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Exclusive interview

Ma Dejun: Safeguarding global safety with Chinese wisdom

马德军：深耕国际标准化35载，以中国智慧守护全球安全

Spotlight

Ten big standardization events of China in 2025

2025年度中国标准化十大新闻事件

Ten excellent standardization papers in 2025

2025年度标准化优秀论文

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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.

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Sharing experience to inspire engagement

Learning from the wisdom and insights of others remains one of the most effective paths to progress. This is the driving force behind our commitment to experience sharing.

The March/April issue features three renowned international standardization experts who share their journeys, the strategic “hows and whys” of global participation, and the critical role of stakeholder engagement in shaping the future of the industry.

As a veteran in the field of international household appliances, and Vice President of China Association for Standardization (CAS), **Ma Dejun**, made history in 2025 as the first Chinese winner of the IEC Lord Kelvin Award. In the EXCLUSIVE INTERVIEW column, he reflects on his decades-long journey, shares strategies for promoting international standards, and discusses China’s role on the global stage.

With 18 years of expertise focused on regional and international standards, **Dr. Zaki Al-Rubaei**, Head of International Cooperation at the GCC Standardization Organization (GSO), outlines the core pillars of effective stakeholder engagement and provides a sustainable roadmap for collaborative development in the GLOBAL VISION column.

Another seasoned expert, **Jack Yao**, Secretary-General of the Organization for Trade Development and Standards Cooperation (ODCCN) and Chairperson of ISO/TC 342, explores the "Chain of Trust" and summarizes key insights from **Professor Kichan Kim**'s 2025 keynote series, and examines the vital links between quality, standards, conformity assessment, and mutual recognition.

In the SPOTLIGHT column, we reveal the results of the China Standardization Press (CSP) online survey, showcasing the 10 big standardization events and 10 excellent academic papers of 2025.

The RESEARCH & EXPLORATION column features four deep-dive academic papers covering topics: innovative standardization in healthcare and cultural tourism, a comparative study of national electric bicycle standards in China and Malaysia, four-dimensional integrated standardization for complex information systems, and the impact of industrial robot safety standards on technological innovation.

We hope these insights inspire your own journey in the world of standards.

Enjoy your reading!

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Supplement 最新标准公告

(free of charge)

Newly approved national standards of P. R. China
(No. 38 and 39 released in 2025 and No. 1, 3, 4, 6, 7 and 8 released in 2026)
中华人民共和国国家标准公告 (2025年第38和39号, 2026年第1、3、4、6、7和8号)

China releases first standards system for humanoid robots and embodied intelligence

The Annual Meeting of Humanoid and Embodied Intelligence Standardization (HEIS) was held on February 28 in Beijing. The 2026 version of the standards system for humanoid robots and embodied intelligence was released at the meeting, which is the first top-level design of standards for the entire industrial chain and lifecycle of humanoid robots and embodied intelligence in China, marking that the related industries are embarking on a new chapter of standardized development.

More than 120 research institutions, enterprises, and industry user units were organized by MIIT/TC 8 on humanoid robots and embodied intelligence under the Ministry of Industry and Information Technology (MIIT) to develop the standards system. The system includes six parts: basic commonalities, brain-like and intelligent computing, limbs and components, complete machines and systems, applications, as well as safety and ethics.

The standards for brain-like and intelligent computing include key aspects such as "brains and cerebellums" of embodied intelligence and intelligent computing, and regulate the entire data lifecycle and the full-chain technology of model training, promotion and deployment. The standards for humanoid robots and embodied intelligence regulate their development, operation and maintenance in various application scenarios. The standards for their safety and ethics cover the entire lifecycle of the industry, providing safety and compliance guarantees for technological evolution and development.

MIIT/TC 8 will collaborate with government departments, enterprises, research institutes and universities to advance the development of sectoral standards within the framework of the standards system. It will take standards as the leading force to facilitate the high-quality development of the industry.

New national standard for ambient air quality released

The new mandatory national standard GB 3095-2026, *Ambient air quality standards*, was jointly released by the Ministry of Ecology and Environment (MEE) and the State Administration for Market Regulation (SAMR). Two corresponding technical regulations, HJ 633-2026, *Technical specifications on ambient air quality index*, and HJ 663-2026, *Technical specifications for ambient air quality assessment*, were released as well.

The newly revised standards impose stricter concentration limits for particulate matter and its primary precursors, tightening the criteria for good air to better safeguard public health.

While China's economy has developed rapidly, the average annual $PM_{2.5}$ concentration has dropped from 68 mg/m^3 in 2013 to 28 mg/m^3 in 2025, making China the fastest country in the world in terms of air quality improvement, according to an official from the Department of Atmospheric Environment at the MEE. The standards for air quality have played a significant role in the battle against air pollution and protecting the health of the people.

The newly released standards will be implemented in a phased manner, to enable a preparatory period for the steady and orderly implementation, and ensure a smooth transition in air quality evaluation.

The standards will effectively drive the development of new quality productive forces, such as clean energy and new energy vehicles, and promote the adoption of advanced production processes in key industries. They will also facilitate the green and low-carbon transition of the industrial, energy, and transportation structures, fostering high-quality economic and social development. It is estimated that various pollutant emission reduction measures could reduce over 7 billion tons of carbon dioxide in 2026-2035.

Three Beijing-Tianjin-Hebei coordinated standards published

Recently, three local standards for the coordinated development in the Beijing-Tianjin-Hebei region were collaboratively issued by the administrations for market regulation in Beijing, Tianjin and Hebei.

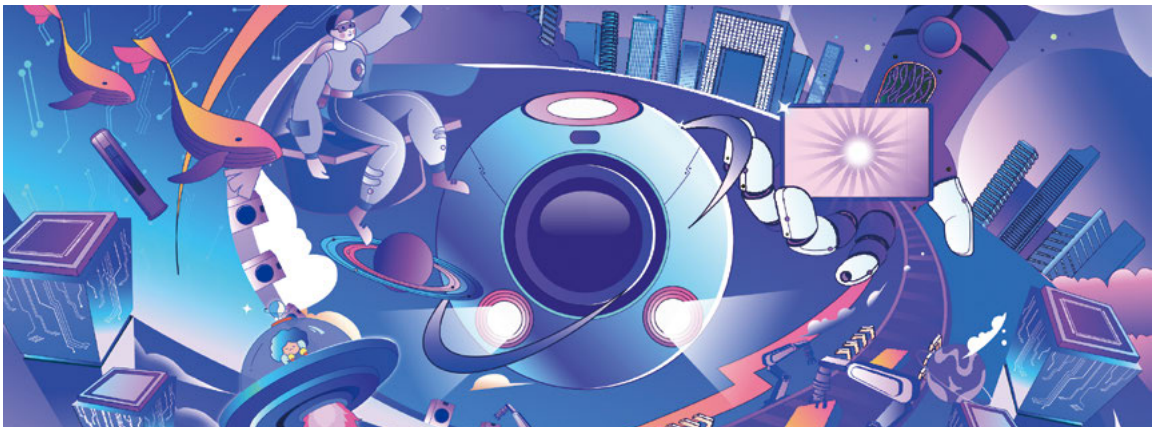
Focusing on the hot topics of people's livelihood and cutting-edge fields, the standards target three major areas respectively: the safety of large-scale amusement devices, the cost measurement of information technology innovation software, and the assessment of the mental health of the elderly. Using unified regulations, the region explores a higher-quality path for regional coordinated development.

As for public safety, the *Specification for operational management and maintenance of large-scale amusement device* requires that operating entities must designate a specific "safety manager" for each piece of equipment and appoint a sufficient number of safety directors and safety officers, all of whom must hold the necessary certifications. In response to sudden malfunctions, the standard highlights that the operating entities should establish a coordinated mechanism with professional firefighting and rescue teams, and regularly conduct exercises.

As for information technology application innovation, the *Information technology application innovation—Cost measurement specification for application software adaptation and transformation* establishes a unified cost measurement model by defining counting rules and value reference ranges for four major adaptation scenarios: middleware, databases, browsers, and plugins. This model provides a clear and transparent basis for financial approval, and offers software developers a reasonable reference for pricing.

As for the mental health of the elderly, the *Specification for psychological assessment for older adults in senior care organization* provides elderly care institutions with a scientific and standardized psychological assessment tool. It requires institutions to offer regular psychological screening services for the elderly, and offers guidance on how to early identify anxiety and depression, as well as how to carry out scientific early interventions.

Three regional working groups for AI established



SAC/TC 28/SC 42 on artificial intelligence has established regional working groups in the Beijing-Tianjin-Hebei region, the Yangtze River Delta region, and the Guangdong-Hong Kong-Macao Greater Bay Area (GBA), embarking on a new phase of China's AI standardization characterized by regional coordination and international collaboration.

Leveraging the strengths of a full-process innovation ecosystem that integrates fundamental research, technological breakthroughs, scenario activation, and agile supply, the AI regional working groups take standards as the main thread to systematically tackle industrial bottlenecks, drive collaborative innovation, and align with global rules. They are committed to setting a benchmark for the deep integration of technology and industry, as well as for the connectivity of standardization practices at home and abroad.

The working group in the Yangtze River Delta region will prioritize international cooperation, including participation in international standards development, as well as promotion of international standards and regulations, laying a foundation for products to go global. The working group in the GBA, which is a world-class industrial cluster, will center on stimulating the vitality of the industry through standards, effectively guiding the efficient allocation of factors such as technology, talent, and capital within the region.

The establishment of the three major AI regional working groups is a crucial step in implementing the national technological innovation strategy and promoting the high-quality development of the AI industry. It is also a window of China's efforts to deepen standardization reform and enhance the international level of standards. The working groups will further deepen the integration of AI technological innovation and industrial development, enhance cross-regional collaborative innovation capabilities, and continuously improve China's AI standards system, which will provide solid standardization support for building China's strengths in AI.

Chinese strontium optical clocks help keep the world on time

The optical lattice clock based on strontium atoms, NIM-Sr1, developed by the National Institute of Metrology, China (NIM), has been approved to calibrate the International Atomic Time (TAI), which marks a milestone in China's research process of optical clocks. China will further participate in the calibration of TAI, and make more efforts in the research on time and frequency.

To achieve the highest accuracy, the International Bureau of Weights and Measures (BIPM) combines the output of some 450 atomic clocks in about 70 national laboratories and timekeeping institutions worldwide to determine TAI, which is the basis for Coordinated Universal Time (UTC), the world's civil time standard.

Atomic clocks deviate 1 second in millions of years, while the latest developed optical clocks deviate 1 second in billions to hundreds of billions of years, which can be used to further improve the accuracy of TAI.

Following NIM5, a strontium atom fountain clock developed by NIM, the data of NIM-Sr1 and NIM6, another new atomic fountain clock developed by NIM, is released in the BIPM Circular T No. 454, which is a monthly publication of the BIPM Time Department, source of traceability to Coordinated Universal Time (UTC) for the local realizations UTC(k) maintained by national institutes.

Currently, three Chinese timekeepers contribute to TAI and highlight China's advance in the field of time and frequency. They ensure the security and controllability of China's time and frequency system, and support the stable development of quantum technology and the quantum industry.

ISO releases standards for electronic bill of lading

Recently, ISO 5909:2026, *Business processes and data interchange of electronic bill of lading based on distributed ledger technology (DLT),* was released. Proposed by China COSCO Shipping Co., Ltd., the standard is collaboratively developed by ISO and the UN/CEFACT, to provide a unified guideline on electronic bill of lading (eBL) for global shipping and trade.

ISO 5909:2026 aims to realize the digitalization of bills through blockchain technology. Blockchain features tamper resistance, traceability and transparent sharing of information, which guarantees the security and credibility of electronic documents. ISO 5909:2026 has established globally applicable business processes, data formats and interaction rules for eBL based on blockchain, providing a digital "common language" for global stakeholders in shipping, trade, finance and other sectors.

ISO 5909:2026 outlines the business processes and data requirements for the implementation of eBL, and focuses on the secure digital transfer of title documents via a trusted platform. Additionally, it specifies optional data elements that are essential for leveraging DLT to support the eBL workflow.

China COSCO Shipping Co., Ltd. has contributed to the development of ISO 5909:2026, and shared China's experience in eBL on the blockchain platform Global Shipping Business Network (GSBN).

The standard is a crucial step in the digital transformation of the shipping industry, where China plays an important role in the formulation of international trade rules.

ISO releases ISO/TS 19384:2026 on service excellence

The first ISO standard for service excellence related to digitalization, ISO/TS 19384:2026, *Service excellence—Guidance for the application of digital approaches to achieve service excellence*, was released recently, with Zheng Juaner, an expert from the China National Institute of Standardization (CNIS), serving as the project leader and convenor of ISO/TC 312/WG 5.

ISO/TS 19384:2026 gives guidance on applying ISO 23592, including principles, models and specific application methods, to achieve service excellence by implementing and using digital approaches. Based on the characteristics of digitalization for service excellence, it proposes key principles such as tailored solutions, security and reliability, inclusiveness, ethical compliance, environmental sustainability, as well as commonality and sharing. It also establishes a model for implementing service excellence through digital methods, and provides specific operational guidelines for the three stages, preparation for the application of digital methods, implementation of digital methods, and evaluation and improvement of the implementation results. The appendix further expounds on the self-assessment checklist for the application of digital methods, the classification of digital methods, and the corresponding relationship between digital methods and service excellence models.

ISO/TS 19384:2026 facilitates various types of service organizations to better apply digital methods to realize service excellence, which is applicable to organizations adopting or planning to adopt digital approaches to achieve service excellence. Its development is supported by countries including Germany, Japan, Russia, and India. Its domestic counterpart, GB/T 47137-2026, was released by SAMR.

APEC meeting on carbon emission management standards and best practices for urban sewage treatment held

Sewage treatment is one of the significant sources of greenhouse gas emissions, and it is also an important area for energy conservation, consumption reduction, as well as resource and energy recovery, demonstrating great potential for carbon reduction.

The meeting on carbon emission management standards and best practices for urban sewage treatment was held in Guangzhou on February 3, during the First Senior Officials' Meeting and Related Meetings of APEC China 2026.

The meeting was hosted by CNIS, and jointly organized by the School of Environment of Tsinghua University and Oceanpower Corporation. It was attended by approximately 50 representatives from economies such as Australia, Canada, China, Hong Kong Special Administrative Region of China, Indonesia, Peru, the Philippines, Singapore, Thailand, the U.S. and Vietnam, as well as non-governmental organizations.

The event was addressed by Zhu Zhongliang, Deputy Director-General of the Department of International Cooperation of SAMR, Li Zhiping, Vice President of CNIS, and Li Pengcheng, President of the Sub-Committee on Standards and Conformance of APEC. Reports were made by representatives from international organizations, including ISO Central Secretariat, and ISO/TC 282 on water reuse, as well as renowned universities and enterprises, including Tsinghua University, City University of Hong Kong, Princeton University, and the University of Queensland.

The attendees had in-depth discussions on the academic research progress, practical experience and prospects of international standardization in terms of carbon emission management and carbon reduction for urban sewage treatment. The meeting reached consensus on key issues of carbon emission management and carbon reduction for urban sewage treatment, such as the core concepts, technical upgrade paths, and international standardization promotion directions.

The meeting is of great significance for strengthening cooperation and exchanges in carbon emission management of regional wastewater treatment and promoting standardized practices in this field.

Jo Cops, the then IEC President, and Philippe Metzger, IEC Secretary-General & CEO, present the IEC Lord Kelvin Award to Ma Dejun.

Safeguarding global safety with Chinese wisdom

Interview with **Ma Dejun,** first Chinese winner of the IEC Lord Kelvin Award

深耕国际标准化35载，以中国智慧守护全球安全

—专访IEC开尔文勋爵奖首位中国获奖者 **马德军**

At the IEC, Chinese experts have been contributing their expertise to international standardization. As one of them, Ma Dejun has grown from an inexperienced explorer in the field of standardization into a distinguished expert driving the development of international standards in key sectors over the past 35 years. He was presented with the 2025 Lord Kelvin Award at the 89th IEC General Meeting held in New Delhi, India, in September 2025. Thus, he became the first Chinese expert to receive the highest honor bestowed by the IEC.

In an exclusive interview with Ma Dejun, he reviewed his original aspiration behind his decades-long journey in international standardization, shared his experience and insights on promoting international standards, and looked forward to China's future role on the international standardization stage.

