SPOTLIGHT 1

The Role of Standards in the East Asian Miracle: Core Infrastructure for Global Competitiveness

The East Asian economic miracle, characterized by rapid, sustained growth and dramatic industrial upgrading across Japan; the Republic of Korea; Taiwan, China; and later China, has been the subject of extensive scholarly inquiry. Prevailing explanations emphasize the role of the developmental state in guiding capital allocation,[1] high saving and investment rates,[2] state-directed export-oriented strategies for industrialization,[3] and effective development of human capital.[4]

An underappreciated factor underpinning the transformative success that these countries achieved was the systematic promotion of manufacturing standards and systems for quality control. From Japan's postwar quality revolution, orchestrated through the Japanese Standards Association (JSA) and the widespread adoption of total quality management, to Korea's Industrial Standardization Act of 1961 and China's 2015 standardization reforms, East Asian states have leveraged the development and implementation of standards strategically. Standards, quality control, and quality infrastructure are not deployed solely for purposes of regulatory compliance, but as deliberate tools in industrial policy to upgrade technological capabilities, build formidable reputations in global markets, and drastically reduce transaction costs associated with information asymmetry and excessive product variability. In this light, standards have not been ancillary to development; they have been core infrastructure for global competitiveness.

Japan: From "shoddy imports" to paragon of global quality

Japan's ascent as a global leader in manufacturing is inseparable from the metamorphosis in its quality standards. Before World War II, Japanese consumer exports were frequently synonymous with low quality and unreliability, a damaging reputation rooted in mass-produced, inexpensive goods.[5] Although pockets of exceptional craftsmanship existed, particularly in traditional artisanal sectors, and the country invested significantly in military hardware, the consumer goods sector more broadly lagged significantly in consistent quality. The postwar imperative for economic reconstruction and export-led growth demanded a radical break from this past. Crucially, Japanese industrial leadership proved exceptionally receptive to external expertise at a pivotal moment. When American experts on quality W. Edwards Deming and Joseph M. Juran lectured in Japan in the early 1950s under the auspices of the Union of Japanese Scientists and Engineers (JUSE), their audiences included the chief executives of Japan's largest industrial conglomerates. This was in stark contrast to their experiences in the United States, where their audiences typically comprised engineers and managers of quality control, rarely top management.[6] This top-level engagement by the leadership of firms, driven by an urgent need to access lucrative markets for exports (especially the United States) and overcome the country's reputation for producing shoddy goods, signaled a commitment to institutionalizing quality as a core strategy for increasing competitiveness.

At the time, prevailing conceptions of quality control, articulated in Juran's *Quality Control Handbook* (1951), primarily focused on the detection and prevention of defects, viewing quality control as an exercise for containing costs. Juran distinguished between avoidable costs (scrap, rework, warranty claims) and unavoidable costs (preventive measures like inspection and testing). In 1956, Armand Feigenbaum took Juran's ideas a step further by proposing total quality control.[7] This approach advocated cross-functional involvement (marketing, engineering, purchasing, and manufacturing) in quality efforts. Although this was a step in the right direction, Feigenbaum did not really consider the ways in which quality was first of all a strategic question for any business; how, for instance, quality might govern the development of a design and the choice of features or options. However, Japanese practitioners, guided by Deming and Juran and facilitated by institutions like the JSA and the Ministry of International Trade and Industry (MITI), recognized that quality needed to be redefined strategically. Starting with Deming's emphasis on reducing process variation through statistical methods and management's responsibility for fostering a culture of continuous improvement, Japanese firms transformed total quality control into total quality management, which put a priority on customer satisfaction, companywide participation, and the integration of quality objectives into the core process of strategic planning led by senior executives.[8]

