
The Role of Standardization in India's Economic Development

Anupam Kaul*

Abstract

The development of quality infrastructure in India has a century-long history, responding to developmental and societal needs. It has involved both reactive responses to emerging problems and proactive planning toward setting up the standards ecosystem to support India's future industrial development.

India's standardization journey has included some features that are unique and some that are common to other developing countries. It has proceeded in several transformative phases—from supporting early railway infrastructure and adopting the metric system in the 1960s, to rationalizing steel use in the 1970s, to promoting safe drinking water in the 1980s, and more recently, to bolstering the energy sector with initiatives like low-voltage grids, biofuels, and green hydrogen. However, during most of the period following independence, standardization remained in the background, with limited integration into broader economic planning. Its role in driving industrial growth and technological leadership was underappreciated, unlike in Western and leading Asian economies. This has changed in the last decade as regulatory and voluntary standards have emerged as key tools in global trade and market access. This shift has led to the mainstreaming of the standards agenda, particularly in trade negotiations and internal policy discussions. An industry-led, government-supported initiative in 2014 culminated in the creation of a National Strategy on Standardization, identifying key focus areas and long-term goals.

India now boasts a mature national quality infrastructure featuring a diverse and integrated standards framework, advanced metrology systems, and a globally aligned conformity assessment set-up. The size and diversity of India, and its history of independence from colonial rule, provides a good mix of positive and negative lessons for developing countries.

Keywords: Standards, National quality infrastructure, National standards system

* Anupam Kaul is an independent Strategic Adviser on standards, conformity assessment, and technical regulations. email: anupam@veriti.in. This study serves as a background paper for the *World Development Report 2025: Standards for Development*. The findings, interpretations, and conclusions expressed in this paper are entirely those of the author. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

How India's Approach to Standardization Has Differed from Other Nations

The development of standardization in India has been characterized by some features that are unique and some that are common to other developing countries.

Scale and diversity. The sheer scale and diversity of the Indian economy and society present unique challenges in implementing and enforcing standards compared to developed nations that are smaller (in terms of size and population) and more homogenous.

Historical context. India's development was more government-led in its initial phases, unlike in many Western nations, which often had a longer and more organic evolution of quality infrastructure, driven by private sector-led industrialization, and/or consumer movements. Moreover, India's economy was largely insulated from the world until 1991.

Level of awareness. General awareness and demand for high-quality products and services has been relatively lower in some segments of the Indian market than in developed nations that have more mature consumer cultures.

Resource constraints. Like all developing nations, India has historically faced investment constraints in building and maintaining a comprehensive quality infrastructure system across all sectors compared to the better-resourced nations.

Focus on socioeconomic goals. Developed nations have traditionally focused on using standardization as a major tool contributing to technical convergence to foster market leadership. In contrast, India's development of its quality infrastructure has focused largely on broader socioeconomic development goals, such as poverty reduction and rural development.

Early Developments in India's Quality Infrastructure

India's national quality infrastructure has evolved over more than 100 years, beginning in the early 20th century (for more on quality infrastructure, refer to box 1). The early quality interventions were driven by safety and health needs, as well as India's growing infrastructure. Many of the inspections and certifications were thus integrated with mandatory regulations that were critical for industry (such as the safety of steam boilers), as well as for the general populace (such as food safety and legal metrology). These early initiatives led to the establishment of quality organizations that were responsible for setting the conformity assessment programs.

Among the earliest institutional arrangement was the establishment of the Inspectorate of Local Manufacturers in 1909 in Kolkatta (then Calcutta) to inspect railways supplies and equipment. The railway network had grown considerably by that time, spanning more than 14,000 kilometers, and a national Railway Board had been set up to ensure unified governance. A simultaneous development was the establishment of the Metallurgical Inspectorate in 1912, after the newly established Tata Steel Plant secured an order to supply 20,000 tonnes of steel to the railways. This need soon expanded to include testing, and in 1913 a Government Test House was established in Kolkata. The success of these early measures enabled the expansion of the testing services to all government departments and semi-government bodies, as well as to private sector on commercial basis.

Box 1. What is quality infrastructure?

Quality infrastructure (QI) comprises the public and private institutions and policies related to standards development, conformity assessment (testing, inspection, certification), accreditation, and metrology. *Standards* specify the criteria that goods or services should meet to ensure required quality and safety performance. *Conformity assessment* encompasses the evaluation processes adopted of ascertaining that the criteria are met. *Accreditation* is the independent, third-party evaluation of a conformity assessment body against recognized standards; it conveys formal recognition of the body's impartiality and competence to carry out specific conformity assessment tasks. *Metrology* is the actual measurement of the parameters that together constitute the conformance criteria. Quality infrastructure also includes associated elements such as capacity building of the personnel, experts, and state agencies and other bodies involved, and the design and implementation of technical regulations that lay down essential requirements that parties must comply with—with the objective of ensuring quality, safety of goods and services, and sustainability.

Early regulatory measures

Various early mandatory regulatory measures influenced India's later standardization journey. The initial regulatory measures emerged based on considerations of safety for industrial workers, as well as health and safety of consumers more broadly. These regulations were mostly adapted from existing regulations in the United Kingdom and other countries. Three examples follow of how regulations led to an expanded quality infrastructure over successive decades.

Boiler regulations. With steam boilers gaining widespread applications across industry and energy sectors, one of the first regulatory inspectorates established in India was the Central Boilers Board, constituted under the Indian Boilers Act 1923. The Board came into operation in 1937 and was responsible for making regulations for establishing standards for the materials, design, and construction of boilers, as well as for their registration and inspection. The inspection of boilers was delegated to state governments, which in turn set up boiler inspectorates. Later, private inspection organizations were approved to perform inspections. This arrangement has continued to date, with the Central Boiler Board responsible for the technical regulations, and authorized state agencies as well as designated bodies performing as inspection and certification of boilers and components.