China Standardization: **What kind of opportunity makes you devote yourself to international standardization?**

Ma Dejun: Over the past 35 years, I have been engaged in standardization work. At the very beginning, I got involved in international standardization by chance. After graduating from university, I worked in a factory. Later, I joined a research institute, where I began to take up work related to international standardization.

When I started work, I had very limited understanding of standardization. However, after years of in-depth exploration and practice, I gradually realized the importance of standards. I found that standards play a remarkably significant role in industries, people's daily lives, economic development, and even national governance. This has enabled me to remain dedicated to the field for decades.

Looking back over the years, what experiences have left a deep impression on you?

Ma Dejun: There are many such experiences. For instance, when we led the development of standards related to the protection against electric shock more than 20 years ago, we found that in poor grounding environments, fatal electric shock might occur if electrical appliances were not specially designed for such conditions. According to relevant statistics, each year more than a thousand people across the world die from electric shock while taking a bath with water heaters due to poor grounding.

We believed that only standardization can guide the industry to avoid fatal electric shocks through innovative product design. To this end, we carried out in-depth research to check whether there were relevant loopholes in international standards. We found there was indeed a problem with the key assumption of sound grounding system in the IEC standards. In fact, the grounding systems in some regions of China and many other developing countries around the world are not perfect. After discovering the problem, we submitted a standard proposal that adopted resistors in series to reduce the current passing through the human body to the safety threshold, so that no injury or death occurs.

From project approval, development to publication, the standard was widely welcomed worldwide, especially by developing countries. China fully demonstrated its responsibility as a major country in international standards development. By promoting the standard, China has addressed not only its own problems but also safety concerns of consumers in similar regions around the world.

Therefore, the significance of standards goes far beyond helping enterprises secure market advantages by developing products. More importantly, standards protect the lives and property of consumers worldwide. Standards are everywhere, and they deliver value to all stakeholders.

Florian Spiteller, Member of the DKE Executive Board and Head of External Relations & Support, and Ma Dejun

In your opinion, why did the IEC establish the Lord Kelvin Award? What outstanding achievements helped you win the award?

Ma Dejun: Named for Lord Kelvin, the first President of the IEC and a renowned physicist, the Lord Kelvin Award is the highest individual honor in the IEC. Only one recipient is selected globally each year to recognize his or her long-term and outstanding contributions to electrotechnical technologies. In my opinion, the IEC establishes the award to attract more people to participate in international standardization and inspire more people to pursue excellence in the field.

The award has extremely rigorous selection criteria, so it has been left vacant for several years in history due to a lack of qualified candidates. When I first entered this profession, I never imagined that I would receive such a high honor. Through continuous accumulation and practice in the IEC work, I gradually became qualified to compete for the award.

The award is not only the recognition of my personal work, but also a microcosm of the great achievements of China's standardization reform and growing international influence in the international arena. The IEC Gold, Silver and Bronze Awards I won earlier also demonstrate China's all-round breakthroughs in international standardization, which makes China an important participant in international electrotechnical standardization.

At the IEC, I have made efforts in three major fields, which are consistent with the technology-oriented characteristic of the IEC.

Firstly, standards for active assisted living (AAL), commonly known as elderly care, especially the standard for AAL robots. Elderly care is a global challenge. As independent home-based elderly care requires the support of products, systems and services, elderly care robots become the core

carriers. The development of IEC 63310 for AAL robots enables more than one billion elderly people worldwide to enjoy high-quality and dignified independent living, thus gaining extensive international attention and recognition.

Secondly, standards for electrical safety in high-altitude areas. In the previous IEC standards, there was no systematic research on electrical safety in high-altitude areas. I delivered special reports at IEC meetings and served as the convenor of a working group to lead relevant research with phased results. At the meeting of IEC TC 61 in 2025, I submitted a report outlining electrical safety hazards in high-altitude areas and relevant recommendations for the standard content. I hope that it could be incorporated into standards to protect consumers in about one third of the world's land, including nearly one quarter of China's land.

Thirdly, standards for electrical air cleaners. We led the development of the world's first international standard for electrical air cleaners designed for both daily and emergency use. In daily situations, it improves indoor air quality by removing $PM_{2.5}$, formaldehyde, odors and other pollutants; while in emergencies such as pandemics, it blocks the transmission of viruses through purification systems, preventing the spread of viruses via central air conditioning. The standard has not only supported the global response to COVID-19 and efforts to resume work, but also safeguarded long-term indoor health.

In addition, my standardization work in carbon footprint accounting and climate change governance has also been recognized. Through international standards, we lead innovation and industrial development, ultimately benefiting consumers across the world.

The award will further promote the alignment of Chinese standards with advanced international standards, and help enterprises timely understand international technological trends and market demands, improve their product quality and technical level, and boost their competitiveness in international markets, contributing to the high-quality economic development in China and the industrial progress in the world.

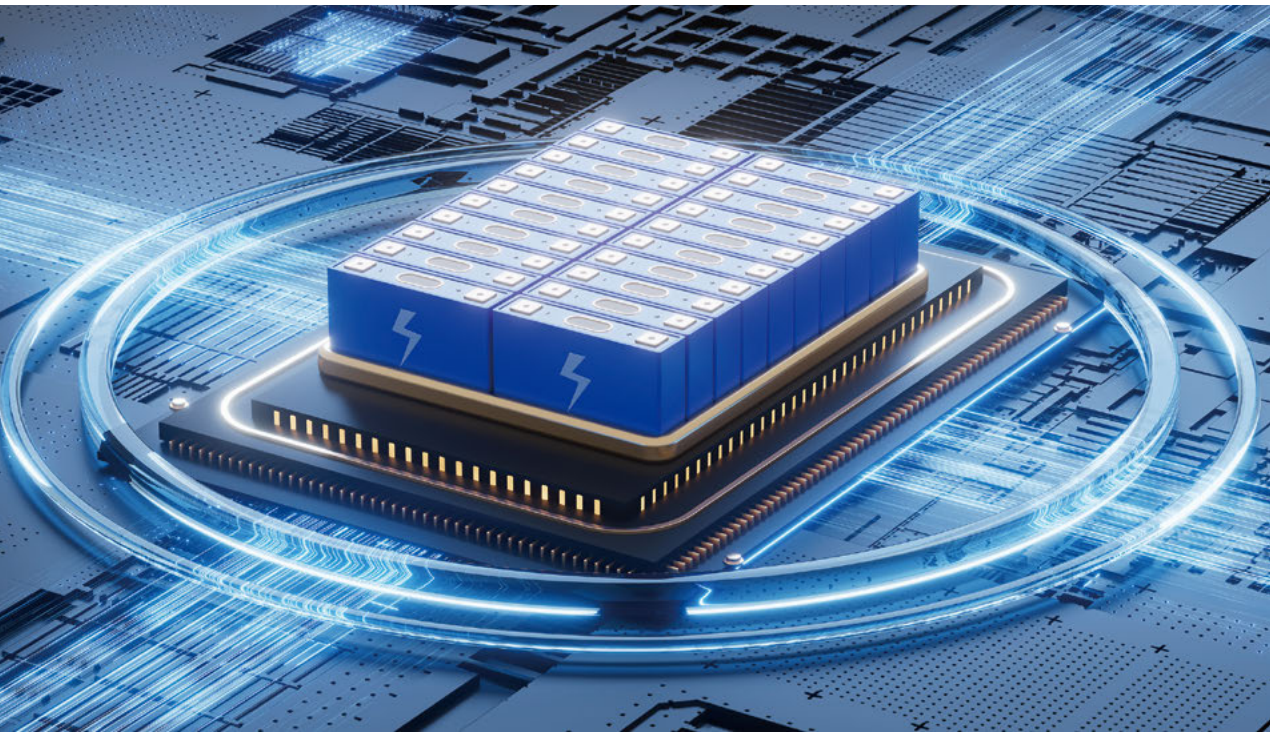
How has China performed in international standardization for traditional and emerging industries?

Ma Dejun: After years of development, China has made remarkable progress in international standardization across many industries. In the fields I am familiar with, household appliances represent a typical traditional industry, while robotics and new energy are key emerging industries.

Most of these industries have gone through a long development process. In 2019, the Chinese Academy of Engineering rated the household appliance industry as one of the world's leading industries, alongside communication equipment, advanced rail transit equipment, power transmission and transformation equipment, and textiles.

Although the robot industry started late, it has developed at a fast pace. The industry is expanding from general-purpose robots to application-specific robots for vertical sectors. They are no longer merely for demonstration, but deeply integrated into real application scenarios with sound development momentum, in particular elderly care and household services.

The new energy sector has achieved remarkable results. China is the world's largest producer, consumer and exporter of batteries. The battery industry provides important support for new energy development, which makes a major contribution to global climate change governance. To mitigate the greenhouse gas impacts, we must reduce the use of fossil fuels, and adopt new energy as an important alternative.



China has made a tangible contribution to global climate change governance with the dual carbon goals.

We are currently advancing several key tasks. Firstly, the standardization of DC direct connection and direct supply technology. In the past, electricity generated by wind and solar energy had to be converted into AC first, and sometimes converted back to DC, with about 30% of energy lost. The technology has been promoted at meetings of IEC TC 61 with smooth progress, which is expected to achieve trial application in the future. If traditional AC electric appliances can be gradually replaced by DC electric appliances, it will open new avenues and inject new impetus into industrial development.

Secondly, the standardization of battery energy storage technology. Wind and solar power generation are characterized by fluctuations between peaks and troughs. Battery energy storage can solve the problem by storing the surplus electricity during peaks in batteries and feeding it into the grid or supplying it directly to electric appliances during troughs. This can fundamentally reduce the reliance on fossil fuels and lower carbon dioxide emissions.

China has made a tangible contribution to global climate change governance with the dual carbon goals. All industries are striving to achieve the dual carbon goals as soon as possible, and we are supporting the process through standardization. We hope to contribute Chinese strength to international carbon emissions control and climate change governance with standardization expertise.

What suggestions can you give to Chinese standardization professionals participating in international work?

Ma Dejun: I have two suggestions. Firstly, take an active part. Only through active participation can we identify problems and find solutions. This is the prerequisite for making an impact. As China has become a major participant in the international electrotechnical standardization, more Chinese professionals should step onto the international stage and share the Chinese experience.

Secondly, be patient and focused. Standardization requires perseverance. We need to concentrate on research and maintain long-term commitment. With continuous efforts, we can carve out a niche of our own and make our voice heard in the international standardization arena.

My own career has been centered on standardization. I place emphasis on different subsectors at different stages, but I have never changed my principle of being problem-oriented and serving global stakeholders. Persistence brings achievements and fulfillment of seeing standards recognized and adopted globally, which is the greatest joy in standardization work.

Many enterprises want to participate in standardization, including developing national or international standards. What advice do you have for them?

Ma Dejun: For enterprises, four aspects need to be noted if they want to participate in standardization, especially international standardization.

Firstly, clarify real needs. Do not follow trends blindly. Enterprises must develop standards based on the actual needs of them. Only such standards are valuable, and help the industry meet the demands of global markets.

Secondly, adopt a national and industrial perspective. Do not think only from an enterprise perspective. With the development of the country and the industry, enterprises as participants and contributors will inevitably become the biggest beneficiaries. The standards developed from a more macro perspective can truly advance industries and gain international recognition.

Thirdly, solve the talent dilemma. Enterprises require talent reserves and expert resources for standardization work. But small and medium-sized enterprises and unicorn companies can hardly afford it. Do not require talents to be affiliated with a single enterprise. If we connect with external experts according to needs and collaboratively promote the tasks, we will yield twice the result with half the effort, solve the talent dilemma, and integrate international standards with domestic industry realities.

Finally, make a bold trial and advance steadily. Many enterprises doubt their ability. In fact, they can do as well as others, even better. In actual operations, they should plan the path well, set a clear work plan, and proceed orderly. In general, after three to five years of efforts, we will see tangible results, enhancing international competitiveness and creating better conditions for expanding overseas markets.

> “China always upholds the vision of building a community with a shared future for mankind.

What expectations do you have for China's future role in the IEC?

Ma Dejun: China always upholds the vision of building a community with a shared future for mankind, and is ready to contribute more Chinese wisdom to the international community.

With further deepened and expanded participation in international standardization in the IEC, China will make an increasingly significant contribution to international standards. It will devote great efforts to the transformation and upgrading of the electrotechnical industry in China and the electrotechnical progress in the world.

About Ma Dejun:

Ma Dejun, Professor-level Senior Engineer, expert in the field of international household appliances. He serves as Vice President of both the China Association for Standardization and the China Battery Industry Association, and Chair of the Special Committee on User-side Low-voltage DC Systems of the Chinese Society for Electrical Engineering.

He is the first Chinese winner of the IEC Lord Kelvin Award. With 35 years of engagement in IEC international standardization, he has devoted himself to advancing the integration of China's manufacturing industry into the IEC and promoting international standardization in emerging industries including robotics, smart home, and energy storage.

He currently serves as Chair of the IEC Systems Committee for Active Assisted Living (IEC SyC AAL), Vice Chair of IEC TC 61, *Safety of household and similar electrical appliances*, and Chair of IEC TC 59/SC 59N, *Electrical air cleaners for household and similar purposes*.

编译/靳吉丽

(Translated and edited by Jin Jili based on the interview in Chinese)

How to design a roadmap for **stakeholder engagement** in standardization development

如何设计利益相关方参与标准制定的路线图?

By Dr. Zaki Al-Rubaei 文/扎基·阿尔–鲁贝伊

Introduction: From rules to participation

Today, standardization is no longer just about unifying technical terms or setting measurements. It has become a strategic tool to build trust, strengthen competitiveness, and drive sustainable economic growth. As industries grow more complex and new technologies and regulations emerge, it is more important than ever to involve all key players: manufacturers, suppliers, consumers, academics, and regulators. Their shared knowledge and input help shape the standards and policies that guide markets, protect consumers, and ensure product quality and safety.

Although concerns are sometimes voiced about "conflicts of interest" when involving the private sector, global experience demonstrates that exclusion is more harmful than overlap. In fact, structured transparency and institutionalized participation are the surest ways to establish an effective and integrated standardization framework. Consequently, stakeholder engagement has evolved from being a procedural choice to becoming an ethical and strategic imperative, ensuring that public policies and standards are grounded in both realism and credibility.

Therefore, it has become essential for standardization bodies to adopt a clear, structured, and sustainable roadmap that defines how stakeholders are involved in every phase of standards development and implementation.

The philosophy of participation in standardization

The success of any standardization system depends largely on the breadth and diversity of those contributing to its development. While every standard or regulation typically begins as a technical draft, it only matures through continuous dialogue, negotiation, and consensus-building among the various parties involved.

Designing a roadmap for stakeholder engagement is thus not limited to gathering feedback or conducting surveys; it is a deliberate strategic process that requires careful planning, in-depth situational analysis, and balanced management of relationships and interests.

The aim of such a roadmap is to transform stakeholder participation from an occasional interaction into an institutional culture, deeply embedded in the organization's operations and decision-making. To achieve this, any successful engagement model must rest on three fundamental pillars that together ensure inclusiveness, credibility, and long-term impact.

> *True participation does not begin when we request opinions, but when we listen sincerely—and when those opinions visibly influence the outcome.*

Core pillars of effective stakeholder engagement

01 Communication	Establish continuous, two-way dialogue with all relevant groups, including manufacturers, regulators, and consumers, to understand their needs and expectations while ensuring transparent and systematic exchange of information.
02 Transparency	Publish policies, procedures, and draft standards openly, and clearly communicate how stakeholder input has been incorporated into revisions or new standards.
03 Sustainability	Ensure that engagement is not a one-time activity but a permanent practice, integrated throughout the lifecycle of standards, from development to review, implementation, and continuous improvement.

By adhering to these three principles, standardization organizations can foster trust, legitimacy, and shared ownership of the standards they develop.

> *The STAKEHOLDER ENGAGEMENT process requires conducting an "X-Ray scan" and in-depth analysis of the current situation to identify all stakeholder groups, classify them, determine their needs and priorities, and ensure communication with them in order to encourage active and continuous engagement. This plan should include regular dialogue with stakeholder representatives and groups, through various means, including: dialogue seminars, discussion sessions, and open days. This must be accompanied by continuous evaluation and the incorporation of feedback at different stages of the process.*

Stages of building a stakeholder-engagement roadmap

A well-designed roadmap follows a structured, cyclical process consisting of four interconnected stages. Each stage feeds into the next, forming a continuous learning and improvement loop.

