FUTURE TRENDS

Report

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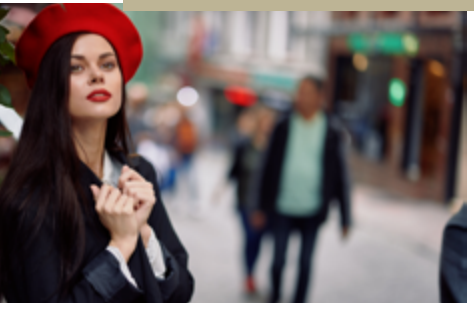
TRENDS RESEARCH & ADVISORY



Future Trends Report

Future Trends Report, published in English and Arabic by TRENDS Virtual Office in Montreal, stands out as a distinctive publication dedicated to highlighting:
1. the most important forward-looking studies that aim to identify future trends, analyze various variables that may influence these trends, and determine the best future scenarios.
2. the most important applied studies that explore the application of knowledge, scientific theories, and information to solve current problems and overcome future challenges.
3. the most important illustrative and graphic forms that visually summarize significant studies, helping readers understand the trends and challenges of the future world.

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This study seeks to explore what experts from Bulgaria expect by the year 2030 regarding the implementation and impact of AI-driven assistive technologies, focusing on stakeholders connected to disability organizations, academia, and practitioners.

The authors develop several research questions, such as: (1) What are the experts' expectations concerning AT implementation by 2030? (2) Which trends do they find most desirable at the national level for supporting the social inclusion of people with disabilities? (3) How do experts envision the medium-term impact of using ATs on social inclusion and quality of life? and finally, (4) What challenges do they identify in the implementation and adoption of such ATs?

To address these questions, the authors employed a two-round Delphi survey. They recruited 23 experts from Bulgaria, representing a range of stakeholder groups (disability organizations, academia/practice), and developed 10 high-ranking future-oriented projections regarding AI-driven ATs, derived from an initial conceptual workshop that generated 28 statements across categories such as politics, education, employment, technology, and society. The Delphi rounds asked respondents to rate each projection in terms of expected probability (0%–100%), desirability (on a 7-point Likert scale), and expected impact (also a 7-point scale). To aggregate responses and calculate consensus, values were normalized (using Min-Max scaling) and averaged to yield a combined consensus score per projection.

The results reflect a generally moderately optimistic outlook: experts expect responsible advances in AI-driven ATs by 2030 in Bulgaria. The top-ranked projections included personalized devices tailored to the needs of individuals, better training of public-service personnel (e.g., educators, social workers), and improved provision of public services for persons with disabilities. According to experts, in terms of social inclusion and quality of life, ATs will contribute to improved participation of persons with disabilities in education, work, and society in general. They do, however, caution that without inclusive design processes—meaning meaningful involvement of end users and professionals—and without addressing usability, cost, and accessibility issues, adoption may remain limited or technologies may even be abandoned. In the end, the article provides important foresight into how AI-driven assistive technologies may develop and be adopted in the coming years within a national context. It underlines that while technological progress can be robust, meaningful social impact in terms of inclusive design, supportive policy, sustainable economics, and service ecosystems is a different matter. For practitioners and scholars, it offers insights on stakeholder consensus and priority trends to guide research, policymaking, and the design of future ATs.

Experts expect responsible advances in AI-driven assistive technologies (ATs) by 2030 in Bulgaria.

ATs will contribute to improved participation of persons with disabilities in education, work, and society in general

Prospective research

Smart Homes: How Will the User Experience Be Improved?

Rey-Jouanchicot, J., Bottaro, A., Campo, E., Bouraoui, J.-L., Vigouroux, N., & Vella, F. (2024). Leveraging large language models for enhanced personalized user experience in smart homes.

This paper identifies one of the main limitations of available smart-home automation systems: most of their devices are controllable by routines and context awareness, but they heavily rely on hand-crafted rules and do not adapt flexibly to the nuanced preferences or behaviors of their residents. The authors introduce a novel architecture that embeds an LLM with explicit user preferences in order to offer personalized, human-centered automation in the home environment.

Their architecture works by connecting events in the home, such as a person entering a room, changing lighting, and adjusting heating, with the user's expressed preferences and context information. The LLM brings in general knowledge through its pretraining and combines that with the retrieval of user-specific data and preferences, making decisions on how to act on smart-home devices. In contrast to traditional systems, these models do not simply trigger fixed routines but make use of richer sensor data.

The results are very encouraging. Incorporating preferences into the LLM-based decision module led to an average performance improvement of up to 52.3% in the user satisfaction "grade" metric. Furthermore, when using the Starling 7B Alpha model, they observed a 35.6% reduction in average processing time compared to a baseline without preferences. Surprisingly, this smaller, preference-augmented model outperformed larger, non-preference models by about 26.4%, with their inference times nearly 20 times faster. These findings suggest that smart-home automation can be both more efficient and more personalized by combining LLMs with preference modeling, rather than scaling up model size alone.

Beyond the quantitative metrics, the authors discuss the qualitative implications: embedding user preferences and context into the decision loop supports greater comfort, safety, and intuitiveness; the system better anticipates the occupant's needs, thereby reducing manual intervention and reliance on static routines. Simultaneously, they mention practical challenges: latency, model size, prompt engineering, context retrieval, and integration of device states remain nontrivial.

In their conclusion, the authors point to future work: exploring multimodal sensor data, richer preference elicitation over time, long-term user adaptation, and edge deployment to reduce latency and privacy risks, as well as broader scenario coverage beyond the testbed. They propose that the architecture offers a promising pathway toward smarter, more adaptive home environments that feel more "human-aware" and personalized rather than rule-bound.

Overall, this work demonstrates that a combination of LLMs with personal preference modeling in smart homes may actually fulfill their promise by significantly improving user experience, reducing latency, and allowing more intuitive, context-sensitive automation—each representing meaningful steps in the evolution of home automation technologies.

LLM-based smart-home systems can replace fixed rules with adaptive automation driven by user preferences, context, and sensor data.

Smart-home automation can be both more efficient and more personalized by combining LLMs with preference modelling.

Prospective research

“Explainable Artificial Intelligence”: A New Approach to the Use of AI in Daily Life

Shajalal, M., Boden, A., Stevens, G., Du, D., & Kern, D.-R. (2024). Explaining AI decisions: Towards achieving human-centered explainability in smart home environments. Preprint. arXiv.

The paper examines the challenge of deploying AI-driven smart home systems—particularly those employing machine learning and deep learning models—into everyday contexts. These systems often automate or assist household processes, but because they rely on complex “black-box” models, their decisions are frequently opaque to end users.

The authors argue that although the field of explainable artificial intelligence (XAI) has matured technically, most existing methods are designed for model debugging or expert users, rather than the lay residents of smart homes.

In response, they propose a “human-centered XAI” approach that emphasizes explanations that are not only technically correct but also understandable, actionable, and meaningful for non-expert users. They review current XAI methods and highlight major gaps: many explanations remain too technical, disconnected from users’ mental models, and thus fail to increase trust or adoption.

The paper then presents two concrete smart-home application scenarios: (1) household energy demand forecasting and (2) occupant thermal comfort preference modeling (for smart heating). In both settings, the authors apply machine learning models and then use standard XAI methods to generate explanations of model decisions. They evaluate how well these explanations can be understood by general users by analyzing their design and suitability. Their findings highlight that many of the standard XAI outputs did not map well to lay users’ understanding of how the system operated or why certain actions were recommended.

Key challenges emerge: on the syntax level, the explanations often overload users or use unfamiliar units rather than user-relevant terms. On the semantic level, users may build faulty mental models when the explanation language does not align with their everyday understanding. On the pragmatic level, explanations must tie to the user’s lived context and decision-making—simply showing “why the ML model predicted X” may not help a user decide what to do.

To support this, they highlight human–computer interaction (HCI) methodologies: user studies, prototyping, technology probes, and heuristic evaluation—all as central to producing effective human-centered XAI in smart-home contexts. They emphasize that user involvement in designing explanation formats, iterating on feedback, and testing in realistic settings is essential for meaningful adoption.

In conclusion, the article argues that while technical XAI methods continue to advance, achieving user trust, adoption, and meaningful interaction in real-world smart homes requires shifting towards human-centered designs—explanations that are understandable by ordinary residents, embedded in their environment, and reflective of their priorities. The authors lay out future directions, including natural language explanations, interactive explanation systems, standardized evaluation frameworks for lay users, and integration of HCI processes into the XAI lifecycle.