Food safety regulations. Due to food shortages and a growing menace of food adulteration, the government of India established the Prevention of Food Adulteration (PFA) Act in 1954, with the objective of ensuring food safety and preventing fraudulent or deceptive practices that were causing serious threats to people's health. The enforcement of the Act was delegated to the state governments, which in turn set up food inspectorates authorized to conduct market surveillance, sampling, and testing in dedicated food laboratories established by the state governments. The PFA Act was later supplemented with other statutes such as the Fruit Products Order (1955), Meat Food Products Order (MFPO) (1973), Edible Oils Packaging (Regulation) Order (1998), and Milk and Milk Products Order (1992). Each of these technical regulations required approval of the manufacturing facility based on food safety standards, followed by surveillance inspections. In 2006, the Food Safety and Standards Act consolidated all former acts and orders related to food safety under a harmonized approach. The Food Safety and Standards Authority of India (FSSAI) is currently the single agency responsible for notifying regulatory standards,¹ approvals, licensing, and inspection regulations and for approval of testing laboratories.

Legal metrology. The International Organization for Legal Metrology (OIML) was set up in 1955. India was one of the founding signatories. In 1956, India enacted the Standards of Weights & Measures Act in line with the model regulations notified by the OIML, thereby aligning India's practices with global practices. An immediate task was converting all systems of commercial measurements to the

International Systems of Units/Système International (SI) (metric system), which was achieved fully by 1965. India set up Weights and Measures Controllers in all states to inspect and certify measuring equipment. These bodies were also among the first statutory inspection and certification systems in the country. Over time the statutes were amended. Currently, the Legal Metrology Act 2009, together with several subordinate rules and regulations, constitute the legal framework. With growth in demand and to ensure a practical monitoring framework, the Department of Legal Metrology has established a network of primary reference and secondary standards laboratories (laboratories that provide services for measurement comparisons).

Early efforts in developing standards (before 1947)

The seeds for collaborative standardization and the quality infrastructure were sown in India as early as 1909 to 1913 (Burt 1949), through initiatives undertaken by the Inspection and Testing Organization to set up specifications for stores (hardware, parts, and components), materials, and equipment, and the revision of those specifications, which included consulting with industry and consumers before finalizing the changes.

Many of these early developments proceeded against the backdrop of British rule in India. Britain had established the Engineering Standards Committee in 1901 (which later became the British Standards Institution). In 1919, the British Standards Institution designated the newly established Institution of Engineers (IE) in India as its Indian Committee.

These developments occurred in the context of widening Demand for standardization, inspection, and testing services following the first world war in both civil and military purchasing. This led to several transitions of the Inspection and Testing Organization, which became part of the Indian Stores Department in 1922. Its primary task was procurement and inspection of government-wide stores, a function that lasted more than seven decades. Among its key activities was drafting of drawings and specifications with the special point of view of suitability for the conditions of services and state of manufacturing in India.

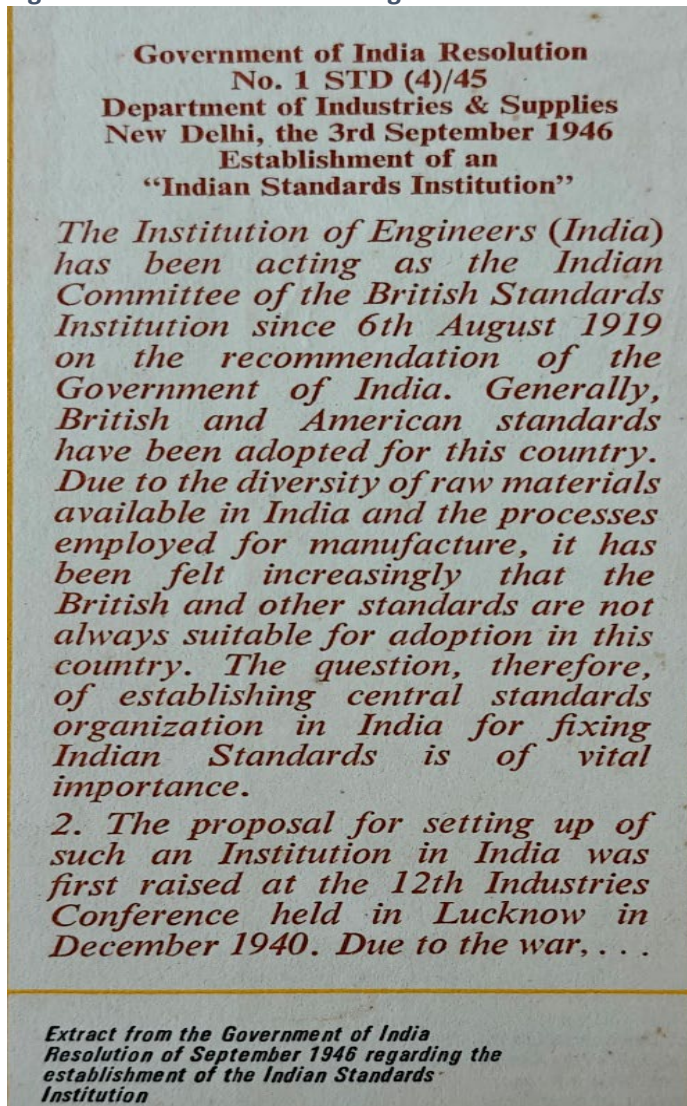
In 1930, the Indian Railway Board set up the Central Standards Office (later renamed the Research Design & Standards Organization) dedicated to developing new designs and related standards (including adoption of other standards) for railway stores and equipment.² It acted in close cooperation with the Inspection Wing of the Indian Stores Department. Together, they steered the standards movement until India's independence in 1947.