Stage	Key activities	Expected results
Planning	· Identify and classify stakeholders. · Define levels of engagement (inform, consult, collaborate, empower). · Map influence and relationships.	Initial engagement plan with clear performance indicators.
Preparation	· Build institutional capacity. · Allocate financial and human resources. · Conduct risk assessments and develop mitigation plans. · Establish a comprehensive stakeholder database.	Organizational readiness for active participation.
Implementation	· Organize meetings, workshops, and forums. · Launch digital and interactive participation platforms. · Document outputs and recommendations.	Effective, evidence-based engagement producing actionable outcomes.
Review & improvement	· Evaluate engagement effectiveness. · Analyze feedback and refine approaches. · Apply continuous improvement mechanisms.	A sustainable learning cycle and growing stakeholder trust.

These stages are not isolated steps but rather an integrated process that promotes the continuous flow of knowledge, dialogue, and innovation between standardization bodies and the industrial community.

Stakeholder analysis: Identifying who and why

To manage participation effectively, organizations must first understand who their stakeholders are and what drives their involvement. This begins with mapping and categorizing stakeholders according to their relationship, influence, and interest:

- **Primary stakeholders:** manufacturers, importers, testing laboratories, conformity assessment bodies, and regulators.
- **Secondary stakeholders:** universities, professional associations, consumers, media, and NGOs.

By creating an influence–interest matrix, decision-makers can prioritize which groups to engage and at what intensity. Such analytical tools help channel institutional efforts toward areas that generate the greatest impact for the industrial and economic ecosystem.

> *How do you begin engaging stakeholders? Always start with: Who? Why? When? Proper planning saves you months of correction.*

From consultation to empowerment

Stakeholders' participation evolves along a continuum, from passive information sharing to full empowerment in decision-making. Understanding this progression allows organizations to apply appropriate engagement tools at each level:

- **Inform:** Provide information without expecting a response.
- **Consult:** Request feedback on specific issues.
- **Involve:** Engage participants in analyzing options and crafting solutions.
- **Collaborate:** Partner to design and implement joint initiatives.
- **Empower:** Grant stakeholders a tangible role in shaping policies and standards.

Remember that empowerment means: Integrating stakeholder participation into governance, decision-making processes, and related matters.

Each level demands distinct communication tools, from technical forums and surveys to targeted consultations and co-creation workshops.

> *Empowerment does not mean losing control; it means gaining strength through trust and partnership.*

Stakeholder engagement process for sustainability in five steps:

Identifying stakeholders
Identify stakeholders who are affected by the organization's sustainability performance or who can influence it, and understand their level of influence when setting your priorities.

1

Participation planning
Create a detailed engagement plan that explains how you will engage with stakeholders, including identifying the most suitable engagement methods (surveys, focus groups, interviews) and setting clear objectives for the engagement process.

2

Implementing engagement
During the engagement process, it is essential to listen to all voices—especially those of marginalized or underrepresented groups. The goal is to gather feedback that helps the organization make better decisions.

3

Integration in decision-making
After collecting stakeholder inputs, the organization should integrate the results into its governance, strategy, and operations. This ensures addressing stakeholders' concerns and expectations in a meaningful and sustainable way.

4

Monitoring and evaluation
Continuously assess and improve the effectiveness of stakeholder engagement. Evaluate the quality of engagement, the significance of the feedback, and the impact of actions taken in response to stakeholders' inputs.

5

Tools and channels of engagement

The effectiveness of a stakeholder roadmap lies in diversifying communication methods to reach all relevant audiences. Examples include:

- Dialogue seminars and open discussion sessions.
- Online surveys and digital consultations.
- Professional media platforms and social networks.
- Joint workshops with industrial and academic partners.
- Regular newsletters and technical follow-up reports.

These tools are not just communication mechanisms; they serve as bridges of trust, enabling stakeholders to participate meaningfully in shaping a transparent and inclusive standardization ecosystem.

Measuring engagement and using feedback

> *What cannot be measured cannot be managed.*

To institutionalize participation, organizations must establish a clear evaluation framework assessing both the quality and impact of engagement. This involves measuring:

1. Outputs: activities completed and documents produced.

2. Outcomes: improvements in understanding, collaboration, and satisfaction levels.

3. Impact: long-term transformation in performance, trust, and transparency.

A structured feedback loop ensures that lessons learned are reintegrated into policies and procedures, promoting institutional maturity and adaptive resilience.

Challenges and opportunities

> *Whoever gives stakeholders a seat at the table gives their institution a chance to survive in the future.*

Although involving stakeholders brings many benefits, it also comes with some challenges.

Some participants may have different levels of technical knowledge, and some organizations may lack the capacity or experience to manage participation effectively. Others may resist change or prefer limited openness, and it can sometimes be hard to balance different interests.

At the same time, new technologies such as digital tools, artificial intelligence, and online platforms are creating great opportunities. They make participation easier, faster, and more inclusive than ever before.

Conclusion: Standardization as a platform for collaboration

Designing a roadmap for stakeholder engagement is not merely an administrative procedure; it is a strategic vision grounded in the belief that quality cannot be imposed; it must be built through partnership.

The broader the participation, the more resilient and relevant the standardization system becomes. Effective standards emerge from dialogue, consensus, and shared ownership, reflecting the evolving needs of markets, industries, and societies.

Ultimately, the goal is to transform standardization into a collective learning process, a space where every stakeholder contributes expertise, every voice is heard, and every decision resonates with trust and inclusivity. Successful standardization is not only written in committees—it is forged through dialogue and built on trust.

About the author:

Dr. Zaki Al-Rubaei serves as Head of International Cooperation at the GCC Standardization Organization (GSO) in Riyadh, Saudi Arabia. He holds a PhD in Management Sciences, with specialization in Leadership and Organizational Development, and has more than 27 years of professional experience, including over 18 years dedicated to regional and international standardization.

Throughout his career, Dr. Al-Rubaei has played a key role in strengthening the Gulf standardization system and expanding its global engagement. He has led and coordinated international cooperation with more than 83 regional and international organizations, including ISO, IEC, WTO, ITU, CODEX, and UNIDO, and has represented GSO in numerous high-level international forums and negotiations.

His professional focus lies at the intersection of standardization, trade facilitation, institutional development, and sustainable development. In parallel with his executive responsibilities, he is an author, writer, and certified trainer and consultant. He has directed several training and capacity-building units and has delivered numerous professional programs in leadership, management, and standardization at regional and international levels.

Trade development and standards cooperation in the digital and intelligent era: Insights from Professor Kichan Kim

数字化、智能化时代的贸易发展与标准合作

By Jack Yao
文/姚歆

In the digital and intelligent era, the synergy between trade development and standards cooperation is no longer a choice but an essential for micro, small and medium-sized enterprises (MSMEs) to integrate into global trade. Based on a series of keynote speeches delivered by Professor Kichan Kim, Chair of the Organization for Trade Development and Standards Cooperation (ODCCN) and the International Council for Small Business (ICSB), this article explores the "Chain of Trust" that connects quality, standards, conformity assessment, and mutual recognition.

1. The importance of synergy between trade and standards

In today's global economy, trade development and standards cooperation must move in tandem to make cross-border transactions more rapid, more reliable, and more inclusive. As the digital transformation accelerates, rules and standards are increasing, posing a risk of marginalizing MSMEs.

Professor Kim delivered eight keynote speeches in China in 2025. This article summarizes his opinions in the speeches. He identifies a critical operational chain: Trade → Standards → Evidence → Mutual recognition. This sequence reflects the institutional pathway through which trust is established in international trade: standards define common requirements, evidence provides verifiable proof that those requirements are met, and mutual recognition enables that proof to be accepted across borders. In practice, such evidence is generated through conformity assessment processes, which convert compliance with standards into verifiable results such as test reports, certifications, or audit findings.

If the digital-intelligent era is a highway, standards act as the "traffic rules" for the highway, conformity assessment serves as the "inspection and insurance", and recognition mechanisms function as the "passes of mutual recognition".

When these elements are coordinated, businesses benefit from lower communication costs, accelerated market access, and fairer opportunities based on verifiable capabilities rather than mere relationships.

- Lower communication cost: the shared vocabulary means fewer explanations and disputes.

- Faster market access: once verifiable credentials and recognition rules are embedded into systems, review shifts from "manual queues" to "system checks + risk-based sampling".

- Fairer opportunities: with transparent rules and clear proof paths, MSMEs can participate based on verifiable capabilities without repeatedly explaining the evidential relationships.

Together, these benefits turn "standards cooperation" from an abstract idea into a practical lever for trade growth: quicker transactions, more stable delivery, and broader participation.

2. Six dimensions of a unified chain of trust

Professor Kim's eight keynote speeches in 2025 outline a comprehensive framework for transforming requirements into verifiable results:

1) Inclusivity (global trade and investment promotion). How can we make growth remain inclusive? The direction is clear: digitalization is reshaping the distribution of trade opportunities. Standards cooperation should lower entry barriers so that MSMEs can not only use standards but also co-create rules rather than being filtered out by platform compliance.

2) Operational trust (conformity assessment). How can trust become operational? If standards remain "text", parties still need extensive reassurance. Conformity assessment converts standards into evidence—turning promises into verifiable results. Digital verification (e-certificates, online verification interfaces) shifts processes from "submitting documents" to "instant validation".

3) Scalable services (services trade). How do services get accepted? Services are less visible than goods; value is created during delivery. Standardizing delivery processes and competencies creates the "verifiable process evidence" necessary for intangible trade.

4) Foundational quality (quality governance). Quality is the foundation of trust. It goes beyond measurement; it is about governance capability. Standards make excellence replicable, conformity assessment makes it provable.

5) Predictability (commercial legal services). Law provides the rights-and-obligations framework; standards translate the framework into operable workflows. As cross-border cooperation becomes more complex, reusable "public tools" for dispute prevention, model clauses, and compliance workflows reduce uncertainty.

6) Project-based coordination (trade development and standards cooperation). Standards cooperation should not stay at the level of slogans; it must be implemented through concrete projects. That means aligning key terms and a minimum dataset around real industry pain points, and moving mutual recognition into procurement, platform onboarding, and supply-chain coordination—reducing repetitive compliance.

Together, these themes form six operational dimensions that support the functioning of the trust chain between trade, standards, evidence, and mutual recognition. Coordination is not about "adding standards onto trade". It is about organizing standards, assessment, and mutual recognition into a unified chain of trust, so that more stakeholders can participate in international cooperation at lower cost.

Apart from the summit in May, Professor Kim made six speeches in September and another speech in December. For many firms, "closing compliance and access before Q4" directly affects the next year's orders and partnerships. That is why the September agendas focused on how to prepare evidence, how to reduce review burdens, how to embed mutual recognition into systems, and how to lower legal uncertainty.

Time	Event	Themes of speeches
May 22	Global Trade and Investment Promotion Summit	Inclusivity (global trade and investment promotion)
September 11	Forum on Conformity Assessment Services for Trade Facilitation	Operational trust (conformity assessment)
September 11	Roundtable on Promoting Inclusive Development through Global Trade in Services, a roundtable hosted by the Global Alliance for Trade in Services (GATIS) and the International Trade Centre (ITC) with support from the United Nations Conference on Trade and Development (UNCTAD)	Scalable services (services trade)
September 12	9th China Forum on Standardization of Trade in Services	Scalable services (services trade)
September 17	China Quality Conference, Nanjing	Foundational quality (quality governance)
September 18	China–ASEAN Commercial Legal Forum, a parallel forum of the 22nd China–ASEAN Business and Investment Summit	Predictability (commercial legal services)
September 26	Symposium on International Cross-Border E-Commerce, a symposium of the World Internet Conference (WIC)	Project-based coordination (trade development and standards cooperation)
December 11	International Trade Development and Standards Cooperation Exchange, a sub-forum of the Annual Meeting of the Alliance of the Chambers of Commerce and Industry of the New International Land-Sea Trade Corridor	Project-based coordination (trade development and standards cooperation)

Figure 1: The eight speeches and their themes delivered by Professor Kim in 2025

3. The trust loop: quality – standards – conformity assessment – recognition

These four keywords form a closed-loop mechanism that assesses compliance:

Quality is the foundation of trust. In the digital era, quality goes beyond product pass rates. It includes delivery stability, process control, data accuracy, and traceability. Many new requirements—data compliance, sustainability disclosure—effectively address the question: can you do things right, consistently, and can you always prove it?

Standards are the universal language. They align "key joints"—definitions, evidence formats, and validity periods—to ensure system interfaces match.

Conformity assessment is the converter. In trade, "I comply" is not merely a statement; it is a set of verifiable facts (test reports, audit conclusions, process records, and ongoing monitoring) that buyers, platforms, and financiers can rely on.

Recognition is the multiplier. This "last mile" allows one investment in compliance to be reused across multiple scenarios, acting as a "passport" for global trade.

This loop becomes clearer in real trade:

- Cross-border e-commerce: initial barriers arise from platform onboarding and advertising compliance. Standards translate requirements (information security, consumer protection, product claims) into checklists; conformity assessment produces verifiable credentials; recognition integrates these credentials with platform review systems, reducing repeated submissions and manual intervention.

- Cross-border service outsourcing: buyers face risks from uncontrolled processes, including delays, personnel changes, and data breaches. Service standards define control points (delivery workflow, access control, incident response); assessment verifies their operation; recognition allows the same evidence to be reused for renewals and scaling.

- Sustainable supply chains: inconsistent data formats are a common challenge, as the same carbon or due-diligence data may be requested in different templates. Coordination should focus on a minimum dataset and standardized evidence formats, enabling one dataset to be accepted across multiple contexts.

Two enabling factors ensure the trust loop functions effectively: explainability (conclusions must be traceable to their basis) and traceability (key records must allow process reconstruction). Without these, recognition remains limited. Therefore, clauses, assessment rules, digital verification methods, and correction mechanisms should be designed as an integrated framework.

Professor Kichan Kim, Chair of ODCCN and ICSB

4. Ten strategic takeaways for the global market

The following ten statements from the speeches are the most important.

1) Trade frictions are shifting from borders to rules, data, and trust; "institutional costs" increasingly determine competitiveness.

2) Quality is the basis of trust; quality governance must extend to processes and data.

3) The goal of standards is to reduce mismatch costs, not create paperwork.

4) Conformity assessment turns standards into evidence; without evidence, standards cannot be used by transaction systems.

5) The efficacy of coordination should be measured by the scope of recognition rather than the sheer number of certificates. Success lies in the seamless integration of evidence into real-world transaction scenarios.

6) Scalable services trade requires verifiable process evidence for delivery, competencies, and continuous improvement.

7) The more complex cross-border cooperation becomes, the more we need law and standardized workflows to improve transparency and predictability.

8) Sustainability requirements are expanding; the key is not to raise barriers but to reduce duplication—align definitions, minimum datasets, toolkits, and cost sharing.

9) For new business models, agile pilot projects matter more than waiting for "perfectly mature standards": make it usable first, then iterate.

10) MSMEs must be considered in the design of coordination mechanisms: accessibility, affordability, and evidence reusability decide whether coordination succeeds.

If you want to turn these takeaways into actions, three priorities usually work best: align high-frequency fields and documentation first (less repeated reporting); strengthen evidence for high-risk control points next (higher pass rates); then scale cross-scenario reuse so one investment yields sustained returns.

5. Conclusion: Reducing friction, widening recognition

The synergy between trade development and standards cooperation is about connecting "doing well" with "being accepted". In the digital and intelligent era, the connection pathway is increasingly clear: align with standards, pass conformity assessment, reduce friction through digital verification, and scale value through recognition mechanisms.

The practical value of this approach is that it turns abstract institutional change into workable collaboration pathways.

In a world where "invisible frictions" are becoming normal, the impact of coordination will be reflected in simple indicators: reduced review cycles, streamlined reporting, increased evidence reuse, lower MSME entry barriers, and higher compliance success rates. The goal is not to make standards look "more sophisticated", but to make trade smoother, more trusted, and more sustainable—while enabling broader participation.

Ultimately, ODCCN and ICSB aim to embed these coordination mechanisms into daily transaction flows, ensuring that as rules increase, the barriers for MSMEs decrease.