A human-centered XAI approach that offers clear, actionable explanations for opaque AI-driven household systems is better suited for everyday smart-home users.

Achieving user-trust, adoption and meaningful interaction in real-world smart homes requires shifting towards human-centered designs.

Prospective research

AI and Smart Homes

Cho, O. H. (2024). A Study on Smart Home Appliances Based on Artificial Intelligence System. Journal of Information Systems Engineering & Management, 10(3s).

In this article, Cho discusses the integration of AI systems into smart home appliances and investigates how recently developed automation technologies are used in home environments. The goal is to investigate different kinds of appliances with integrated AI mechanisms, compare their functionality and performance with those of traditional ones, and consider their affordability, usability, energy efficiency, and potential value in home settings.

It includes the study of current smart home appliances based on AI principles, analyzing their components and control systems. Cho outlines the architecture of home automation control systems: user interfaces, such as smartphones and computers; wired or wireless transmission modes; central controllers; and connected electronic appliances that respond to control signals, including fans, lights, air conditioners, and refrigerators. The article then identifies technical techniques that feature in the construction of smart home appliances: sensors, data processing, speech/image recognition, decision-making, and prediction. These six major categories of AI capability are then mapped into smart home applications such as behavior recognition, energy monitoring, anomaly detection, and autonomously adaptive environments. Cho then proceeds to enumerate several features of AI-enhanced smart home appliances: reduced installation cost, especially through wireless connectivity; enhanced connectivity by way of smartphone apps/remote access; expandability, or easy extension of the system when needed; and improved safety due to embedded security features within a smart network. The article further provides comparative analyses of smart versus traditional appliances regarding their efficiency, security, installation cost, and connectivity, with the former outperforming the latter in many respects. The results also include a breakdown of appliance usage and acceptance rates: lights and fans constitute the largest segment (~30%) of current smart appliance usage, household appliances and heating/cooling each roughly 20%, and smart kitchen appliances and "other" categories each about 15%.

The conclusion of Cho argues that it is in this regard that AI-based smart home appliances are not only technologically advanced but also human-friendly, offering ease of use and convenience, lowered cost, and improved energy efficiency compared to traditional appliances. The author thus concludes that as AI technologies continue to mature and integrate further into home automation, they will be released for wider domestic markets and make smart homes more accessible and affordable. Overall, the paper gives a good overview of the current status of AI-powered home appliances: their architecture, features, benefits, and acceptance trends. The article is mostly descriptive and comparative rather than deeply experimental; nonetheless, it provides useful insights into how AI shapes everyday home technology and points toward future directions for consumers, industry, and research.

Preference is given to superior connectivity, expandability, safety, and lower installation costs of AI-enhanced smart-home appliances.

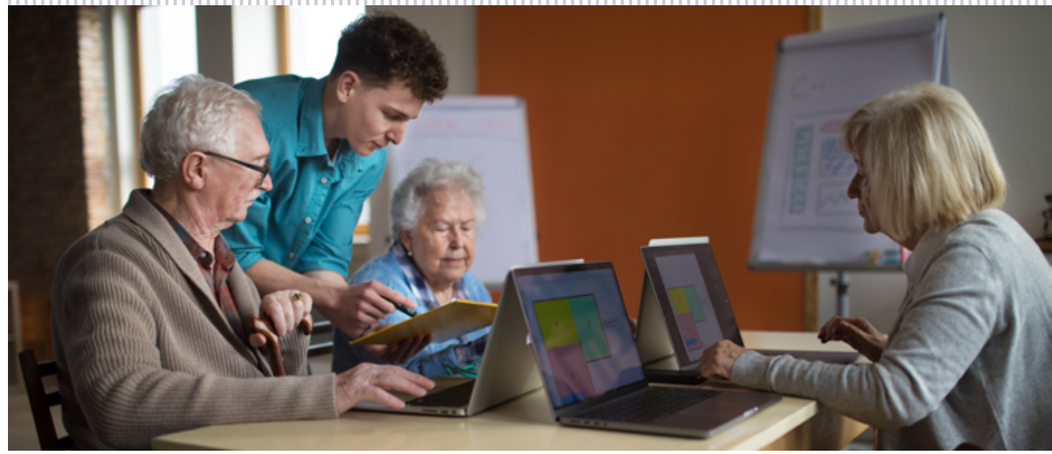
Smart-appliance adoption is led by lights and fans (~30%), with household and HVAC systems at ~20% each, and kitchen and other devices at ~15%.

Prospective research

Meaningful Activities and Well-being for Older Adults

Zhao, W., Kelly, R. M., Rogerson, M. J., & Waycott, J. (2024). Older adults imagining future technologies in participatory design workshops: Supporting continuity in the pursuit of meaningful activities.

This paper explores how older adults envision the role of emerging technologies in sustaining meaningful activities that contribute to their identity, autonomy, and continuity in later life. Instead of approaching older users as passive recipients of assistive technologies, the authors position them as co-designers of their own digital futures.



The study is based on Continuity Theory, which assumes that people try to sustain consistent patterns of activity, interests, and ways of self-expression throughout the process of aging. Accordingly, the authors contend that future technologies should not just compensate for physical or cognitive decline but should allow for continuity in personal meaning, social participation, and creativity.

Methodologically, the study employed a participatory design approach, which consisted of three collaborative workshops with community-dwelling older adults aged 65 and above, followed by in-depth interviews. Participants discussed what "meaningful activity" means to them (such as gardening or reading) and reflected on how these pursuits contribute to purpose and well-being. They were then introduced to a set of emerging technologies, such as virtual and augmented reality, artificial intelligence, and robotics, and invited to imagine how such tools might support their activities in the future.

The workshops showed that the participants were neither technophobic nor uncritically enthusiastic. They were curious and discerning, weighing the excitement of possibilities against concerns over usability, complexity, and cost. For many, there was a strong emphasis on technology enhancing independence and pleasure rather than perpetuating dependence. In this study, four design principles emerged that these older adults valued: simplicity, regarding intuitive and low-effort interfaces; positivity, promoting growth and enjoyment rather than deficit-focused support; proactivity, in systems anticipating needs while remaining under user control; and integration, whereby digital tools are seamlessly embedded within daily routines.

Participants also emphasized relational and emotional dimensions: technologies should enhance social connection, maintain dignity, and accommodate personal rhythms. Their designed futures included AI "companions" that promote hobbies, VR environments simulating familiar places, and adaptive devices that support mobility or memory without overt medicalization of daily life. Such ideas underpin the notion that meaningful activity concerns identity and belonging no less than function. They conclude that engaging older adults in co-imagining future technologies reveals design opportunities overlooked by conventional assistive-tech approaches. Rather than narrowly focusing on safety monitoring or health management, participatory foresight enables designs that sustain selfhood and agency.

Older adults should be co-designers of technologies that support identity, autonomy, and meaningful continuity in later life.

Technologies should enhance social connection, maintain dignity, and accommodate personal rhythms.

2 Applied research

Robots as Older Life Companions?

Park, Y., Chang, S. J., Kim, H. J., & Jeong, H. N. (2024). Effectiveness of artificial intelligence robot interventions on psychological health in community-dwelling older adults: A systematic review. Journal of Korean Gerontological Nursing, 26(3), 234247-.

This paper examines the psychological benefits of AI robot interventions for older adults in community settings and those living independently. Given the rise in mental health concerns—characterized by symptoms of depression, loneliness, and social isolation—among aging populations, the authors explore the extent to which AI-powered robotic companions can foster emotional health, social engagement, and overall quality of life.

It integrates findings from recent experimental and quasi-experimental studies that have evaluated the effectiveness and limitations of such interventions.

An extensive search was conducted regarding the studies published from 2015 to 2023 in national and international databases on AI or socially assistive robot interventions with adults aged 60 years and older. Based on PRISMA, a total of 13 eligible studies were identified, which included five RCTs and eight quasi-experimental designs, representing over 800 participants across settings, including community centers, elder care facilities, and home settings. The robots included both socially interactive humanoid types (e.g., Paro, Pepper) and functional service robots with conversational AI or sensor-based interaction.

