefore, standards.

We can see that the most complicated aspect is *self-enhancement*, as there are no conceivable requirements due to the lack of recognised values in the EU under such a high-level value. This could hinder the interoperability of EU's AI systems within a regulatory context like China. However, *openness to change,* as one of the minimum threshold values, could facilitate interoperability when conceptualising the related basic value of freedom as a "movement of information" (Gonzalez Torres & Ali-Vehmas, 2024). Therein, standards could pursue an enhancement in compatible information (e.g., common protocols), removing traditional sectoral boundaries, towards a use of information and communication technologies expanded to the entire society (Ali-Vehmas et al., 2020).

For high-level values where there is no cross-border recognition (e.g., self-enhancement and openness to change) due to the absence of aligned requirements, then an AI standard from a specific regulatory context (e.g., EU) will have to grant leeway to (*other*) value-based international systems' designs (e.g., self-enhancement leading to highly customisable features). However, the design of alternatives could still be guided by a respect for a "high-level order of values", even if there is no concrete regulatory requirement (e.g., customisable features designed in accordance to self-enhancement, could be available only when they are not in collision with agreed upon values under conservation, as in its conception of the rule of law).

In our considerations, the ISO/IEC/IEEE 24748-700:2022 standard can be used as an example when developing a standard with a minimum threshold of values. However, this example is not to be taken broadly as it is limited to stating the problem (addressing value considerations in autonomous and intelligent systems) while leaving it to stakeholders to determine how to embed values. Thus, there is still a need for concrete guidance on *how* to convey values that are below or beyond an agreed minimum threshold. We argue this guidance should stir towards the configurability of AI-based systems. In the next section, we will discuss the use

**Table 3** AI Act's requirements according to the Theory of Basic Values

| Self-Transcendence | Conservation | Self-Enhancement | Openness to Change |
|---|---|---|---|
| • Risk management<br>• Human oversight | • Data governance and quality<br>• Record keeping<br>• Transparency<br>• Accuracy<br>• Robustness<br>• Cybersecurity | - | - |

of value sensitive design as a useful methodology suitable for configurability in AI standards.

## Value sensitive design in standards

Value sensitive design (VSD) is a theoretical framework aiming to take into account human values in the design of technologies (Friedman, 2004; Friedman & Hendry, 2019; Friedman et al., 2006). Originally from information systems design and human–computer interaction, it offers a methodology which can lead to alternatives in the design of technology based on values. In our considerations, values below or beyond a minimum threshold will require specific technical implementation that can benefit from the VSD's tripartite methodology encompassing conceptual, empirical and technical investigations. In terms of AI standards, the tripartite methodology could convey configurability in AI-based systems development to achieve the goals of different regulatory contexts' values:

Conceptual investigations:

- Identifying stakeholders and values through stakeholder analysis and value elicitation.
- Defining values and determining value conflicts.

Empirical investigations:

- User studies and impact assessment.

Technical investigations:

- Value-driven design choices, prototyping and iteration.

Conceptual investigations could provide an opportunity for legitimising (diverse) value considerations through standards developed for the design stage of AI systems (Sadek et al., 2024). For example, legitimising values that might not find across border recognition, as could be the case for basic values under *self-enhancement* and *self-transcendence*.

Empirical investigations could lead to configurability through standards in the design of different interfaces. For example, in the case of *openness to change*, in its relation to the freedom of users; interfaces can enhance the user's ability to directly manipulate interfaces, access information, and invoke services or, on the contrary, automate the agency of machines by enhanced tracking of user's activity for automatic actions (Maes et al., 1997).

Technical investigations could drive standards that enhance certain AI properties by nudging the proactive design of systems to support values identified in stakeholder elicitation and conceptual investigations. For example, choosing between algorithm alternatives, such as a rule-based algorithm (if–then logics), a category-based matching algorithm (clustering users based on certain properties), a bond-based algorithm (ranking users in relation to "social connections" to other users), or a co-edit-based algorithm (ranking users by similarities in their use of the system) (Zhu et al., 2018).

In relation to the AI Act, VSD could aid compliance with the requirements related to AI deployment. For example, in article 9 of the AI Act, the requirement of lifecycle monitoring could be based on a minimum threshold of values and VSD value investigations. This could lead to a control over long-term value-based sustainability through ongoing supervision and information management.

## Standardised configurability: virtual home environments

To demonstrate how a value-sensitive AI standardisation approach could work in practice, we can look at the past case of virtual home environments (VHE). In such case, when international mobile communication systems were initially developed, mobile users (especially roaming users) needed dynamic solutions that would allow them to choose and control their services and applications based on the requirements of the place where they may be at any given time. Even aspiring to a system that could choose and control services automatically, based on the preferences of the user.