About ICSB

ICSB is an initiating organization behind the United Nations' MSME Day and has long promoted innovation, entrepreneurship, and sustainable development for MSMEs.

About ODCCN

ODCCN is a Category A liaison organization to the International Organization for Standardization (ISO), a partner of the World Trade Organization (WTO) Informal Working Group on MSMEs, and a partner of the African Regional Organization for Standardization (ARSO). Through these linkages, ODCCN helps connect standards, conformity assessment, and capacity-building across regions.

About the author:

Jack Yao serves as Secretary-General of ODCCN and Chairperson of ISO/TC 342, *Management consultancy*. He plays an active leadership role in advancing international consensus-building and the development of globally applicable standards. In recognition of his sustained contributions to international standardization, he received the ISO Excellence Award twice (2023, 2024). He was also honored as the "Standardization Figure of the Year" by China Standardization Press (2019, 2021, 2022, 2023, 2024).

Global Age Assurance Standards Summit 2026

April 14-16, Manchester, United Kingdom

The Global Age Assurance Standards Summit 2026 brings together the international age assurance community for three days of practical insight, shared learning and real-world experience focused on implementing age assurance systems in live environments.

This year's programme centers on the newly published ISO/IEC 27566-1:2025, *Information security, cybersecurity and privacy protection—Age assurance systems—Part 1: Framework*, and the operational challenges faced by organizations deploying age assurance across platforms, services and jurisdictions.

For more information, please visit the event website: **https://events.ringcentral.com/events/global-age-assurance-standards-summit-2026/registration.**

International Girls in ICT Day

April 23, global celebration & webcast

International Girls in ICT Day has been a flagship ITU initiative since 2011, aimed at encouraging girls and young women to pursue studies and careers in information and communication technologies (ICT). It focuses on awareness raising on the opportunities that ICT can provide for educational and socio-economic empowerment of girls and young women.

Under the theme "AI for Development: Girls Shaping the Digital Future", the ITU global celebration of the International Girls in ICT Day will be co-hosted, on April 23, by the Europe and Americas regions, featuring a live link between Tirana, Albania and Brasília, Brazil, and the global celebration will be webcast.

For more information, please visit the event website: **https://www.itu.int/women-and-girls/girls-in-ict/international-girls-in-ict-day-2026/overview/.**

APEMC 2026

May 4-7, Kuala Lumpur, Malaysia

The APEMC 2026, organized by a passionate joint team from Singapore and Malaysia, will be held in Kuala Lumpur, Malaysia from May 4 to 7, 2026. APEMC will serve as a premier platform to showcase cutting-edge advancements in Electromagnetic Compatibility (EMC), addressing the growing requirements of the Asia-Pacific region and beyond. The symposium fosters global collaboration, providing a unique opportunity for academia, industry, and regulatory bodies to exchange knowledge and strengthen connections.

Participants will be immersed in an inspiring mix of groundbreaking research, industry insights, and cultural vibrancy. Researchers, professionals, and policymakers are welcomed to contribute, engage, and help shape the future of EMC. For more information, please visit the event website: **https://www.apemc2026.org/.**

ITU Global CyberDrill 2026

May 5-7, Dubai, United Arab Emirates

The ITU Global CyberDrill 2026 (3rd Edition) will be held from May 5 to 7, 2026, at the Dubai Exhibition Centre (DEC), Expo City Dubai, United Arab Emirates (UAE). This event will take place during GISEC Global 2026 conference and exhibition. The first day will feature a high-level conference for senior government officials and relevant authorities to discuss cybersecurity and digital resilience, and strengthen national coordination and international cooperation.

Days two and three will be dedicated to CyberDrill exercises, structured around a variety of scenarios that involve emerging types of cyberattacks. For more information, please visit the event website: **https://www.itu.int/en/ITU-D/Cybersecurity/pages/cyberdrills.aspx#.**

Ten big standardization events of China in 2025

2025年度中国标准化十大新闻事件

In 2025, prominent achievements have been made in the standardization field of China, from the promulgation of policies on standards work, the development and revision of standards at various levels, to the establishment of the digital platform for standards development.

Earlier this year, an online voting was organized by China Standardization Press (CSP) through its WeChat (a popular social media platform in China) official account to select 10 big standardization events of China in 2025. Here, the results are presented to our readers.

01

Premier Li Qiang presides over the State Council's special study session on standards

The State Council held the 16th special study session with the theme of "Strengthening the leading and guaranteeing role of standards, and promoting high-quality economic development through standards upgrading" on October 15, 2025.

When presiding over the session, Li Qiang, Premier of the State Council, stressed the need to accelerate the reform and innovation of standardization work, boost the quality upgrading of the real economy, and continue to strengthen the internal driving force for high-quality development.

Li Aixian, Vice President of China National Institute of Standardization (CNIS), gave a presentation on the theme. After the presentation and exchanges, Li Qiang pointed out that it is essential to give better play to the leading and guaranteeing role of standards. He emphasized the need to optimize the supply of standards, enhance the implementation of standards, raise the internationalization level of standards, and continue to improve the systems and mechanisms for standardization work.

He also indicated efforts to properly balance the relationship between the government and the market, national standards and local standards, as well as standards management and industry governance.

02

Standardization highlighted in the recommendations for the 15th Five-Year Plan

The Recommendations of the Central Committee of the Communist Party of China for Formulating the 15th Five-Year Plan for National Economic and Social Development was adopted at the Fourth Plenary Session of the 20th Central Committee of the Communist Party of China on October 23, 2025.

The document set forth the following requirements directly related to standardization work:

· Enhancing the technical infrastructure capacity for quality, strengthening the guiding role and internationalization level of standards, and advancing brand building;

· Improving service standards and quality brand building;

· Strengthening brand leadership, standards upgrading and new technology application, expanding and upgrading commodity consumption, and creating new consumption scenarios with broad impact and high visibility;

· Improving the integrated and coherent circulation rules and standards, connecting market facilities with high standards, and reducing logistics costs in society;

· Vigorously developing trade in services, encouraging service exports, improving the negative list management system for cross-border trade in services, and raising the standardization level of trade in services;

· Driving the construction of high-standard farmland with high quality, strengthening the protection of black soil and the comprehensive utilization of saline-alkali land, and improving the quality of cultivated land;

· Developing the standard for evaluating the equalization of basic public services;

· Improving the systems for standards, monitoring, evaluation and assessment of the ecological environment;

· Establishing and improving the standards system for green and low-carbon development, and promoting and leading the improvement, alignment and mutual recognition of international rules and standards;

· Building an industrial system for advanced national defense science and technology, optimizing the industrial layout of national defense science and technology, and promoting the general utilization of military and civilian standards.

03

Provisions on national guiding technical documents for standardization issued

The revised Administration Provisions on National Guiding Technical Documents for Standardization was issued and put into effect on April 7, 2025. National guiding technical documents for standardization adapt to the rapid development of scientific and technological innovation, and support and guide the promotion, trial application, dissemination and growth of innovative technologies when relevant scientific research achievements are not yet mature for national standards development, which serve as an important supplement to national standards.

The revision features the following innovations: expanding document types to specifications and reports; implementing the registration system for project approval without administrative procedure; adjusting the proportion of votes required for technical review from two-thirds to more than a half; and expediting the development process to accelerate the formulation and issuance of technical documents.

04

Ma Dejun receives the IEC Lord Kelvin Award

At the 89th IEC General Meeting in India in September 2025, Ma Dejun, Vice President of China Association for Standardization, was presented with the IEC Lord Kelvin Award in recognition of his 35 years of efforts to the IEC standardization.

Ma Dejun became the first Chinese expert to receive the highest lifelong individual honor at the IEC. In addition to the top honor, he also won the IEC Gold, Silver and Bronze Awards, demonstrating comprehensive and profound professional attainments in international standardization.

With the sustained efforts of Chinese experts, China has become an important participant in the development of global electrotechnical standards, actively contributing experience and solutions in relevant fields.

The award will contribute to the development of the electrical and electronic industry in China. Chinese enterprises can participate more deeply in international standards, timely grasp global technological trends and market demands, and promote the integration of internationally advanced standards with the actual development of the domestic industry, thereby improving product quality and technical level and enhancing international market competitiveness.

05

Administrative Measures for the Adoption of International Standards issued

To further regulate the adoption of international standards, steadily expand the institutional opening up of standards, and accelerate the integrated development of domestic and foreign trade, SAMR revised and issued the Administrative Measures for the Adoption of International Standards in April 2025, which came into force on June 1, 2025.

The main content of the revision includes the following five aspects: firstly, clarifying the scope of international standards to be adopted and the scope of the national standards with the adoption of international standards; secondly, establishing a full-process tracking mechanism for international standards; thirdly, specifying the requirements for the development cycle of national standards with the adoption of international standards; fourthly, strengthening the requirements on copyright policies; fifthly, improving the mechanism for the regulation and error correction of the adoption of international standards.

06

National Standards Intelligent Development System (SIDS) launched

The theme event for World Standards Day 2025 was held in Beijing on October 14, 2025, where the National Standards Intelligent Development System (SIDS) was officially released.

Developed under the guidance of SAMR, the SIDS is a digital platform designed to innovate the development process of national standards through artificial intelligence and big data technologies. It marks China's entry into a new digital stage in terms of standards development.

Relying on millions of pieces of data resources in the National Digital Library of Standards and the intelligent computing foundation, the SIDS has realized the online transformation of the entire process of standards development. The traditional offline compilation mode has been upgraded to a multi-person collaborative online operation, and the intelligent editor of standards automatically assists in generating the content of standards, which significantly improves the efficiency of compilation.

The SIDS has functions covering the drafting, technical review, release and implementation and other links of standards development, and it is gradually integrating innovative modules such as digital twins and intelligent compliance inspection.

07

SAMR provides free download service of over 30,000 national standards

In early March 2025, SAMR announced that it had provided the public with an online reading and free download service of 28,694 voluntary national standards, 1,523 mandatory national standards and 267 national guiding technical documents for standardization via the National Public Service Platform for Standards Information.

Since the start of this year, the online views of national standards have seen a new increase of nearly 17 million times, the reading volume has seen an increase of nearly 3.4 million times, and the download volume has hit over 1.5 million times, with continuously raising attention and influence. Up to now, the total online views of national standards have reached 400 million times, and the total visits have topped 70 million.

08

SAMR strengthens the management of the national standards development cycle

The Department of Standards Technical Management of SAMR officially issued the notice on strictly managing the development cycle of national standards in January 2025. The notice stipulates that the development cycle of a national standard refers to the time limit from the issuance of the plan of a national standard to the submission of its approval materials.

The development cycle of mandatory national standards shall generally not exceed 24 months, and the development cycle of voluntary national standards shall generally not exceed 18 months. For those national standards failing to submit the approval materials within the time limit specified in the plan of a standard project, the application for an extension shall be submitted 30 days in advance. The extension period for mandatory standards shall not exceed 12 months, and that for voluntary standards shall not exceed 6 months.

Starting from January 1, 2025, the strict cycle management system shall be implemented for the development of national standards, and the development cycle of national standards shall be managed automatically through the Information System for National Standards Development and Revision Management. The plans that exceed the time limit shall be automatically frozen.

09

World's first international standard for elderly care robots released

IEC 63310:2025, *Functional performance criteria for AAL robots used in connected home environment*, was officially released in February 2025 by the IEC. The standard is the first of its kind in the world, and its development was led by Chinese experts.

Based on the physiological and behavioral characteristics of the elderly, the standard provides benchmarks for the product design, manufacturing, testing, certification and other aspects of various elderly care robots, which will guide the sound development of the global elderly care robot industry.

Focusing on the needs and characteristics of the elderly in daily life, health care and other fields in the connected home environment, the standard provides the functions and performance classification of elderly care robots according to the level of assistance required by elderly users.

In addition to general requirements, it also proposes specific technical requirements for elderly care robots in terms of health status and emergency monitoring services, communication support, support for diversified activities, mobility support, as well as information and data management performance.

10

GB/T 45701-2025 for school meal preparation and delivery service enterprise released

SAMR released the voluntary national standard GB/T 45701-2025, *Guideline to school meal preparation and delivery service enterprise*, in May 2025, to further improve the food safety regulatory system for schools.

This standard, the first of its kind, applies to school meal preparation and delivery service enterprises that provide meal production and distribution services for students in primary and secondary schools as well as kindergartens. It specifies full-process normative guidelines from recipe and raw material management, processing and production, meal preparation and distribution, dining service, service evaluation and improvement, to emergency response. It also provides standardized guidance for the compliance management of relevant enterprises.

In addition, it puts forward operational guidelines on food safety, nutrition and health information exchange, as well as food waste prevention, and guides students to enhance their awareness of a balanced diet, conservation and environmental protection with good dietary habits from an early age.

编译/靳吉丽

(Translated and edited by Jin Jili based on relevant media reports in Chinese)

Ten excellent standardization papers in 2025

2025年度标准化优秀论文

Standardizers keep making theoretical explorations and innovations to advance the standardization process in China. By the end of 2025, the China Standardization Press organized experts to conduct a rigorous review of all articles published on *China Standardization (Chinese version)* and *Standard Science* in 2025. The top ten excellent papers were hereby showcased.

Research on International Standard Cultivation Pathways Based on Influence and Intellectual Contribution Assessment

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Published in the 23rd issue of *China Standardization (Chinese version)*

Abstract: Focusing on issues in China's international standard cultivation, such as "emphasizing quantity over quality" and "insufficient in-depth participation", the paper established a dual-dimensional evaluation system assessing both influence and intellectual contribution of standards. Based on the full life-cycle theory, evaluation indicators were designed from the dimensions of standards development and application. A multi-strategy coupling approach—incorporating the Analytic Hierarchy Process (AHP), entropy weight method, and grey relational analysis—was applied, combined with multi-source data including meeting minutes and standard texts, to conduct a quantitative assessment of China-led international standards. The results revealed that China's international standards have structural characteristics of "strong in development but weak in implementation" and "strong in organization but weak in communication". The influence scores predominantly cluster in the lower range, and there is a significant deficiency in the intellectual contribution in terms of core technological innovation and international communication. Accordingly, the study proposed a cultivation strategy of "short-term breakthrough of weak links and medium- to long-term strengthening of advantages", and the construction of a comprehensive cultivation system encompassing technical validation, regional promotion, patent linkage, and digital platforms. This provides scientific decision-making support and practical pathways for enhancing China's influence in international standardization and advancing standards internationalization. The research fills a theoretical gap in the quantitative evaluation of international standard cultivation and offers significant reference value for optimizing global standardization governance.

Research on the Design and Configuration of a Standard Content Main Structure Model from a Modular Perspective

WANG Yiyi[1] GU Fu[2*] LIU Xize[1] LU Xiaoping[3] GU Xinjian[2] WANG Ruoya[1]
(1. China National Institute of Standardization; 2. Zhejiang University; 3. National Key Laboratory of Mass Personalized Customization Systems and Technologies)
Published in the 11th issue of *Standard Science*

Abstract: [Objective] The current diversity in the descriptive structures used for the same conceptual systems across standards has led to multiple challenges, including difficulties in similarity analysis, limited reuse of similar structures and modules, communication and coordination barriers among stakeholders in standardization activities, prolonged drafting cycles, and quality control issues. [Methods] By mining, standardizing, and describing recurring structures and content across a wide range of standards, this study proposes a standard content master structure model composed of three dimensions: configuration items, structure, and process. [Results] The proposed master structure model facilitates rapid configuration of new standards, improves drafting efficiency and quality, and reduces unnecessary structural and modular diversity in standard content, thereby promoting the digitalization and intelligent application of standards. [Conclusion] The design and implementation of the standard content master structure model will fundamentally advance the digital transformation of standardization.