Across the studies reviewed, most interventions ranged from 4 to 12 weeks and included structured programs—such as conversation, music therapy, cognitive games, or guided physical activities—mediated through the AI robot. Quantitative synthesis indicated consistent positive results in reducing loneliness, depressive symptoms, and anxiety, as well as increasing emotional expressiveness and enhancing self-esteem. For older adults, robots provided companionship, regularity, and nonjudgmental interactions—particularly helpful for those living alone. However, the authors advise that while AI-robot interventions show promise, these effects were moderate and heterogeneous. The generalization of results was limited by variability in the type of robots used, duration of intervention, and measurement of outcome variables. Some studies mentioned novelty effects that may wear off over time, while others faced technical barriers such as poor connectivity or speech interpretation difficulties. Ethical and relational concerns were also raised, especially regarding authenticity in companionship and the replacement of human care.

The review concludes that interventions using AI robots may meaningfully support psychological well-being and social connectedness among community-dwelling older adults, especially if integrated into holistic care models. However, their actual impact is highly dependent on program design, user engagement, and continuous human facilitation. The authors suggest longitudinal trials to investigate sustained benefits, comparative studies of robot types, and culturally sensitive approaches in developing technology to meet the emotional and social needs of older adults. Ultimately, the authors believe that human-AI collaboration, not substitution, offers the most promise in empowering healthy, independent aging.

AI-powered robotic companions can foster emotional health, social engagement, and overall quality of life.

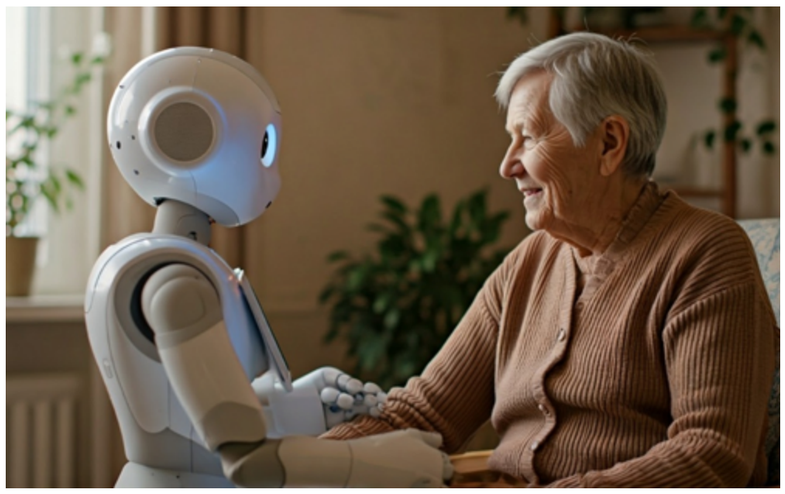
AI-robot interventions can enhance psychological well-being and social connectedness in older adults, especially when embedded in holistic care models.

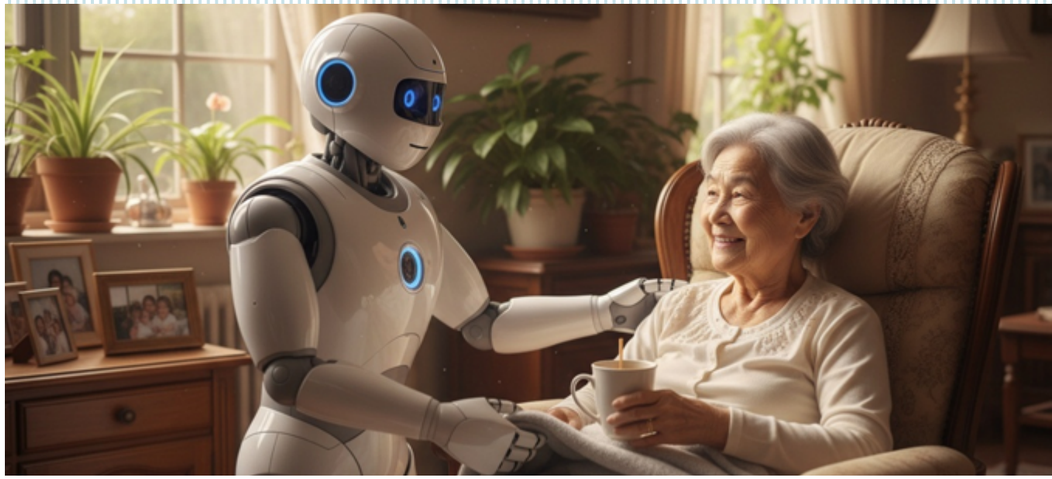
Applied research

Home-Based Cognitive Intervention for Healthy Older Adults Living Alone

Tokunaga, S., et al. (2024). Home-Based Cognitive Intervention for Healthy Older Adults Living Alone: A Randomized Controlled Trial of Robot-Assisted Training. JMIR Aging, 7(1), e47229.

The study represents a trial investigating the effects of robot-assisted cognitive training in healthy older adults who live alone in Japan. Since population aging is associated with increased social isolation and heightened risk of cognitive decline, the authors sought to determine if a home-based AI-enabled robot might provide accessible cognitive stimulation and improve psychological well-being without professional supervision or institutional participation.





In total, 102 community-dwelling adults aged 65 years and older participated. They were randomly assigned either to a robot-assisted cognitive training group (n = 51) or to a control group (n = 51) that engaged in self-directed cognitive tasks using printed materials. The intervention lasted for eight weeks, with sessions conducted five times per week for 20–30 minutes each. The robot, equipped with speech recognition, emotion detection, and adaptive feedback, guided participants through memory, attention, and problem-solving tasks while providing conversational encouragement and performance monitoring. Cognitive and emotional outcomes were measured pre- and post-intervention using standardized instruments.

These results showed that, compared with controls, the robot-assisted group evidenced statistically significant cognitive improvements. Participants interacting with the robot also demonstrated mean MMSE gains of 1.7 points ($p < .01$), and their completion times for the Trail-Making Test were faster, reflecting improved attention and executive function. Emotional outcomes similarly improved: GDS scores were reduced, while self-reported motivation and daily engagement increased. Notably, adherence was high (> 90% session completion), suggesting strong acceptability of the robot interface. Participants described the robot as "encouraging," "nonjudgmental," and "companionship-like," especially for those with limited daily interaction.

These results indicate that AI-enabled robots can effectively provide scalable cognitive interventions for older adults at home. Apart from enhancing cognitive performance, frequent human-robot interaction can offset feelings of loneliness and encourage emotional resilience through structured activities. However, the authors avoid generalizing the results, pointing to the fact that the effects were measured for only eight weeks, the participants were healthy and technologically literate, and a single model of robot was used in this study. Limitations include the short intervention duration, lack of long-term follow-up, and the need for larger and more diverse samples to assess sustainability and cost-effectiveness. This trial overall supports the feasibility and effectiveness of home-based robot-assisted cognitive training as an addition to standard care for older adults. By providing stimulating, personalized activities and emotional reinforcement, such interventions may help maintain cognitive vitality and independence among older adults who are living alone, offering a promising direction for preventive digital health strategies in aging societies.

> **Participants described the robot as "encouraging," "nonjudgmental," and "companionship-like."**

> **Frequent human-robot interaction can offset feelings of loneliness and encourage emotional resilience through the structured activity.**

Applied research

AI & Mental Healthcare

Babu, A. (2024). Artificial intelligence in mental healthcare: Transformative potential in psychological practice. Frontiers in Psychology, [Article 1378904]. https://doi.org/10.3389/fpsyg.2024.1378904

This article provides a comprehensive overview of how artificial intelligence (AI) is reshaping the face of mental health care and psychological practice while emphasizing both its transformative potential and its ethical complexities. The author contends that AI-powered systems—from diagnostic algorithms and chatbots to predictive analytics—are beginning to fundamentally redefine how psychological assessment, therapy delivery, and monitoring of mental health are conducted.

The paper positions AI as one tool that holds considerable potential to widen access, increase personalization, and improve clinicians' decision-making—particularly in contexts where there is an increase in the global demand for mental health services.

Babu first explains some of the important applications of AI in modern psychology, including machine learning models that can detect depressive or anxiety patterns using linguistic, physiological, and behavioral data; conversational agents and virtual therapists for delivering CBT or offering emotional support; and predictive algorithms for forecasting relapse or crisis risk based on continuous data from wearables or smartphones. The author points out that such technologies have demonstrated a measurable benefit: they improve early detection of mood disorders, enhance treatment adherence, and offer scalable support in resource-poor regions.

