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Exclusive interview

ISO Secretary-General Sergio Mujica: Standards are the key to inclusive, sustainable growth

ISO秘书长塞尔吉奥·穆希卡：标准是实现包容性、可持续增长的关键

2026中关村论坛年会
2026 ZGC FORUM ANNUAL CONFERENCE

Spotlight

Voices about standards in the Two Sessions

2026年全国两会标准声音

Special report

Standardization and Science & Technology Innovation Development Forum

2026标准化与科技创新发展论坛

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The voluntary national standard GB/T 33450-2025, *Guideline for the transformation from scientific and technical achievement to standard,* came into force on February 1, 2026.

The standard provides guidance on demand analysis, feasibility analysis, feasibility evaluation, and the determination of types and contents of standards for the transformation of scientific and technological achievements into standards.

It will facilitate the transformation of achievements in the fields of cutting-edge and key emerging technologies.

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Standards boost but need broader

ISO Secretary-General Sergio Mujica attended the 2026 ZGC Forum Annual Conference in Beijing as a special guest. In an exclusive interview with China Standardization Press, he shared his impressions of the Forum and his fruitful visit to China, elaborated on the pivotal role of ISO international standards in boosting innovation, and offered in-depth insights into China's future development pathway.

"The Forum is a dynamic platform for exchange and collaboration between changemakers who recognize the event's central role in steering the global agenda on innovation...In an era of geopolitical uncertainty and fragmentation, International Standards provide the common language that builds trust and security, enabling innovation to flourish...China's journey exemplifies how, by embracing standards, countries can build resilient economies, foster innovation and lead the way toward a more interconnected, equitable world," Mr. Mujica noted.

The EXCLUSIVE INTERVIEW column also features an interview with ISO/COPOLCO Chair Eunsook Moon. She shared the similarities and differences in standardization governance between China and South Korea, outlined the work priorities of ISO/

innovation participation

COPOLCO this year, and explained how to facilitate wider consumer participation in standardization activities.

"It would be valuable to bring more Chinese consumer organizations into COPOLCO events. We welcome not only participation from national standards bodies at COPOLCO plenaries and workshops, but also direct involvement of consumer experts from relevant organizations," Ms. Moon remarked.

The SPOTLIGHT column interprets standardization-related content in the government work report of the annual Two Sessions, alongside professional perspectives on standardization put forward by deputies to the National People's Congress and members of the National Committee of the Chinese People's Political Consultative Conference.

The SPECIAL REPORT column shows a series of in-depth coverage of 2026 Standardization and Science & Technology Innovation Development Forum hosted by the Beijing Municipal Administration for Market Regulation this March.

Wish you an enjoyable reading experience!

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特别报道

GLOBAL VISION
国际视野

RESEARCH & EXPLORATION
研究与探索

Supplement 最新标准公告 (free of charge)

China promotes the construction of data infrastructure and data standards

The National Data Administration announced the establishment of the "data infrastructure technology community" and launched the "data standard semantic service platform" on April 28, which aims to accelerate the national data infrastructure and data standardization process during the 15th Five-Year Plan period (2026-2030).

Data infrastructure construction has been included in the 109 major projects of China's 15th Five-Year Plan. The data infrastructure technology community brings together key participants such as builders, operators, technology service providers, scenario developers, and data processors for data infrastructure. It will carry out technical discussions, validation, sharing, application, and promotion, to lower the practical implementation threshold for data infrastructure.

The newly launched platform will help large models and other artificial intelligence technologies accurately analyze data, deeply mine information, and perform intelligent computing, providing standard guarantees for data processing, value discovery, and business implementation.

China issues 51 national vocational standards in 2026

According to a press conference held by the Ministry of Human Resources and Social Security, 51 national occupational standards have been issued so far this year. The standards feature three main characteristics:

First, most standards are newly developed, with few standards revised for supplement. Forty-four of the 51 national occupational standards are newly developed, accounting for 86.3%. This reflects the ongoing emergence of new occupations, such as user growth operators, operators for the installation, adjustment, and maintenance of intelligent connected vehicles, and carbon sequestration metering and evaluation specialists. The development and revision of these standards aim to regulate new occupations and renew outdated standards.

Second, the standards focus on key areas and respond to demands. Efforts have been made to align with the needs of developing new productive forces and people's demand for a higher quality of life.

In terms of emerging production services, national occupational standards have been developed for occupations such as photovoltaic power plant operation and maintenance workers, electromechanical equipment repairers, and environmental monitors. In terms of people's demands for consumption upgrading, standards have been improved for occupations including organizing and storage specialists, and scenic area operation managers. In terms of the transformation and upgrading of traditional industries, standards for meat product processors, tea plantation managers, and other occupations have been developed or revised.

Third, the standards are unified to facilitate mobility. The standards specify the work content, knowledge, and skill requirements of each occupation, providing a unified national basis for training and assessment of vocational skills, and enhancing the authority, portability, and recognition of the evaluation.

Plenary meeting of the National Intelligent Manufacturing Standardization General Group and Expert Advisory Group held

China has ascended one of the global manufacturing powerhouses, greatly supported by the achievements of intelligent manufacturing engineering. Its intelligent manufacturing standardization has entered a critical stage of forward-looking planning and proactive leadership.

The 2026 annual plenary meeting of the National Intelligent Manufacturing Standardization General Group and Expert Advisory Group was held in Beijing on April 14.

The meeting called on the two groups to focus on frontier areas, accelerate the development of critical standards, iteratively upgrade the standards system, fully leverage the coordinating role of the groups, and strive to resolve issues such as overlap and duplication in standards proposals.

With the development of AI, a new generation of intelligent manufacturing systems is urgently needed to support the transformation of manufacturing models, said Yu Haibin, Academician of the Chinese Academy of Engineering and Director of the Institute of AI for Industries, Chinese Academy of Sciences, in his report titled "Intelligent Manufacturing in the Age of Artificial Intelligence." He suggested conducting research on four types of standards for various business domains: framework models, technical requirements, evaluation specifications, and integration applications.

Zhang Xiaogang, former President of ISO, believed that standardization internationalization represents the key to global industrial competition. China should actively participate in the formulation of international rules, promote the "going global" of Chinese standards, and utilize standards to facilitate technological innovation and trade.

During the 15th Five-Year Plan period, cross-industry standards coordination, forward-looking systematic planning, and deeply integrating standards with industrial application scenarios will be strengthened to provide solid support for the high-quality development of intelligent manufacturing.

Shenzhen holds the 10th ISO/IEC Young Professionals (China) Programme

Hosted by the Shenzhen Administration for Market Regulation, the 10th ISO/IEC Young Professionals (China) Programme kicked off in Shenzhen.

The event was attended by 310 young experts from 82 central state-owned enterprises and top research institutes nationwide. Their expertise covers strategic emerging industries such as new-generation information technology, high-end equipment, new energy, and new materials, which will drive the cultivation of China's international standardization young talent.

This activity invited experts from authoritative institutions such as the China Three Gorges Corporation, the China National Institute of Standardization, and the National Center for Nanoscience and Technology, to deliver lectures. The courses reconcile theoretical depth with practice, including ISO/IEC working procedures, conformity assessment practices, and standardization topics in cutting-edge fields such as artificial intelligence, smart grids, digital twins, and brain-computer interfaces.

The Shenzhen Administration for Market Regulation has adopted a dual-track model of "training+selection," and significantly improved the effectiveness of talent cultivation. Outstanding candidates who pass the rigorous selection will be included in the international standardization young talent pool and receive priority recommendations to participate in international or regional young expert exchange activities.

Started in 2017, the programme has trained 1,330 young talent for international standardization so far. Among them, more than 75% hold postgraduate degrees; 4 individuals have received the title of IEC Young Professional Leader; a number of outstanding young people hold important positions in international standards organizations such as ISO, IEC, and ITU; over 100 experts have registered at international standards organizations.

Chinese national standards in foreign language version freely available to the public

The State Administration for Market Regulation (SAMR), the Ministry of Housing and Urban-Rural Development, the Ministry of Transport, and the Ministry of Commerce jointly held a press conference on April 14 to expound on the free public release of national standards in foreign language versions.

As of the end of March 2026, China had issued a total of 2,613 national standards in foreign language version, covering more than 20 key areas, including equipment manufacturing, overseas contracted projects, commodities, information technology, and new energy. The standards involve 11 languages, English, Russian, French, German, Japanese, Lao, Cambodian, Mongolian, Burmese, Portuguese, and Vietnamese.

The full-text free access function module has been officially launched on the national public service platform for standards information (**https://openstd.samr.gov.cn/bzgk/std/**). Users can also visit the official English website of the National Standardization Administration of China (SAC) and click "GB standards foreign languages version" on the right side to reach the module. Users can search for standards by standard number, Chinese or English title, or browse by industry according to the International Classification for Standards (ICS).

The platform also links the Chinese and foreign language versions. When browsing the Chinese version of standards, visitors can easily find the corresponding foreign language version, and vice versa. The full text of the foreign language version can be read online or downloaded free of charge, without any need for registration or login.

It is a practical step for SAMR to implement the concept of a service-oriented government and deepen the institutional opening up of standards. It is expected to help both domestic and foreign enterprises and the public to find, understand, and use Chinese standards, and truly appreciate the supporting role of standardization in economic and social development.

BRICS Economic and Trade Forum held in Beijing

The BRICS Economic and Trade Activities Forum was held by the Council for the Promotion of International Trade (CCPIT) in Beijing on April 24, with the theme of "BRICS Cooperation Empowering Global South Development: Co-building Standards, Integrating Trade, and Sharing Development." More than 200 people attended the forum, including leaders of relevant Chinese and foreign standardization organizations, administrative authorities, business associations, enterprises and research institutes, and envoys from embassies of relevant countries to China.

Li Qingshuang, Vice Chairperson of CCPIT, Yu Xubo, Chairman of China General Technology (Group) Holding Co., Ltd. (Genertec), Zhang Weiwu, Vice President of the Industrial and Commercial Bank of China, Wang Gang, Deputy Director General of the Department of International Economic Affairs of the Ministry of Foreign Affairs, Guo Chenguang, Deputy Director-General of the Department of Standardization Innovative Management of SAMR, and Kichan Kim, Chair of the International Council for Small Business addressed the opening ceremony. Representatives of the embassies of Indonesia and Egypt to China made keynote speeches during the forum.

Participants exchanged views on topics such as the current status and future trends of BRICS economic and trade exchanges and standardization cooperation, and the deepening cooperation among BRICS business and industrial communities in digital economy, green transformation, and sustainable development. They fully affirmed the positive role of the forum in building consensus, expanding economic and trade ties, and deepening standards alignment, and put forward suggestions to further promote trade facilitation through standards cooperation.

The *Handbook on BRICS Trade Development and Standards Cooperation* was released, which supports enterprises in reducing information acquisition costs, avoiding compliance risks, enhancing abilities to address TBT, and deeply participating in international cooperation on economy, trade, and standards. It lays a solid foundation for promoting connectivity of trade policies and standards and expanding industrial cooperation.

ISO/IEC 17020:2026 on conformity assessment released

Inspection is the examination of items such as materials, products, installations, plants, processes, work procedures or services, and the determination of their conformity with requirements.

As the core basis for the capacity building and business operation of inspection bodies, ISO/IEC 17020:2026, *Conformity assessment—Requirements for bodies performing inspection*, was officially released recently. It will further regulate the operation of inspection and testing institutions, enhance the credibility of inspection results, and provide solid support for smooth international trade and building national strengths in quality.

The previous version of ISO/IEC 17020, released in 2012, has been widely applied globally, and China has adopted this standard equivalently and converted it into the national standard GB/T 27020 for the management of inspection institutions.

Chinese representatives have vigorously participated in the revision of this standard, putting forward suggestions and proposals on key issues such as ensuring the effectiveness of inspection results, based on China's practical experience in inspection and testing.

SAMR has now initiated the conversion of ISO/IEC 17020:2026 into a national standard to improve the inspection and testing system. With higher standards, stricter requirements, and better services, it aims to improve the quality and efficiency of China's inspection and testing service industry to achieve its stable long-term development, and inject new momentum into building China's strengths in quality and the global development of conformity assessment.

Twenty-one BRICS standards released to promote technological innovation

As a part of the 2026 ZGC Forum series event, the Belt & Road and BRICS Forum on Technology Innovation and International Cooperation was held on April 17 in Beijing. A series of international cooperation achievements were released at the forum, including 21 BRICS standards.

The Belt and Road Initiative and the BRICS cooperation mechanism have provided an important platform for emerging markets and developing countries to jointly promote technological breakthroughs and share innovation results, said Yu Huarong, Party Secretary of the China Invention Association. He called for actively promoting institutional innovations such as mutual recognition of technical standards and cross-border protection of intellectual property rights, so as to create a more open, transparent, and fairer environment for international technology cooperation.