Research on Standardization Pathways for AI Governance from the Perspective of Consumer Rights Protection

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Published in the 11th issue of *Standard Science*

Abstract: [Objective] This study aims to address key challenges in the global application of artificial intelligence (AI)—such as the erosion of consumer autonomy, privacy and security risks, and fragmented transnational regulation—by proposing a new global AI governance paradigm centered on the protection of consumer rights, so as to balance technological advancement with equitable governance. [Methods] Through literature analysis and comparative case studies, this research systematically examines international standards systems (e.g., ISO) and policy practices in China, the United States, and Canada. Grounded in the dual-effect theory, it further analyzes the opportunities and potential risks that AI poses to consumer rights. On this basis, an integrated international governance framework is constructed to explore the logic of building a coordinated standardization pathway. [Results] The study reveals that while AI enhances consumer well-being, issues such as data misuse exacerbate crises related to consumer privacy, security, and equity. Moreover, AI governance models vary across countries due to differences in technological development stages and legal systems, and the lack of cross-border regulatory coordination undermines governance effectiveness, highlighting the urgent need for international collaboration. Accordingly, a four-dimensional standardization

pathway is proposed, including: integrating international normative consensus into technical standards; establishing a full-process risk governance framework; strengthening data sovereignty safeguards; and building a coordinated "certification–supervision" mechanism. [Conclusion] Effective global AI governance should be based on a multi-stakeholder co-governance model that aligns regional rules and embeds consumer rights protection across the entire standard-design process. By forming a closed loop between technical norms and legal accountability, the coordinated development of technological innovation and social justice can ultimately be achieved.

Discussion on the Legal Nature of ICAO Navigation Standards and the Enhancement of BeiDou System's Influence

GONG Zhihui **CAI Gaoqiang**
(Faculty of Law, Xiangtan University)
Published in the 11th issue of *China Standardization (Chinese version)*

Abstract: The inclusion of BeiDou SARPs in the Volume I of Annex 10 of the *Convention on International Civil* Aviation is undoubtedly a major breakthrough in the internationalization of BeiDou civil aviation standards, which marks that the BeiDou system has officially become a global satellite navigation system recognized by the ICAO. The stable operation of the system can not be separated from the perfect standards development, and the research on ICAO navigation standards including BeiDou SARPs is the prerequisite foundation for the subsequent development of the BeiDou system. This paper introduces the main contents of ICAO navigation standards such as the development body, the form of performance, as well as the development and revision process. Through analysis and demonstration, it is concluded that although SARPs should be regarded as international soft law in terms of the legal nature, the actual implementation can also have certain legal effects. In the future, China should improve the domestic standards system of BeiDou civil aviation application as soon as possible, continue to promote the standardization work of BeiDou SARPs in ICAO, and continuously enhance the international influence of the BeiDou system in standards development, so as to realize the global and industrial application of the BeiDou system in the civil aviation field.

Thoughts and Development Suggestions on the Path of Empowering Standard Digital Applications with Large Language Models

FANG Siyi
(Shanghai Institute of Quality and Standardization)
Published in the 6th issue of *Standard Science*

Abstract: [Objective] Large language model can effectively promote the in-depth development of standard digitization, and plays a pivotal role in the transformation of standard digitization. [Methods] Through literature analysis, text mining, qualitative analysis and other methods, this paper discusses the prospect of applying large language model in the field of standard digitization, summarizes the application status of large language model in the field of standard digitization, and preliminarily explores the application effect of large language model in the specific standard digitization scene based on a small sample of national standard dataset. [Results] This paper proposes a technical roadmap for the large language model to enable the digital application of standards at different levels, and gives suggestions for the development of the large language model in the digital application of standards in view of the potential problems. [Conclusion] From the perspective of the large language model, it provides technical reference for the further development of standard digitization.

Research on the Impact of Data Standards on the Digital Economy and Countermeasures

YANG Lijuan DONG Lingyu
(School of Economics, Lanzhou University)
Published in the 9th issue of *Standard Science*

Abstract: [Objective] To study the impact of data standards on the digital economy and put forward countermeasures and suggestions to promote the high-quality development of the digital economy. [Methods] By constructing a theoretical framework for data standards to influence the digital economy, combined with the Western economic theory, the paper analyzes the impact of data standards on transaction costs, network externalities, technological innovation, resource allocation and market structure. [Results] Data standards affect the development of the digital economy through multiple effects. The effect in the short term depends on the net effect, and promotes the development of the digital economy in the long term. In addition, the process of data standardization still faces challenges such as imperfect standards system, disconnection between technology and standards, data security and privacy protection, and intensified competition for international cooperation and rules. [Conclusion] Improving the data standards system, dynamically updating data standards, strengthening cooperation in international data standards, and building a solid data security defense line can further release the potential of data elements, promote the high-quality development of the digital economy, and improve China's competitiveness in global digital competition.

A Study on the Development Characteristics and Trends of Chinese Association Standards (2015–2024)

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(College of Economics and Management, China Jiliang University)
Published in the 8th issue of *Standard Science*

Abstract: [Objective] This study aims to analyze the development characteristics and trends of association standards in China over the past decade, explore their role in promoting economic and social development, and propose strategies for optimizing their future development. [Methods] Adopting a hierarchical perspective, this research employs word frequency and trend analysis methods, utilizing Python programming and the Jieba Chinese word segmentation tool. The study analyzes over 100,000 association standards published on the National Association Standards Information Platform to examine their development patterns, challenges, and key issues. [Results] The findings reveal that the development of association standards has evolved in distinct stages: the initial stage addressed basic needs; the middle stage emphasized technological innovation and industrial upgrading; and the recent stage has focused more on high-end manufacturing and sector-specific standardization. Association standards issued by nationally registered associations exhibit notable advantages in cutting-edge areas such as intelligent technologies and digitalization, while those issued by locally registered associations perform prominently in agriculture, ecological protection, and public services. Nonetheless, the rapid growth of association standards has exposed issues related to unclear positioning, inconsistent quality, and a lack of coordination with national standards. [Conclusion] In light of the observed development patterns over the past ten years, it is essential to acknowledge and address emerging problems, regulate disorderly practices, and improve governance models in areas such as data governance, role positioning, and value orientation. These steps are vital to guiding association standards toward higher-quality and more standardized development.

Research on Mechanisms of Standardization to Enhance the Resilience and Security Level of the Industrial Chain and Supply Chain—Based on the Perspective of the Transformation and Upgrading of the Status and Role of Standardization

ZHANG Hong WANG Xiaoyi* GONG Jing
(China Electronics Standardization Institute)
Published in the 7th issue of *China Standardization (Chinese version)*

Abstract: At present, the standards competition of global powers and the real needs of industrial science and technology innovation are promoting the transformation of the status and role of standardization. Standardization has been upgraded from a technical method to a systematic discourse issue at the level of national governance and development strategy, expanded from the original industrial field to the whole economic and social field. Based on the perspective of transformation and upgrading of the status and role of standardization, this paper analyzes the mechanism of standardization to enhance the resilience and security level of the industrial chain and supply chain, and puts forward the path for standardization to play a leading role in supporting the effectiveness.

Research on the Regional Collaboration Standards System for Ecological Protection and High-quality Development of the Yellow River Basin

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Published in the 4th issue of *Standard Science*

Abstract: [Objective] Focusing on the theme of ecological protection and high-quality development of the Yellow River Basin, based on the overall and long-term interests of the whole basin, this paper carries out research on the regional collaborative standards system of ecological protection and high-quality development in the Yellow River Basin, which provides comprehensive theoretical and practical guidance for the standardization of ecological protection and high-quality development in the Yellow River Basin. [Methods] By analyzing the current situation and actual development needs of the standards system construction for ecological protection and high-quality development in the Yellow River Basin, the standards system is constructed based on the standards system construction method in the standardized system engineering. [Results] Constructs the three-dimensional spatial structure of the standards system of ecological protection and high-quality development in the Yellow River Basin, and further builds the standards system framework of the two subsystems of ecological protection and high-quality development, suggestions are put forward for the organization and implementation of the standards system. [Conclusion] Regional collaboration in the development and implementation of standards is highly significant for the implementation of ecological protection and high-quality development strategy of the Yellow River Basin.

Status Analysis and Countermeasure Research of Standardization Development of Low-altitude Economy

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Published in the 14th issue of *China Standardization (Chinese version)*

Abstract: As a strategic emerging industry, the low-altitude economy has high technologies and concentrated innovation factors, and is related to multiple fields. It has the characteristics of long industrial chain, rich application scenarios, and various objects. In order to promote the standardized, orderly and efficient industrial development of low-altitude economy, this paper tracks and analyzes the status of industrial development and policies of low-altitude economy. It analyzes the current situation of the standards system, standards development and standardization technical bodies, and puts forward measures and suggestions for the standardization and industrial development of low-altitude economy in China. The standardization of low-altitude economy is a key link and an important support to promote the high-quality development of the industrial chain, which helps improve the stability and international competitiveness of the industrial chain and supply chain of low-altitude economy, and leads to the high-quality development of the industry.

The mandatory national standard, GB 28007-2024, *Technical specifications for the safety of infants' and children's furniture,* came into force on January 1, 2026.

This standard specifies general safety requirements for furniture used by infants and young children aged 0 to 14 in terms of materials, structure, flame retardancy, electrical safety, hazardous substance limits and warning labels, as well as safety requirements for specific products including children's high chairs, bunk beds, cots and folding cots, cradles, and upholstered furniture.

The implementation of the standard will help improve safety performance of furniture for infants and young children and protect their health and safety.

公益广告

Research on standardization practice of integrated innovative development of healthcare and cultural tourism

医疗与文旅融合创新发展的标准化实践研究

By Shuai Feifei[1], Wu Wenyan[1], Wang Luxin[1], Huang Xinrui[1], Gu Dayong[2], Zhang Zifei[3*]
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Abstract: Against the backdrop of the Healthy China strategy and the vigorous development of the cultural tourism industry, the integration of healthcare and cultural tourism has emerged as a highly promising direction for innovation. This paper takes the Dapeng Hospital of the Shenzhen Second People's Hospital as the research object, and analyzes how to organically combine medical academic activities, clinical medical services with the cultural and tourism resources of Dapeng New District in Shenzhen within the policy framework. By constructing a compliance-oriented, professional, and distinctive integration standards system, this paper explores an innovative development path that integrates academic exchanges, medical services, spiritual healing, and cultural experiences, providing a practical example and theoretical support for the integration of healthcare and cultural tourism nationwide.

Keywords: integration of healthcare and cultural tourism, standardization construction, innovative development, Dapeng Hospital

1. Introduction

As health awareness grows, the boundaries between healthcare and cultural tourism are blurring, with integrated development becoming prominent. The Healthy China strategy raises higher requirements for comprehensive health protection. The continuous advancement of tiered diagnosis and treatment has facilitated the descent of high-quality medical resources to grassroots levels, creating conditions for the integration of medical services with local characteristic resources[1]. Meanwhile, the cultural tourism industry is transitioning from traditional sightseeing to immersive experiences. Against this backdrop, the integration of healthcare and cultural tourism has become a new trend to meet people's health and spiritual needs.

In terms of theoretical frameworks, the Tourism Destination Life Cycle Theory (TALC) was introduced as an analytical tool, though researchers made adaptive modifications to address the unique characteristics of culture-driven destinations. For instance, Chen Caihong et al. (2025) noted that Butler's classic model is primarily insufficiently applicable to cases like the Traditional Chinese Medicine (TCM) cultural corridor, so they proposed three modified dimensions—cultural value transformation, industrial synergy, and spatial governance effectiveness—to construct a dynamically evolving model that reveals the evolutionary patterns of health-tourism integration pathways[2]. Li Wei et al. (2025) pointed out that the global medical tourism market is expected to grow from 102.6 billion U.S. dollars in 2019 to 272.7 billion U.S. dollars in 2027, with a compound annual growth rate of 15% to 25%[3]. However, China faces the issue of a "deficit" in cross-border medical services, with approximately 800,000 people seeking medical treatment abroad annually, while the scale of inbound medical tourism remains small.

The Dapeng Hospital of the Shenzhen Second People's Hospital is located in Dapeng New District, known for its natural beauty, volcanic landscapes, and Hakka architecture[4].

Since establishing the Shenzhen Dapeng New District Medical Health Group in 2018, Shenzhen Second People's Hospital has enhanced primary healthcare services and integrated medical expertise with cultural heritage. Its distinctive "Double Hakka Encircling House" design blends medical facilities with cultural landmarks, fostering innovative healthcare and cultural tourism models.

2. Methodology

This study primarily employs content analysis, conducting case studies at Dapeng Hospital and Shenzhen Dapeng New District Medical Health Group. It aims to analyze the initial practices, standards development, and future plans of multiple hospitals in Dapeng New District under the integration of these two institutions regarding healthcare-tourism integration, thereby providing empirical evidence for theoretical frameworks.

The research data sources mainly include: First, policy text, such as the national Healthy China strategy, Shenzhen and Dapeng New District cultural tourism development plans, hospital construction plans, and other relevant policy documents, to analyze the standardization process of the Dapeng Model; second, secondary data, such as hospital operation data, patient satisfaction survey reports, etc. The satisfaction scores will be analyzed to further illustrate the practical outcomes.

3. Dapeng Model

Building on the resource advantages of the Shenzhen Second People's Hospital and the natural-cultural endowments of Shenzhen Dapeng New District, the Dapeng Hospital of the Shenzhen Second People's Hospital and Shenzhen Dapeng New District Medical Health Group have jointly explored the establishment of a standardized system aimed at systematically promoting the deep integration of medical services and cultural tourism industries. This system is not a mere accumulation of single standards, but rather a mutually supportive and synergistic standardized framework formed around four core dimensions: compliant operations, medical services, academics and talent, and cultural experiences.

3.1 Compliance operation standards

Under the policy framework of the Healthy China strategy and the integrated development of culture and tourism, the compliance operation standards of the Dapeng Model have taken the lead in clarifying the legal and policy boundaries of cross-border integration. Its standards system not only follows the basic requirements of medical institution management and healthcare regulations, but also actively incorporates relevant norms such as cultural tourism, cultural heritage protection, and scenic area management. This standard provides standardized definitions for operational procedures, responsible entities, and risk management of innovative business formats such as cultural guided tours utilizing medical facilities and the integration of health consultation and experiential services into cultural tourism routes. It ensures that all innovative practices in the integration of healthcare and cultural tourism operate in a standardized and safe manner within policy-permitted boundaries, thereby laying an institutional foundation for the sustainable development of this integrated model.

When organizing medical academic events, clear distinctions are made between scholarly discussions and cultural experiences, with academic components taking precedence. Prior to any event, thorough reviews are conducted on themes and content to ensure academic topics closely align with cutting-edge medical issues and meet industry development needs. All event budgets and itineraries must undergo rigorous internal review and filing procedures. A regular audit supervision mechanism has been established, where professional auditing agencies conduct inspections on fund utilization. Any identified issues are promptly addressed to ensure every event meets rigorous verification standards.

3.2 Standardization of medical technology and services

The Dapeng Hospital has established a series of standardized medical service procedures and technical specifications. The survey on Shenzhen medical industry public satisfaction in 2024 reveals Dapeng New District's outstanding performance in regional healthcare services. The Dapeng District Education and Health Bureau topped all administrative departments with 97.18% outpatient satisfaction, 97.03% inpatient satisfaction, and an overall satisfaction score of 93.68 points. These results highlight the district's remarkable achievements in streamlining medical service processes and enhancing cross-departmental collaboration efficiency.

At the institutional level, satisfaction metrics from public hospitals in Dapeng New District further validate the tangible outcomes of service optimization. The Dapeng New District Maternal and Child Health Hospital achieved a 98.12% inpatient satisfaction rate and a 94.34-point overall satisfaction score, ranking the 6th. The Nan'ao People's Hospital in the same district scored 96.87% overall satisfaction, placing the 10th, while the Kuichong People's Hospital recorded 97.37% outpatient satisfaction. These figures demonstrate that medical institutions in the district have established systematic approaches to enhance patient experience and strengthen service quality control, providing crucial support for the implementation of integrated medical-tourism services in TCM health tourism.

The high satisfaction rate is closely tied to multiple optimization measures. For instance, in public hospitals' international medical tourism services, initiatives like implementing a multidisciplinary collaboration model, improving multilingual signage and triage systems, and

enhancing commercial health insurance settlement support have significantly improved the service experience for cross-border medical tourists. Meanwhile, the development of TCM wellness routes focuses on tourist needs, with node service coordination and sequential content design to enhance user experience—a trend that aligns with the high recognition reflected in satisfaction surveys. These high-standard, quantifiable service achievements constitute one of the core competitive elements of "medical + cultural tourism" products, providing solid medical credibility and user satisfaction support for the subsequent deep integration of specialized projects such as TCM wellness and coastal therapeutic programs with cultural tourism routes.