The solution, to the need for dynamicity (or configurability), was to allow portability of a "Personal Service Environment" (PSE) while roaming. Such a concept was initially created for the Global System for Mobile communication (GSM), where it was called "Virtual Home Environment" (VHE). In the beginning, VHE was merely a philosophy guiding *how* to provide the necessary tools to address the needs of customers (Hillebrand, 2002). However, later, due to the approval of technical report TRS22.121, the VHE concept was further developed to address the needs of 3G and later generations.

In relation to standardised configurability, VHE aimed to establish that each user could define its own sandbox, with their own preferences when running applications. If utilised today, a user could run AI applications according to the requirements and regulations of their own home country. In the case of VHE, specific modalities were activated when the user was moving across borders where requirements and regulations were different. For instance, if located in a visiting mobile context (visited environment), the functions and features of services would be set according to the regulations of the user's home environment, like protection of communication connections or enabling privacy for the user. However, the user was not able to access local services while connected only to their home environment. In such an instance, there was an option to switch from the virtual home environment to the visited environment, subjecting the user to the rules of the visited environment.

Today, AI-based services follow local regulations and, hence, also local value preferences (e.g., Apple's introduction of its AI-based system in 2024, available in the US but not available when using an iPhone in the EU or China). Thus, to protect the user, AI standards could guide the design of disclosure features, giving enough information to users about applicable regulations *and, hence, values*. Similarly, although the switch between the home and visited environment (e.g., applications, services, data) might not be automatically done, in some cases, the user may still want to share some of their personal data with the AI-based system available in the "visited environment", even at the cost of "home environment" values (e.g., differences in the protecting of privacy). Then, interoperability of AI systems, from the user's perspective, would be a disclosure of applicable values and the possibility of switching between "home" and "visited" *values.*

To conclude, in section "Value-sensitive AI standardisation", we have proposed an implementable approach in support of AI standards in an effort to help accommodate the variations in value conceptions as presented in different regulatory contexts. This approach is meant for standardisation processes and standards aiming to maintain AI systems' interoperability. In the next section, we discuss the practical implications and limitations of this approach.

## Discussion: a way forward for future AI standardisation

In international standardisation, the tension between fully harmonised standards and real-life differences between jurisdictions is not new. However when the tensions between regulatory contexts' values grow higher (Stubb, 2024), the need to manage the emerging frictions grows accordingly. This is the case when regulatory values touch upon the development of technology and related standards, potentially leading to (non-compatible) country or region-specific options, fragmentating global standards and markets. In relation to AI, where there is a globally diverse network of standards-developing organisations, it is not always obvious which values are used in standardisation and within standards. This is regrettable since standards can leverage their ability to facilitate trade by bring common approaches to highly fragmented markets (Swann, 2000). However, the current issues in AI regulation and related standards have the same origin; the world market is only partially harmonised. This is a persistent issue which can find partial answers by revisiting and revising past solutions in an effort to identify and develop solutions to present issues. This is what we have aimed to do in the proposal of our value-sensitive AI standardisation approach.

Referring back to our *RQ1*, we have identified a lack of consideration for values in the context of an international landscape of AI regulatory frameworks. We consider this lack of consideration could hinder the interoperability of AI-based systems and services. Furthermore, we found that the EU's approach relies on standards but does not take into account the potential global different conceptions of values in its quest for AI standardisation. Thus, we developed an example in Table 1**,** showing AI-related values in the US, EU and China and how to navigate them according to a high-level categorisation, as shown in Table 2.

In relation to *RQ2*, to address the issue of how to conceive values while maintaining interoperability between AI-based systems, we proposed a value-sensitive AI standardisation approach. This approach combines a minimum threshold of values, complementing previous ISO/IEC/IEEE 24748-700:2022 standard's process, and configurability, through the value sensitive design methodology. We argued and presented examples, such as Table 3 and the case of virtual home environments, to demonstrate how this approach could relate to regulatory requirements and maintain interoperability when AI systems are to be developed and deployed across regulatory contexts with different value conceptions.

From our analysis, we provide the following concrete recommendations to stakeholders:

European standardisation organisations. Consider the EU's role in standardisation broadly so as not to exacerbate value-based conflicts that could prevent interoperability. For standardisation, Table 2 can be a useful tool when engaging in AI standardisation negotiations and when standardising guidance in the navigation of values in different regulatory contexts. Our opinion is that, while it is clear that future conflicts over value conceptions and priorities cannot be avoided, we must seek to establish ways to manage conflicts and find constructive ways forward.

AI standardisation development organisations. Consider the proposed approach (minimum threshold and configurability) and develop standards to address different value conceptions in their relation to AI-based systems' interoperability. This will be important even in contexts where values are considered in relative terms instead of absolute truths. Observed differences in value conceptions will not disappear. Rather, they could hamper global collaboration and global markets, even more so if we deny their existence.