A total of 21 BRICS standards were released at the forum, covering 7 key areas including data analysis, robotics automation, the Internet of Things, unmanned aerial vehicles, and VR/AR, which aim to promote the Belt and Road Initiative as well as technological innovation and international cooperation among BRICS countries.

Moreover, the Belt & Road and BRICS Science, Technology and Innovation Cooperation Project announced that international competitions will be held this year in countries including Brazil and Russia and regions such as South Africa, ASEAN, Central Asia, and the Middle East. The International Alliance of Skills Development for Belt & Road and BRICS has established in-depth cooperation with more than 40 “BRICS Plus” countries, signed over 60 MoUs, and set up more than 100 international training bases (BRICS workshops).

Photo: Beijing Municipal Administration for Market Regulation

From technological innovation to development impact, standards are the key to inclusive, sustainable growth

标准是实现包容性、可持续增长的关键

By ISO Secretary-General Sergio Mujica
文/国际标准化组织秘书长 塞尔吉奥·穆希卡

Editor's note:

In March, ISO Secretary-General Sergio Mujica was invited to Beijing as a special guest at the 2026 ZGC Forum Annual Conference. He delivered a speech at the Standardization and Science & Technological Innovation Development Forum. During his visit to China, Mr. Mujica toured the State Administration for Market Regulation (SAMR), the National Standardization Administration of China (SAC), and the China National Institute of Standardization (CNIS). China Standardization Press invited him to share his impressions of the Forum, his productive trip, the role of ISO international standards in driving innovation, and his insights on China's future development pathway.

In a rapidly evolving digital world, fuelling innovation across the twin pillars of technology and industry is essential to foster sustainable, inclusive growth. This was the clear takeaway from my recent trip to the Zhongguancun (ZGC) Forum in Beijing, where I joined top scientists, leading entrepreneurs and heads of international organizations to explore the integration of innovation across these sectors.

The Forum is a dynamic platform for exchange and collaboration between changemakers who recognize the event's central role in steering the global agenda on innovation. As a leading center of scientific and technological excellence, Beijing served as a particularly fitting host city—a place where world-class talent, forward-looking policies and an innovative mindset are creating international impact.

Chinese President Xi Jinping himself has publicly acknowledged the Forum's significance, calling for China to join hands with the world to promote innovation and ensure science and technology better serve humanity.

Opening the doors to innovation

During the Forum's opening ceremony, I had the opportunity to highlight how standards are key levers in driving this process. In an era of geopolitical uncertainty and fragmentation, International Standards provide the common language that builds trust and security, enabling innovation to flourish. They serve as a crucial bridge between technological advances and industrial development.

International Standards are shaping the future of the digital age. Together with our close partner the International Electrotechnical Commission (IEC), ISO develops standards that support artificial intelligence (AI) governance, providing a toolkit for how to develop, deploy and scale AI technology responsibly. From blockchain and bio-digital convergence to quantum technologies and the Internet of Things, our organizations are committed to ensuring that emerging technologies don't deepen the digital divide but benefit the whole of society.

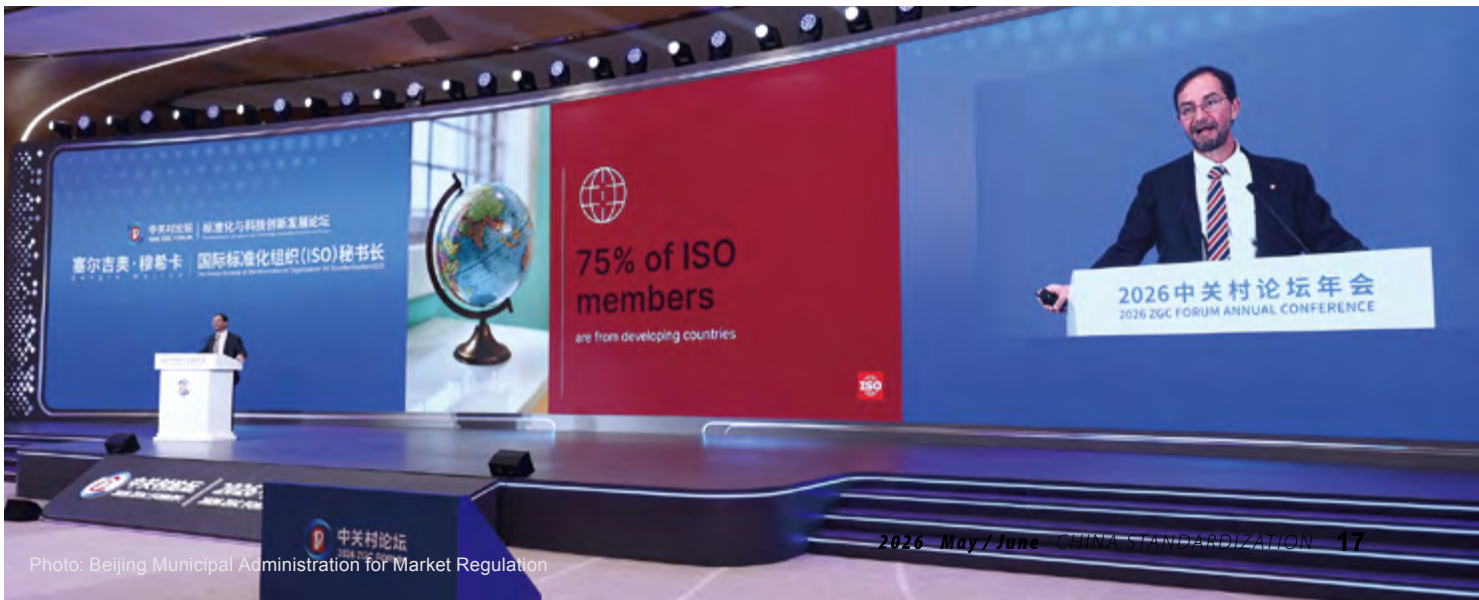


Photo: Beijing Municipal Administration for Market Regulation

Sergio Mujica delivers a speech at the Standardization and Science & Technological Innovation Development Forum in Beijing, China in March.

Standards drive development

In Beijing, I also attended the Standardization and Science and Technology Innovation Development Forum. It was a chance to present on how standards function as critical drivers of sustainable, inclusive development. This message is emphasized in the World Bank's flagship World Development Report 2025—the first of its kind to be devoted entirely to standards.

The Report shines a light on the silent power of International Standards to enable trade, safety, quality and interoperability across borders and sectors. Standards, it argues, provide the hidden foundations of prosperity and are instrumental in shaping modern development pathways.

In practical terms, this means that countries which integrate standards into their national development strategies stand to gain access to global markets, attract investment, strengthen productivity and build resilient industries. Thanks to their versatility, standards can be adapted, aligned or even created by countries to meet their unique economic needs.

Building capacity to boost participation

As the World Bank Report emphasizes, the potential of standards to drive development in low- and middle-income countries remains largely untapped due to economic and institutional barriers. While these countries may face access issues, the deeper challenge lies in their ability to participate meaningfully in the development of standards.

To address this, ISO is focused on empowering these countries through our Action Plan for Developing Countries (APDC), which aims to bridge the gap in capacity and enhance their participation in global standardization efforts, while increasing the uptake of International Standards.

In recognizing that strong national standards bodies are essential to achieve our vision, the Action Plan complements the ISO Strategy 2030 and accelerates progress towards the United Nations Sustainable Development Goals (SDGs).

Why this matters for ISO goes beyond mere altruism. Empowering experts from developing countries to participate more effectively and equitably in standardization ensures the global relevance of our standards. In addition, because participation promotes the uptake and implementation of standards, it helps achieve ISO's strategic goal of standards used everywhere.

Sergio Mujica visits the National Standards Library at the China National Institute of Standardization (CNIS) during his trip to China.

China's development pathway

China's remarkable socioeconomic development is a testament to the power of standards in driving national growth. As a world leader in technological and industrial innovation, it relies heavily on standards to build trust, ensure safety and scale solutions, accelerating the country's ambitious development policies.

Through its ISO member, SAC, China makes a huge contribution to international standardization, showing leadership and vision in heading around 90 ISO technical committees. The input of Chinese experts and stakeholders from across sectors helps ISO standards meet market needs and reflect diverse user experiences.

By continuing to invest in national quality infrastructure and encouraging broader participation in standards development, China can ensure its national priorities are reflected globally – helping to write the rules that shape economies and offer a pathway to a more inclusive, sustainable future.

China's journey exemplifies how, by embracing standards, countries can build resilient economies, foster innovation and lead the way toward a more interconnected, equitable world. As we continue to shape society through the collaborative power of International Standards, we are not only building a better today, but paving the way for a future in which technology and sustainable development work for everyone, everywhere.

Photo: CNIS

Sergio Mujica meets with Wang Xudong, Director of the Palace Museum and visits the secretariat of ISO/TC 349 on cultural heritage conservation at the Palace Museum in Beijing.

Photo: CNIS

Sergio Mujica (L7), Deputy Director-General of Standards Innovative Management Department of SAMR Sun Wei (L6), CNIS President Wang Kun (L8), CNIS Vice President Chen Weiliang (L5), along with staff from SAMR, SAC and CNIS.

About Sergio Mujica:

Sergio Mujica has been ISO Secretary-General since 2017.

ISO is a leading international organization in standardization with a membership of about 177 national standards bodies. ISO standards support global trade, drive inclusive and equitable economic growth, advance innovation and promote health and safety to achieve a sustainable future.

Under Sergio's leadership, ISO approved a new Strategy 2030, which is aligned with the UN Sustainable Development Goals, with a vision of "making lives easier, safer and better."

Bridging consumer protection and standards

Interview with ISO/COPOLCO Chair
Eunsook Moon

在消费者保护和标准之间搭建桥梁

——专访国际标准化组织
消费者政策委员会主席 **文恩淑**

Photo: CSP

China Standardization: **Could you share your personal journey into standardization? What first attracted you to this field?**

Eunsook Moon: I come from the Korean Institute of Consumer Safety and Standards. My career began with work on consumer policies, general consumer safety and protection.

Over time, I came to realize that policy measures alone are insufficient to fully protect consumers worldwide. A global protection framework is needed for global consumers. Alongside policy initiatives, international standards—in particular—are indispensable. This is what motivated me to engage in international standardization work.

How is your current visit to China? From your perspective, what are the notable similarities and differences between China and South Korea in terms of standardization governance and industrial development?

Eunsook Moon: China and South Korea are neighboring countries with shared cultural roots, so I feel very much at home here.

In the realm of international standardization, China has emerged as a major and influential player, delivering remarkable progress in advancing international standardization. Compared with South Korea, China boasts a far larger scale of development and well-coordinated institutional arrangements. For example, non-governmental organizations effectively support government authorities in standardization efforts.

As a smaller country, South Korea is also committed to participating in international standards development, yet there remains considerable room for further progress.

Our two countries share much in common in cultural heritage and civilization, as well as similar consumption patterns. This creates a broad space for joint cooperation and collaborative development, making Chinese culture very familiar to me.

What are priorities of ISO's Committee on Consumer Policy (COPOLCO) for 2026? In which key areas do you expect deeper cooperation between COPOLCO and China in the coming year?

Eunsook Moon: I highly appreciate the strong support that the National Standardization Administration of China (SAC) has provided for this year's plenary meeting. Importantly, this year's core themes center on AI and digital consumer rights. Beyond serving as a platform for member discussions, we aim to formulate practical action plans under these themes. SAC has offered tremendous backing, and we are confident of a highly successful plenary session this year.

Culturally, many similarities exist between our countries in lifestyle, dining habits and interpersonal communication, as well as consumer behavior patterns. As COPOLCO Chair, I strongly encourage China to take an even more active role in COPOLCO's work.

Asia has a huge consumer population, and we need to represent regional consumer voices, address their concerns, and integrate consumer perspectives into standardization processes to deliver practical solutions. There are extensive areas where China and South Korea can cooperate and contribute jointly.

How does COPOLCO encourage broader consumer participation in standardization activities?

Eunsook Moon: This is a critical, systemic challenge for COPOLCO. In many countries, particularly developing economies, sustainable consumer engagement in standardization is not yet a priority.

We are working to encourage national standards bodies to facilitate meaningful consumer participation—not merely symbolic involvement, but substantive engagement that enables consumers to voice their views and even propose new standardization projects. This challenge is shared by China, South Korea and many other nations, presenting great potential for joint collaboration.

I strongly recommend that SAC strengthens engagement with consumer organizations. These bodies possess professional expertise and can bring valuable consumer insights and perspectives into standardization work. COPOLCO actively encourages national standards bodies to communicate and collaborate closely with consumer organizations and involve them in related initiatives.