3.3 Standardization of academic exchange and talent training

To promote the deep integration of healthcare and cultural tourism, the Dapeng Model has established specialized standardized mechanisms in the fields of academia and talent development. First, Shenzhen Dapeng Medical Health Group involved a standardized platform for integrating academic activities. The hospitals regularly hosted high-level medical academic conferences, inviting renowned experts and scholars at home and abroad. And the hospital established standardized organizational guidelines for these conferences, ensuring themes are closely aligned with evolving industry trends and clinical needs to maintain both foresight and practical relevance. The program features a well-structured schedule including keynote speeches, case studies, and interactive discussions. Selection of experts emphasizes professional authority, with thorough consultations conducted in advance to guarantee the depth and value of their presentations.

Second, Shenzhen Dapeng Medical Health Group also established training standards for multidisciplinary healthcare professionals. The hospitals have established a talent development system to encourage medical staff to participate in academic training and research projects. The "1+3+N" expert outreach program is implemented, where "one" core specialist leads "three" specialized experts to grassroots medical institutions weekly for technical guidance and training. This initiative integrates "N" local community health initiatives, such as promoting appropriate TCM techniques and providing rehabilitation training, to enhance primary healthcare capabilities. Additionally, the hospitals collaborate with universities and research institutions to conduct continuing education programs and joint research projects for on-duty personnel, broadening medical professionals' academic perspectives and elevating their research proficiency.

3.4 Specialization standard of cultural tourism experience

To achieve seamless integration and replicable promotion of medical services with cultural tourism experiences, the Dapeng Model has conducted professional and standardized transformation of distinctive cultural and tourism resources. Shenzhen Dapeng New District Medical Health Group integrated mountain-sea landscapes, historical sites, and folk culture into medical services and academic activities. Dapeng Hospital developed regionally distinctive cultural tourism programs, with the "Coastal Health Trail" featuring rehabilitation training-designed walking routes and exercise intensity standards. The "Coastal Health Trail" will customize walking plans for patients based on their physical conditions, with professional medical staff providing guidance and monitoring. The trail will be designed based on clearly defined rehabilitation training objectives, including corresponding route length, slope configuration, rest node density, and exercise intensity classification standards. These guidelines will be standardized and formulated into a protocol in the future, to be implemented in hospitals under the Medical Group.

Dapeng Hospital has fully utilized its "Double Hakka Encircling Houses" architectural space to create an integration of medical care and cultural tourism. The "Hakka Cultural Experience Tour" adheres to a series of standards and guidelines for psychosocial rehabilitation activities, integrates social training and cultural immersion into mental rehabilitation programs. Participants visit Hakka Encircling Houses (Weiwu) and engage in traditional activities like mountain song performances and handicraft workshops. The Dapeng Hospital has established standardized regulations for the procedures of these experiential activities, including guidance scripts, group interaction segments, and the anticipated social and psychological improvement objectives. Cultural exhibition zones and wellness relaxation areas have been established in public spaces such as courtyards and corridors, showcasing Hakka culture and traditional Chinese medicine practices.

4. Challenges and approaches of the Dapeng Model

4.1 Challenge of the practice of the Dapeng Model

Currently, the development of the Dapeng Model and the entire medical-cultural tourism integration sector is primarily constrained by the following aspects.

The TCM health tourism industry currently suffers from insufficient integration of all elements, with most market players exhibiting limited value recognition[5]. While many professionals either specialize in medical fields or excel in cultural tourism sectors, those who can effectively combine both domains remain scarce. This scarcity makes it challenging to balance medical professionalism and cultural tourism appeal during project planning and implementation processes[6]. Many consumers remain unfamiliar with

this concept and uncertain about its value proposition. Traditional perceptions of tourism and healthcare also create psychological barriers when considering medical-cultural tourism products.

The integration of healthcare and cultural tourism remains in its infancy, with shortcomings evident in project design, service quality, and industrial coordination that require deeper collaboration. Many medical-tourism projects merely cobble together healthcare services with cultural activities. As Southern Network's Zhuhai-Macau case study reveals, these offerings lack depth and diversity, often limited to basic wellness elements during travel[7]. This indicates that the combined model of healthcare and cultural tourism lacks systematic innovation, with synergistic effects between industries yet to be fully realized.

4.2 Approaches to the challenges

First, collaborate with universities and vocational colleges to establish "medical-cultural tourism service" related majors or courses to cultivate interdisciplinary talents. The curriculum covers multiple aspects, including medical fundamentals, cultural-tourism planning, and service management, emphasizing practical teaching to help students accumulate real-world project experience during their studies. Meanwhile, hospitals can recruit experienced professionals in cultural-tourism planning and operations to strengthen team capabilities. The Medical Health Group needs to provide attractive working environments and development opportunities for recruited talents to encourage long-term commitment.

Second, strengthen cooperation with cultural-tourism enterprises and research institutions to jointly develop innovative medical-cultural tourism integration projects. Hospitals will collaborate with cultural-tourism enterprises to design more appealing experiential projects based on market demands and local characteristics; the healthcare industry can partner with research institutions to conduct studies on medical-cultural tourism-related topics, exploring new integration models and technological applications. For instance, specialized hospitals should focus on rehabilitation and recuperation services, while scenic areas could emphasize ecological experiences[8]. A comprehensive service quality monitoring system should be developed to supervise and evaluate every aspect of medical-cultural tourism services, promptly identifying and addressing issues.

5. Future prospects of the Dapeng Model

5.1 Build an evaluation index system for the integration of "healthcare and cultural tourism"

This evaluation system establishes quantitative metrics across multiple dimensions, including compliance, medical professionalism, and cultural-tourism experience distinctiveness, to address the gap in domestic standards for integrating healthcare with cultural tourism. The compliance dimension includes indicators such as activity compliance review approval rates and fund usage compliance. The medical professionalism dimension covers metrics like advancements in medical technical capabilities and academic output. The cultural-tourism experience distinctiveness dimension encompasses innovation in cultural-tourism projects and tourist satisfaction. Through this evaluation framework, comprehensive and objective assessments can be conducted for integrated healthcare-tourism projects, providing a basis for their optimization and improvement.

5.2 Build a coordinated development model of "medical consortium and cultural tourism"

The Dapeng Hospital will establish a collaborative mechanism between medical institutions and cultural tourism enterprises within the medical consortium to achieve resource sharing and complementary advantages in th healthcare and cultural tourism sectors. The community health center and local homestays jointly operate emergency medical stations equipped with standardized first-aid kits and AED devices, providing timely medical support for guests. Medical institutions within the consortium can offer health check-ups and medical training services to employees of cultural tourism enterprises, while these enterprises can

provide preferential cultural tourism services to patients and medical staff from affiliated institutions.

5.3 Explore the integration path of "medical science and spiritual healing and local culture"

By integrating medical academic exchanges, patient psychological healing, and local cultural experiences, the Dapeng Hospital plans to develop a healthcare-tourism fusion model. The "Mountain-Sea Memory Therapy" program for Alzheimer's patients combines coastal environments with Hakka cultural elements to enhance cognitive function recovery. In tranquil seaside settings, patients listen to ocean waves and feel sea breezes while engaging with Hakka cultural narratives and traditional artifacts. This immersive approach stimulates memory retention and slows disease progression through cultural immersion.

6. Conclusion

By establishing a compliant, professional, and distinctive integrated standards system, enhancing medical services, developing the cultural tourism industry, and expanding academic influence. The integration of healthcare and cultural tourism will become an important avenue to benefit people's psysical and mental health. It not only enhances the added value of medical services and expands the development space of the cultural tourism industry, but also promotes local economic prosperity and drives social harmony, demonstrating broad application prospects and profound social significance.

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References

[1] National Health Commission. Healthy China Initiative (2019-2030)[EB/OL]. (2019-07-28) [2025-07-08].https://www.nhc.gov.cn/guihuaxxs/c100133/201907/2a6ed52f1c264203b5351bdbbadd2da8.shtml

[2] Chen Caihong, Wang Fengxiang, Yuan Rongjuan, et al. Evolution of Health and Tourism Integration Pathways in Shandong's Traditional Chinese Medicine Cultural Corridor from the Perspective of Tourism Destination Life Cycle Theory [J]. *Western Tourism*, 2025, (12):34-36.

[3] Li Wei, Zhou Pu, Chen Hong, et al. Strategies for Public Hospitals to Develop International Medical Tourism [J]. *Healthy Development and Policy Research*, 2025,28(05):573-578.

[4] Shenzhen Dapeng New Area Administrative Committee. Shenzhen Dapeng New Area Tourism Development 14th Five-Year Plan [EB/OL]. (2023-01-12) [2025-07-08].https://www.dpxq.gov.cn/xxgk/xxgk/ghjh/fzgh/content/post_10379511.html

[5] Zong Anpeng, Yu Xingmin, Chen Dandan, et al. Challenges and Development Paths of Traditional Chinese Medicine Health Tourism in China from the Perspective of All-for-One Tourism [J]. *Journal of Nanjing University of Chinese Medicine (Social Sciences Edition),* 2025,26(4):253-259.

[6] Yang Qian, Zhang Jie. Analysis of Issues in Modern Hospital Building Design [J]. *Brick & Tile World*, 2022(10):19-21.

[7] Southern Network. Research on the Integrated Development Path of Tourism and Healthcare Industries in Zhuhai-Macao[EB/OL].(2021-03-26) [2025-07-31].https://opinion.southcn.com/node_4eddbd6bd8/5f6998fe09.shtml.

[8] Zhou Mi. Strategies for the Integrated Development of Cultural Tourism Industry in Guangdong-Hong Kong-Macao Urban Agglomeration [J]. *Social Science Journal*, 2022(10):39-46.

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A comparative study of national electric bicycle standards in China and Malaysia

中国与马来西亚电动自行车国家标准比对研究

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Abstract: China ranked first worldwide in the production and export of electric bicycles. As an emerging market for electric bicycles, Malaysia holds significant potential for trade collaboration with China in this sector. This study presents a comparative analysis of the national electric bicycle standards in China and Malaysia, offering technical insights from a standardization perspective. These insights aim to support Chinese enterprises in strategically positioning their technologies in the Malaysian market. The findings reveal significant differences in technical parameters, safety requirements, and testing methods, highlighting the need for tailored product adaptation.
Keywords: electric bicycle, standards, comparative study

1. Introduction

As the commitment to green and low-carbon development draws global attention, the focus on sustainable transportation increases worldwide. The electric bicycles (hereinafter referred to as e-bikes) have emerged as a key component of sustainable transportation, showing strong growth and promising prospects in international trade. A key contributor to this global trend is China, where the annual exports of e-bikes have exceeded 20 million units, with an export value running into billions of U.S. dollars, according to China's customs statistics. This export trend is further accelerated by the implementation of the Regional Comprehensive Economic Partnership (RCEP), which has significantly reduced trade barriers with ASEAN members and created a historic opportunity for China's e-bike exports. The e-bike market in ASEAN countries has been steadily growing in recent years, with its scale continuously expanding. Among the ASEAN export destinations, Indonesia ranks as the largest market, while Malaysia holds the 5th position.

Malaysia presents a vast personal transportation market, with 16.9 million registered motorcycles (Motosikal) at the end of 2023, a figure nearly equal to the number of passenger cars (Motokar), 17.4 million, according to statistics from the Ministry of Transport Malaysia. The Malaysian government is actively promoting the adoption of electric two-wheelers, such as e-motorcycles and e-bikes, by offering road tax exemptions and other financial incentives. Malaysia's e-bike market holds great potential, driven by RCEP tariff cuts and the above-mentioned domestic incentives. This creates a promising opportunity for China, a global e-bike export leader, to develop trade with Malaysia in the e-bike sector. Therefore, this paper analyzes the differences between Chinese and Malaysian e-bike standards regarding technical parameters, safety performance, and test methods. The study also aims to provide reference for Chinese enterprises in product design, certification and export strategy, and to offer insights for international standardization efforts and regional market adaptation within the e-bike industry.

2. The e-bike standardization landscape in China and Malaysia

2.1 The e-bike standardization landscape in China

China's e-bike regulatory system is mainly built upon the mandatory national standard GB 17761-2024, *Safety technical specification for electric bicycle*, which was revised and issued in 2024. This standard defines core parameters, including maximum speed, vehicle weight, motor power, and battery voltage—for two-wheel bicycles equipped with onboard auxiliary batteries, pedal capabilities, and electric-assisted or electric-driven functions. It also introduces, for the first time, systematic safety requirements,

including fire resistance, tamper-proof design, and BeiDou positioning and communication, thereby enhancing the overall safety and quality of e-bikes. It helps form a solid technical foundation for the development of China's e-bike industry. Additionally, other mandatory national standards have been issued to specify more detailed requirements, for instance, GB 43854-2024, *Safety technical specification of lithium-ion battery for electric bicycle*, GB 42296-2022, *Safety technical requirements of charger for electric bicycles*, and GB 42295-2022, *Safety requirements for electric bicycles electrical*, which establish a comprehensive regulatory framework for e-bike safety.

2.2 The e-bike standardization landscape in Malaysia

Malaysia adopts a combined "national standard + traffic regulations" approach to administer e-bikes. From the perspective of standards, the technical requirements are defined by MS 2514:2015, *Electric bicycles (electric pedal assisted bicycles) - Specification*, which is largely aligned with the EU standard EN 15194:2017+A1:2023, *Cycles - Electrically power assisted cycles - EPAC Bicycles*. In terms of traffic regulations, the legal framework is established primarily by the Malaysia Road Transport Act 1987 (Act 333). Section 2 of the Act defines "electric bicycle" as "cycles with pedal assistance which are equipped with an auxiliary electric motor having a maximum continuous rated power of 0.25 kW". Furthermore, the Road Traffic (Prohibition of Use of Certain Micromobility Vehicles) Rules 2021 explicitly prohibit non-compliant vehicles—such as mopeds and personal mobility devices (PMDs)—on public roads, thereby creating a negative list for enforcement.

3. Comparison of e-bike standards in China and Malaysia

3.1 Applicable scope

Regarding the vehicle types covered by the standards, the Chinese standard excludes tricycles, quadricycles, and other forms of electric mobility. In contrast, the Malaysian standard applies to both two-wheeled and three-wheeled electrically power-assisted bicycles, except for vehicles powered solely by an electric motor. A fundamental difference lies in the operational modes: the Chinese standard covers both pure electric drive and power-assisted modes, while the Malaysian standard strictly confines e-bikes to the "bicycle" category, stipulating that the electric motor may only provide assistance. This distinction leads to differences in all key technical parameters between the two standards. The specific scopes of application for Chinese and Malaysian standards for e-bikes are presented in Table 1.

3.2 Key performance parameters

Both Chinese and Malaysian standards cover fundamental performance parameters such as total vehicle mass, motor power, battery voltage, speed, and pedal-assist functionality. Although both countries reference the EU standard EN 15194:2017+A1:2023, *Cycles - Electrically power assisted cycles - EPAC Bicycles for speed limits*, the Malaysian standard sets significantly lower thresholds than its Chinese counterpart in terms of maximum vehicle mass, motor power, and battery voltage. In this regard, Malaysia emphasizes more on lightweight design and the non-motorized vehicle classification. Detailed parameters are provided in Table 2.

Item	China (GB 17761-2024)	Malaysia (MS 2514:2015)
Vehicle types covered	Two-wheeled e-bikes	Two- and three-wheeled electrically power-assisted cycles (EPACs)
Pure electric drive capability	Included	Not included
Power assist capability	Included	Included and mandatory
Motor cut-off condition	-	The motor must cut off when the speed reaches 25 km/h or when the rider stops pedaling.

Table 1: Applicable scope of Chinese and Malaysian standards for e-bikes

Item	China (GB 17761-2024)	Malaysia (MS 2514:2015)
Maximum vehicle mass	≤55 kg (≤63 kg for lead-acid batteries)	≤40 kg
Maximum motor power	≤400 W	≤250 W
Maximum battery voltage	≤48 V	≤60 V (Direct current)
Maximum speed	≤25 km/h	≤25 km/h
Pedaling function	Mandatory	Mandatory; motor assistance is dependent on pedaling

Table 2: Key performance parameters of Chinese and Malaysian standards for e-bikes

3.3 Safety parameters

3.3.1 Insulation performance

Both Chinese and Malaysian standards specify insulation performance requirements for e-bikes. They also require that the insulation resistance must not fall below 250 Ω after water exposure and should recover to at least 500 Ω following a 24-hour rest.