The article places AI within a complementary rather than a substitutive framework: AI enhances the psychologist's work by carrying out routine screening, data analysis, and monitoring, freeing practitioners for more empathetic, complex, and relational dimensions of care. Importantly, Babu refers to the rise of precision mental healthcare, wherein AI integrates multimodal data on speech, affect, sleep, and social behavior to tailor interventions to individual profiles. This personalized approach, informed by continuous feedback loops, has the potential for improved efficacy of therapy and longer-term outcomes.

Nevertheless, the paper critically discusses the limitations and risks of AI. The possible biases of algorithms may reproduce social inequalities in diagnosis, data privacy, and confidentiality in digital mental health, as well as a reduced therapeutic alliance due to patients interacting primarily with machines. The author cautions that practice in psychology must remain firmly anchored in empathy, ethics, and human understanding—attributes AI cannot simulate.

Babu concludes that the future of AI in psychology will be based on responsible integration in which human clinicians, not algorithms, keep interpretive authority. The author envisions hybrid models of care that blend human empathy with computational precision, allowing for more inclusive, preventive, and accessible mental health systems. By bridging technology with compassion, AI can become an ally in advancing psychological well-being while preserving the ethical core of therapeutic practice.

AI can improve early mood-disorder detection, boost treatment adherence, and provide scalable support in resource-limited settings.

Algorithmic biases can reinforce social inequalities in diagnosis, data privacy, and confidentiality in digital mental health.

Applied research

Fear of Happiness, Explained with Cultural Influence

Happiness Science Labs. (2025, August 4). Mohsen Joshanloo: Fear of happiness, explained with cultural influences | Sero Boost #81 [Video]. YouTube. https://www.youtube.com/watch?v=OrtwHpkDTiU

In this podcast from Sero Boost, produced by Happiness Science Labs, psychologist Dr. Mohsen Joshanloo speaks on the phenomenon of a fear of happiness—a counterintuitive yet empirically acknowledged attitude where people consciously or unconsciously avoid positive emotions due to the belief that happiness may lead to negative consequences. The discussion illuminates the psychological mechanisms and cultural frameworks forming this fear within a broad cross-cultural understanding of well-being.

Joshanloo defines the fear of happiness as a belief that experiencing or expressing happiness invites misfortune, envy, or moral weakness. Although Western psychological theories commonly assume happiness to be an unquestionable human goal, cross-cultural studies have shown significant variation in this regard: for example, exuberant happiness can be seen as a threat to social harmony in many collectivist or interdependent societies and may also attract the "evil eye." Drawing from his comparative research across more than 40 countries, Joshanloo describes distinct cultural narratives in which modesty, restraint, and emotional balance are valued over exuberant positivity within East Asian, Middle Eastern, and some African cultures.

The discussion emphasizes that the fear of happiness is not clinical depression or anhedonia but a culturally conditioned mindset concerning emotion regulation and moral responsibility. For example, in Joshanloo's studies, some respondents associate happiness with arrogance, moral decline, or loss of spiritual vigilance. What the podcast really brings out, however, is the idea that such beliefs, although seemingly maladaptive, also have social and moral functions that nurture humility, empathy, and social cohesion. In an increasingly globalized world, saturated with "happiness imperatives" via self-help media and digital culture, these traditional emotional norms create tension for those trying to navigate multiple cultural expectations. Joshanloo and the hosts discuss the methodological challenges of measuring happiness across cultures. Standardized psychological instruments created in Western contexts may mistakenly equate emotional intensity with well-being and miss cultural variations that emphasize balance, serenity, or acceptance. The conversation calls for pluralistic approaches to happiness research that take local values, language, and worldviews into consideration. The episode also touches on applied implications: understanding the fear of happiness can help cross-cultural counseling, assist psychologists in interpreting emotional expression appropriately, and guide international well-being policies that avoid ethnocentric biases.

He concludes that acknowledging the fear of happiness is necessary for the development of a more inclusive science of well-being. Happiness should not be treated as a uniform universal ideal but rather as a family of culturally embedded experiences. Recognizing that emotional restraint can coexist with life satisfaction allows psychology to better reflect the diversity of human flourishing throughout societies.

The fear of happiness is the belief that experiencing or expressing happiness invites misfortune, envy, or moral weakness.

Fear of happiness is not clinical depression or anhedonia but a culturally conditioned mindset concerning emotion regulation and moral responsibility.

Applied research

AI in Healthcare: A Review

Hassan, M., et al. (2024). Barriers to and facilitators of artificial intelligence adoption in healthcare: A scoping review. JMIR Human Factors, 11.

This review systematically explores the factors affecting the adoption of AI in healthcare by synthesizing evidence across the clinical, organizational, technical, and ethical domains. Since AI technologies will increasingly support diagnosis, treatment planning, and patient monitoring, understanding why integration remains limited is a priority for policy and practice. The authors have identified persistent gaps between technological innovation and implementation, highlighting the need for holistic, human-centered strategies to ensure sustainable adoption.

Following the framework from the Joanna Briggs Institute, the researchers searched six international databases for studies published between 2018 and 2023. Of the 1,274 records screened, 64 articles were eligible for inclusion and presented qualitative, quantitative, or mixed-method study designs from hospitals, clinics, and research facilities worldwide. Collectively, these works represented AI applications within areas such as imaging, decision support, diagnosis, and administrative functions. The resulting findings from the review are categorized into two major themes: barriers and facilitators of adoption.

The key barriers identified included inadequate trust and transparency, lack of interpretability of AI models, insufficient regulatory frameworks, and data privacy and accountability issues. Clinicians often resist dependence on non-transparent algorithms, especially when potentially life-and-death diagnoses are at stake in specialties like oncology or emergency medicine. Organizational challenges include a lack of appropriate digital infrastructure, misalignment of AI tools with clinical workflows, and a lack of training opportunities for health professionals. Ethical concerns, including bias, job displacement, and medico-legal liability, further dent the prospects of AI systems that inspire confidence.

On the other hand, multiple facilitators were identified: strong institutional leadership and governance, collaboration between clinicians and data scientists from different disciplines, transparency in model development, and evidence of improvement in patient outcomes. The engagement of end-users during the design of the system—in particular, the early involvement of clinicians—was a crucial determinant of acceptance. Studies further underscore the need for continuous education, explainable AI interfaces, and demonstration of real-world utility, not just technical performance.

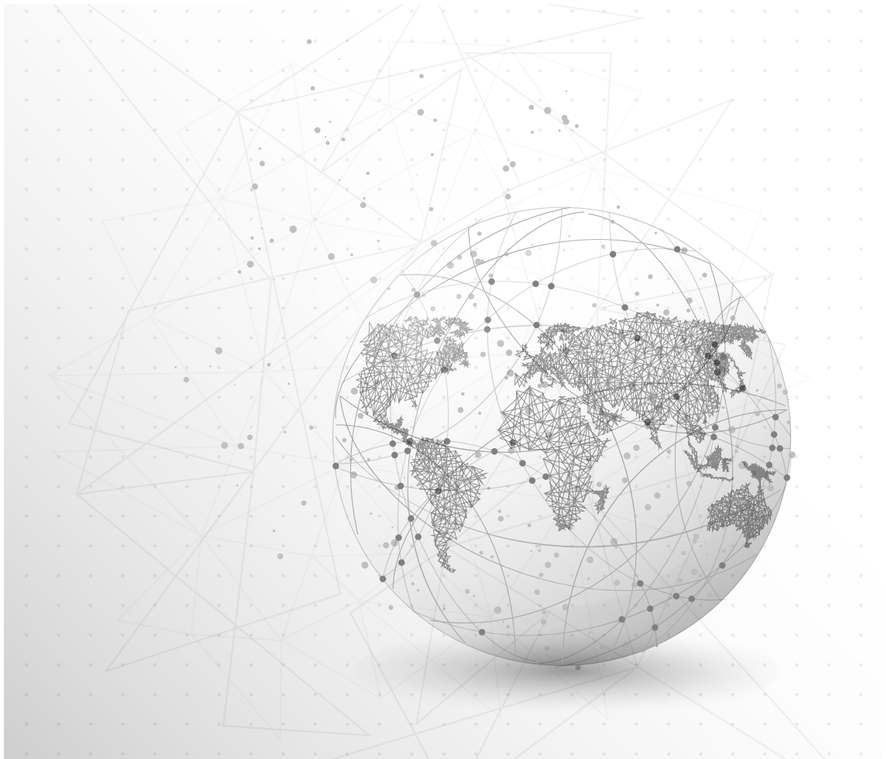
The authors propose an integrated framework for AI adoption based on four pillars: trustworthiness, usability, organizational readiness, and policy alignment. They assert that AI implementation needs to be viewed not only as the deployment of a technology but as an adaptive sociotechnical change process in need of cultural transformation within healthcare institutions.