Photo: CSP

The 47th ISO/COPOLCO Plenary Meeting and workshops will be held in May in Haikou, South China's Hainan province. What specific outcomes do you expect from this event?

Eunsook Moon: We adopt important resolutions at our annual plenary meeting. This year, we aim to deliver actionable resolutions to safeguard consumer safety amid AI-driven digital transformation. We hope to achieve concrete, practical outcomes at this session.

China has become a key participant in international standardization and continues to deepen its involvement in global governance. What suggestions would you offer to further strengthen China's national standardization system and elevate its influence in international standardization?

Eunsook Moon: As an ISO Council Member, China already holds strong influence and maintains high engagement in international standardization. My main suggestion is to sustain and expand its active participation in COPOLCO as well.

It would be valuable to bring more Chinese consumer organizations to COPOLCO events. We welcome not only participation from national standards bodies at COPOLCO plenaries and workshops, but also direct involvement of consumer experts from relevant organizations. I sincerely hope China will bring more representatives and leaders from consumer organizations to attend this year's COPOLCO plenary in Haikou.

采访/曹欣欣 方洛凡

(Interviewed by Cao Xinxin and Fang Luofan)

Voices about standards in the Two Sessions

2026年全国两会标准声音

The annual Two Sessions, the meetings of the National People's Congress (NPC) and the National Committee of the Chinese People's Political Consultative Conference (CPPCC), were held in Beijing from March 4 to 12, 2026. As the first year of the 15th Five-Year Plan period (2026-2030), this year is crucial for securing a good start for China's high-quality development over the five years.

The government work report was delivered by Chinese Premier Li Qiang at the fourth session of the 14th NPC on March 5. The report reviewed the work in 2025, outlined main objectives and major tasks for the 15th Five-Year Plan period, made overall requirements and policy orientations for economic and social development in 2026, and set major tasks for 2026.

In the report, **the main targets for development this year are as follows:** GDP growth of 4.5–5 percent, while striving for better in practice; surveyed urban unemployment rate of around 5.5 percent; over 12 million new urban jobs; CPI increase of around 2 percent; personal income growth in step with economic growth; a basic equilibrium in the balance of payments; grain output of around 700 million metric tons; a reduction of around 3.8 percent in carbon dioxide emissions per unit of GDP.

Standards, fundamental for modernizing China's governance system and capacity, are a major highlight in the report. For instance, a total of 583 national standards for key areas were formulated or revised in 2025 to pursue innovation-driven development and continue to build a modernized industrial system.

In terms of fostering new growth drivers at a faster pace, one of the major tasks for 2026, China will "work faster to upgrade standards, enhance quality oversight, and promote brand building to support enterprises in producing more distinctive products of better quality" to upgrade traditional industries. To enhance the capacity and quality of the service sector, China will "improve national standards for the service sector and cultivate the 'China Services' brand."

When it comes to expanding high-standard opening up, China will "better align our development strategies with those of Belt and Road partner countries and take solid, well-measured steps to promote stronger infrastructure connectivity, greater connectivity on rules and standards, and closer bonds with the people in these countries."

As for continuing to deepen reform in key areas, China will "address monopolies and unfair competition with greater intensity, enhance the binding force of fair competition review, and thoroughly address rat race competition with a full range of approaches, including production regulation, standard-based guidance, pricing compliance and enforcement, and quality supervision, so as to cultivate a sound market environment."

Insights into standards in the Two Sessions

全国两会代表、委员话标准

During the Two Sessions, members of the CPPCC National Committee and deputies to the NPC discussed issues of common concern in the standardization field, such as artificial intelligence (AI) and digital technologies, vehicles and new energy, construction engineering, as well as food and agricultural products. Here, we summarize their insights into standards, to help standards play a bigger role in vigorously promoting the Chinese modernization.

On AI and digital technologies

Accelerating standards development for AI agents

Xian Handi, Deputy to the NPC

AI agents are entering the stage of large-scale application. However, AI agents developed by different vendors lack unified communication protocols, certification, and scheduling specifications. Many rules remain absent in agent collaboration, and the industry also lacks influential open-source projects and industrial alliances. China is still lagging behind in the standards research and ecosystem construction of AI agents, said Xian Handi, Chairman of the Board of China Prosperity Capital.

In this regard, he put forward launching national-level research projects to strengthen technical foundations, and establishing a coordinated standardization promotion mechanism to translate research outcomes and practical experience into standards and specifications.

He suggested launching a national key R&D project for key technologies and standards on agent interoperability to make systematic breakthroughs on core technologies; supporting the construction of a national engineering research center for agent interoperability technologies, and building a public technology service platform based on domestic resources; strengthening the leading role of standardization research institutions to accelerate the development of national, sectoral or association standards; encouraging Chinese experts to participate in the international standardization work of the Internet Engineering Task Force (IETF), the World Wide Web Consortium (W3C), the Linux Foundation and other organizations; launching application and demonstration projects for multi-agent collaboration to verify standards in real-world scenarios and explore a new model of cross-domain collaboration; supporting leading enterprises in building an open-source ecosystem.

Strengthening safety standards system to promote humanoid robot

Lei Jun, Deputy to the NPC

With continuous breakthroughs in general AI technologies, China has established first-mover advantages in humanoid robot technologies. However, the large-scale engineering application of humanoid robots still faces prominent challenges, including poor process stability, high costs of single hardware, and a small number of workshop workstations, according to Lei Jun, Founder, Chairman of the Board and CEO of Xiaomi.

He put forward the following suggestions. Firstly, overcoming engineering application challenges and establishing conditions for large-scale mass production. Secondly, expanding application scenarios in intelligent manufacturing and increasing the utilization rate of humanoid robots. Thirdly, strengthening the development of the safety standards system to facilitate the application of humanoid robots.

"We should accelerate standards development in intelligent manufacturing scenarios, and regulate standards for the integrated application of large AI models and humanoid robots; we should also participate in the international standards for 'humanoid robots + intelligent manufacturing,' and align relevant domestic standards with international ones," he added.

Enhancing independent technical system through standards

Deng Zhonghan, Member of the CPPCC National Committee

The integrated and innovative development of integrated circuits and AI is the core driving force for the upgrading of advanced manufacturing. However, problems such as the current "brute-force computing" model of traditional large AI models and the low utilization rate of video data have restricted the efficiency of digital transformation in the manufacturing industry, said Deng Zhonghan, Academician of the Chinese Academy of Engineering.

Drawing on R&D practices and development needs in integrated circuits and AI, he suggested breaking away from the traditional technological catch-up path, conducting forward-looking layout of original and leading technologies such as meta-computing and XPU architectures, bridging the gaps between technology and industry, accelerating the demonstration and application of core technologies driven by application scenarios, and leveraging industrial demands to drive technological iteration.

"We must strengthen the leading role of standards and the development of ecosystems, improve supportive policies in core technological fields, build an independent and controllable technical system, and enable China's manufacturing industry to achieve a higher level of self-reliance and strength in the global industrial landscape," he remarked.

Establishing a unified standards system for high-quality datasets

Jiang Ying, Member of the CPPCC National Committee

High-quality datasets are essential to truly transform general large models of AI into industry-specific vertical large models and integrate them with the real economy and physical industries, said Jiang Ying, Chair of the Board of Deloitte China. She observed that many industries and enterprises gather data without standardization at the source, resulting in inconsistent structures across the collected data.

To address this issue, she put forward the following recommendations. Firstly, establishing a unified and normative standards system for high-quality datasets. Industrial guidelines and demonstration cases should be refined to guide key industries to conduct standardized transformation of existing data, and provide SMEs with directly referable demonstration projects and universal templates. Secondly, improving the supporting system for data ecosystem to boost the efficiency of high-quality dataset development. A national certification and credit system for data service providers should be established to offer authoritative endorsement to the market and resolve the trust deficit issue. Thirdly, strengthening application-oriented design to enhance the practical value of datasets.

Improving technical standards for AI mobile phones to drive industrial coordination

Miao Wei, Deputy to the NPC

Miao Wei, Senior Vice President of ZTE Corporation, believes accelerating the development of AI phones helps consolidate first-mover industrial advantages, foster new quality productive forces, and enhance national scientific and technological competitiveness. However, challenges remain in the large-scale popularization of AI phones, including the need for breakthroughs in core technologies, incomplete sectoral standards, and urgent improvement of security and ethical norms.

In this regard, he recommended a two-pronged approach. On the one hand, strengthening policy support to drive technological innovation and commercial application of AI phones. This involves overcoming technical bottlenecks in core areas, leveraging market and scenario advantages, optimizing market access and development environments to unlock vitality, and accelerating AI commercial application and popularization. On the other hand, improving technical standards for AI phones to promote coordinated industrial development. This includes accelerating the standardization development in fields such as large model interface, strengthening collaboration across the industrial chain, establishing self-regulatory AI ethical guidelines, and improving compliance systems, thereby promoting healthy and sustainable industrial development.

Promoting standards for smart home interconnection

Zhong Zheng, Deputy to the NPC

Zhong Zheng, Vice President and CFO of Midea Group, noted that the household appliance industry faces problems such as fragmented operating systems and a lack of unified interconnection standards. Different brands need to install separate apps, which cannot communicate with each other, turning data into isolated silos. Meanwhile, enterprises act independently and conduct redundant R&D, which wastes social resources and impedes intelligent development.

To address these issues, she proposed the following measures. Firstly, strengthening top-level design, formulating a roadmap for industrial technological development, and accelerating the development and implementation of national standards for smart home interconnection covering key technical specifications. Secondly, building an open and collaborative industrial ecosystem, leveraging the leading role of key enterprises by encouraging technical interoperability, and lowering the technical and financial thresholds for SMEs by providing standards support. Thirdly, launching large-scale application demonstrations, popularizing standards through scenario-based implementation, and developing characteristic demonstration projects featuring whole-house intelligence, proactive energy conservation, and elderly care.

On vehicles and new energy

Strengthening the international promotion of battery standards

Zeng Yuqun, Member of the CPPCC National Committee

Zeng Yuqun, Chairman of the Board of CATL, called on strengthening the international promotion of Chinese battery technical standards based on the actual development of the new energy industry and CATL's decades of industrial experience. "The most critical thing is to stay committed to independent innovation," Zeng said. "CATL has been deeply involved for more than 20 years, with cumulative R&D investment exceeding 80 billion yuan and more than 50,000 patents. This is why our battery products are available in dozens of countries and regions worldwide."

"Besides leading products, CATL is also highly advanced in technologies and standards systems. CATL will promote Chinese products and technical standards to the world," Zeng added. Together with peers worldwide, CATL will contribute to the global new energy cause. He believes that investment should be concentrated on high-quality products. In terms of regulation, standards should be developed to distinguish between high-quality products and low-quality products. High-quality products should be encouraged for better development.

Accelerating the development of standards system for battery swapping

Li Xia, Member of the CPPCC National Committee

National policies have been issued to accelerate the application and promotion of battery swapping. Through field research, Li Xia, Director of the Anhui Committee of China National Democratic Construction Association, found that there are prominent challenges, notably inconsistent technical standards and incompatible networks.

Therefore, she proposed accelerating the development of a unified standards system for battery swapping. Leading enterprises are encouraged to appropriately open intellectual property rights, and develop differentiated technical standards in a categorized, phased and scenario-based manner, thereby advancing standardization across technical routes and breaking cross-brand and cross-model barriers.

She also recommended fostering an open and shared battery swapping ecosystem. Battery manufacturers, vehicle OEMs, swapping operators, energy enterprises and financial institutions should deepen cooperation to build an interconnected, interoperable and mutually beneficial battery swapping network. Efforts should be made to realize one-stop, cross-brand services including station searching, reservation, real-time monitoring and unified settlement, so as to improve operational efficiency and user experience.

Establishing standards for national intelligent driving data sharing

Zhou Yanfang, Deputy to the NPC

Given the opportunities and challenges brought by the transformation of the new energy vehicle industry, Zhou Yanfang, Director of the Strategic Research Center (ESG Office), China Pacific Insurance (Group) Co., Ltd., proposed advancing the high-quality development of related insurance from four aspects to better serve industrial transformation and upgrading.

Firstly, establishing national-level standards and a platform for intelligent driving data sharing. Financial regulatory departments are encouraged to join forces with all stakeholders to develop intelligent driving safety standards, and build a national-level intelligent driving and insurance data interaction platform. Secondly, accelerating the revision and improvement of laws and regulations related to intelligent driving. Revisions to relevant laws and regulations such as the Road Traffic Safety Law and the Insurance Law should be initiated in a timely manner in line with the development of intelligent driving technology. Thirdly, developing a standards system for key technologies and services, such as maintenance technologies, damage assessment, and environmental recycling. Fourthly, implementing guidelines for differentiated product innovation and pricing.