3.3.2 Braking performance

Both Chinese and Malaysian standards specify requirements for e-bicycle braking performance, covering testing under both dry and wet conditions. However, there are differences regarding test methods and emphases. The Chinese standard specifies different speeds and braking methods for dry and wet conditions, while the Malaysian standard adopts a uniform speed and places greater emphasis on vehicle stability during wet-condition braking. A detailed comparison of the specific requirements is presented in Table 3.

3.3.3 Waterproof performance

The Chinese standard GB 17761-2024 sets more detailed requirements for water resistance, specifying specific Ingress Protection (IP) ratings and test conditions for different components. For instance, the electrical system and key components must meet at least an IPX7 rating, meaning they must remain fully functional without performance degradation after 30 minutes of immersion at a depth of 1 meter. The standard also mandates that the insulation resistance must recover to the specified value after 24 hours of rest following water exposure, to ensure long-term safety. Test methods for waterproof performance include spray tests and immersion tests.

In contrast, the Malaysian standard MS 2514:2015 specifies a relatively lower level of water—an IPX4 water resistance rating, which protects against water splashes. It does not assign specific IP ratings to key components but defines a system-level spray test (4 hours, ≥25 cm/h) with operational checks. This standard also includes a flood fording test, requiring the e-bike to travel 140 meters in 10 cm water at 10-15 km/h while maintaining all electrical functions.

3.3.4 Fire resistance, anti-tampering, and intelligent supervision

In contrast to Malaysia, the Chinese standard adopts a more proactive approach in these three domains. It focuses on preventing safety problems before they happen, rather than dealing with them afterwards, therefore creating a full safety system that includes physical protection, anti-tampering technology, and data supervision. Such a closed-loop system directly addresses recent issues like frequent e-bike fires, and also helps guide the future of city traffic control. A detailed comparison of the specific requirements is indicated in Table 4.

Item	China (GB 17761-2024)	Malaysia (MS 2514:2015)
Test condition (dry)	Dry pavement	Dry pavement
Test condition (wet)	Simulated rainy pavement	Simulated wet/slippery pavement
Test speed (dry)	25 km/h	20 km/h
Test speed (wet)	16 km/h	20 km/h
Braking distance (dry)	≤7 m (both brakes), ≤15 m (rear brake only)	≤5 m (both brakes), lateral deviation ≤±0.5 m
Braking distance (wet)	≤5 m (both brakes), ≤10 m (rear brake only)	≤10 m (both brakes), lateral deviation ≤±0.5 m
Specific braking mode	Includes rear-brake only	Not specified

Table 3: Braking performance requirements of Chinese and Malaysian standards for e-bikes

Item	China (GB 17761-2024)	Malaysia (MS 2514:2015)
Fire resistance	Comprehensive and tiered: specifies flame retardant grades (e.g., V-0 to V-1) for non-metallic materials such as the battery compartment, electrical components, wiring, and seat.	No specified or systematic requirements
Anti-tampering	Mandatory: includes mutual charging/discharging recognition, anti-tamper controllers, and physical/software measures to prevent illegal modifications.	No specified requirements
Intelligent supervision	Mandatory (commercial vehicles): requires BeiDou positioning and 4G/5G communication modules for real-time safety monitoring.	Intelligent supervision

Table 4: Fire resistance, anti-tampering, and intelligent supervision requirements of Chinese and Malaysian standards for e-bikes

For Chinese manufacturers planning to enter the Malaysian market, the lack of corresponding requirements in the Malaysian standard presents a valuable opportunity to highlight their products' safety advantages and promote higher safety awareness and expectations locally.

3.3.5 Safety devices and labeling

Both Chinese and Malaysian standards require e-bikes to be equipped with front and rear lights, reflectors, and plates to ensure basic riding safety and vehicle identification. The Malaysian standard sets higher requirements for label durability and information completeness. Labels (or plates) must pass weather resistance tests to ensure they do not fade or detach under extreme conditions such as high temperature and humidity.

The Malaysian standard includes additional environmental information requirements, for example, "This battery must be returned to the manufacturer or importer for recycling or disposal", with example label designs (see Figure 1) indicated. Furthermore, warning devices (e.g., a bell) and charge indicator are also required based on the standard, further enhancing user safety and convenience.

Figure 1: Separate collection symbol

3.3.6 Comprehensive performance and whole-vehicle testing

In comprehensive performance and whole-vehicle testing, Chinese standards focus on fundamental safety and functionality validation, including flame retardancy, radio disturbance, and labeling inspections. China also specifies detailed burning behavior requirements for non-metallic materials, electrical wiring, and seat coverings. For instance, non-metallic components must meet the vertical burning test V-0 rating per GB/T 5169.16-2017, *Fire hazard testing for electric and electronic products—Part 16: Test flames—50 W horizontal and vertical flame test methods*, while textiles and leather materials must comply with specific after-flame and smoldering time criteria.

In comparison, the Malaysian standard emphasizes real-world usage scenarios and operational reliability. It includes a range capability test that evaluates maximum travel distance under different terrain and load conditions, along with a flood fording test tailored to tropical climates, requiring normal operation in waterlogged environments. Additionally, the standard mandates electromagnetic compatibility according to MS CISPR 12:2012, *Vehicles, boats and internal combustion engines - Radio disturbance characteristics - Limits and methods of measurement for the protection of off-board receivers (Third revision) (CISPR 12:2009, IDT)* and ISO 11451-2:2025, *Road vehicles - Vehicle test methods for electrical disturbances from narrowband radiated electromagnetic energy*, ensuring safety and stability in complex electromagnetic settings through comprehensive emission and immunity tests.

4. Conclusion

The comparison of key parameters requirements reveals significant differences between Chinese and Malaysian e-bike regulations.

4.1 Different technical regulatory system

China's e-bike standards have evolved within a robust industrial ecosystem and large market demand, resulting in comprehensive regulations that align closely with national transportation infrastructure, road conditions, and industrial strategy. These standards are characterized by a Chinese systematic structure and detailed technical specifications. In contrast, the Malaysian standard framework is still in its developmental phase. While it incorporates international references and adapts to local road environments, climate, and consumer habits, some of the requirements are less comprehensive than those in China. However, specific requirements such as the flood fording test pose a clear challenge for Chinese manufacturers entering the Malaysian market.

4.2 Different market priorities

Chinese consumers have diverse needs that differ between urban and suburban areas. Therefore, while ensuring safety, Chinese standards also accommodate varying performance requirements for different user groups, allowing for a certain degree of flexibility. In contrast, the Malaysian market is still developing, and consumer preferences are not yet fully formed. Local standards emphasize lightweight design and non-motorized vehicle characteristics to match regional travel habits. Technical requirements are relatively basic, though some tests—such as those for flood fording—reflect adaptations to local conditions. This requires Chinese companies to adjust their product designs and feature sets accordingly.

4.3 Different industry development stages

China's e-bike industry is mature, with a complete supply chain and strong technological innovation capabilities. Its standards aim to enhance overall product performance and promote high-quality development. In contrast, Malaysia's industry is still in its early stages, relying heavily on imports. Its standards mainly focus on regulating imported product

quality and guiding industrial growth, such as requiring compliance with international norms in electromagnetic compatibility. Understanding these differences helps Chinese companies better grasp market trends and develop effective market strategies.

5. Suggestions

5.1 Enhancing the understanding of market access requirements in Malaysia

It is necessary to thoroughly investigate the key parameters specified in Malaysian e-bike standards, such as motor power, speed limits, and battery voltage. In terms of hardware, products must strictly adhere to these regulations; and in terms of product positioning, it should be defined as a "pedal-assist" e-bike, where the motor provides assistance only when the rider is pedaling. Given the lack of specific Malaysian requirements in areas such as fire resistance and battery safety, Chinese manufacturers could consider making advanced safety technologies—such as flame-retardant materials, charge protection, and battery management systems (BMS)—a core selling point for market entry.

5.2 Developing mutually agreed standards with Malaysia

Chinese companies should collaborate with industry associations to actively engage with relevant standardization bodies and enterprises in Malaysia. On the one hand, they can share China's experience and achievements in the development and implementation of e-bike safety standards, supporting Malaysia in enhancing its own standards system. On the other hand, regarding standards with significant differences—such as water resistance performance and braking performance test methods—both sides should conduct joint research and testing to promote alignment and eliminate technical barriers to product exports.

5.3 Enhancing industrial collaborative development

It is essential to fully leverage the benefits of the RCEP agreement and strengthen industrial collaboration with local Malaysian enterprises. By establishing joint ventures, cooperative R&D centers, and similar entities, both sides can integrate their advantages and resources. Utilizing the sales networks and brand influence of local partners, along with the advanced technology and mass-production capabilities of Chinese firms, will enable the joint development of e-bike products tailored to the local market. This approach will increase market share in Malaysia and achieve mutual growth and shared success for both China and Malaysia.

References

[1] *Statistik Pengangkutan Malaysia: Malaysia Transportation Statistics 2023* [DB/OL]. (2024-01-28) [2025-03-01]. Available from: https://www.mot.gov.my/en/Statistik%20Tahunan%20Pengangkutan/Transport%20Statistics%20Malaysia%202023.pdf

[2] GB 17761-2024, *Safety technical specification for electric bicycle* [S]

[3] MS 2514:2015, *Electric bicycles (electric pedal assisted bicycles) - Specification* [S]

[4] Minister of Transport of Malaysia. *Road Traffic (Prohibition of Use of Certain Micromobility Vehicles) Rules 2021* [S/OL]. (2021-12-17) [2025-05-02]. Available from: https://lom.agc.gov.my/act-view.php?type=pua&lang=BI&no=P.U.%20(A)%20453/2021

[5] Minister of Transport of Malaysia. *Safe Cycling Guide (1st edition)* [OL]. (2022-01-30) [2025-05-03]. Available from: https://www.miros.gov.my/userfiles/file/SafeCyclingGuide.pdf

[6] Malaysia. *Road Transport Act 1987 (Act 333)* [S/OL]. (2013-02-01) [2025-01-28]. Available from: https://www.jpj.gov.my/en/act-333/

[7] Horizon Gitano Briggs & Leong Hau Kian. *Malaysia Stocktaking Report on Sustainable Transport and Climate Change* [DB/OL] (2021-11-03) [2025-01-06]. Available from: https://www.mot.gov.my/en/Documents/summary%20of%20malaysia%20stocktaking%20report-MY_StockTakingReport_Final.pdf

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Four-dimensional integrated standardization practice in the construction of large-scale complex information systems

大型复杂信息系统建设中的四维一体标准化实践

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Abstract: Large-scale complex systems are integral to the functioning of various organizations within the national economy. Despite their significance, the lengthy construction cycles and the involvement of multiple entities often result in the deprioritization of standardized management practices, as they do not yield immediate benefits. The implementation of such systems typically encompasses the integrated phases of "development, construction, utilization, and operation and maintenance". To enhance the overall delivery quality of these systems, it is imperative to dismantle the management barriers among these phases and adopt a holistic approach to standardized management. This paper takes a specific system project as a research object to identify common challenges, and proposes improvement strategies in the implementation of standardized management. Empirical results indicate a substantial reduction in the system's full-lifecycle costs.
Keywords: large-scale complex information systems, quality management, standardization

1. Introduction

Large-scale complex information systems are developed to meet the needs of cross-organizational departments, multiple scenarios, and high concurrency. They support complex business processes and a large number of functional applications, and achieve complex goals through in-depth collaboration among multiple subsystems and components. These systems are widely used in key fields such as government affairs, finance, energy, and transportation.

Therefore, in the practical process, large-scale complex information systems often face challenges in data consistency, performance bottlenecks, high availability, and operation and maintenance to meet user needs and achieve their quality goals.

With the development of IT technology, a large number of tool software have played an important supporting role in the construction and implementation of large-scale complex information systems. However, from a system perspective, improving the efficiency of tools at a single level cannot solve the systematic problems of large-scale complex information systems. In particular, for the full lifecycle of the development, construction, utilization, operation and maintenance of information systems, it is necessary to adopt a standardized work mode to reduce the complexity of the system and improve the coordination of various components, thus ensuring the final quality is controllable[1].

2. Current standardized management model

2.1 Standardization and quality management

Standardization management serves as the fundamental framework and implementation basis for quality management: quality objectives must be quantitatively decomposed with reference to industry or internal organizational standards to avoid quality control failures due to misunderstandings among roles. Quality-related activities in each phase of an information system project shall be carried out in accordance with relevant standards. For instance, in the software

coding phase, compliance with coding specifications can reduce problems such as poor code readability and difficult maintenance caused by arbitrary coding by individuals. When quality issues arise in a project, it is necessary to identify the causes and trace responsibilities through relevant standards, thereby minimizing the buck-passing phenomenon among different links[2].

Quality management acts as the goal-driven guide and value realization guarantee for standardization management. Changes in project quality objectives will drive the synchronous optimization of rules in standardization management to support new quality requirements. The effectiveness of standardized management needs to be verified by quality data. If the standards can effectively improve project quality and reduce defect rates, they can be further applied in subsequent projects.

At present, some projects suffer from the disconnection between standardization and quality management. On the one hand, some projects emphasize standardization over quality and excessively pursue the completeness of standards without supervising the implementation through quality management. In this case, standards become "paperwork" and fail to ensure system quality. On the other hand, some projects prioritize quality over standardization, focusing only on the final quality results and relying on emergency testing before launch to fix defects. Due to the lack of established process standards, these projects have to deal with frequent emergency responses and cannot truly avoid problems, which often results in low efficiency and repeated rework.

2.2 Characteristics of information system standardization

The standardization of large-scale complex information systems is based on project management and systems engineering principles, requiring adaptive adjustments to its characteristics: frequent requirement changes, high technology intensity, cross-domain collaboration, and long lifecycles. Its core features are as follows:

1) Compatibility challenges from parallel heterogeneous systems. Differences in technology stacks lead to discrepancies in data formats, coding specifications, models, and interface protocols across systems/components, easily forming information silos and increasing system architecture design difficulty[3].

2) Technical standards lag behind technological evolution. Rapid IT development makes existing standardization frameworks incompatible with new technologies, leaving no reference specifications for new technology adoption. Technical selection thus requires balancing standardization and innovation, posing challenges to decision-makers.

3) Conflicts between rigid processes and changing requirements. Traditional models (e.g., the waterfall model) define strict procedures for requirements, development, and testing, but in scenarios with frequent iterations, teams often simplify standardized testing to meet schedules, which raises project risks[4].

4) Standards implementation deviations due to collaboration and skill gaps. Projects involve cross-domain suppliers, with significant differences in their understanding and execution of standards, leading to integration risks. Additionally, high IT personnel turnover and insufficient standardization training weaken staff's standards awareness, resulting in perfunctory implementation.

3. Current progress

3.1 Current situation and problems

A large-scale complex information system is usually composed of multiple teams, multiple professional roles, as well as a variety of technologies, tool software, and a large number of devices. Only by coordinating organizational goals, business requirements, and user experience can the value of the large-scale complex information system be exerted.

At present, domestic teams have carried out long-term practices in the full-lifecycle chain of "development, construction, utilization, and operation and maintenance" of large-scale complex information systems. They have made active innovations in system architecture design, efficient resource management, and automated operation and maintenance systems, successfully completed the acceptance of multiple projects, delivered them to user units, and promoted the progress of the industry.

Nevertheless, several key issues persist:

1) The accelerated iteration of new technologies increases the difficulty of selection, and there are adaptability problems with business processes, affecting the overall project progress. For example, the traditional waterfall model requires a complete clarification of user requirements first, while the agile development model only focuses on partial functions. This difference leads to fragmentation in the business process design, affecting the connection of the entire process chain.

2) Inconsistent goals across departments and organizations result in difficulties in coordination and poor communication, which hinders the project progress. For example, the business departments of the user side focus on whether the functions meet the business needs and frequently propose changes to requirements during the project implementation. In contrast, the development side pays more attention to on-time delivery and may cut some phases for the sake of progress, leading to misalignment of goals and priorities.

3) The information system has insufficient usability, complex operation steps, and poor alignment with actual business habits, causing inconvenience to users and failing to improve work efficiency. For example, in many government

affairs industries, adjustments and reforms are constantly being carried out, and some systems often struggle to adapt to the dynamic changes brought about by policy adjustments.