Japanese firms built a quality revolution around total quality management. With senior executives assuming direct responsibility for quality management, companies invested heavily in training engineers and managers in sophisticated statistical techniques for process control, empowering front-line workers through quality-control circles to identify and solve problems.[9] Critically, Japanese firms moved away from relying solely on end-of-line inspection to catch defects. Instead, they emphasized designing quality into products and processes from the beginning and building strong networks of suppliers. Recognizing that the final quality of products depended on the consistent excellence of components, leading manufacturers like Toyota worked closely with their suppliers, sharing knowledge regarding total quality management and enforcing strict standards for quality, which helped raise capabilities across the entire supply chain.[10] The JSA played a vital role in disseminating best practices and harmonizing domestic standards with those of its international counterparts. A dual focus—establishing precise technical specifications for both inputs and end products (through Japanese Industrial Standards) and codifying specific processes for management (like procedures for total quality management through standards equivalent to the Japanese Industrial Standard Q 9000 series)—ensured that quality meant adherence to defined, measurable standards throughout the value chain.[11]

The drive to access demanding export markets, particularly the United States, catalyzed adoption of standards and upgrading of quality. Foreign buyers (and competitors), acting as conduits of knowledge and enforcers of compliance, played a crucial role in pushing Japanese suppliers beyond initial domestic capabilities.[12] Furthermore, compliance with standards likely played a role in lowering variable costs of trade associated with rejection, returns, and reputational damage, facilitating deeper integration into global markets. Firm-level evidence from industries like automobiles and electronics shows that meeting these external standards spurred significant upgrading of technologies and gains in productivity, moving Japan up the quality ladder and building comparative advantages in high-value manufacturing.[13]

This relentless, systemic focus on integrated standards had transformative results. Japanese automobiles, emblematic of the country's reputation for poor quality in the 1950s, improved dramatically. By rigorously applying principles of total quality management, focusing on customer-defined dimensions of quality (reliability, durability, conformity, perceived value), and empowering their workforces and suppliers, Japanese automakers achieved unprecedented levels of consistency and reliability, surpassing their US counterparts in key metrics of quality by the late 1970s and early 1980s.[14] Japan's journey demonstrated that quality, underpinned by robust standards and institutionalized management systems, was not merely a defensive cost but a potent strategic instrument in building global competitive advantage. The state, through MITI and the JSA, provided the framework and impetus, and industry leadership, driven by export imperatives and competitive pressure, internalized and executed the quality revolution, creating an ecosystem in which standards became the foundation of manufacturing excellence.

The Republic of Korea: Strategic standardization as an engine of industrial transformation

The Republic of Korea's extraordinary journey from postwar devastation to global technological powerhouse offers a compelling case study in the deliberate deployment of standards and quality infrastructure as core instruments of industrial policy and export competitiveness.[15] Although Korea shared the East Asian model in having a developmental state, its approach to standardization was anchored in a systematic integration of standards into the national economic strategy and a pioneering role in stimulating education in the area of standardization. Ultimately the country transitioned from adopting to authoring international standards, particularly in the area of information and communications technologies.[16]

From the outset of its export-driven strategy for industrialization in the early 1960s, Korea recognized that penetrating international markets necessitated achieving international benchmarks for quality and safety. The state took measures to establish the foundational elements of its national quality infrastructure, encompassing metrology, standardization, conformity assessment, and accreditation.[17] The 1961 Metrology Act and Industrial Standardization Act launched Korean Industrial Standards (KS), with the Korean Standards Association (now known simply by its acronym, KSA) managing dissemination. Crucially, the 1962 Export Inspection Act mandated preshipment checks, directly linking compliance with standards to export viability. The introduction of the KS mark certification system in 1961, coupled with preferential treatment in government procurement for KS-certified products, created powerful domestic incentives for KS adoption, embedding quality control into nascent export sectors like textiles and light manufacturing. Korea's accession to the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) in 1963 affirmed the country's commitment to international alignment.