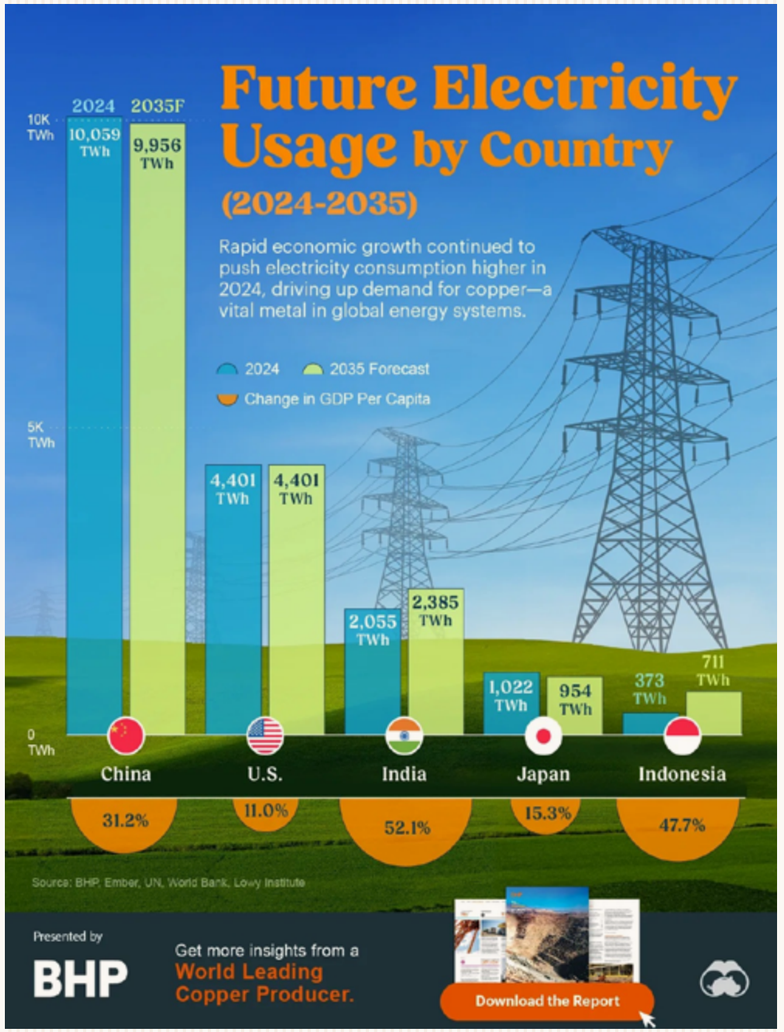
The review concludes that, while enthusiasm for AI in healthcare is strong, translation into routine clinical practice remains limited without parallel attention to ethics, regulation, and human factors. Sustainable integration depends on co-design, governance transparency, and capacity building that empower clinicians as informed collaborators rather than passive end users. In the end, success is achieved.

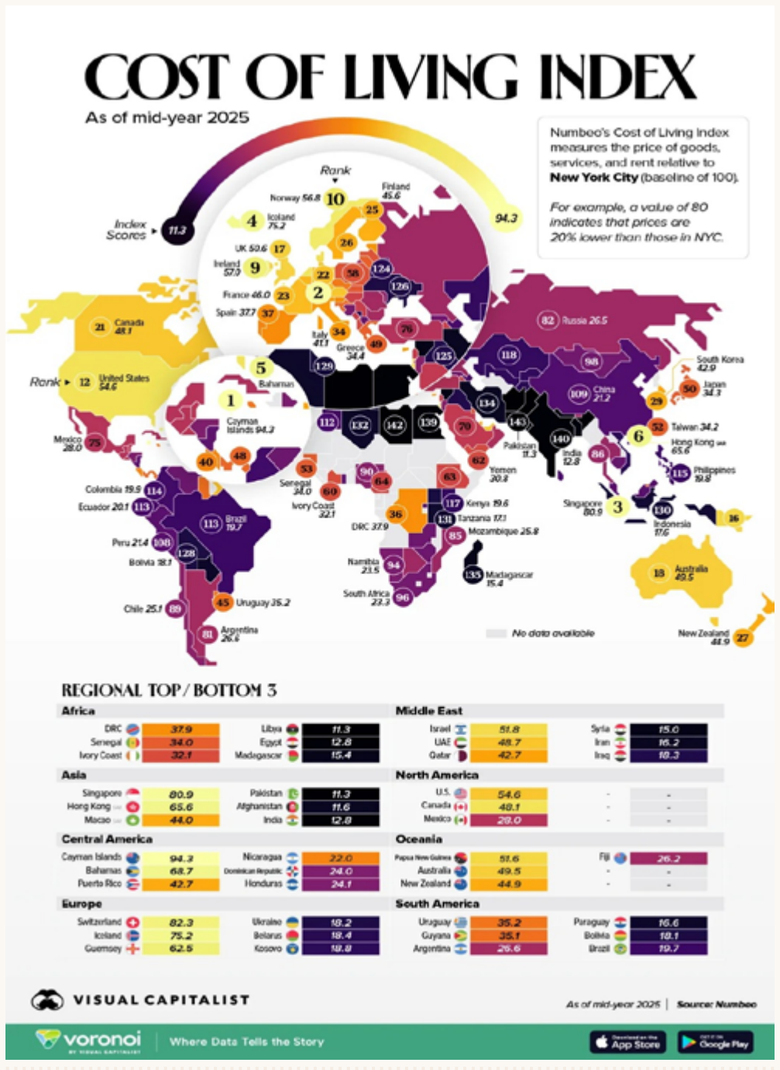
There are persistent gaps between technological innovation and implementation.

Ethical concerns—bias, job loss, and medico-legal liability—further undermine confidence in AI systems.