EU's governmental authorities. Leverage experimental frameworks, like AI regulatory sandboxes (defined in article 57, AI Act), as they could provide a space to test the impact of Union values on interoperability and even the usefulness of a value-sensitive approach. In concrete, the use of regulatory sandboxes could serve to generalise the results of real-world testing a minimum threshold and value-based configurability of AI systems in upcoming EU AI standards (Gonzalez Torres & Sawhney, 2023; Yordanova & Bertels, 2024).

Developers of AI-based systems. Leverage Tables 1, 2 and 3 examples. They could facilitate value-based considerations in the development and deployment of AI systems as well as complement awareness of different value conceptions in the EU, the US, and Chinese regulatory contexts. Furthermore, for the purposes of compliance with the AI Act, a value-sensitive approach could aid with requirements like transparency and accountability, as it could provide value-based justifications for design choices and the system's resulting functionalities (Ylä-Anttila, 2023).

In a broader sense, our analysis is valuable for an optimisation of the working processes in standardisation. For example, according to the EC's standardisation requests, formally recognised ESOs (i.e., CEN, CENELEC, ETSI) have to focus on addressing the specific requirements of the AI Act (Soler Garrido et al., 2024), which respond to the higher-level order of *self-transcendence* and *conservation*, as shown in Table 3. This leaves the door open for the development of other standards that respond to basic values under potentially unrecognised high-level values (e.g., *self-enhancement*'s basic value of prosperity). In these areas, standardisation could potentially be left to market-driven groups.

## Limitations

Achieving a combined approach of minimum threshold and configurability through AI standards could successfully tackle interoperability issues, which would help expand market opportunities due to economies of scale and network externalities (Swann, 2000, 2010). However, there are limitations to our proposed approach:

One potential limitation is that a minimum threshold of agreed-upon values could also mean *zero agreement* (or entirely ignoring) values. This could be the case for *self-enhancement* or *self-transcendence*. There could be no overlap between certain regulatory contexts. Even if this might not be entirely true in practice, if a zero values scenario does happen, we could foresee future bannings of AI-based systems in regulatory contexts due to different value considerations (e.g., ChatGPT banning in Italy and China) or the rise of different implementations and lack of interoperability of technology due to regulatory contexts' specificities (e.g., the case of contact tracing application during the COVID-19 pandemic) (Kaiser, 2024; Sharon, 2021).

We argued that international interoperability could be maintained by a value-sensitive AI standardisation approach based on VSD. However, VSD's methodology has been mainly researched in Western societies. Thus, extending the framework through standardisation, with its global implications, will require cautiousness regarding Western-based presumptions. Acknowledging and wary of this risk, we have strived to maintain criticality while hoping readers can be open to exploring a new and different approach. Even when standardisation efforts are increasingly faced with requests for higher levels of reflexibility (Meijer et al., 2023).

In terms of methodology, we limited our analysis to values explicitly mentioned in AI regulatory frameworks, which encompasses measures not strictly considered "regulation" in the sense of the AI Act. Thus, the effect that executive orders and administrative measures might have on standards might not be as straightforward as in the EU. However, we based our analysis on the consideration that the discursive assertions of governmental authorities impact their regulatory contexts (Foret & Calligaro, 2018) and, therefore, standardisation and standards.

In terms of our analysis and comparison of values, it could be argued that it will be forever incomplete, privileging some values over others or faulty due to the variations in values encountered across the globe (Lewis et al., 2020). However, we consider that failing to mention or suggest navigation of certain values, such as Tables 1, 2 and 3, misses an opportunity to bring values into the conversation, ignoring previous knowledge and requiring iterative engagement in the time-consuming processes of identifying and navigating values from scratch (Friedman & Hendry, 2019). Thus, there are strong incentives that support the legitimisation of at least some values in AI regulatory frameworks and related standards.

Finally, we limited ourselves to discussing future possibilities, however the tasks ahead will require much-needed collaboration between SDOs. For instance, the development of a minimum threshold of values will need to be part of governmental authorities' and standardisation organisations' tasks of recognising the state-of-the-art (e.g., values expressed in relation to AI by other regulatory contexts). We encourage it as a step in maintaining, to a certain extent, global harmonisation and interoperability.

## Conclusions

AI-based systems and values represent a new phenomenon for the conjuncture of Information and Communication Technologies (ICT), regulation and standardisation. While technologies have been standardised before, this is a paradigm shift. We are faced with a need to standardise how we develop AI-based technologies based on values that we consider important in our regulatory contexts. In lack thereof, AI will be in continuous development without commonly agreed processes for embedding value-based considerations.