During this period, the Indian Stores Department developed 793 standards (ISI 1972a), and the Railway Central Standards Office developed 219 standards (ISI 1972b), in addition to specific drawings and schedules for special needs. Because British Standards were already available in many areas, the standards development invariably involved examining their suitability for adoption or adaptation to the Indian context. The process was dynamic, and revision of standards, based on experience and feedback from industry, became a continuous process.

In the immediate aftermath of the second world war, in October 1946, the Commonwealth Standards Conference was held jointly with the International Standards Conference. India was invited and elected to the Council of the newly formed International Standards Organization (ISO). At this Conference, India was awarded the secretarial responsibility of developing standards on mica and shellac, materials of great importance in that time.

Also in 1946, the British Committee engaged with the Institution of Engineers (IE) in India, then working as their Indian Committee, to establish the Indian Standards Institution (ISI) (refer to figure 1). It was formally established in January 1947 and commenced operations in June the same year.

Figure 1. Resolution establishing the Indian Standards Institution (ISI) in 1946



Source: ISI 1972a.

The First 25 Years Following Independence (1947–72)

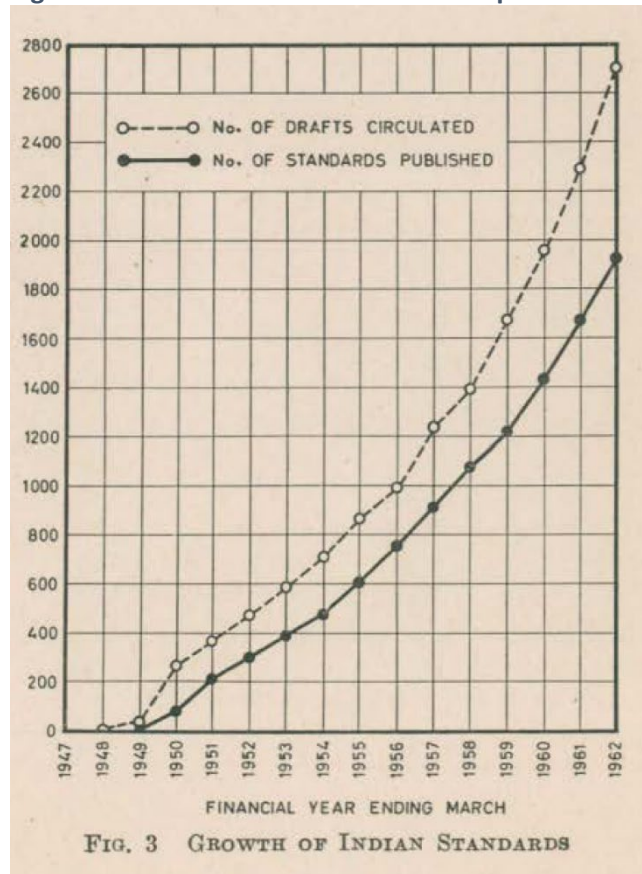
The first 25 years following India's independence from Britain was the period of nation building as India emerged from almost 200 years of colonial rule and a war-ravaged global economy. During this period, India was also embroiled in three wars (1962, 1965, and 1971) that constrained growth and forced a change in priorities from time to time. India adopted a socialist approach to governance, with a heavy emphasis on development of the public sector as the engine of growth.

The newly formed ISI adopted the British model of developing standards through cooperative, consensus-based expert groups representing wide stakeholder interests. This enabled standards-setters to draw on a wide range of expertise while keeping the standards grounded in the state of technological development. ISI established standardization divisions, starting with an Engineering Division and Textile Division in 1947 and a Chemicals Division in 1948.

As a strategic approach, ISI decided to establish and follow Five Year Plans for its own workplans. These were aligned with the national Five Year Plans starting in 1951. The alignment helped ensure that the

selection of subjects for standardization was in line with the economic, industrial, and societal priorities delineated in the national plans. The first two plans, covering 1951 to 1961, focused on developing basic engineering standards that promoted variety reduction (a measure of simplification), import substitution, interoperability, and machine efficiency to support the growth of India's nascent industries. IISI's Food & Agricultural Division was established in 1956, during the second Plan, to support the farm sector, which was then India's main economic sector. During this period, the number of draft and published standards grew rapidly (refer to figure 2).

Figure 2. Growth in draft standards and published standards in India, 1948–62



Source: Fifteenth Annual Report of the Indian Standards Institution (ISI).

The alignment of the standardization strategy with the national plans played an important role in undertaking projects of critical importance in an emerging economy. Examples include the following:

- Supporting the conversion from the Foot-Pound-Second System (FPS) to the metric system in the mid- to late-1950s. This included setting standards for the measuring devices as well as revising all domestic standards to SI units of measurement and publishing engineering conversion tables (Verman 1970). The transition through the standardization efforts was so efficient and fast that it became a benchmark and was emulated by several other developing and developed nations.
- Aiding rationalization of the national economy for steel, a critical infrastructure component at the time, by developing a full suite of standards for lighter steel sections without compromising the engineering standards.
- Developing standards for plywood and wooden chests, an important export commodity during the 1960s.
- Devising standards for electrical and electronic products suited to India's tropical climate, which later served as a benchmark for the larger tropical belt countries.

- Developing a full suite of standards in the late 1960s for jute and jute products, a commodity where India held 60 percent global market share. The standardization effort enabled a reduction of grades from 80 to just 16, leading to enhanced production efficiency.
- Establishing mechanical engineering standards for sewing machines, bicycles, and their components that reflected people's needs.
- Engaging in a marathon effort in writing India's code for unfired pressure vessels used across the chemicals, petroleum, and petrochemical industries in the early 1970s.
- Seeking to standardize the diverse building construction practices across different cultural milieus of the large country through the publication of the National Building Code (NBC) in 1970.