On construction engineering

Improving standards and assistant policy system for glass

Wang Gang, Deputy to the NPC

To promote the construction of safe, comfortable, green and smart houses in an orderly manner, Wang Gang, Chairman of the Board of Jinjing Group, suggested improving standards and assistant policy system for high-performance glass, advancing energy-saving renovation of glass, and facilitating coordinated development between green buildings and the future energy industry.

In his view, energy-efficient glass helps raise product added value and strengthen international competitiveness, driving enterprises to proactively scale up research, development and production, and thereby advancing industrial structural adjustment.

Drawing on practical experience and in-depth industrial insights, he called for establishing unified standards for quality glass. He proposed introducing a three-tier comprehensive energy efficiency certification system for glass, similar to the energy labeling system for household appliances. He further recommended including energy-saving renovation of building doors and windows within the expanded scope of the national policies for large-scale equipment upgrading and trade-in of consumer goods. To curb shoddy products and false advertising, he suggested building a full-chain traceability system for quality glass and encouraging enterprises to provide product liability insurance.

Improving standards to facilitate the development of construction industry

Yuan Silang, Deputy to the NPC

Housing development is shifting from quantity-oriented expansion to quality improvement. Yuan Silang, Secretary of the Party Committee and Chairman of the Board of China MCC22 Group Co., Ltd., noted that issues including the absence of standards for stilt floors and inconsistent rules for floor area calculation have constrained further upgrades to residential quality.

To address these challenges, he proposed refining national standards and optimizing the coordination of specifications, so as to enhance the scientificity, consistency and operability of the high-quality housing standards system. Firstly, clarifying the attribute of stilt floors, appropriately reducing floor-area-ratio included area, balancing the interests of developers and residents, unifying measurement and regulatory rules, and supporting the delivery of high-quality residential buildings. Secondly, establishing vertical design standards and promoting the inclusive application of advanced technologies. Thirdly, unifying floor area calculation criteria to ensure clear and transparent property rights. Fourthly, standardizing the definition of usable floor ratio and safeguarding fair and credible market order.

On food and agricultural products

Boosting standards development for effective components in food

Zhu Shuifang, Member of the CPPCC National Committee

In the view of Zhu Shuifang, Chief Scientist at China Academy of Quality and Inspection & Testing, the genuine development direction of the food industry lies in researching the nutritional values and key components of food. He called on manufacturers, distributors and regulatory departments to jointly establish an indicator system and quality standards for active ingredients in food.

Existing laws and regulations, including the Product Quality Law and the Food Safety Law, lack clear labeling provisions for product authenticity and active ingredient content. To address this challenge, he suggested incorporating product authenticity and quality grading into the national credit system, establishing a labeling management system covering the entire industry, and developing classification and grading standards with the leading efforts of industry associations.

He also expected to introduce a series of technically sound quality grading standards that can accurately reflect product quality levels. Only by establishing a market mechanism that ensures better goods with higher prices can the food industry achieve sound and sustainable development.

Establishing standards system for *baijiu* in international organizations

Liang Jinhui, Deputy to the NPC

Based on the current realities of the brewing sector, Liang Jinhui, Chairman of the Board of Gujing Group, put forward proposals focusing on four directions.

Firstly, systematically protecting time-honored *baijiu* brewing techniques and related cultural heritage to explore the connotations and value transformation of liquor culture. Secondly, accelerating digital and intelligent upgrading to drive technological innovation and quality improvement. It is suggested to develop a unified digital standards system to advance the optimization and upgrading of the *baijiu* industrial chain. Thirdly, developing an international standards system for Chinese *baijiu* and setting up a national working group for the advancement of relevant standards, so as to establish a standards system for Chinese *baijiu* within international organizations including ISO and CAC. Fourthly, establishing a cross-departmental coordination mechanism to coordinate key issues concerning standards development, cultural protection and market expansion in the *baijiu* industry, removing obstacles to the high-quality development of the sector.

Raising standards for edible oil safety

Yu Ziwen, Deputy to the NPC

Yu Ziwen, Chairman of the Board of Hunan Xiang Jia Animal Husbandry Co., Ltd., stated that the quality and safety of edible vegetable oil are directly related to food safety, livestock and poultry production safety, and public health and security.

He suggested building a nationwide unified traceability, reporting and verification platform for edible oil, and implementing a management system featuring "one order, one code and one test report" for edible vegetable oil. He recommended conducting regular national-level risk monitoring, issuing timely early warnings and revising relevant standards to consolidate the bottom line of food safety and agricultural production safety.

He also suggested establishing a rapid identification indicator system for gutter oil, improving mandatory safety standards for edible vegetable oil, strengthening grassroots regulatory capacity and rapid testing equipment deployment, as well as tightening law enforcement and supervision.

Improving standards system for prepared dishes

Wang Honghong, Member of the CPPCC National Committee

In recent years, the growing variety and market size of prepared dishes in China have sparked widespread public attention. Wang Honghong, Vice Chairman of the Jiangsu Provincial Committee of the China Democratic League, noted that the standards system for prepared dishes in China remains in the initial stage. Existing standards are mostly concentrated in the production and processing stage, which has led to uneven product quality in the market and fails to keep up with the pace of the industrial development.

To this end, she suggested that a market-aligned standards system covering the entire industrial chain should be established. Targeted product standards and quality requirements should be developed for different categories of prepared dishes. She also proposed establishing a multi-stakeholder standards development mechanism and a dynamic revision mechanism.

She further recommended establishing a quality traceability system for prepared dishes, incorporating standards implementation status into enterprise credit evaluation. She also called for building a standards information sharing platform, ensuring full industrial coverage of regulation and effectively safeguarding public food safety.

编译/靳吉丽

(Edited and translated by Jin Jili based on the reports in Chinese)

Standardization and Science and Technology Innovation Development Forum held in Beijing

2026标准化与科技创新发展论坛在京举办

By Jin Jili
文/靳吉丽

As a part of the 2026 ZGC Forum, the Standardization and Science and Technological Innovation Development Forum was held on March 26 at the Zhongguancun International Innovation Center in Beijing, which was hosted by the Beijing Municipal Administration for Market Regulation.

Deng Zhiyong, Vice Minister of SAMR and Administrator of SAC, Tang Wenhong, Vice Mayor of Beijing Municipal People's Government, and Sergio Mujica, Secretary-General of the International Organization for Standardization (ISO), attended and addressed the forum.

As the new round of technological revolution and industrial transformation is accelerating, standards have become a key factor in the profound adjustment of the global innovation landscape and industrial layout. It is imperative to improve the mechanism for transforming innovative achievements into standards, accelerate the application of sci-tech outcomes and the iteration and upgrading of products, and advance the integrated development of the innovation chain, standards chain and industrial chain.

Photos of this column are provided by the Standardization Division of Beijing Municipal Administration for Market Regulation.

Efforts shall be made to strengthen the standards for the modern industrial system: enhancing the standards development in emerging industries such as integrated circuits, aerospace and low-altitude economy; optimizing the standards layout in future industries, including quantum technology, embodied intelligence, and brain-computer interfaces; promoting the quality improvement and scope expansion of service standards.

It is also essential to deepen international cooperation and exchanges on standards, vigorously implement measures for steadily expanding the institutional opening up of standards, and facilitate the alignment and compatibility of domestic and international rules, regulations, management practices and standards, thereby advancing extensive consultation, joint contribution and shared development through the soft connectivity of standards.

The event was attended by representatives from relevant municipal departments and district governments of Beijing, and market regulation departments of Tianjin, Hebei, Shanxi, Inner Mongolia and other regions, as well as experts from renowned standardization research institutions, industry associations, enterprises and universities.

During the forum, Gao Niandong, Director-General of the Beijing Municipal Administration for Market Regulation, announced the achievements of standardization development in Beijing during the 14th Five-Year Plan period (2021–2025) in the following four aspects.

Firstly, the influence of capital standards has been greatly enhanced. During the 14th Five-Year Plan period (2021-2025), Beijing added 54 secretariats and 55 chair/vice-chair positions of the technical bodies in ISO and IEC, ranking the first nationwide. The city led and participated in the development of over 500 ISO and IEC international standards in this period. It has also led the development of the world's first international standards in stem cell data, industrial 5G and other fields. With 64 secretariats of national standardization technical bodies newly established in Beijing, it has led the development of over 6,000 national standards, contributing to building China's strengths in science, technology and quality.

Secondly, the distinctive standards systems have been further improved. Beijing issued 24 standards systems in key fields, basically forming an all-round standards support layout covering urban planning and construction, operation and management, green development, public services, rural revitalization and other areas. A total of 1,299 local standards were developed and issued during the 14th Five-Year Plan period, a 39.5% increase compared with the previous five years. Also, 53 harmonized standards in the Beijing-Tianjin-Hebei region were released, together with the rapid development of serial standards for special projects on energy conservation, water conservation, public safety, and garden cities, injecting strong impetus into the city's sustainable development and refined governance.

Thirdly, the market innovation vitality has been constantly stimulated. A total of 70 national-level standardization pilot projects were launched in fields such as high and new technology, intelligent manufacturing, and services, along with 16 municipal-level standardization pilot projects in elderly care, cultural tourism and other sectors, fostering a vibrant market-driven standards ecosystem. Over 45,000 association standards were developed and issued by social organizations in Beijing, including over 3,000 ones issued by over 110 technological innovation alliances. In addition, 287 association standards application and demonstration projects were selected as the National Top Hundreds of Association Standards Application and Demonstration Projects by the Ministry of Industry and Information Technology, and 28 association standards in fields, such as new generation information technology and blockchain, were adopted and converted into voluntary national standards, providing the standardization path for the high-quality development of relevant industries.

Fourthly, policy support has been further strengthened. Beijing issued and implemented regulations and policies, including the Capital Standardization Development Outline 2035, the Measures for Standardization in Beijing, and the Action Plan for Empowering the Integrated Development of Sci-tech Innovation and Industrial Innovation with Standards in Beijing (2025–2027), making the policy framework steadily improved. The coordination mechanism of the Capital Standardization Committee was vigorously strengthened with members expanded from Beijing, Tianjin, and Hebei to five regions in North China. Municipal and district-level standardization subsidies totaling 156 million yuan were provided for the advanced standards development, overseas demonstration and application of Chinese standards, and the establishment of technical organizations.

In addition, an MoU was signed by the British Standards Institution (BSI) and the Beijing Association for Standardization, represented by Tatiana Schmollack-Tarasova, Managing Director of Greater China, BSI, and Yao Ping, President of the Beijing Association for Standardization. The two sides reached consensus on standardization training, conformity assessment and other aspects, and expected to carry out in-depth cooperation to advance the high-quality standardization development in Beijing.

Standards are the essential drivers for development

The ISO system is composed of three main pillars: ISO members, experts, and ISO Central Secretariat. We have nearly 800 technical committees and around 50,000 experts creating our standards on a daily basis. We work in a transparent manner. We work with inclusivity, inviting everyone to our table, even those who disagree with us. We also enable the participation of developing countries. In our vision, we believe that through our standards, we can make people's lives easier, safer, and better. This is fully aligned with the sustainable development goals (SDGs) of the United Nations.

When we talk about capacity building in developing countries, it is not about charity, but about effectiveness. We cannot be an effective organization if we do not ensure that developing countries have a voice. The World Development Report 2025, a flagship report of the World Bank, recognized with all clarity that we need to do more, because developing countries are still underrepresented in the creation of international standards.

The good news is that ISO has a very concrete strategy to provide capacity building to developing countries. We were very visionary when we created the DEVCO in 1961. And we have been consistently providing this capacity building with the help of many organizations, including those from China. That is about the contribution of standards to economic and social development.

Now, what are some of the key trends that we are observing in standardization? The first one is sustainability, which is very important and also aligns with the ISO strategy. Our standards can support the implementation of the SDGs. That is why ISO has created a partnership with the UNDP to co-create a standard that will support the participation of any kind of organization in integrating the SDGs with their daily activities. We are creating the very first management standard on SDGs.

The second one is climate change. It is not a threat in the future. Unfortunately, it is a reality that is happening today. Standards are essential to address these challenges. We are very busy working on a standard on net zero under the leadership of the U.K. We are also working together with the GHGP to create a single harmonized standard on carbon accounting, which is very important as well.

The next one is AI. It is predicted that around 30% of efficiency can be achieved through AI right now, and it is anticipated that over 70% of companies will use AI to support their activities in the next three years. But at the same time, we are very aware of the risks associated with AI. That is why we need standards to provide the guardrails as well as the proper governance of AI. We are working together with the IEC. We have a joint technical committee, and we have also created the very first management standard on AI. In the area of cybersecurity, we are more and more dependent on AI technologies. That means that the risks are even higher. We also have management standards to address cybersecurity in any organization. It sets risk-based approaches where we have the right tools to address those risks.