3 The future in numbers






COST OF LIVING INDEX
As of mid-year 2025
Numbeo's Cost of Living Index measures the price of goods, services, and rent relative to New York City (baseline of 100).
For example, a value of 80 indicates that prices are 20% lower than those in NYC.
Rank
Index Scores
11.3
94.3
No data available
REGIONAL TOP / BOTTOM 3
Africa
DRC 37.9
Senegal 34.0
Ivory Coast 32.1
Libya 11.3
Egypt 12.8
Madagascar 15.4
Asia
Singapore 80.9
Hong Kong 65.6
Macao 44.0
Pakistan 11.3
Afghanistan 11.6
India 12.8
Central America
Cayman Islands 94.3
Bahamas 68.7
Puerto Rico 42.7
Nicaragua 22.0
Dominican Republic 24.0
Honduras 24.1
Europe
Switzerland 82.3
Iceland 75.2
Guernsey 62.5
Ukraine 18.2
Belarus 18.4
Kosovo 18.8
Middle East
Israel 51.8
UAE 48.7
Qatar 42.7
Syria 15.0
Iran 16.2
Iraq 18.3
North America
U.S. 54.6
Canada 40.1
Mexico 29.0
Oceania
Papua New Guinea 51.6
Australia 49.5
New Zealand 44.9
Fiji 26.2
South America
Uruguay 35.2
Guyana 35.1
Argentina 29.6
Paraguay 16.6
Bolivia 18.1
Brazil 19.7
VISUAL CAPITALIST
As of mid-year 2025 | Source: Numbeo
voronoi
Where Data Tells the Story
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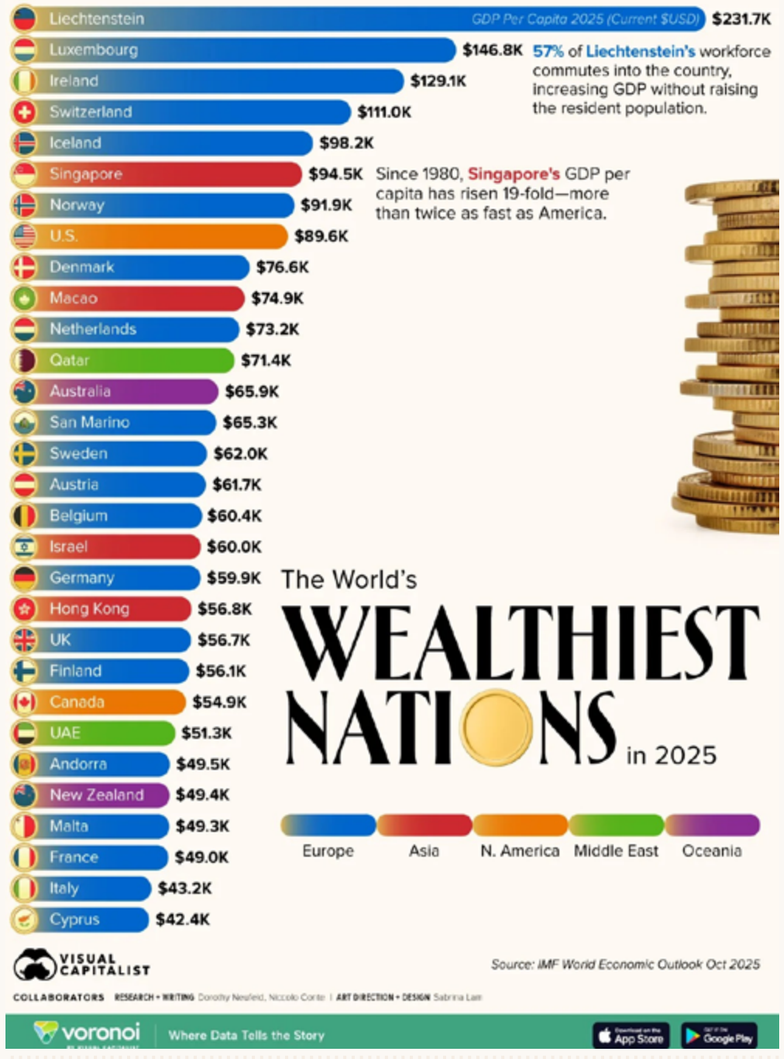
Liechtenstein GDP Per Capita 2025 (Current $USD) $231.7K
Luxembourg $146.8K
Ireland $129.1K
Switzerland $111.0K
Iceland $98.2K
Singapore $94.5K
Norway $91.9K
U.S. $89.6K
Denmark $76.6K
Macao $74.9K
Netherlands $73.2K
Qatar $71.4K
Australia $65.9K
San Marino $65.3K
Sweden $62.0K
Austria $61.7K
Belgium $60.4K
Israel $60.0K
Germany $59.9K
Hong Kong $56.8K
UK $56.7K
Finland $56.1K
Canada $54.9K
UAE $51.3K
Andorra $49.5K
New Zealand $49.4K
Malta $49.3K
France $49.0K
Italy $43.2K
Cyprus $42.4K
57% of Liechtenstein's workforce commutes into the country, increasing GDP without raising the resident population.
Since 1980, Singapore's GDP per capita has risen 19-fold—more than twice as fast as America.
The World's
WEALTHIEST NATIONS in 2025
Europe
Asia
N. America
Middle East
Oceania
VISUAL CAPITALIST
Source: IMF World Economic Outlook Oct 2025
COLLABORATORS RESEARCH + WRITING Dorothy Neufeld, Niccolo Conte | ART DIRECTION + DESIGN Sabrina Lee
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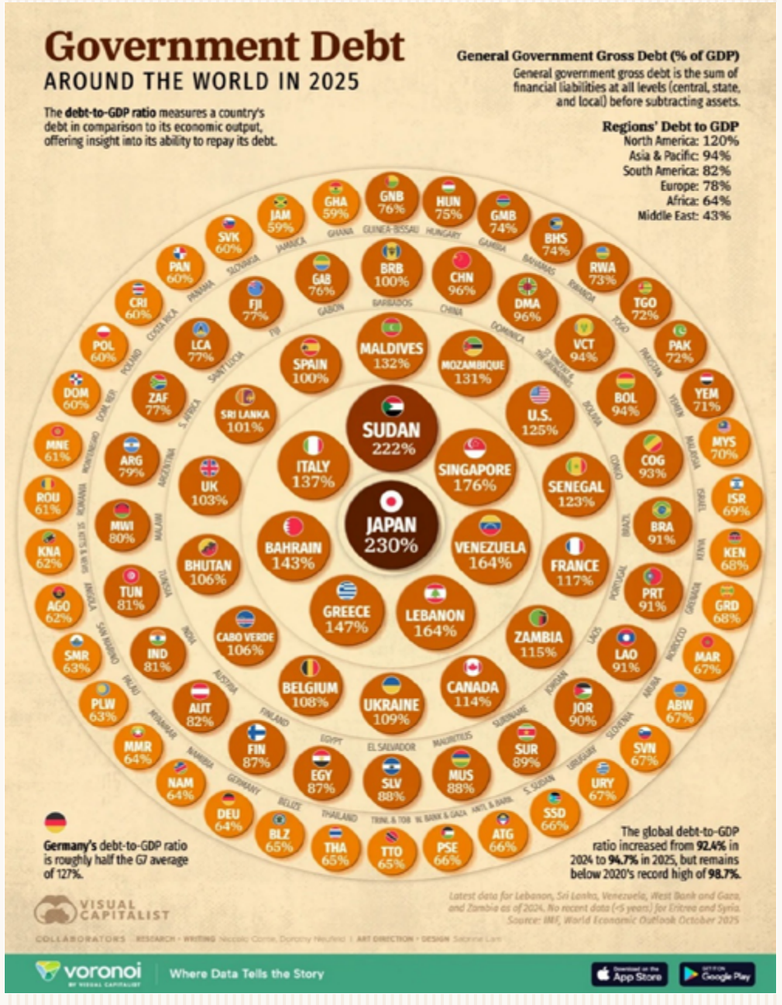
Government Debt
AROUND THE WORLD IN 2025
The debt-to-GDP ratio measures a country's debt in comparison to its economic output, offering insight into its ability to repay its debt.
General Government Gross Debt (% of GDP)
General government gross debt is the sum of financial liabilities at all levels (central, state, and local) before subtracting assets.
Regions' Debt to GDP
North America: 120%
Asia & Pacific: 94%
South America: 82%
Europe: 78%
Africa: 64%
Middle East: 43%
SUDAN 222%
JAPAN 230%
SINGAPORE 176%
ITALY 137%
VENEZUELA 164%
SENEGAL 123%
FRANCE 117%
BAHRAIN 143%
GREECE 147%
LEBANON 164%
ZAMBIA 115%
BHUTAN 106%
MALDIVES 132%
MOZAMBIQUE 131%
SPAIN 100%
U.S. 125%
UKRAINE 109%
CANADA 114%
BELGIUM 108%
BRB 100%
CHN 96%
DMA 96%
VCT 94%
BOL 94%
COG 93%
PRT 91%
LAO 91%
BRA 91%
RWA 73%
TGO 72%
PAK 72%
YEM 71%
MYS 70%
ISR 69%
KEN 68%
GRD 68%
MAR 67%
ABW 67%
SVN 67%
URY 67%
SSD 66%
ATG 66%
PSE 66%
TTO 65%
THA 65%
BLZ 65%
SLV 88%
MUS 88%
SUR 89%
JOR 90%
EGY 87%
FIN 87%
AUT 82%
IND 81%
TUN 81%
MWI 80%
ARG 79%
ZAF 77%
FJI 77%
LCA 77%
GAB 76%
GNB 76%
GHA 59%
JAM 59%
SVK 60%
PAN 60%
CRI 60%
POL 60%
DOM 60%
MNE 61%
ROU 61%
KNA 62%
AGO 62%
SMR 63%
PLW 63%
MMR 64%
NAM 64%
DEU 64%
HUN 75%
GMB 74%
BHS 74%
SRI LANKA 101%
UK 103%
CABO VERDE 106%
Germany's debt-to-GDP ratio is roughly half the G7 average of 127%.
The global debt-to-GDP ratio increased from 92.4% in 2024 to 94.7% in 2025, but remains below 2020's record high of 98.7%.
Latest data for Lebanon, Sri Lanka, Venezuela, West Bank and Gaza, and Zambia as of 2024. No recent data (>5 years) for Eritrea and Syria.
Source: IMF, World Economic Outlook October 2025
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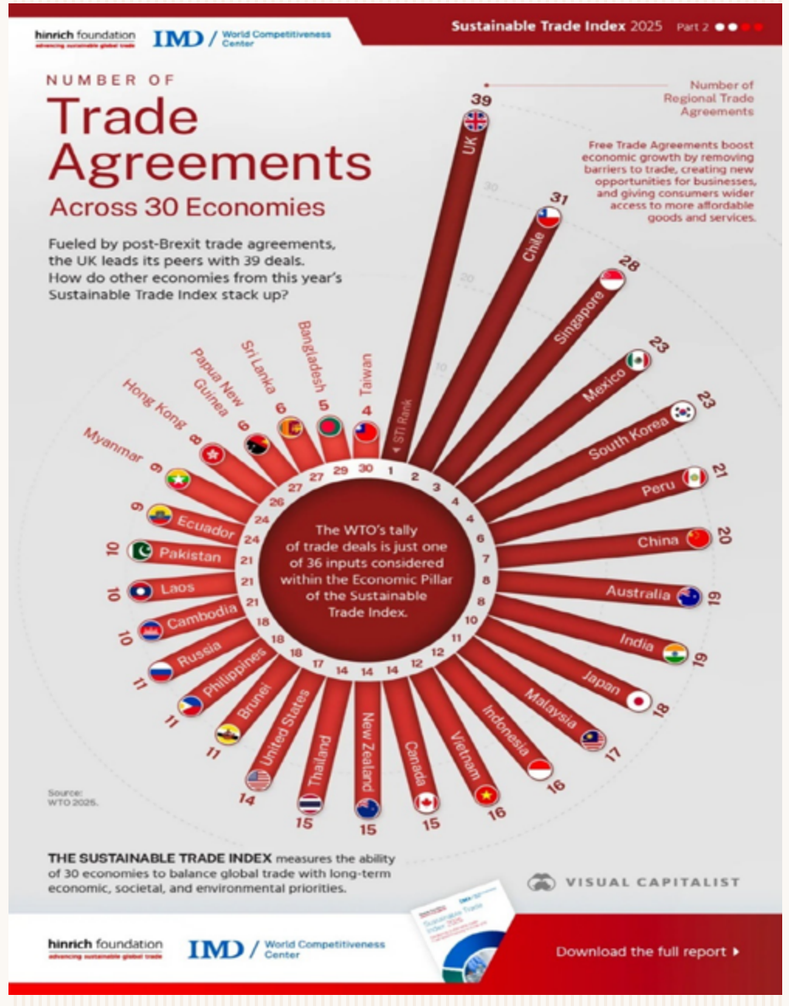
hinrich foundation
IMD / World Competitiveness Center
Sustainable Trade Index 2025 Part 2
NUMBER OF
Trade Agreements
Across 30 Economies
Fueled by post-Brexit trade agreements, the UK leads its peers with 39 deals. How do other economies from this year's Sustainable Trade Index stack up?
Number of Regional Trade Agreements
Free Trade Agreements boost economic growth by removing barriers to trade, creating new opportunities for businesses, and giving consumers wider access to more affordable goods and services.
UK 39
Chile 31
Singapore 28
Mexico 23
South Korea 23
Peru 21
China 20
Australia 19
India 19
Japan 18
Malaysia 17
Indonesia 16
Vietnam 16
Canada 15
Qatar 15
New Zealand 15
Thailand 15
United States 14
Brunei 11
Philippines 11
Russia 11
Cambodia 10
Laos 10
Pakistan 10
Ecuador 9
Myanmar 9
Hong Kong 8
Papua New Guinea 6
Sri Lanka 6
Bangladesh 5
Taiwan 4
◄ STI Rank
The WTO's tally of trade deals is just one of 36 inputs considered within the Economic Pillar of the Sustainable Trade Index.
Source: WTO 2025.
THE SUSTAINABLE TRADE INDEX measures the ability of 30 economies to balance global trade with long-term economic, societal, and environmental priorities.
VISUAL CAPITALIST
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Download the full report