By the early 1970s, ISI had set up nine divisions covering Mechanical Engineering, Civil Engineering, Electrotechnical, Chemicals, Textiles, Structural & Metals, Food & Agriculture, and Marine Cargo & Packaging. A parallel activity was supporting the development of company standards at the corporate level. Several public sector undertakings, such as the Bharat Heavy Electricals Ltd and the Steel Authority of India, set up company-level standardization departments that contributed usefully to the development of national standards.

During this period, India's national efforts also proceeded against the backdrop of international developments in standardization. These are discussed in box 2.

Box 2. Developments at the international level related to India's efforts toward standardization

Formal international standardization activities started in the early 20th century in the electrotechnical field with the founding of the International Electrotechnical Commission (IEC) in 1906. While some attempts were made in the 1930s to develop international standards in other fields, it was not until after the second world war that the United Nations Standards Coordinating Committee, established by the United States, Great Britain, and Canada, provided the leadership that resulted in the formation of the International Organization for Standardization (ISO) in 1946.

During the 1950s and 1960s, international standardization work focused almost entirely on the development of international agreements on reference methods for testing, basic mechanics, in such areas as screw threads, roller bearings, pipe sizes, shafts, couplings, and power transmissions. For example, the first standard published by ISO was on reference temperature for measuring industrial lengths, an important parameter because metallic measuring devices expand or contract with temperature. In 1960, ISO published ISO 31 on quantities and units based on the Systeme International (SI), with the objective of the SI system reaching world-wide uniformity in units of measurement. These early efforts addressed issues primarily related to international harmonization for interchangeability, vocabularies, and standards for units and symbols, and in that context were important drivers for national standardization efforts.

As a consequence, the adoption of international standards by many nations, including India, increased in the 1960s and 1970s, in lieu of national standards. In the 1980s and 1990s, robust standardization work supporting the introduction of information and communications technologies (ICT) was launched.

Evolution of conformity assessment

Recognizing the need for a credible mechanism to produce and deliver quality products when Indian industries were still finding their way following independence, the Indian Standards Institution established the first product certification program in the 1950s, backed by statutory provisions of the ISI (Certification Mark) Act 1952.

The ISI Mark Scheme grew in popularity, aided by preferential purchasing by government. Various public and quasi-public agencies notified policies to accord preference to ISI certified products. For example, the National Bank for Agriculture and Rural Development imposed a condition for refinancing the national banks only if their lending for farm equipment ensured that the equipment was ISI certified. The Directorate General for Supplies & Disposal responsible for supplier rate contracts and inspection of purchased consignments waived its own inspections at manufacturing units that were licensed to use the ISI mark. The Central Insecticides Board mandated that subsidized prices for purchasing pesticides by the farmers would be allowed only for certified products. These measures helped in the development of the agro sector as well as in ensuring that public sector purchasing became efficient and reliable. The Iron and Steel Controller, in the early 1960s, mandated that integrated steel plants must secure ISI certification for all steel products they produced. This led to the establishment of ISI offices in all steel plants for on-site testing and certification.

In addition to the wide-ranging and popular ISI Mark, other certification schemes were established to address sectoral needs, especially where exports are involved.

One of the important bodies was the Export Inspection Council (EIC), established in 1963 to ensure quality control and inspection for exports. It played a key role in ensuring that certain notified commodities were inspected for quality before export. This was important to promote exports at a time when industrial quality control practices were still nascent. EIC was authorized to pre-inspect food, dairy, meat, poultry, and marine products, and cattle feed, among others. Over the years, the EIC has entered into agreements with the European Union (EU) and other importing countries, and gained recognition for its compliance programs that enable India to inspect or certify certain exports, and allow the results of these inspections or certifications to be accepted by the regulating authority of the importing country, saving costs and lowering the possibility of rejection of exports at the destination country.

The central government has established statutory commodity boards at different times under the Department of Commerce. These boards, which promote the production, development, and export of traditional commodities that have a global market, such as tea, coffee, rubber, spices, and tobacco, have played a key role in regulating the quality of the commodity for exports. Two examples follow:

Tea certification. The Tea Board India, established in 1954, certifies varieties of teas grown in India as genuine and permits the use of the Certification Marks (logos) for each tea identified by region, such as Darjeeling and Nilgiri Orthodox. No tea can be exported unless covered by a licence/permit issued by or on behalf of the Board. The Board also approves and registers certification bodies for Food Safety Management System Standards Certification.

Spices certification. The Spices Board was constituted as a statutory body in 1987 and is responsible for the development and export promotion of 52 spices listed in the Schedule of the Spices Board Act. Its activities include issuing certificates of registration to companies as exporters of spices; improvement of processing, grading, and packaging of spices; and controlling and upgrading quality for export (including setting up of regional quality evaluation laboratories and training centers). The Board has established a Quality Evaluation System that requires mandatory sampling and testing of

export consignments of spices and spice products for parameters prescribed by the importing country, such as pesticide residues.

Other commodities that are being similarly certified by their respective boards include silk, organic produce, and medicinal plants.