In a nutshell, standards are the essential drivers for development. They build trust, which is very important in the current context, even in the geopolitical context. What we bring to the table is trust, and then the importance of bringing developing countries to the conversation, so that they have a meaningful voice.

Shu Yinbiao
Academician of the Chinese Academy of Engineering (CAE), the 36th President of IEC, Advisor of State Grid Corporation of China

International standards lead the integrated development of scientific & technological and industrial innovation

International standards are a key element in achieving the integrated development of scientific and industrial innovation. This integration is the fundamental path for developing new quality productive forces. The relationship between scientific and industrial innovation is transitioning from a traditional linear transformation to a more tightly coupled structural integration.

International standards provide leading and strategic support for this integrated development. Taking 6G communication technology as an example, at the early stages of R&D, the global industry sector and scientific innovation entities discussed and defined a series of technical indicators, spectrum rules, and network architecture requirements within international platforms such as the International Telecommunication Union (ITU) and the 3rd Generation Partnership Project (3GPP). Together, they planned a roadmap for technical evolution, demonstrating the leading and driving role that high standards play in technological development.

Pathways and practices of international standards empowering China's scientific and industrial innovation. China is a significant participant in the development of international standards and a contributor to them. By the end of 2025, China held 104 chair and vice-chair positions and 101 secretariats within ISO and IEC technical bodies. The country has more than 14,000 experts registered with international standards organizations and has led the development of over 2,000 international standards.

In 2005, China initiated the establishment of TC 115 on High Voltage Direct Current (HVDC) transmission for DC voltages above 100 kV and TC 122 on Ultra-High Voltage (UHV) AC transmission

systems within the IEC, contributing China's UHV technological achievements to international standards. For instance, an HVDC project in Brazil applied eight IEC standards led by China, which facilitated the export of high-end domestic power equipment. By leading the development of international standards, the State Grid Corporation of China has achieved the "going global" of the entire value chain of Chinese technical equipment standards and services.

International standards support the rapid development of China's strategic emerging industries. In 2010, China led the preparation of the IEC white paper on grid integration of large-capacity renewable energy sources and use of large-capacity electrical energy storage. Subsequently, in 2013, China initiated the establishment of IEC/SC 8A, *Grid integration of renewable energy generation*. This subcommittee has systematically carried out the development of international standards in the field of new energy, providing vital support for building international cooperation networks and integrating global industrial chain resources.

Chinese experts have been deeply involved in the revision of IEC standards for electric vehicle (EV) charging. By independently developing "ChaoJi", the next-generation DC charging technology, China successfully solved the challenges of safety and compatibility in high-power charging, ultimately facilitating the rapid transformation of this technology into IEC international standards. By leveraging high-quality association standards, China also introduced its domestic charging roaming service practices to the IEC 63119 series, *Information exchange for electric vehicle charging roaming service*, providing a technical framework for the global interconnectivity of charging facilities.

As the current round of technological revolution and industrial transformation accelerates, the leading role of international standards in industry has become even more prominent. To this end, several recommendations are proposed. First, improve the "technology-standard-industry" integrated collaborative development mechanism, strengthen the synergistic effects of National Quality Infrastructure (NQI) elements, including metrology, standards, inspection and testing, as well as certification and accreditation. Second, deepen international cooperation and consensus building in key areas, enhance international collaboration in critical sectors to jointly develop and share high-quality international standards. Third, build a standardization ecosystem "led by government, centered on enterprises, and grounded in talent," encourage increased investment from enterprises in standardization work, establish professional teams and funding guarantee mechanisms, and cultivate multidisciplinary talent who understand technology, are proficient in rules, and excel at communication.

Tatiana Schmollack-Tarasova
Managing Director of Greater China, British Standards Institution (BSI)

How international standards support the global development of Chinese enterprises

BSI is a founding member of ISO. Many international standards, such as ISO 9001, ISO 45001, ISO 55001, and ISO 37001, were originally British standards before becoming international. China's adoption of these standards is remarkable. Currently, there are more than 2 million active certificates in China alone, showing that Chinese organizations are actively using international best practices in their processes.

The role of standards is changing rapidly. In 2023, ISO and IEC launched a joint initiative on "smart standards" to accelerate the digital evolution of international standards and make them more accessible, especially to developing nations. SMART stands for Searchable, Machine-readable, Accessible, Readable, and Transferable. Digitalization will improve accessibility, usability, and efficiency. BSI is involved in two pilot projects: one on smart transformation API processes, and the other on medical devices and AI—an area where China is taking a leading role.

BSI helped create the ISO Net Zero Guidelines (IWA 42:2022), involving 1,200 organizations from over 100 countries. We are now chairing the ISO committee to develop a formal Net Zero Standard, which is planned to be published in 2026.

Technology moves faster than traditional standardization. To address this, BSI has introduced "Flex"—a faster standardization platform. The Flex helps stakeholders develop a standard quickly when no active development exists. It can also become a pathway into European or international standards. In 2025 alone, we published many meaningful Flex standards, including: publicly available charging sites for EV manufacturers; maintenance protocols for hydrogen fuel heavy-duty vehicles; minimal risk maneuvers for automated vehicles; U.K.-specific compliance means for aircraft systems. All information about the Flex is available on our website.

My suggestions for the future are as follows:

1. Open collaboration. Continue facilitating the participation of all nations in ISO, IEC, ITU, and other global platforms. Chinese innovators should lead more working groups and steering committees.

2. Joint initiatives. Fund pilot projects with international partners to solve large-scale problems. Standards emerging from such projects will have multi-stakeholder buy-in from the start, creating a positive narrative of China solving global challenges with the world.

3. Reframe the message. Standards are often seen as obstacles. Instead, we can frame them as enablers: faster charging, safer roads, affordable EVs, circular economy. China leads in electric vehicles—this is an opportunity to position Chinese technology as a vital tool to achieve the UN SDGs and climate goals.

4. Data-driven demonstration. Run large pilot projects in overseas markets to collect real data, such as accident reduction in autonomous driving zones or carbon reduction in cities with high EV penetration. This "soft power" demonstration helps standards sell themselves, reduces barriers, and builds bottom-up pressure for regulation.

5. Sensitive areas (cybersecurity, data security). Adopt trusted, internationally recognized frameworks. This respects national security policies while turning blind market access barriers into negotiated, calm discussions.

China is no longer a student in international standardization, as it was 30 years ago. China is a peer, a teacher, and a very strong contributor in many areas. Together, we can usher in a new era of global innovation.

Wang Haizhou
Academician of the Chinese Academy of Engineering (CAE), Professor of China Iron & Steel Research Institute Group Co., Ltd. (CISRI)

Quality infrastructure empowers the deep integration of scientific & technological and industrial innovation

Standardization serves as the foundational carrier in the paradigm of transforming innovation achievements. **To address whether scientific innovation needs to be, can be, or should be standardized, we explore the following three core theories.**

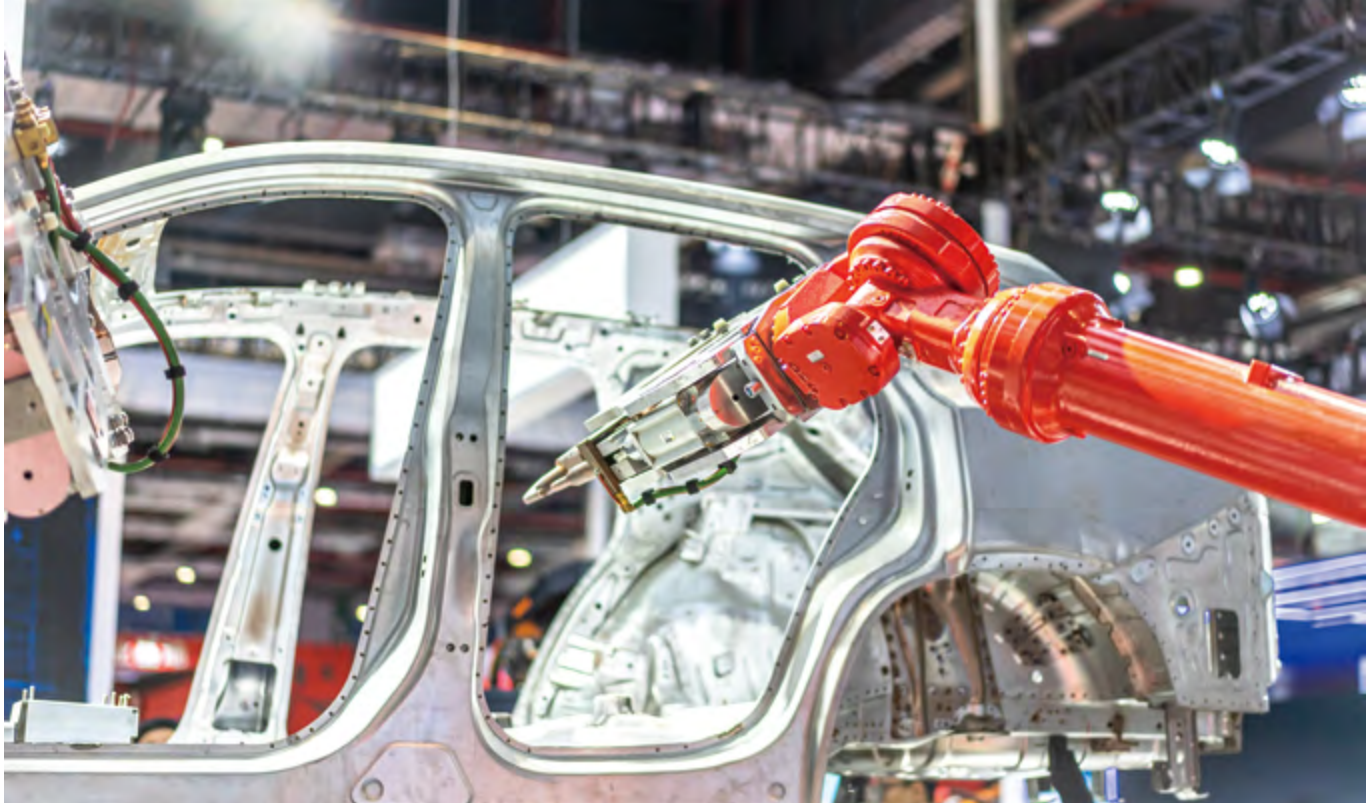
1. Standardization Entropy Reduction Theory: it reveals that the essence of standardization is to form a stable and orderly dissipative structure. This provides the theoretical basis for standardizing scientific research and supports the construction of a scientific innovation standardization system.

2. Standardization Multi-dimensional Matrix Structure Theory: it illustrates the integration of multiple disciplines, technologies, and scenarios. It lays the groundwork for matrix-based standardization and supports advanced cross-industry systems.

3. Standardization Multi-element Interwoven Chain-network Configuration Theory: it centers on various nodes within the industrial chain to form a chain-network configuration. This supports the serialization of standards and the construction of global conformity assessments.

The combination of "source standardization" (origin-based) and "process standardization" forms a complete system, which guarantees that every field of scientific research has standards to follow, making processes rigorous and traceable, and ensuring results are authentic and valid.

Conformity assessment is an important pathway in modern industrial practice for embedding problem-oriented innovation into the transformation of standardization outcomes. It promotes the deep integration of scientific and technological innovation with industrial innovation, and enables leapfrog, high-quality development of industries. The foundational quality mechanism for



innovation-driven, high-quality development of modern industrial chains lies in the coordinated advancement of all elements within the chain. This is driven by the integration of four key "chains": the innovation chain as the embedded driver, the standardization chain as the foundational carrier, the data chain as an effective support, and the industrial chain as the vehicle for quality upgrading. Together, these form a full industrial-chain quality infrastructure that supports development, ultimately generating new quality productive forces and facilitating high-quality innovation within modern industrial systems.

The technical pathway for achieving innovation-driven, high-quality development in modern industrial chains should follow several principles: rationality in research and design, stability in production processes, conformity in product quality, and suitability in service performance. On this basis, the implementation path for high-quality development lies in comprehensive, domain-wide professional conformity assessment. Guided by such an approach, conformity verification should be conducted at all nodes of the industrial chain using a matrix-based mapping model built on the fundamental unit of "objectives—standards—data—quality." This enables the establishment of conformity assessment at each node, and subsequently a systematic evaluation across all nodes in the entire industrial chain. Through this process, the effectiveness of new quality productive forces and improvements in total factor productivity can be achieved.