During the country's growing stage (1973–95), Korea's strategic pivot toward heavy and chemical industries demanded a more sophisticated national quality infrastructure. The Korea Standards Research Institute (KSRI), later the Korea Research Institute of Standards and Science (KRISS), strengthened its metrological capabilities, aided by Germany and the United States. Importantly, a 1980 constitutional amendment obligated the state to establish a national standards system, elevating standardization to a national priority, reflected in the country's ten-year industrial standardization plan (1971–80) and subsequent five-year strategies. In the country's upgrading stage (1996–2014), standardization became integral to innovation and global competitiveness. Private sector organizations were empowered to develop standards, increasing alignment within industries. Korea significantly increased its participation in international standards development organizations (like ISO and the IEC) and in emerging technologies in which Korean firms were becoming technological leaders (such as the 3rd Generation Partnership Project, or 3GPP, and the one Machine-to-Machine Partnership Project, or oneM2M), boosting the country from standards adopter to aspiring author.[18] More recently, in its expanding stage (since 2015), Korea has decentralized its standardization authority, delegating responsibility for developing KS to relevant ministries, enhancing expertise, responsiveness, and collaboration among ministries while reducing duplication. Concurrently, Korea has intensified its drive to author global standards in frontier fields such as artificial intelligence, 5G and 6G wireless communications technology, and quantum, backed by the country's 2022 Measures for Promoting National Strategic Technologies.

Korea's ascent vividly illustrates how standards, strategically planned and institutionalized, can function as indispensable economic infrastructure. The state provided the initial vision, legal frameworks, institutions, and incentives (like the advantage given in government procurement to products certified with the KS mark), recognizing standards as fundamental to export credibility and industrial discipline. Long-term plans ensured continuity and alignment with national goals, and initiatives to build human capital and a standardization culture fostered sustainability. Rarely did firms alone drive Korea's successful cases of "stage-skipping" and "path-creating" catch-up.[19] Rather, these cases relied on coordinated public-private investments, strategic access to foreign knowledge, and a policy environment that made standardization a complement to, rather than a substitute for, industrial upgrading.

Korea's global economic role transformed as a result: Standards began as keys unlocking export markets, became drivers of domestic efficiency and quality enabling upgrading of industries, and ultimately evolved into strategic levers allowing Korea to shape the technological landscape itself. The country's deliberate, phased, and state-facilitated integration of standards into the core of its economic strategy was not ancillary to the Korean miracle; it was a critical enabler and accelerator, transforming the nation from an adopter of global standards into a formidable architect of them.

China: Strategic standardization for global leadership

China's stunning economic ascent, lifting hundreds of millions of people out of poverty and transforming the nation into a technological superpower, represents a distinct yet integral chapter within the narrative of the East Asian miracle.[20] Although state-led investment, export-oriented manufacturing, and development of human capital were essential to the country's economic success, the development community has overlooked China's strategic use of standards and quality infrastructure in industrial upgrading and global integration. China's path reflects a transition from passive adoption of foreign standards to active leadership in developing them, particularly in the areas of telecommunications, high-speed rail, and renewable energy.

China laid the foundations for its economic miracle during the post-1978 reform era. Recognizing that standards were vital for modernization, quality control, and access to global markets, China passed the Standardization Law in 1988. This period has been characterized by strategic alignment with international standards. China joined key international bodies (the IEC in 1957; ISO in 1978; and the World Intellectual Property Organization, or WIPO, in 1980), and by 2001, 38 percent of ISO/IEC standards had been converted into Chinese national standards, and 43.7 percent of China's national standards had been developed by adopting international standards.

China's accession to the World Trade Organization (WTO) in 2001 was a turning point and marked an acceleration in its economic transformation, shifting the country's strategy from alignment toward active participation in standards development and indigenous innovation. The establishment of the Standardization Administration of China (SAC) and the Certification and Accreditation Administration (CNCA) centralized functions that had previously been fragmented, providing stronger governance. SAC formalized procedures for adopting international standards, and CNCA drove conformity assessment, approving 182 certification bodies by 2007 and increasingly aligning China with the international systems for quality management (ISO 9001) and environmental management (ISO 14001) to bolster global legitimacy for the country's products.[21] Strategic plans like the National Medium- and Long-Term Plan for Science and Technology Development (2006–20) explicitly tied standardization to indigenous innovation and institutionalized collaboration across sectors.