Evolution of metrology infrastructure

India's National Metrological Institute, the National Physical Laboratory (NPL), established in 1950, has aided the development of the testing infrastructure across sectors. Its primary functions are to conduct research with the objective of developing national standards of measurement and serving as the custodian of the measurements system in India that can be used for establishing the chain of measurement traceability. When the SI system of measurements was set up in India in 1956, the NPL played a critical role in developing the national reference standards based on SI units, which assisted a fairly rapid transition across India. The NPL became a signatory of the BIPM (Bureau International des Poids et Mesures) and in 1999 became a signatory to the International Committee for Weights and Measures (CIPM) Mutual Recognition Arrangement. Over the years, NPL has secured 236 Calibration and Measurement Capabilities (CMCs) in the BIPM database and 168 international/bilateral key comparisons.³ However, these numbers are lower than those of most developed countries and China. Consequently, Indian laboratories and industry must depend on reference standards, especially for materials from overseas suppliers.

The testing infrastructure in the initial years was predominantly government backed. The National Test House (NTH), established in 1912, expanded its scope and presence, opening several new branches in the early and mid-1970s. NTH has played a pivotal role in developing testing protocols and capacity across a wide range of products. Other important test laboratories included the Central Power Research Institute, recognized in 1960 as the national testing and certification authority for electrical equipment; the Automotive Research Association of India, established in 1966 with core services including standardization, certification, and testing of automobiles and components; and the Food Research and Standardization Laboratory, established by the Ministry of Health in 1971 as the apex food testing laboratory. In the private sector, important national-level laboratories have included the Shriram Test House, founded in 1947 in New Delhi, and the Electrical Research and Development Association, established in 1974 in Vadodara, Gujarat. Several engineering institutes that set up research facilities have extended them to offer commercial testing and calibration services.

Transformative Phase (1972–97)

The next 25 years witnessed political shifts in the central government that affected economic and trade policy as well as in shaping the social sector, with the emerging recognition of a growing young workforce. Even as India's growth rate slipped and the country went through phases of economic crisis and internal political strife, important sectors such as telecom, automotives, and information technology opened up, leading to an infusion of technology, starting with HCL Tech in hardware in 1976 and Infosys in software in 1981. Civil construction emerged as an important sector of the domestic economy. Agricultural yields improved, based on the previous efforts of the Green Revolution (1968–78), transforming India's status from a food-deficient country to one of the world's leading agricultural nations. Consolidation of cooperatives in diverse sectors such as textiles, milk, fertilizers, and sugar accelerated growth in these sectors, leading to self-sufficiency and even exports in areas such as apparel and dairy. The economic liberalization from 1991 onward led to deregulation of private enterprise and growth in foreign direct investment, boosting both manufacturing and services sectors to significantly higher growth rates.

Consolidation of standardization efforts

The standardization activity led by Bureau of Indian Standards was mainly directed to align with the growing demands by specific sectors as well as national development priorities set by the government. India was also beginning to be perceived as a major standards developer among developing nations, which led to several leadership positions, including ISO Chair in 1983, Chair of the Non-Aligned Movement (NAM) Expert Group,⁴ Chair of the General Agreement on Trade and Tariffs (GATT) Committee on Technical Barriers to Trade in 1985, and ISO's Regional Liaison Officer for South Asia-Iran Region for the 1987–89 term.

In 1986, the national standards body (ISI) was renamed the Bureau of Indian Standards (BIS). It was also made into an apex oversight body to harmonize all standardization work in the country. Significantly, the Act authorized the central government to notify mandatory compliance with Indian Standards and further make the use of ISI Mark mandatory. The Bureau was accorded statutory status, and Indian standards were accorded legal status as national documents.

During this period, India's engineering sector underwent a significant transformation with the establishment of its first world-class automotive manufacturing unit, Maruti Suzuki Limited. The roll-out of affordable cars and small utility vehicles propelled sales, and with it the development of auto component supplier industry. Responding to the emerging needs of the auto industry, BIS established the Transport Engineering Department (TED) in 1989. The first committee of this Division, TED 1, was established to formulate basic standards in automotive engineering. Other committees were set up to develop standards on different categories of automotive components, accessories, assemblies, test methods, and so on. In 1997, the Ministry of Road Transportation and Highways (MoRTH) set up the Automotive Industry Standards Committee (AISC) under the Automotive Research Association of India (ARAI) to formulate safety standards for vehicles, systems, and components. The AISC works in close collaboration with TED.

Evolution of accreditation systems

In the 1960s and 1970s, many countries established accreditation program for laboratories. The criteria for accreditation varied in content and therefore the results of testing and calibration could not be accepted in international trade. With a view to developing common understanding and evolving mutually acceptable criteria, the International Laboratory Accreditation Cooperation (ILAC) was established in 1977. This generated interest across countries in setting up national accreditation programs.

In India, accreditation of laboratories was initiated as a program under the Sixth Five Year Plan (1980–85) in the Department of Science and Technology. It culminated in the establishment of National Coordination of Testing and Calibration Facilities (NCTCF) in 1981. The second edition of ISO/IEC Guide 25, "Guidelines for the Technical Competence of Testing Laboratories," was published in 1982 and became the de facto criterion for recognition of laboratories, mainly because it was backed by ILAC (Breitenburg 1994).

The 1982 edition of Guide 25 included some requirements for quality systems (which preceded the first publication of ISO 9001 standards, published in 1987). NCTCF initiated the calibration programs for testing laboratories in India using the guidance and requirements of Guide 25. As part of the accreditation process, a national system of measurement traceability was introduced, with National Physical Laboratory as the apex provider of reference standards as well as calibration services. Second and third echelons of calibration standards were established in laboratories that had ramped up their calibration systems. The NCTCF granted 175 accreditations during the 10 years it existed, before it transitioned into National Accreditation Board for Testing and Calibration Laboratories (NABL) in 1993,

under the Department of Science and Technology. NABL finally merged with the Quality Council of India in 2016.