Overall, the mechanism by which domain-wide conformity assessment and the integration of the "four chains" facilitating the transformation of scientific and technological achievements operates as follows: domain-wide conformity assessment identifies problems at each node of the industrial chain; standards for these problems are developed through technological innovation and standardization; data are then generated based on these standards; through the embedding of the standardization chain and data chain into the industrial chain, deep integration of technological and industrial innovation will be achieved. This ensures that objectives, standards, data, and quality are fully aligned across all nodes of the entire chain, thereby enabling the effective transformation of innovation, upgrading the quality of the industrial chain, and ultimately forming new quality productive forces.

Luis Jorge Romero
CSO of Comentropy Industry and Standards Innovation Service Center, former Director-General of European Telecommunications Standards Institute

Standardization: Empowering international cooperation and expanding outreach

Standards are a great platform, and a tool of globalization. Standardization work is about words that are common and reusable. Some people may think that it takes too long to develop standards, but that is not the truth. As for standards development, we need to avoid repeatability, safeguard product quality, expand markets, reduce costs, and strengthen the supply chain, which is fundamental and complicated.

Confronted with some common issues, we all have great ideas, some of which may be similar to others' solutions. If we come up with our own solutions to each issue separately, it will be a huge waste. Why don't we simply get in a room and work together? We don't have to start from scratch or reinvent the wheels. Standardization helps us achieve the cycle from technology to standards, then to industry, and back to technology.

When you talk about levels of quality, especially when you talk about safety, I am sure that most of our governments have attached great importance to those standards. There are many countries putting very stringent requirements on the quality and security of products. However, if each country tries to develop standards on its own, it will be a very heavy work. In fact, most of us have a shared understanding of the minimum levels. So let's get the world together, which is what standards are trying to achieve. Let's get a single common solution that helps us all.

As much as we contribute, as much as our influence will be in the final solutions. If we are enlarging the marketplace, we will get bigger volumes. Bigger volumes mean that production costs will be decreased. So the more we go international, the better for every stakeholder.

Dou Baoxin
Chairman of China Railway Electrification Engineering Group Co., Ltd.

Standards make life better —Practice and inspiration of Jakarta-Bandung High-Speed Railway in implementing ISO Strategy 2030

Standards are not isolated technical provisions. They are a common language connecting the world, and a vital carrier to serve human's common welfare, which echoes the ISO Strategy 2030 and the UN SDGs.

In the Jakarta-Bandung High-Speed Railway project, we have always adhered to the tenet that it is not about "my standards," it is about jointly building "our standards system." Indonesia is located in the Pacific Ring of Fire, with a hot and rainy climate throughout the year. The unique geographical and climatic environment poses challenges to the electrification system of high-speed railways. Rather than simply applying the existing solutions, we have developed a systematic solution that suits local conditions, which can be further promoted through standardization means as a mature technological achievement.

The construction of the railway has referred to over 800 standards, integrating global advanced technical practice and applicable requirements. Among them, more than 210 international standards have been adopted, covering general fields such as basic terms, environmental conditions, electronic compatibility, and safety requirements; over 70 advanced standards of cooperative countries have been referred to in professional fields including material performance and experimental methods; over 500 Chinese standards for high-speed trains have been integrated, covering the full chain of survey and design, equipment manufacturing, construction and installation, operation, and maintenance.

Standards are an accelerator that releases economic potentials and benefits all parties. In this process nearly 600 Indonesian technical professionals for high-speed railway have been trained. The railway has effectively stimulated the coordinated development of upstream and downstream industries, with local procurement of over 5 billion yuan; it has increased the GDP contribution rate of the region along the railway by approximately 0.5% and created over 3,000 new jobs.

Standardization supports the "vehicle-road-cloud integration"

Xu Hongwei
Deputy Executive Director of Beijing Municipal Office for Collaborative Development of Smart City Infrastructure and Intelligent Connected Vehicles

Many countries around the world are preparing for intelligent connected vehicles by issuing acts or carrying out commercial demonstration projects. The smart city infrastructure twins intelligent connected vehicles, and standards serve as the main thread from the "vehicle-road-cloud integration" construction to application scenarios of data.

Initiated in September 2020, the Beijing High-Level Automated Driving Demonstration Area is the world's first "vehicle-road-cloud integration" high-level autonomous driving demonstration zone. Adhering to national and industrial requirements on intelligence and connectivity, and directed by SAMR, a "vehicle-road-cloud-network-map" safety standards system has been established. A standardization working platform coupling the government and industry together has been established as well, which has generated over 80 deliverables, including standards of the demonstration area, association standards, sectoral standards, local standards, national standards, and international standards.

The roadside infrastructure includes intelligent perception equipment such as cameras, millimeter-wave radars, and edge computing devices, which needs unified standards for the "vehicle-road-cloud" integration construction. It covers the entire process of design, construction, and operation and maintenance, and enables devices from different manufacturers to function in the same way, laying a solid foundation for future large-scale promotion.

The demonstration area currently focuses on five key directions that underlie the smart city infrastructure and intelligent connected vehicles: autonomous driving services, intelligent signal control, urban safety management, urban operation scheduling, and urban comprehensive governance. These five directions support each other under the same standards system. For instance, data from autonomous driving can be fed back to the signal control system in real time as the basis for traffic light allocation, forming a closed loop. A standard for a unified data format is being promoted to establish a data circulation system, with the world's first dataset for vehicle-road collaboration already released.

Tang Jian
CTO of Beijing Humanoid Robot Innovation Center Co., Ltd.

Standardization promotes industrialization and large-scale implementation of humanoid robots

Some professional agencies see a promising outlook for humanoid robots. Morgan Stanley Research estimates the market is likely to reach $5 trillion by 2050, plus related supply chains as well as repair, maintenance, and support. There could be more than 1 billion humanoids in use by 2050.

More than 20 humanoid robots debuted at the World Robot Conference in 2024. Merely a year later, many enterprises have achieved small-scale production, with the rapid development of motion control technology. Though new technologies and products spring day by day, there are still many problems.

First, there is a lack of safety assessment standards, and a shortage of authoritative certification, leading to a low level of market trust.

Second, the interfaces are not unified, especially the hardware interfaces and software interfaces. With poor compatibility of components, the integration cost is relatively high. Also, the general technical route is rather scattered and lacks unified standards.

Third, the most crucial issue is data silos. Collaboration across robots is rather difficult, and data sharing across the entire industry has not been achieved yet, resulting in a fragmented ecosystem.

Standards serve as a common language that connects the upstream and downstream of the industrial chain. It is a crucial link in driving the humanoid robot industry from a single breakthrough to systematic integration and large-scale implementation.

Based on top-level design and regional practice, China is working on a leading standards system for humanoid robots and embodied intelligence. SAC/TC 591 on robotics has established the working group on humanoid robots, and released the white paper on standardization of humanoid robots. The Ministry of Industry and Information Technology has established a standardization technical committee for this hotspot, and put forward the top-level design of standards for the whole industrial chain and full lifecycle of humanoid robots and embodied intelligence.

编译/靳吉丽 曹欣欣 方洛凡
(Edited and translated by Jin Jili, Cao Xinxin, Fang Luofan)

European standardization supports new legislative cybersecurity landscape

—The 10th Cybersecurity Standardization Conference successfully held

欧洲标准化工作为新网络安全立法提供支撑
——2026欧洲网络安全标准化大会成功召开

By Cao Xinxin, Jin Jili and Fang Luofan 文/曹欣欣 靳吉丽 方洛凡

The 10th Cybersecurity Standardization Conference, co-hosted by the European Standardization Organizations (ESOs), CEN, CENELEC, and ETSI, together with the European Union Agency for Cybersecurity (ENISA), took place in Brussels, Belgium, on March 12, 2026. The annual conference was held in a hybrid form, attracting participants from government, industry, academia, NGOs, and enterprises in particular SMEs to discuss the evolving European cybersecurity landscape. The conference has become an important platform for stakeholders to have dialogue, helping shape the role of standards in strengthening the cybersecurity framework in Europe.

This year's conference, themed "European standardization supporting a new legislative cybersecurity landscape," discussed the current situation of the global standardization ecosystem, the legislative proposals and their impact on standardization, updates on the Cyber Resilience Act (CRA), interplay of CRA with other legislation and its impact on standards, and the future of the EU standardization. The event aimed to facilitate communication and collaboration among stakeholders to help standards better support legislation and cybersecurity.

Challenges and opportunities for the EU standardization activities

The opening session explored the position of European standardization in the global ecosystem, and discussed the opportunities and challenges faced by European standardization. Martin Chatel, Chief Policy Officer of ETSI, Apostolos Malatras, Team Leader for Knowledge and Information Team at ENISA, Cinzia Missiroli, Acting Director General at CEN-CENELEC, and Raluca Stefanuc, an officer from European Commission, participated in the panel discussion. Sławomir Górniak, an expert from ENISA, gave a presentation titled "ENISA cybersecurity standards observatory."

Speakers explored how standards contribute to strengthening Europe's influence and enhancing cybersecurity resilience in an increasingly complex technological and geopolitical environment. Although there was a call on ESOs to prioritize speed and increase the agility of the standardization system, panellists agreed that the consensus-based quality that European standards have relied on for decades should not be compromised.

A few interesting online surveys were carried out during the session. For example, one question was: Are you optimistic or pessimistic about the state of play of European cybersecurity standardization? Most of the answers were optimistic. Martin said, "We have to be optimistic, and we should not lose sight of the very essence of standardization."

Cinzia Missiroli was also very optimistic. She said, "We have engaged very much with the European Commission to understand the expectations and needs of the legislators at the very beginning of the process. For us, this is key to deliver useful standards. We have to have dialogue with legislators to see how and if our processes and procedures need to be adapted and aligned to meet the expectations."

Talking about the importance of standardization, Martin said, "Standardization is to develop technical specifications for interoperability and security with the global dimension. So it is important to uphold the principles of governing standardization of openness, independence from special interests, and non-discrimination, so that all stakeholders can be involved and contribute to technical alignment."

Landscape of legislative proposals and their impact on standardization

At the beginning of the second session, Jean-Pierre Quémard, CEO of KAT and board member of the Alliance pour la Confiance Numérique (ACN), gave a presentation to expound on the cartography of European standardization, which includes the Cybersecurity Act (CSA), CRA, NIS2 for network and information systems, AI Act, Data Act, Digital Services Act (DSA), and EU Cybersecurity Certification Scheme on Common Criteria (EUCC).

He highlighted several problems as follows. Given that there are so many topics, there is a lack of standardization experts. The emerging TCs must have a clearly defined scope to avoid overlapping and contradiction, and coordination and liaison management has to be improved, since there are different technical bodies working in parallel.

Jakub Dysarz, PL Permanent Representation to the EU, Constant Kohler from Siemens, Thomas Stubbings from Cyber Trust Services, and Kim Nordström, Technical Officer for ETSI Technical Committees and Industry Specification Groups, joined the discussion.

The fine art of producing harmonized standards is that it is a standard where we translate the legal requirements into technical requirements that are linked to a specific piece of legislation, said Kim Nordström.

With EU legislation, we aim to increase the cybersecurity posture of European organizations, said Thomas Stubbings, who focuses on baseline security. We need something more structured to give those smaller suppliers the possibility to give evidence of their cybersecurity posture, and have lower barriers to market access.

The attendees discussed the balance between high regulatory ambition and the need to keep implementation manageable for industry, especially for SMEs, and other topics such as harmonized standards, conformity, and flexibility of regulation.

Standards for the Cyber Resilience Act—a gamechanger for European cybersecurity

The CRA entered into force on December 10, 2024 in the EU. To support its implementation, this session focused on the progress, challenges and other key issues concerning the development of CRA standards.

Camille Dornier from the European Commission (EC) gave a presentation on the assessment of CRA harmonized standards. Horizontal standards are not product-specific, so they can be applied to any kind of products listed in CRA Annex I, and vertical standards are specific product standards which cover all the important and critical product categories listed in CRA Annexes III and IV.

The standards for risk-based approach and vulnerability handling in the horizontal standards should be ready by August this year, all vertical standards should be ready by October this year, and horizontal standards covering every essential cybersecurity requirement should be ready by October next year. The EC is progressing well with over 30 standards on track through an internal assessment to ensure that these standards are technically and legally sound.

Sonia Compans from STMicroelectronics believed that the CRA was really a big challenge. Sandra Feliciano from ETSI TC CYBER EUSR found that it was complex and difficult to keep all standards on track considering the interoperability with these standards as well as the needs of the market, stakeholders, and the EC. Christophe Stenuit from VIEW CONCEPT believed that the implementation of CRA would raise maturity. Roland Atoui from Red Alert Labs took the CRA as an opportunity to collaborate with stakeholders and authorities to align all on a certain baseline level of security.