China's standardization strategy was closely integrated with government efforts to boost manufacturing by encouraging foreign firms to invest heavily—not only financially, but also in manufacturing expertise, as well as an array of complementary activities, through infrastructure, subsidies, and access to a large pool of inexpensive migrant labor. Systematic efforts in regard to education and research to support standardization underpinned these efforts.[22]

By 2015, adoption of international standards in key consumer sectors in China exceeded 80 percent. Chinese standards for specific sectors, such as those for food safety and environmental regulation, boosted export performance in two ways. First, it reduced information asymmetries between Chinese firms and importers by signaling quality to foreign buyers, especially when harmonized with international standards.[23] Additionally, it lowered import barriers associated with noncompliance with international standards (rejections, delays) and facilitated transfer of knowledge regarding international best practices. China's institutional clout also grew: Chinese experts held more than 10 leadership positions on ISO and IEC technical committees by 2015, and their contributions to international standards jumped from 13 (before 2000) to 182 that same year. Xiaogang Zhang's election as ISO president, again in 2015, further affirmed this rise.

The 2015 adoption of international standards, embodied in the Program for Deepening the Reform of Standardization Work and later the National Standardization Development Outline (targeting global leadership in the area of standardization by 2035), represented a strategic shift toward a market-driven, innovation-centric model for standards. The government consciously moved from direct control to setting baseline thresholds (often via mandatory national standards focused on health, safety, and security), while empowering enterprises, research institutions, and industry associations to lead standards development. Government-led standards provided a regulatory foundation, and market-driven standards became the engines of innovation and competition, mirroring international practices.

The resulting framework, balancing state direction with market dynamism, has positioned China as a global leader in development of standards in key emerging technologies. In telecommunications, for instance, it moved from developing stand-alone standards for third-generation wireless communications technologies to dominating 5G standards. By 2024, Chinese firms held 40.8 percent of standards-essential patents for 5G technologies declared to the European Telecommunications Standards Institute (ETSI) and contributed about 34 percent of technical proposals accepted by the 3GPP, with Chinese multinational technology company Huawei alone accounting for more than 20 percent of contributions and 16.9 percent of standards-essential patents. In the area of high-speed rail, China evolved from a technology importer to standard setter, holding about 70 percent of global patents in the area of high-speed rail by the mid-2020s, chairing subcommittees of ISO Technical Committee 269 and driving all 13 International Union of Railways system-level international standards for high-speed rail.

Chinese standards underpin major international projects like the Jakarta-Bandung and Mombasa-Nairobi railways, demonstrating economic impact and serving as vectors for standards diffusion. In the realm of solar energy, China leads in both production and standard setting, holding 66 percent of global photovoltaic patents by 2023, driving work in IEC Technical Committee 82 on next-generation technologies, and exporting solar components embedded with Chinese standards. However, unlike what happened in regard to 5G wireless communication technologies, which are globally interoperable, in the case of charging infrastructure for electronic vehicles, China chose its own path, supporting domestic industry, even though it means incompatibility with foreign charging technology for such vehicles, which is based either on Japanese or European/US standards.

Standards diplomacy has been an important component of China's Belt and Road Initiative. Bilateral agreements between China and other countries regarding standardization grew from 81 (with 47 countries) in 2017 to 108 (with 65 countries) by 2023. Regional platforms such as the China-ASEAN [Association of Southeast Asian Nations] Standardization Cooperation Forum promoted alignment of these agreements with one another. Underpinning these efforts were massive increases in spending on research and development, with Chinese patent filings surging from 103 in 1995 to 70,153 in 2024 (25.6 percent of the global total). A strengthened regime regarding intellectual property (observable in a 450 percent rise in litigation in the area of intellectual property between 2013 and 2023) and proenforcement rulings by China's Supreme People's Court enhanced trust in Chinese standards. All of these contributed to China's growing influence in bodies that develop international standards.