With the economic liberalization in 1991, the demand for testing, inspection, and certification increased substantially. This led to a proliferation of private sector-led laboratories, reflected in the steady growth of accreditations granted by the NABL. Sectors that started relying more on accredited test results included construction (especially testing of concrete, steel, soil); irrigation and water supply (use of tested and certified pipes, fittings, gate valves); processed foods and packaged drinking water; pharmaceuticals; and oil & gas products. By the mid- to late-1990s, several procurement tenders by the government and public sector companies started including requirements for submitting test results of the supplies backed by NABL accreditation.

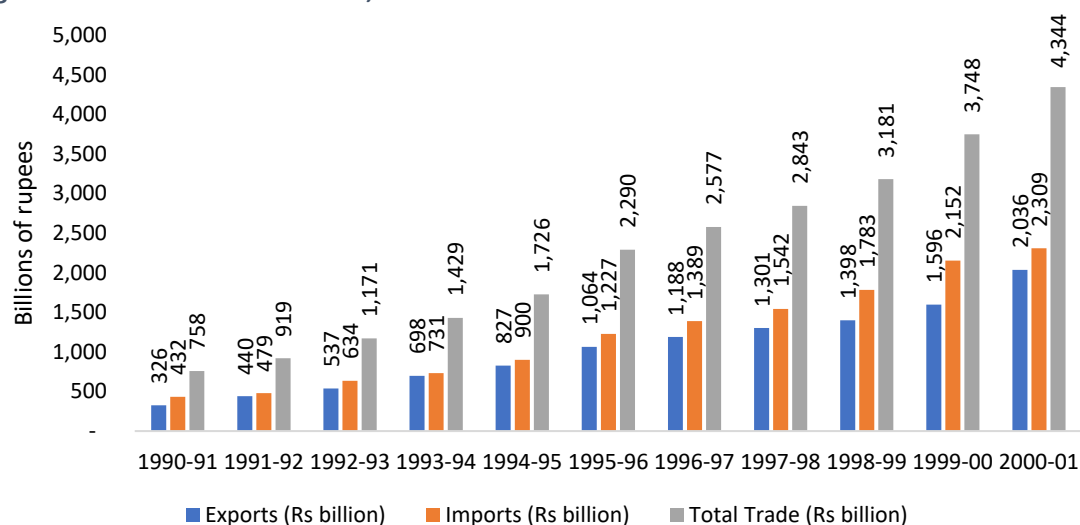
The quality wave

A major event with effects around the world was the adoption of the ISO 9000 series of Quality Management Systems (QMS) Standards in 1987. This led to a massive transformation of how quality was perceived and practiced by public and private corporations. Indian industry, led by the Confederation of Indian Industry, launched a nationwide total quality movement. Major corporates, including public sector undertakings and defence production units, led by their top leaders, embarked upon the quality journey through the adoption of the QMS Standards.

While the initial wave was served by overseas certification bodies, BIS set up its own Management Systems Division Council in 1989 and launched a nationwide campaign in 1991 in collaboration with the industry bodies to popularize the ISO 9000 series of standards through awareness, trainings, and certification. During this period, international and other prominent national bodies opened operations in India, including the American Society of Mechanical Engineers (ASME), the British Standards Institution (BSI), Bureau Veritas, the Canadian Standards Association (CSA), the Institute of Electrical and Electronics Engineers (IEEE), TUV, and Underwriters Laboratories (UL).

The liberalization of the economy and the adoption of the quality standards had a positive impact on export volumes, which grew from 326 billion rupees (US\$19 billion) in 1991 to 2.036 trillion rupees (\$US46 billion) in 2001 (Chaturvedi 2025) (refer to figure 3).

Figure 3. India's volume of trade, 1991–2001



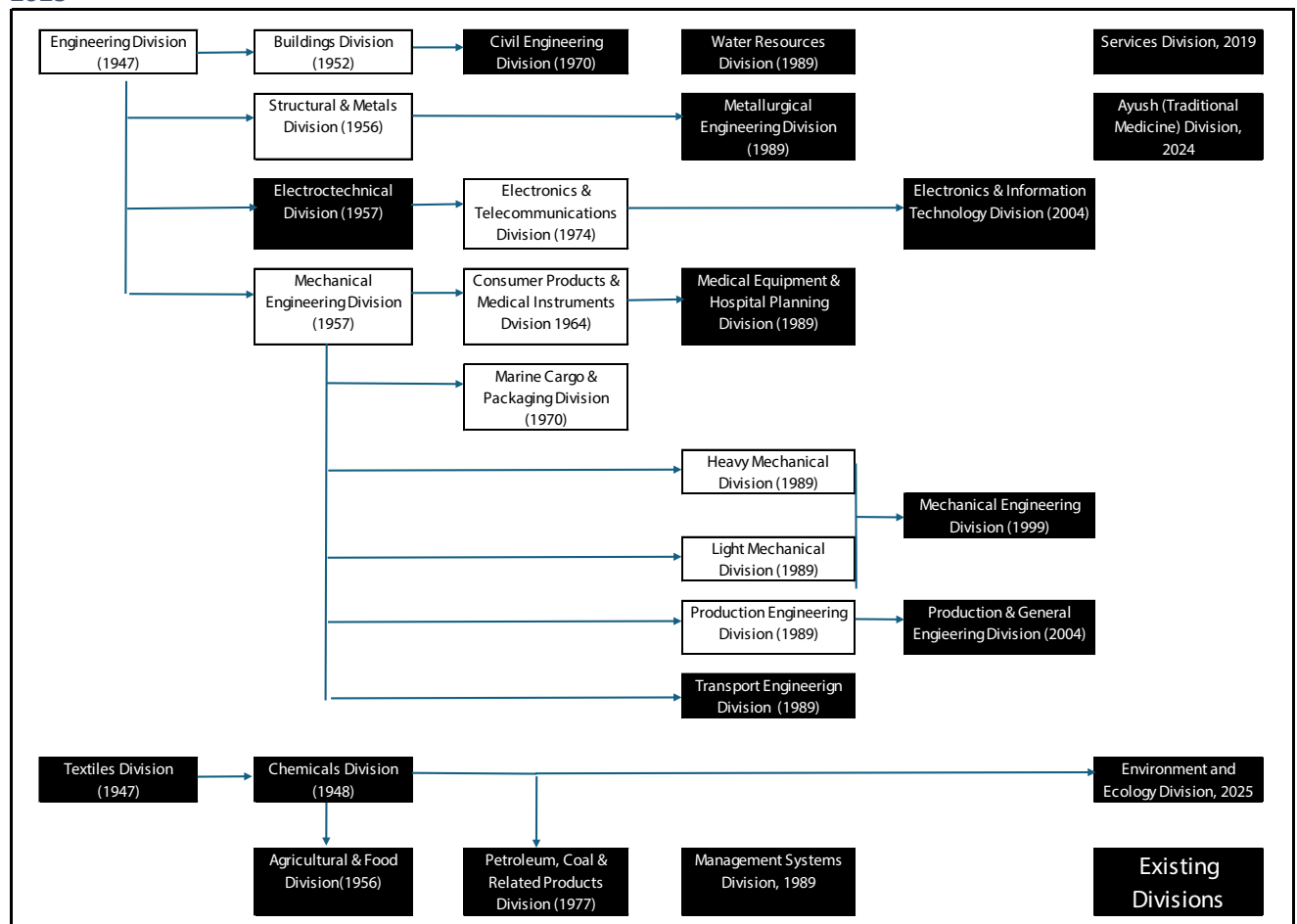
Source: Chaturvedi 2025.