Concerning how we were doing with the CRA, Sandra emphasized that the standards were very challenging this time. It has to do with the complexity and the diversity of standards, which require more time for consensus reaching. The on-site audience's votes showed that the industry was nervous because of the deadlines, and some people were worried about whether the standards would be delivered on time. Camille noted that the EC had achieved a lot and wanted to ensure no delays.

Regarding what we should be doing, the audience gave most of their votes to "more time for implementation." However, Christophe pointed out that we should not make the decision too early in the process. Sandra stated that "procrastination is universal, but it doesn't apply to the standardization community." Roland said that enterprises should start now instead of waiting. Sonia echoed and said that large companies have started, but SMEs maybe know nothing about CRA standards.

As for the key to wide, enthusiastic and effective adoption, Camille said that the standardization bodies were carrying out dissemination activities to reach the national markets, who encouraged more experts to get involved in standardization work. She emphasized that "the more experts we have, the better the quality and the result will be ultimately."

Way forward for the EU standardization

The final session focused on the future of EU standardization, which invited Eric Vetillard from ENISA to give a presentation, and Martin Chatel from ETSI, Omar Dhaher from DIGITALEUROPE, Andreea Gulacsi from CEN-CENELEC, and Rob van der Veer from OWASP for a panel discussion.

Eric introduced the ENISA work on certification schemes and the need for standards. ENISA has been working on certification for about five years with a great success. Now, there is one scheme out, which is called EUCC, and another four schemes in the pipeline focusing on cloud, 5G, digital identity wallets, and unmanaged security services.

He noted that some schemes started quite well but turned into a long marathon before they were adopted, and some schemes even had hurdles and got stuck. He found that each scheme was relying heavily on standards in different ways.

Regarding the vision for future standardization, Martin suggested building on the success stories of the European transition system and replicated across new and emerging ICT and digital technologies. Omar pointed out that the industry was still involved, but the result was a little disappointing. Andreea took the European system as a team sport, which is very strong but with a few cracks to be fixed. It needs to be more inclusive. Rob believed that one of the opportunities is to embrace more collaboration, such as open source communities, to get more people on the table.

As for great examples or best practices, Martin said the EU standards in the cybersecurity area were being adopted by big countries worldwide, which shows that Europe can lead in benchmarking global standards. The key ingredient for that success is an open system that is trusted, inclusive and non-discriminatory. Andreea believed that "consensus is a very strong asset of the system and open source is a new dynamic for CEN-CENELEC to collaborate with other SDOs." As a response to the audience's call for free standards, Omar thought that a universal fund should be set up to help migrate from a paid model to a free model in the next few years, but someone had to pay for it.

When asked "what we should invest in," the audience gave most of their votes to "mobilizing communities through liaison partnerships" and "collaboration across continents." Rob said he was happy with the outcome, because he saw a lot of opportunities. Meanwhile, he thought that the role of working groups was underestimated. Andreea agreed with Rob, but she stressed the importance of standardization education in companies. She called on that "let's not change the system as it is, but shift its importance where it deserves to be."

World Summit on the Information Society Forum 2026

July 6-10, Geneva, Switzerland

The World Summit on the Information Society (WSIS) Forum serves as the central multistakeholder convening platform mandated to advance the implementation of the WSIS Action Lines and support global digital cooperation. Anchored in the renewed UNGA mandate, the Forum brings together governments, the private sector, civil society, technical communities, academia, youth, and international organizations in a uniquely inclusive environment for dialogue, collaboration, and action.

WSIS Forum 2026 will take place from July 6 to 10 in Geneva. As the first forum convened after the WSIS+20 UNGA review, it will play a vital role in supporting Member States as they begin implementing commitments set out in the December resolution. The 2026 edition will feature an expanded High Level Track, strengthened ministerial participation, the WSIS Prizes 2026, thematic exhibitions, and a programme shaped through the Open Consultation Process.

For more information, please visit the event website: **https://www.itu.int/net4/wsis/forum/2026/**

Webinar "OpRa: a new transmodel-based exchange format for operational raw data"

June 25, online

This one-hour webinar is a presentation of the new CEN Technical Specification for the exchange format of operational raw data in support of the "observed data" category of the MMTIS EU delegated regulation.

The target audience of this webinar includes public transport authorities, public transport operators, national transport regulatory authorities, MMTIS data producers, and consumers.

For more information, please visit the event website: **https://www.cencenelec.eu/news-events/events/2026/2026-06-25-webinar-opra/.**

Workshop on "AI-Enabled Network Evolution: Cloud Native & AI Innovation for Telco Future"

June 24, Geneva, Switzerland

The ITU in joint collaboration with ETSI NFV is organizing a workshop on "AI-Enabled Network Evolution: Cloud Native & AI Innovation for Telco Future", which will take place on June 24, 2026.

The workshop will focus on:

·the integration of AI and telecom cloud/NFV based on the latest technological trends on telecom cloud architecture, network function orchestration, cloud-native and AI-native evolution.

·exploring standardization progress and industrial practices of AI-driven network transformation.

For more information, please visit the event website: **https://www.itu.int/en/ITU-T/Workshops-and-Seminars/2026/0624/Pages/default.aspx#.**

AI for Good Global Summit

July 7-10, Geneva, Switzerland

AI for Good is unlocking AI's potential to serve humanity. It is organized by ITU in partnership with over 50 UN Sister Agencies and co-convened with the Government of Switzerland.

The inaugural Global Dialogue on AI Governance, established under the recent landmark UN General Assembly Resolution A/79/L.118 on AI, and hosted by the UN Secretary-General with ITU's support, will be held back-to-back along the margins of the 2026 AI for Good Global Summit.

For more information, please visit the event website: **https://aiforgood.itu.int/summit26/.**

A preliminary study on microbial load quantification method and standardization in fermented foods based on microbial diversity absolute quantitative sequencing: A case study of Inner Mongolia traditional fermented vegetables (*lanyancai*)

基于微生物多样性绝对定量测序技术的发酵食品微生物负荷计量方法及标准化初探——以内蒙古传统食品“烂腌菜”为例

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Abstract: Traditional fermented vegetables (*lanyancai*) in Inner Mongolia are culturally significant fermented foods characterized by intricate microbial communities. However, the empirical traditional production methodologies frequently result in inconsistent product quality. Conventional high-throughput sequencing approaches, which generate relative abundance data, are inherently limited in their capacity to reflect absolute microbial biomass dynamics. This limitation obscures the distinction between quality deterioration attributable to “microbial community succession” and that driven by “total biomass over-accumulation.” To address this methodological gap, this study implemented the Absolute Quantitative Microbiome Profiling (aQMP), utilizing a spike-in normalization strategy to establish a metrological framework for microbial load quantification within this high-salt and high-acid fermented matrix. The data demonstrated the robust stability of this method, enabling precise quantification of total microbial load. Notably, while lactic acid bacteria maintained a dominant relative abundance throughout the process, samples exhibiting quality defects displayed a significant escalation in total microbial load—increasing approximately tenfold compared to samples at the standard fermentation stage. These findings suggest that product quality decline is primarily due to the uncontrolled proliferation of the total microbial biomass rather than the dominance of specific spoilage organisms. This study provides a scientific foundation for the standardized production and quality control of traditional fermented foods through absolute microbial quantification.

Keywords: absolute quantification; microbial load; spike-in normalization; traditional fermented vegetables; quality control; standardization

1. Introduction

Traditional fermented vegetables (*lanyancai*) are distinctive culinary specialties deeply rooted in the gastronomic heritage of Ordos in Inner Mongolia. Historically essential for winter sustenance in this semi-arid area, *lanyancai* is not merely a side dish but a culturally significant foodstuff characterized by a complex microbial ecosystem that governs its unique flavor and preservation. As interest in traditional ethnic ferments grows, ensuring the consistency and safety of this specific regional product has become a critical challenge. The quality of *lanyancai* is predominantly determined by the dynamic interplay of microbial communities during the fermentation process, making it an ideal model for studying traditional vegetable fermentation.

High-throughput sequencing has long been the cornerstone for microbial diversity analysis. While these

methods effectively reveal the relative abundance of taxa (i.e., who is there and their proportion), they inherently fail to quantify the absolute microbial load (i.e., how many are there in total). This methodological limitation presents a significant obstacle: it obscures whether quality deterioration is driven by a "shift in community composition" (e.g., spoilage organisms outcompeting lactic acid bacteria) or by the "over-accumulation of total biomass" (e.g., uncontrolled proliferation of microbes within a seemingly stable community)[1]. Consequently, distinguishing a "healthy" fermentation from a "spoiled" one based solely on relative abundance data remains scientifically ambiguous.

To bridge this critical gap in food microbiome metrology, this study introduces Absolute Quantitative Microbiome Profiling (aQMP) utilizing a spike-in normalization strategy. It is hypothesized that by establishing a precise quantification standard for total microbial load in this high-salt matrix, the specific role of biomass accumulation in product quality could be deconvoluted. This approach stands in stark contrast to traditional methods; whereas conventional sequencing merely reallocates percentages among taxa without revealing total biomass changes, aQMP provides a three-dimensional view of the microbiome by anchoring relative data to an absolute quantitative scale. This research aims to provide a scientific basis for the standardization of traditional fermented foods by shifting the paradigm from qualitative community analysis to quantitative biomass control.

2. Materials and methods

2.1 Sample collection and preservation

Homogeneous *lanyancai* samples (approximately 10 g each) were aseptically collected from three distinct households in Ordos City. To ensure their traceability and consistency, the samples were systematically labeled as S1 (Household Sample 1), S2 (Household Sample 2), and S3 (Household Sample 3). Immediately after collection, the samples were transferred into sterile, DNA-free 50 mL centrifuge tubes, sealed with parafilm to prevent contamination and water loss, and then rapidly frozen by packing in dry ice for transportation. Upon arrival at the laboratory, the samples were stored at −80℃ to inhibit microbial metabolic activity and preserve the integrity of the microbial community structure until DNA extraction.

2.2 Spike-in absolute quantification protocol

In this study, a strategy combining exogenous synthetic DNA spike-ins with high-throughput sequencing was employed to achieve absolute quantification of microbial communities[2]. The specific experimental procedures were as follows:

Introduction of exogenous standards (critical step): Prior to DNA extraction, 1×10^6 copies of synthetic "spike-in" DNA were accurately spiked into each sample. These exogenous sequences were rigorously designed to ensure no sequence homology with known plant or microbial genomes, thereby avoiding competitive interference with target amplicons.

DNA extraction and purification: An optimized kit specifically designed for complex matrices rich in polysaccharides, polyphenols, and plant DNA (typical fermented pickle samples) was utilized for nucleic acid extraction. Strict negative controls were implemented throughout the process to rule out contamination.

Library construction and sequencing: The V3-V4 hypervariable regions of the 16S rRNA gene were amplified using universal primers (Forward: ACTCCTACGGGAGGCAGCA; Reverse: GGACTACHVGGGTWTCTAAT)[3]. Subsequent paired-end sequencing was performed on the Illumina NovaSeq platform.

2.3 Data analysis

Data preprocessing and standard curve generation: Raw sequencing data were first processed using Trimmomatic[4] and Cutadapt[5] to discard sequencing adapters and primer sequences. Subsequently, all exogenous spike-in sequences were identified and filtered out via BLASTN alignment[6]. For each sample, a specific standard curve was generated by performing linear regression, plotting the logarithm of the theoretical spike-in copy numbers against the logarithm of the corresponding observed read counts.

Absolute abundance transformation: Based on the regression equations derived above, the relative read counts of all Amplicon Sequence Variants (ASVs) in each sample were converted into absolute copy numbers. This resulted in a species abundance matrix expressed in units of "copies/g."

Community profiling: Sequence denoising and ASV partitioning were conducted using the QIIME2 platform coupled with the DADA2 algorithm[7,8]. Taxonomic assignment was performed against the SILVA 138 database. Based on the absolute quantitative abundance table, downstream analyses were carried out, including alpha diversity, beta diversity, taxonomic composition, and functional prediction[9].

3. Results

3.1 Sequencing data quality and linear verification of standard curves

Sequencing yielded a total of 344,238 raw reads across the three sampling sites, as shown in Table 1. After rigorous quality filtering, denoising, and merging of paired-end reads, 343,830 high-quality non-chimeric reads were ultimately retained, with individual samples ranging from 95,072 (S3) to 128,905 (S2) reads. The high recovery rate (>99.8% of raw reads were successfully processed into non-chimeric reads) indicates excellent sample quality and stringent bioinformatic processing, providing a robust dataset for absolute microbial load quantification.