China's standards development has been based on *incremental adoption*, beginning with selectively adapting foreign standards that suited domestic conditions; *pilot testing*, with new technical standards introduced in limited pilots or select industries, tested in practice, and only later scaled nationwide; and *hybrid strategies* with dual systems allowing domestic standards to coexist with international ones before decisions were made as to which pathway would dominate. The country's swift ascendence from aligning with international standards to systematically shaping them in specific sectors has involved a two-legged approach: mandatory state standards to ensure baseline compliance and voluntary standards driven by the market to spur innovation and competitiveness in high-tech sectors. Although strategic direction on priorities is set centrally, there has been a deliberate shift from top-down control to delegated standard-setting authority.

Lessons for latecomers

The East Asian economic miracle was underpinned by the strategic deployment of standards, quality control, and quality infrastructure as core tools of industrial policy for technological upgrading, export competitiveness, and productivity growth. Japan's quality revolution, Korea's phased institutionalization of its national quality infrastructure, and China's shift from alignment with international standards to indigenous innovation and development of international standards each demonstrate distinct yet effective approaches that fit the countries' cultures and institutions.

Institutional setup critically shaped outcomes: Japan's initial emphasis focused on internal (company) standardization to build quality rather than participation in international standardization, and its polycentric model fostered deep capacity building but required strong interfirm trust; Korea's centralized hierarchy enabled rapid mobilization of resources but initially limited private initiative; China's two-legged approach balanced regulatory control with market dynamism but risked fragmentation. Delegated authority to private actors (such as business networks and industry consortia) proved essential for responsiveness to technical change. Strong state capacity was crucial in all three cases: Japan's MITI and JSA, Korea's KATS/KSA, and China's SAC provided coordinated vision, legal frameworks, and institutions to align standards with industrial policy.

Although the precise causal weight of each of the components of these institutional models varies, a common thread emerges: a feedback loop between trade and standards. The imperative to access demanding export markets and integrate into global value chains acted as a potent catalyst, driving firms to adopt and upgrade standards through mechanisms like learning-by-exporting.[24] This adoption and upgrading, in turn, lowered trade costs, boosted productivity, facilitated diversification into higher-value exports, and built endogenous comparative advantages, further enhancing trade competitiveness.[25] Another common thread has been the emphasis on building expertise by incorporating standards in regular education courses.

East Asia's success in the area of economic transformation rested on three interlocking conditions: strong state capacity to orchestrate standards ecosystems, export orientation to catalyze upgrading, and alignment with lead firms for knowledge transfer. Although many low-income developing countries would find these conditions difficult to reproduce, it must be remembered that six to seven decades ago, China, Japan, and Korea were in roughly similar straits. A more challenging international environment, however, means that latecomers need to engage more actively with standards development while fostering agile public-private partnerships.

Notes

1. Johnson (1982).
2. World Bank (1993).
3. Amsden (1989); Wade (1990).
4. Stiglitz (1996).
5. Vogel (1979).
6. Cole (1989); Juran (1995).
7. Feigenbaum (1956).
8. Nonaka (1998).
9. Ishikawa (1985).
10. Asanuma (1989); Cusumano (1985); Fruin (1992).
11. Nakamura (1993).
12. Lawrence and Weinstein (1999).
13. Henn et al. (2013); Hummels and Klenow (2005); Ito and Pucik (1993).
14. Liker (2004); Womack et al. (2007).
15. This section on Korea draws on Lee and Kim (2025), a background paper prepared for this Report.
16. Choi and de Vries (2013).
17. Choi and Choi (2019).
18. Lee and Kim (2025).
19. Lee and Lim (2001).
20. This section draws on Gong and Zhang (2025), a background paper prepared for this Report.
21. Kennedy (2006).
22. China has a university specializing in the elements of the quality infrastructure, China Jiliang University in Hangzhou.
23. Mangelsdorf et al. (2012); Sun et al. (2023).
24. Clerides et al. (1998).
25. Hausmann et al. (2007).

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