Integration with the World Economy (1997 onward)

The economic reforms introduced by the PV Narasimha Rao government (1991–96) opened up India to foreign investment, privatization, and globalization. The growth rate surged to 7.5 percent by 1996, laying the foundation for India's rapid economic expansion in the 2000s that allowed new businesses and startups to emerge in sectors like information technology (IT), manufacturing, and telecom. Inflows of foreign direct investment increased from US\$237 million in 1991 to US\$2.14 billion by 1996 (Akhtar 2013) and have continued to increase. Multinational enterprises (MNEs) entered India, bringing in capital, technology, and employment. With privatization in telecom, mobile phone penetration increased rapidly. Private sector participation in power, roads, ports, and airports boosted infrastructure, while industrial production accelerated due to easing of import of technology and raw materials. The accelerated growth in many sectors placed unprecedented demand on standards both for goods and services.

The standardization response came in multiple ways. BIS revamped and restructured its Standards Division councils with changed scopes (refer to figure 4).

Figure 4. Establishment of standardization divisions in the Bureau of Indian Standards (BIS), 1947–2025



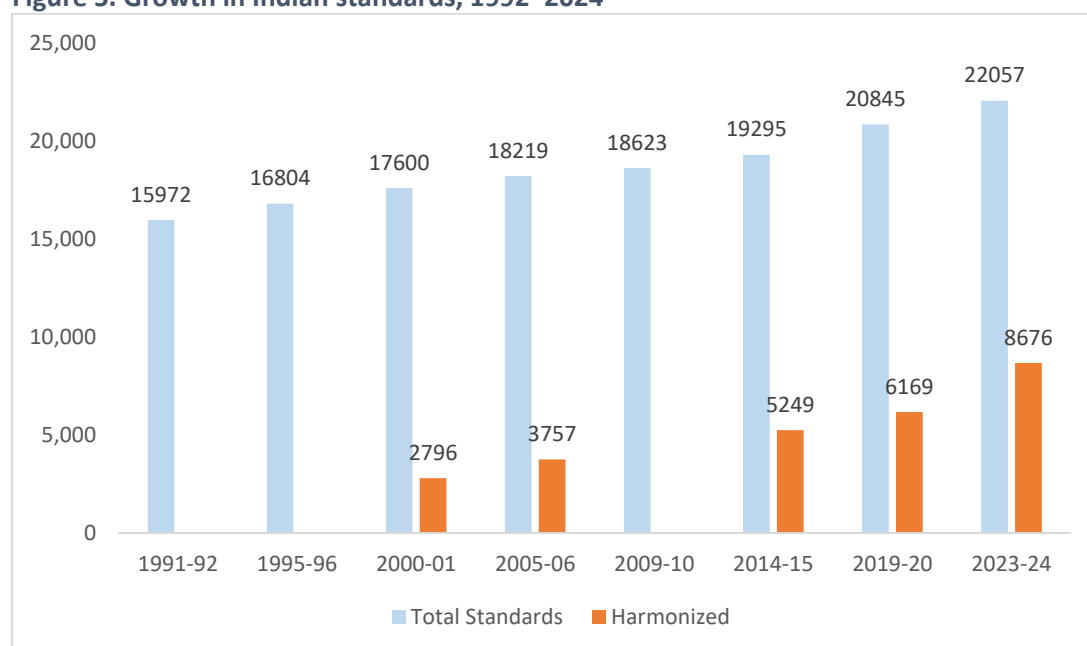
Source: Compiled from data in Indian Standards Institution (ISI) and Bureau of Indian Standards (BIS) annual reports.

New standards development bodies were established. Various foreign standards development organizations expanded their operations in India. BIS became more active in adopting international standards as well as in participating in those organizations. Standards development also became a more participative activity domestically, with greater coordination among standards bodies, regulatory bodies, and policy divisions at the ministries, and much higher involvement of industry bodies in standards setting as well as in capacity building.