4) The operation and maintenance of the system largely rely on manual experience for fault diagnosis. However, as the system architecture becomes more complex, the requirements for the capabilities of operation and maintenance personnel become extremely high. The traditional manual mode is inefficient and error-prone, making it difficult to meet the needs of efficient and stable system operation. For example, the causes of faults in many complex systems are often deeply rooted. What users may perceive is a simple unresponsive system interaction, but behind it may be a storage failure caused by hardware faults, and the manual troubleshooting cycle is long.

3.2 Cause analysis

A key reason for these problems is the lack of a systematic standardization system during implementation, which leads to systemic deviations in the entire process. Small oversights can amplify risks across phases, ultimately causing loss of project risk control. The standardization system for large-scale complex information systems is established to unify goals, reduce collaboration costs, and avoid such risks. The main reasons for the lack of standardized management in large-scale complex information systems are as follows:

1) Misunderstanding. Personnel in different roles and positions have inconsistent understandings of standardization. Some people believe that standardization restricts innovation, limits the selection of technical architectures, and affects team innovation. However, standardization does not adopt a rigid "one size fits all" model, but rather retains reasonable flexibility in technical selection while ensuring the unification of core rules—a balance that avoids the risk of insufficient maintenance resources caused by niche technology choices.

2) Management habits. Due to the complexity of the system, it is often difficult to accurately divide the full lifecycle of the project into the project initiation phase. It focuses on development progress and function realization, and standardization is not included in the overall planning[5].

3) Cost priority. Standardization requires long-term investment from the organizational level to the project level, but it is difficult to generate immediate economic benefits. In fact, it may take two to three years to show benefits. Therefore, under cost pressure, some decision-makers pay more attention to the short-term completion of the schedule, often adopting the approach of "implementation first, supplement standards later".

4. Typical practice

Notably, the authors' project team has long been engaged in the development and construction of large-scale complex information systems. This paper analyzes the experience of implementing standardization throughout the "development, construction, use, and operation and maintenance" process of a certain system, providing useful references for the standardization construction of other systems.

4.1 Basic project situation

This large-scale complex information system mainly serves a national-level industry management institution, with a large number of branches and end-users. Due to the overall organizational framework being continuously adjusted and reformed in accordance with the unified deployment requirements of China, the project team undertook the development of this system against this background.

1) The young project teams tend to lack standardization awareness. Although the members had basic quality awareness, they failed to consciously apply standardization requirements in their work. In the early stage, no standardization engineer was assigned. Although the standardization work was planned, it only remained at the document level, without timely tracking and control.

2) Since the end-users are scattered across the country and there are significant differences in business specialization, only the needs of some user units were considered in the project planning phase, while the needs of other users with special professional backgrounds were ignored. Additionally, integrated planning with subsequent construction and operation and maintenance was not conducted.

3) The project's standardized document templates were inadequate: the organization's existing software development templates were outdated (not aligned with technological trends) and had poor applicability for large-scale complex systems.

4) There were many outsourced participants (e.g., software and hardware manufacturers). The system also relied on external infrastructure (e.g., networks and data centers) and required data sharing with other systems, which posed risks due to inconsistent construction schedules.

5) The first phase of the project only undertook the system development work. However, after the software system was launched, in accordance with the user requirements, software trials were carried out simultaneously based on the priority of function development, and the demonstration of system integration was also initiated.

4.2 Measures

The standardization work of large-scale complex information systems is mainly managed through a closed loop of "planning, development, implementation, supervision, revision, and optimization". To solve the problems encountered in practice, the standardization requirements are implemented from the four-in-one perspective of development, construction, utilization, and operation and maintenance.

1) For the development phase, under the leadership of the project chief engineer, subsystem designers, quality engineers, and other stakeholders collaborated to overhaul the project's standardization framework. The general standardized system of the organization for various departments was refined, and in combination with the development of technological iteration, national standards related to cloud computing and artificial intelligence were incorporated into the project's standardization system. Standards and specifications suitable for the project were established, such as clarifying the use of relevant tool software and the granularity of requirement document writing in each phase. New standards were also introduced for user interaction, API access, and database migration. After refinement, various document templates could better adapt to the subtasks in different fields of the project.

2) For the construction phase, during system construction, newly released standards (e.g., the national standard GB/T 42131-2022, *Artificial intelligence—Technical framework of knowledge graph*) were promptly incorporated into the project's reference standards as needed. To enhance the standardization awareness of project team members, especially against the background of high overall personnel mobility in the IT industry, targeted training sessions were organized to unify the ideological understanding of personnel in different roles. Through training, personnel in each role can clearly understand the work standard requirements of their respective positions and the collaboration standards with other project team members. For example, developers are required to rely on various interaction designs in the user interaction prototypes designed by requirement analysts and should not omit any of them; the test outlines written by testers are required to strictly cover all contents of the requirement analysis documents.

3) For the utilization phase, the relevant tools required for standardized management were identified. The previously discrete, fragmented, and document-based management of various requirements and defects was transformed into centralized management through interactive collaborative management tools such as ZenTao (a collaborative project management tool for IT teams). This connected personnel in various phases, including requirement design, development, testing, and operation and maintenance implementation, and supported the entire process through standardized tools, reducing communication and collaboration costs.

4) For the operation and maintenance phase, the standardized management requirements among the four phases were connected. On the one hand, a standardized operation and maintenance service process was formulated, specifying the phases and steps in which requirement and development personnel participate, to quickly respond to and handle problems in accordance with the process manual. On the other hand, at the initial stage of system

launch, requirement designers were involved in part of the business operation and maintenance work as a starting point to improve the usability of the system design. Requirement designers assisted in compiling the manual for common business problems, which was then handed over to operation and maintenance personnel for business support services.

In particular, to realize the integrated coordination of the above four phases, unified and integrated design was carried out for basic data management throughout the whole process, including user roles, organizational structures, function permission allocation, data dictionaries, and other related aspects. Such unified design provides overall basic support for the entire lifecycle, ensuring that implementers can start collecting relevant information from the initial stage of the project, feed it back in a timely manner, and apply the basic information into the system steadily.

5. Conclusion

Implementing the four-in-one standardization requirements (development, construction, utilization, and operation and maintenance) eliminated information silos and process discontinuities across phases, reducing system failure rates and shortening the launch cycle in subsequent improvements. Specifically, the positioning time for common problems was reduced from days to hours through standardized interfaces, and the delivery cycle for new functions was shortened from approximately one month to one to two weeks through standardized module design. Ultimately, the lifecycle cost of the entire system was reduced, which not only ensured the continuity and stability of the business but also laid a solid foundation for subsequent function expansion and technological iteration.

Although some benefits have been achieved in practice, it should be noted that IT technology is developing rapidly, especially artificial intelligence technology based on large models, which has brought significant changes to the system integration and development models. In the future, the standardized management work of large-scale complex information systems needs to align with the development trend of technology, further carry out management innovation, and enhance adaptability to new technologies.

References

[1] FEI Z H. Research on quality management of large-scale information systems [J]. *China Information*, 2021, (04): 48-49.

[2] WU J H. Quality management and control of information system integration projects [J]. *New Technology & New Products of China*, 2020, (09): 136-137.

[3] WANG H W. Standardization of communication engineering construction and application of information system management [J]. *Information Recording Materials*, 2021, 22 (01): 76-77.

[4] BU S M, LI X, ZHANG W, et al. Key strategies for project management of large-scale complex information systems [J]. *Project Management Technology*, 2015, (06): 87-88.

[5] XIANG B. Discussion on project management of large-scale complex information systems [J]. *Electronic Testing*, 2016, (05): 173-174.

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Research on the impact of industrial robot safety standards on technological innovation

工业机器人安全标准对技术创新的影响研究

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Abstract: With the progress of Industry 4.0, collaborative robots (cobots) have become a key area of innovation. However, safety standards such as ISO/TS 15066 often lag behind rapid technological advances, failing to balance safety and innovation. This paper analyzes the conflicts between standards and innovation of industrial cobots, including lag, rigidity, and safety-performance trade-offs. It proposes flexible standards, regulatory sandboxes, and lifecycle safety approaches to align safety with technological progress.
Keywords: industrial robots, collaborative robots, safety standards, technological innovation

1. Introduction

Industrial robots are crucial for manufacturing transformation. Cobots, which operate alongside humans, have become a focal point of innovation in robotics. However, close interaction raises safety risks, which is why standards like ISO/TS 15066[1] are developed. These standards, while ensuring safety, may lag behind fast-evolving technologies such as AI and sensing systems, creating a conflict between standardization and innovation.

Standards establish safety boundaries and foster trust for large-scale adoption, but their slow update and universal requirements may hinder the implementation of new methods. For instance, due to the absence of corresponding provisions for emerging technologies in current safety standards, innovative products often face certification delays, which hinders their timely market entry[1], highlighting the tension between standards and innovation. This paper analyzes the conflictive impact of safety standards on technological innovation of cobots. By examining the manifestations and causes of these conflicts, it aims to support the development of a more adaptive standards framework and explore pathways for coordinating safety with continuous technological advancement.

2. The role of safety standards in technological innovation

On the one hand, standardization provides important support and a basic platform for technological innovation. Standards serve as the carrier of knowledge accumulation, systematically summarizing the mature experiences and technical achievements within the industry. It means that subsequent innovation does not have to "start from scratch" but to continue advancement based on the existing foundation.

On the other hand, certain standardization may also constrain technological innovation and create a lock-in effect. Slow-updated standards may fail to keep pace with rapid technological advances, becoming an obstacle to innovation. Both insufficient and excessive standardization may hinder technological innovation.

The field of cobots clearly reflects this nature of safety standards. Safety standards such as ISO/TS 15066 define the safe boundaries for innovation by setting safety parameters, such as power and force limiting (PFL), speed monitoring, and minimum distance requirements. These help ensure basic safety and strengthen market confidence. However, specific technical requirements within these standards may directly conflict with goals for higher performance and greater intelligence in technological innovation.

3. Specific manifestations of conflict: safety standards and technological development in cobots

3.1 The contradiction between lagging standards and technological progress

The technical standards development process is rather long, compared with rapidly evolving technologies such as AI and adaptive control. For example, ISO/TS 15066 defines collaboration modes like PFL, but the assessment methods for newer technologies like deep learning-based behavior prediction and dynamic obstacle avoidance are not included in current standards[2], leading to certification barriers for innovative technologies.

3.2 Tension between standards uniformity and innovation diversity

The core objective of safety standards is to establish unified and general technical specifications to ensure that all products meet the basic safety requirements. However, technological innovation often pursues differentiation and adaptability to specific scenarios. In practical applications, the demands for robot performance vary significantly across different tasks. If the same safety threshold is imposed on all scenarios, it may lead to excessive restrictions on performance in high-demand scenarios, forcing enterprises to adopt conservative designs[3].

3.3 Trade-off between risk avoidance and performance optimization

The fundamental principle of safety standards is "fully reducing risks". Therefore, it is often required to introduce redundant protection mechanisms in system design and impose restrictions on key parameters (such as speed and torque)[4]. For instance, to meet the PFL requirements, robots may need to reduce their operating speed or output capacity. However, this directly conflicts with the technological innovation goals of enhancing production efficiency, such as shortening cycle time and increasing unit output.

4. Analysis of underlying causes of the conflict

4.1 Mismatch between development cycles and innovation speed

The standards development process requires consensus among various stakeholders and involves rigorous procedures that are often time-consuming. In contrast, technological innovation, especially in software and AI, follows agile development and rapid iteration models commonly seen in the internet industry. This fundamental gap in pace forms an objective basis for the conflict[5].

4.2 Disagreements among stakeholders

The development of safety standards involves multiple parties' participation, but the focus of different entities varies. Regulatory agencies and end-users place greater emphasis on the safety and operational reliability of the system, and tend to adopt mature and verifiable technical solutions to minimize accident risks to the greatest extent.

4.3 Intrinsic contradiction between safety and efficiency

Safety prioritizes controllability, stability, and predictability, requiring conservative designs that operate within known risk boundaries. In contrast, innovation embraces uncertainty and seeks to push beyond existing limits, often through experimentation[5]. This conceptual clash leads to practical conflicts: for example, speed limits imposed for safety may hinder production efficiency, while pursuing higher performance can complicate safety verification. Thus, an inherent tension between safety conservatism and innovation aggressiveness persists throughout technology and standards development[5].

5. The impact of the conflict between safety standards and technological innovation

The conflict between safety standards and innovation is not entirely negative. While it may temporarily constrain emerging technologies and increase R&D costs, it also drives the co-evolution of both systems[6]. To meet safety requirements while improving performance, companies are compelled to develop advanced technologies, such as smarter control algorithms and faster-response materials. Simultaneously, technological progress exposes gaps in existing standards, pushing standards bodies to accelerate revisions and adapt to emerging fields such as AI and autonomous decision-making[6].

6. Suggestions for coordinated development of safety standards and technological innovation

6.1 Adopt a regulatory sandbox for emerging technologies

For promising yet immature technologies, a "regulatory sandbox" approach can be piloted[7]. This approach allows temporary exemption from certain rigid standard requirements within a confined environment (e.g., test sites or pilot enterprises), provided that overall safety objectives are achieved. Real-world testing and data collection enable risk assessment and generate evidence for future standards updates. It creates a feedback loop of innovation, data, and standards refinement, enhancing the relevance and timeliness

of safety regulations.

6.2 Strengthen international coordination and foresight research

Active participation in international standards organizations such as ISO should be encouraged to integrate China's technological innovations and practical experience into international standards. Meanwhile, standardization research institutions should strengthen cooperation with research institutes and leading enterprises to conduct technology forecasting and initiate forward-looking research on next-generation safety standards.

6.3 Promote a full lifecycle safety approach

Risk should be mitigated from the design stage by encouraging inherent safety design principles. Safety considerations must be integrated from the traditional "physical protection" level into earlier stages such as algorithm design and software development, achieving deep integration of safety and performance rather than applying remedial measures after the fact[8].

7. Conclusion

This paper identifies three conflicts between safety standards and innovation in cobots: lag, rigidity, and safety-performance trade-offs, driven by slow updates, stakeholder disagreements, and inherent tension[3]. While challenging, these conflicts can bring about progress. To reconcile the tension between safety and innovation, this paper proposes three coordinated strategies: first, the development of dynamic and adaptive standards that can be updated more frequently to keep pace with technological advancements; second, the implementation of regulatory sandboxes that allow emerging technologies to be tested in controlled environments under flexible oversight; third, the adoption of a full lifecycle safety approach that integrates risk assessment from the design phase through to operation and decommissioning. These measures together can foster an ecosystem where safety and innovation evolve in tandem[2].

References

[1] Fu L, Wu R, Zhao J. The Evolution and Enlightenment of Safety Specification of Cooperative Robots: ISO/TS 15066 [J]. *Robot*, 2017, 39(04): 532-540.

[2] LIU Yi, LIU Tangshu, JIANG Jianhui, etal. Research on Construction of Standard System of Industrial Robot in China [J]. *Machine Tool & Hydraulics*, 2019, 47(21): 38-40.

[3] Cui Z Y, Wu G L. Research and Development Trends of Performance Standards for Collaborative Robots [J]. *Brand & Standardization*, 2024, (01): 51-53.

[4] Yao B. Study on the Interaction between Standardization and Technological Innovation Based on the Hype Cycle [J]. *China Standardization*, 2023, (17): 39-43.

[5] Wang Z. The Impact of Industrial Robotics Engineering on Society, Health, Safety, and Law and Its Constraining Factors [J]. *Marketing Management Review*, 2024, (36): 164-166.

[6] Tao Z Y, Xia J. The Interactive Effect between Technological Standardization and Technological Innovation in China's Manufacturing Industry: An Empirical Study Based on Nine Subdivided Sectors [J]. *Science & Technology Progress and Policy*, 2015, 32(08): 61-66.

[7] Yu Y D, Du Y S, Liu H C, etal. Research on Emerging Technologies Standardization Development Process Based on Hype Cycle [J]. *Information Technology & Standardization*, 2020, (10): 38-40+45.

[8] Wang A G. Interpretation for ISO /TS 15066 Technical Specification of Collaborative Robots [J]. *Electrical & Energy Management Technology*, 2017, (14): 69-73.

[9] Cui Z Y, Wu G L. Research on Safety Standard and Development Route of Industrial Robot [J]. *Brand & Standardization*, 2023, (05): 190-192.

[10] Zhang G, Guo P. Construction of an Interaction Model between Technology Standardization and Technological Innovation Based on SD [J]. *Future and Development*, 2016,40(04): 67-70.

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