In specific, the EU aims to maintain Union values in the AI Act and related harmonised standards. However, regardless of the regulator's expectations, the EU cannot expect standards to secure Union values outside its borders (Cantero Gamito, 2018, 2023). Thus, the EU's specific value conceptions should strive to maintain its values while supporting and maintaining interoperability with regulatory contexts that have different value conceptions.

Concretely, we proposed a *value-sensitive AI standardisation* approach, combining a minimum threshold of agreed-upon values and configurability. It is based on identified AI regulatory frameworks' values, Table 1, and establishing a *minimum threshold* through an analysis of values according to a generalising lens (high-level order values), as stated in Table 2. These tables provided examples of tools for value-based considerations in standardisation negotiations and in the development of standards. We strived to complement our approach by incorporating the ISO/IEC/IEEE 24748–700:2022 standard's process for value considerations during systems' design. However, since people are likely to subscribe to a far richer set of values (Nissenbaum, 2005), either beyond or below a minimum threshold, we included *AI-based systems' configurability*, according to VSD. We demonstrated the practical applicability of our approach to the AI Act's requirements in Table 3, and by exploring impact of our proposed standardisation of configurability based on the previous example of virtual home environments.

Overall, we contributed to furthering the value-based engineering approach found in ISO/IEC/IEEE's standard (Spiekermann & Winkler, 2022) and expanding the usability of the Theory of Basic Values (Schwartz, 2012) as well as VSD (Friedman & Hendry, 2019; Friedman et al., 2006) to AI standardisation and standards. While there might be different opinions about the exact "basic values" of the selected regulatory contexts (Roberts et al., 2021), and even more so for our interpretation and categorisation under specific "high-level order values". We consider that to be precisely our point: that inevitable different conceptions of values could hinder interoperability between AI systems.

Mainly we aimed to spark a conversation on how to conceive regulatory values for AI-based technologies while maintaining interoperability, focusing on standards and standardisation. In our considerations, we address these issues from the EU perspective and expanded it to the US and China in an effort to demonstrate the relation in the international standardisation landscape. In our view, through value-sensitive AI standardisation, EU standards could be able to maintain access to markets with different value conceptions. Even if, in the real world, values may collide with each other, collisions may present an opportunity to innovate by designing alternatives (Friedman et al., 2006).

Finally, engaging in value considerations will require, first and foremost, to question whether or not certain values are appropriate for other contexts (Nissenbaum, 2005). For instance, even within the EU, there are 27 member states with different cultural histories, which makes it challenging to agree on what really constitute *Union values*. The same can be said for the different states in the US or provinces in China, as well as the broader world. Thus, a holistic understanding of values will require an understanding of the various value conceptions, even within geographical areas. This is a task that will require broad approaches and being cautious of implicitly advancing geography-based value superiority narratives, not only for AI but for all kinds of technology and future developments beyond technology.

## Annex I. Sources used for the identification of regulatory contexts' values

| | |
|---|---|
| Comparative literature | Roberts et al. (2021) |
| | Hine & Floridi (2022) |
| European Union | Consolidated Version of The Treaty on European Union (2012) |
| | Spieker (2023) |
| | 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) |
| United States | Executive Order on AI (2017–2021 Administration) |
| | Executive Order on Safe, Secure, and Trustworthy Artificial Intelligence (2021–2025 Administration) |
| China | Miao (2020) |
| | Interim Measures for the Management of Generative Artificial Intelligence Services (2023) |
| | Sheehan (2023) |

**Acknowledgements** The original idea stems from a previous conference presentation: Gonzalez Torres & Ali-Vehmas (2024). We want to thank the reviewers for their comments, and our colleagues for their feedback. In particular, Viivi Lähteenoja, Antti Rannisto, Matti Nelimarkka, Susanna Lindroos-Hovinheimo, Salla Westerstrand, Jussi Heikkilä, Karolina Drobotowicz, Kaisla Kajava, and Petri Vuorimaa.

**Funding** Open Access funding provided by Aalto University. This work was undertaken as part of the research project "Civic Agency in AI? Examining the AI Act and Democratizing Algorithmic Services in the Public Sector (CAAI)" in the Critical AI and Crisis Interrogatives (CRAI-CIS) research group, Department of Computer Science, Aalto University. The project is supported by research grants awarded by the Kone Foundation (2022–2025) and the Research Council of Finland (2023–2027). Open access provided by Aalto University.

**Data availability** Not applicable, we do not generate any datasets.

## Declarations

**Conflict of interest** The authors declare their affiliation as members of the Finnish Standardisation Organisation (SFS), which informed but did not influence the research results.

**Ethical approval** This research did not involve human participants and/or animals.

**Informed consent** Not applicable.



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