RankingRoyals

WHERE PEOPLE TRUST EACH OTHER THE MOST

From samples of roughly 1,000–1,500+ interviews of adults per country, conducted in waves. Responses shown to the question, "Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?" Possible answers include "Most people can be trusted", "Do not know" and "Need to be very careful". The UK includes England, Scotland, and Wales, with Northern Ireland listed separately. Major processing done by **Our World in Data**.

Agree with "Most people can be trusted"

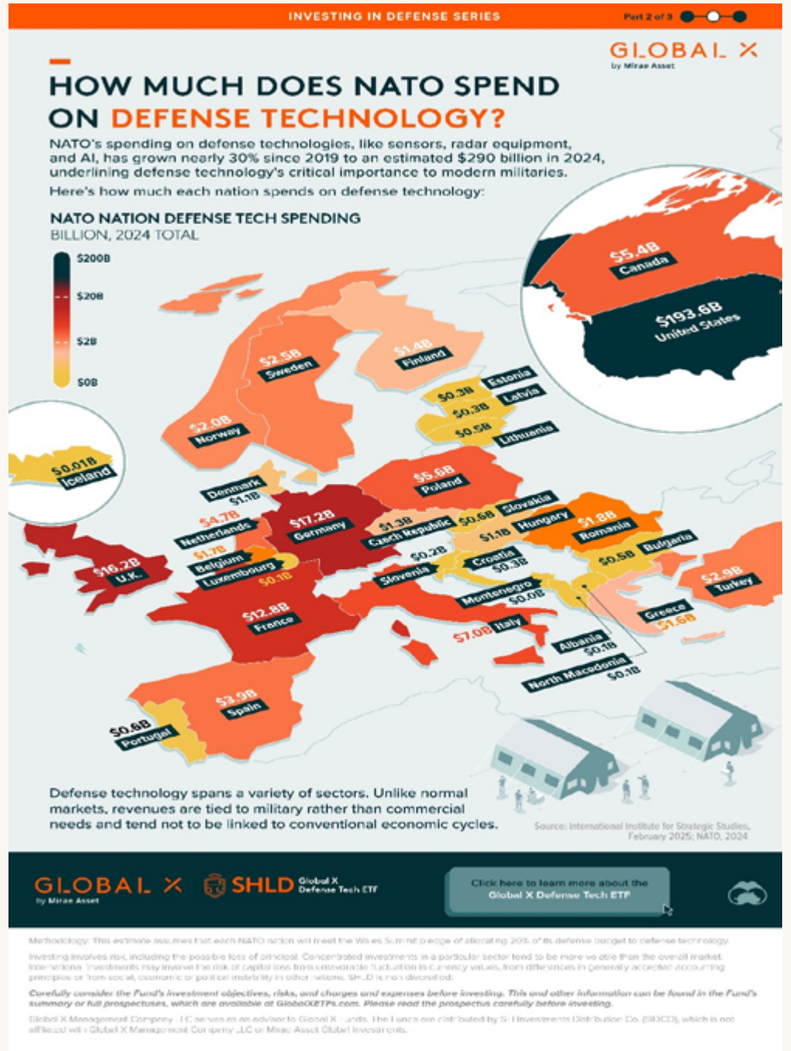
1.	Denmark	74%	11.	Australia	49%
2.	Norway	72%	12.	Canada	47%
3.	Finland	68%	13.	United Kingdom	43%
4.	China	63%	14.	Germany	42%
5.	Sweden	63%	15.	Macao SAR	41%
6.	Iceland	62%	16.	Spain	41%
7.	Switzerland	59%	17.	Belarus	40%
8.	Netherlands	57%	18.	Northern Ireland	39%
9.	New Zealand	57%	19.	United States	37%
10.	Austria	50%	20.	Hong Kong SAR	36%