All standard curves for fermented vegetable samples

Sample ID	Raw reads	Clean reads (Non spike-in)	Denoised reads	Merged reads	Non-chimeric reads
S1	119,985	119,779	119,769	119,745	119,703
S2	129,084	128,944	128,942	128,933	128,905
S3	95,169	95,107	95,107	95,104	95,072

Table 1: Raw data of total microbial load across the three household samples

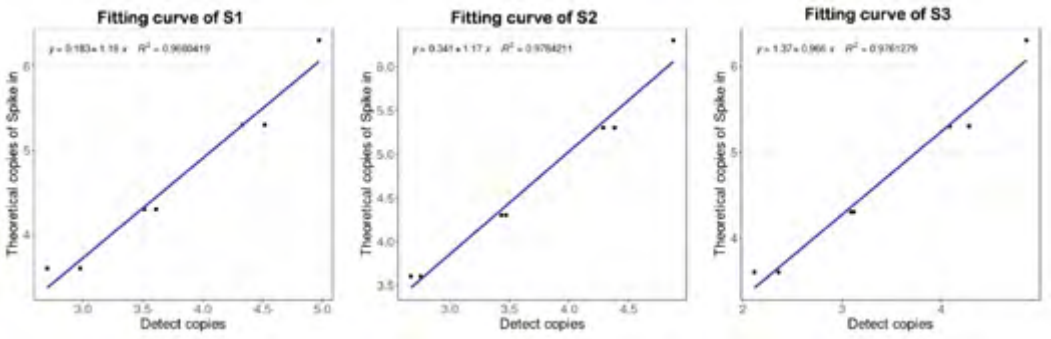

Figure 1: Standard curves for absolute quantification based on spike-in sequences

exhibited extremely high linear correlation (R^2>0.96), as shown in Figure 1. This indicates that despite the complex matrix of fermented vegetables (high salt, high acid), spike-in DNA remained stable throughout the extraction and amplification processes, demonstrating the feasibility of this method in fermented food testing.

3.2 Dynamic changes in microbial load between different household samples

Comparative analysis revealed significant heterogeneity in microbial diversity across the three household samples, as shown in Table 2. While all samples harbored microorganisms from two kingdoms, they differed notably in species richness at lower taxonomic levels. Sample S2 exhibited the highest biodiversity, containing the most species at every level from phyla to species, culminating in 201 identified species. Sample S1 showed intermediate diversity with 172 species, while Sample S3 was the least diverse, with 169 species.

This gradient of diversity (S2>S1>S3) suggests that the fermentation environment of S2 may be more conducive to supporting a wider variety of microbial life. In contrast, the lower diversity in S1 and S3 could indicate more selective environmental pressures or a less complex initial microbial community. These findings highlight that the differences between the samples extend beyond the total microbial load to include the complexity and composition of the microbial communities themselves.

3.3 Beta diversity and sample clustering

The Unweighted Pair-group Method with Arithmetic Mean (UPGMA) clustering based on Beta diversity revealed that samples S1 and S2 were the most closely related, while S3 showed significant divergence from the other two, as shown in Figure 2. This indicates that the microbial community composition in S3 is fundamentally different from that in S1 and S2.

Sample	Kingdom	Phylum	Class	Order	Family	Genus	Species
S1	2	17	29	53	80	126	172
S2	2	14	24	54	86	131	201
S3	2	13	20	45	74	117	169

Table 2: The microbial diversity across the three household samples

Figure 2: UPGMA clustering result

3.4 Species abundance clustering

ASVs' species abundance heatmap visualized the absolute abundance (Z-scores) of species across samples, as shown in Figure 3. Compared to S1 and S2, S3 showed significantly higher abundances of specific species, including *Klebsiella aerogenes*, *Enterobacter kobei*, *Acinetobacter lwoffii*, and various Lactobacillus and Pseudomonas species. Sample S3 was differentiated from S1 and S2 by the high abundance of specific species (e.g., *Klebsiella aerogenes*, *Enterobacter* spp.), which are often associated with uncontrolled fermentation or quality deterioration in such products.

3.5 Functional gene prediction

The COG functional analysis revealed distinct metabolic strategies and regulatory profiles between samples S1 and S2, despite the conservation of core cellular machinery, as shown in Figure 4. While fundamental processes such as translation, ribosomal biogenesis, and DNA replication remained statistically consistent across both samples, significant divergence was observed in metabolic and information processing pathways. Sample S2 exhibited a marked enrichment in genes associated with carbohydrate and nucleotide transport and metabolism, suggesting a

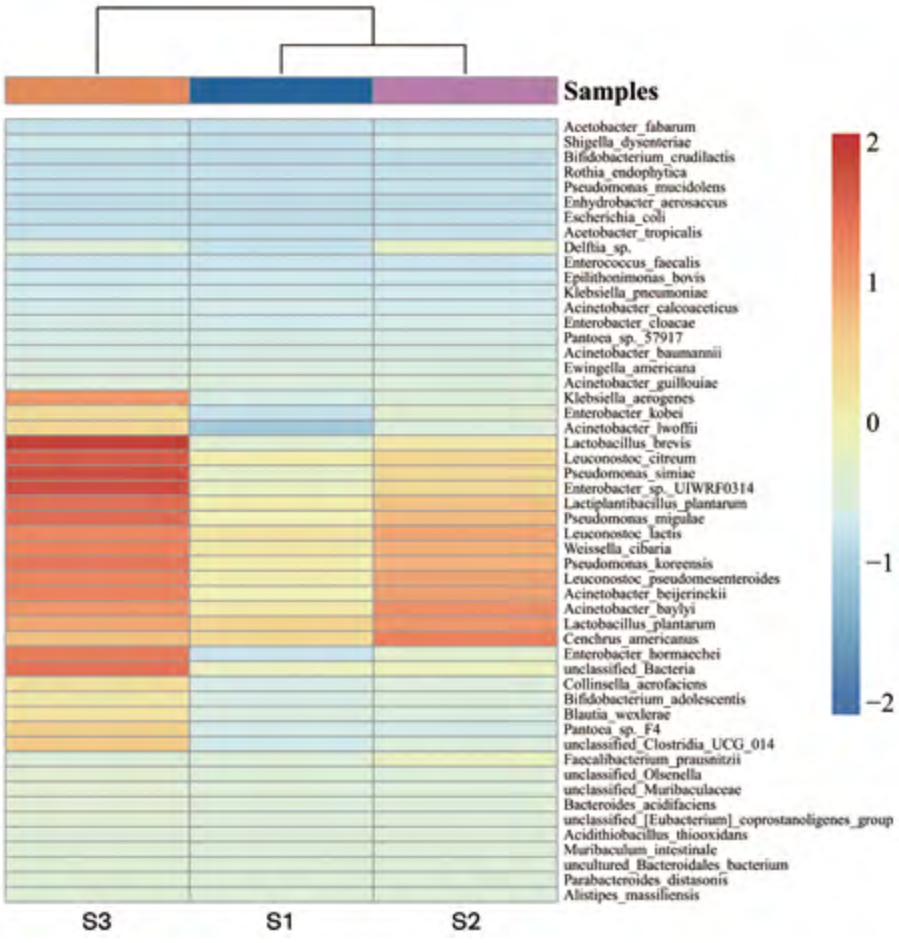

Figure 3: Species abundance of different samples

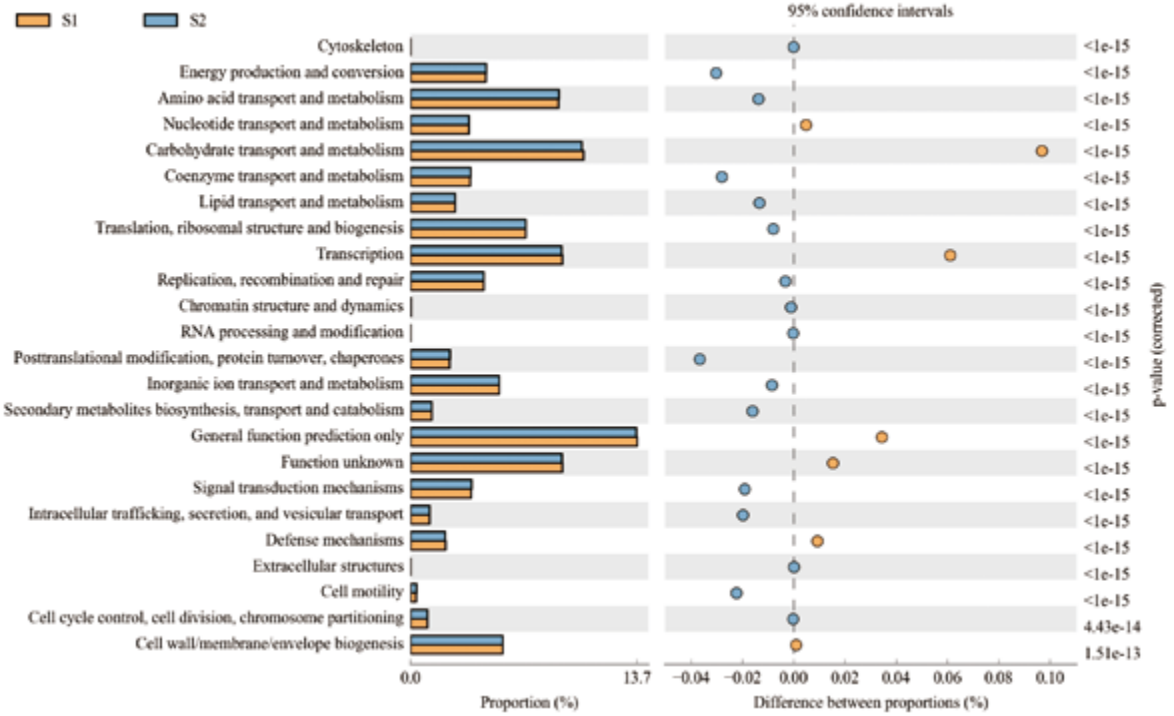

Figure 4: Result of COG analysis

genetic capacity optimized for rapid energy acquisition and growth, which correlates with the high microbial load observed in S3, a sample exhibiting signs of over-fermentation or quality deterioration. In contrast, Sample S1 displayed a significantly higher relative abundance of genes involved in transcription, RNA processing, and amino acid metabolism, implying a microbial community potentially more engaged in complex gene regulation and stress adaptation. These findings highlight that while the core functional framework is shared, the specific fermentation environments have driven functional specialization, particularly regarding carbon source utilization and transcriptional activity.

4. Discussion on standardization—opportunities and challenges

4.1 Methodological validation of spike-in in fermented foods

This study successfully validated the application of spike-in absolute quantification in traditional high-salt fermented vegetables. The high linearity of the standard curves (R^2>0.96) confirms that this method effectively corrects the biases introduced by PCR amplification and DNA extraction efficiency in complex food matrices. Unlike relative abundance data, which only indicates the "proportion" of microbes, the results provide a "quantity" metric, which is critical for food safety risk assessment.

4.2 Microbial load dynamics in fermentation versus deterioration

A key finding of this study is the ability to distinguish between normal fermentation and quality deterioration using absolute quantification. While traditional relative sequencing might suggest that lactic acid bacteria dominate all samples, the absolute quantification revealed a 10-fold increase in total microbial load in Sample S3. The high abundance of potential spoilage-associated bacteria (such as *Enterobacter* and *Klebsiella*) in S3, coupled with the functional shift towards rapid carbohydrate metabolism, suggests that the quality decline observed in this specific household sample is driven by uncontrolled microbial proliferation. This indicates that maintaining a balanced microbial load, rather than merely the presence of specific taxa, is crucial for the quality of *lanyancai*.

4.3 Implications for standardization

The heterogeneity observed between households highlights the need for standardization. Sample S3, which exhibited characteristics of over-fermentation, likely resulted from uncontrolled environmental factors (e.g., temperature or salt concentration). Establishing threshold values for "total microbial load" could serve as a reliable metric to differentiate between "normal fermentation" and "uncontrolled

fermentation," ensuring the safety and consistency of this traditional food.

4.4 Limitations

One limitation of this study is the small sample size (n=3). Future research should expand the sampling scale to establish robust statistical models. Additionally, while PICRUSt2 provides insights into potential function, metatranscriptomic validation is required to confirm the actual metabolic activity of these communities.

5. Conclusion

This study successfully applied spike-in-based absolute quantification technology to the microbial detection of traditional fermented vegetables from Ordos City, Inner Mongolia. The results indicate that the deterioration of pickle quality is accompanied by a significant increase in total microbial load. This method not only corrects the misinterpretations caused by traditional relative abundance analysis but also provides a scientific basis for establishing microbial metrology standards for traditional fermented foods. In the future, control charts for the fermentation process of fermented vegetables will be further developed based on absolute quantification, guiding the modernized and safe production of traditional delicacies.

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