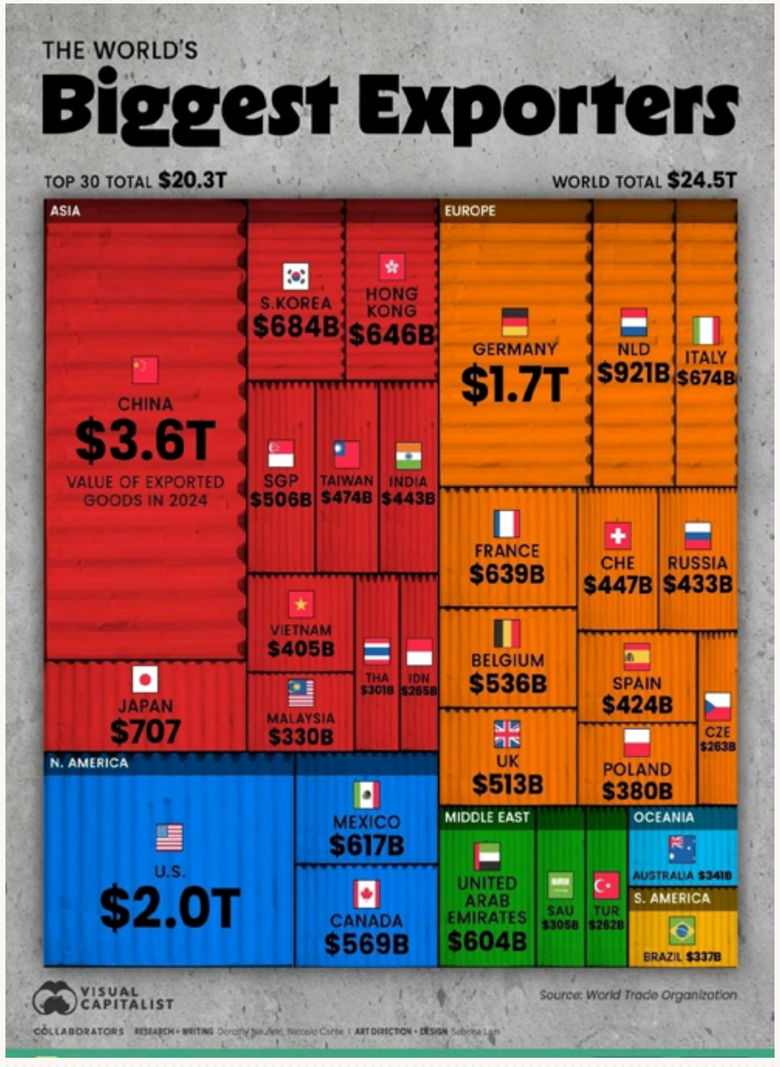
*Figures are rounded

Source: Integrated Values Surveys 2024

www.rankingroyals.com

RankingRoyals




THE WORLD'S
Biggest Exporters
TOP 30 TOTAL $20.3T
WORLD TOTAL $24.5T
ASIA
EUROPE
CHINA
$3.6T
VALUE OF EXPORTED GOODS IN 2024
S.KOREA $684B
HONG KONG $646B
SGP $506B
TAIWAN $474B
INDIA $443B
VIETNAM $405B
THA $301B
IDN $265B
MALAYSIA $330B
JAPAN $707
GERMANY $1.7T
NLD $921B
ITALY $674B
FRANCE $639B
CHE $447B
RUSSIA $433B
BELGIUM $536B
SPAIN $424B
CZE $263B
UK $513B
POLAND $380B
N. AMERICA
U.S.
$2.0T
MEXICO $617B
CANADA $569B
MIDDLE EAST
UNITED ARAB EMIRATES $604B
SAU $305B
TUR $262B
OCEANIA
AUSTRALIA $341B
S. AMERICA
BRAZIL $337B
VISUAL CAPITALIST
Source: World Trade Organization
COLLABORATORS RESEARCH + WRITING Dorothy Neufeld, Niccolo Conte | ART DIRECTION + DESIGN Sabrina Lam


Donald Trump
Views (All Languages)
68.8M
Elon Musk
58.1M
ChatGPT
51.7M
2024 U.S. Presidential Election
47.7M
Kamala Harris
46.1M
YouTube
44.1M
Pope Francis
40.2M
United States
37.7M
Cristiano Ronaldo
37.0M
Deaths in 2024
36.0M
Deaths in 2025
31.4M
Pope Leo XIV
29.0M
World War II
28.4M
Deadpool & Wolverine
28.2M
Lamine Yamal
27.0M
Menendez Brothers
26.2M
2024 Summer Olympics
25.6M
JD Vance
25.5M
List of U.S. Presidents
24.3M
Lionel Messi
22.6M
THE MOST VIEWED
WIKIPEDIA
PAGES IN 2025
A Netflix series reignited interest in the **Menendez brothers** 30 years after being convicted for murdering their parents
Source: We Are Social
Ranking is based on Wikipedia page views between July 1, 2024 and June 30, 2025.
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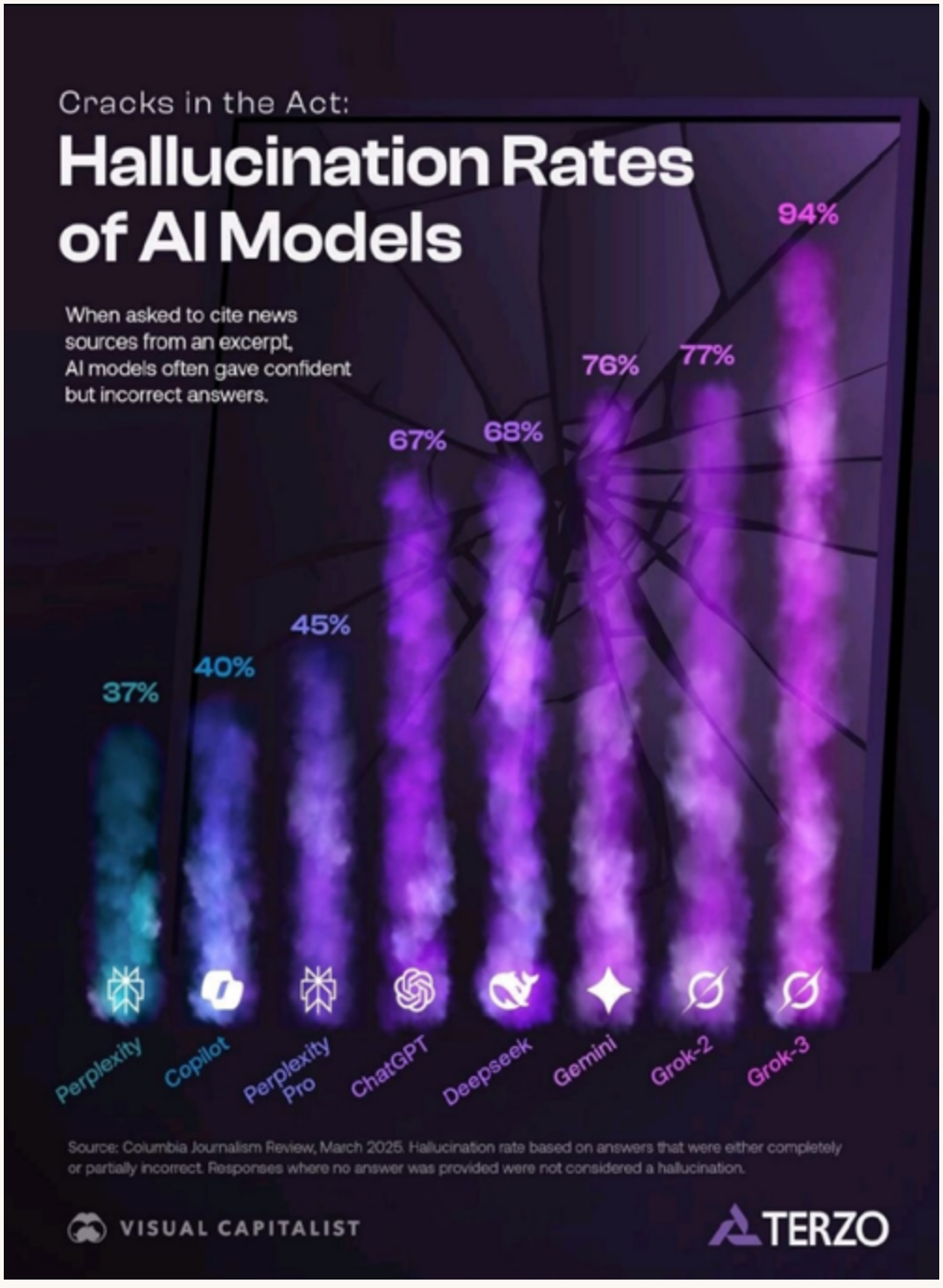
Cracks in the Act:
Hallucination Rates of AI Models
When asked to cite news sources from an excerpt, AI models often gave confident but incorrect answers.
37%
40%
45%
67%
68%
76%
77%
94%
Perplexity
Copilot
Perplexity Pro
ChatGPT
Deepseek
Gemini
Grok-2
Grok-3
Source: Columbia Journalism Review, March 2025. Hallucination rate based on answers that were either completely or partially incorrect. Responses where no answer was provided were not considered a hallucination.
VISUAL CAPITALIST
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