In 2005, India signed its first Comprehensive Economic Cooperation Agreement with another country (Singapore) that included a dedicated chapter for mutual recognition of conformity assessment results based on harmonized standards. Almost all subsequent Free Trade Agreements (FTAs) have included chapters on standards, mutual recognitions, and/ or references to the World Trade Organization (WTO) Agreement on Technical Barriers to Trade (TBT Agreement) and WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement).

Standards development activity was ramped up to meet the growing sectoral demands. This is reflected in the steady growth in standards developed by BIS since 1992. Figure 5 illustrates the growth, as well as the number of standards harmonized.

Figure 5. Growth in Indian standards, 1992–2024



Source: Compiled from data in Indian Standards Institution (ISI) and Bureau of Indian Standards (BIS) annual reports.

A policy approach to promote the harmonization of standards

These changes—especially the infusion of technology due to technical collaborations and MNEs setting up manufacturing bases in India—spurred growth in the automotive sector and advances in the agro sector, especially food processing, that in turn led to dynamic changes in the standardization landscape. Realizing the necessity of harmonizing national standards to international ones, BIS conducted the first exercise to map the number of Indian standards that were harmonized with ISO/IEC standards in 2000–01. It found that only 2,796 of 17,600 published standards were harmonized.

A policy approach in favor of harmonization, backed by a conscious drive by the technical committees, was undertaken to enhance India's harmonization levels. As a result, the number increased to 3,757 in 2005–06 and to 5,091 by 2011–12. A further mapping revealed that this number represented more than 80 percent harmonization based on ISO/IEC standards that existed on the same subjects. The remaining Indian standards were typical to India and no matching standards existed at the international level.

This drive continued as a top policy feature of both BIS and the government. As of December 31, 2023, out of a possible 9,475 standards, 8,676 Indian standards (88 percent) had been harmonized. The harmonization has been backed by careful examination and wide stakeholder consultation to ensure that the national conditions (such as tropical climate, cultural practices, the state of the technology) have been taken into account before the standard has been adopted. For example, the Indian Standard for Safety requirements of electric kitchen machines notes: *“This standard is based on IEC 60335-2-14 (2006) ‘Safety of household and similar electrical appliances—Part 2-14: Particular requirements for kitchen machines’ issued by the International Electrotechnical Commission except for the following modification: a) The leakage current value is more stringent as compared to IEC Publication, and b) Ambient test conditions are based on national conditions.”*

Participation in international standards development

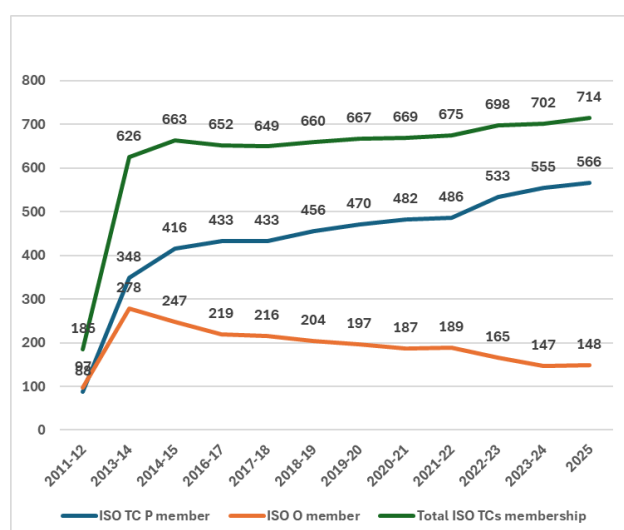
India was one of the active participants in international standards development when the ISO was founded and took leadership in leading standardization work on subjects important to its interests, including mica, shellac, spices and condiments, and leather. In 1964 India proposed the establishment of TC 113 on hydrometry (the science of the measurement of water) and has since been chairing the technical committee.

Despite these early achievements, India's participation in international standardization has been tepid for several reasons: (1) lack of funding support to travel, reflecting a concern faced by most developing nations; (2) complex administrative approvals for international travel; (3) lack of continuity in nominating the same expert for a specific project; (4) an insulated economy until 1991 that prevented Indian industries from representing their direct interests in the international standards development process, while domestic standards fulfilled most of the country-level needs. In 2000–01, for instance, India sent delegations to attend only five international meetings.

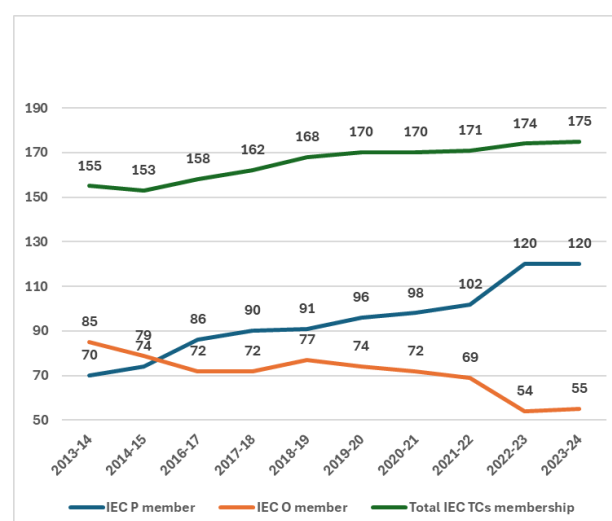
With a shift in emphasis to harmonization of standards, the interest level for direct participation, as well as substantive contributions to international standards, increased. National committees were encouraged to become active as mirror committees of ISO and IEC, to identify experts who could be nominated to attend the international meetings on a sustained basis. A more liberal funding policy from BIS' own funds enabled easing of norms for travel approvals. Figure 6 depicts the progress in the last decade toward memberships in ISO and IEC technical committees, as well as participation in the committee meetings.

Figure 6. India's participation in ISO and IEC technical committees and general meetings, 2011–25

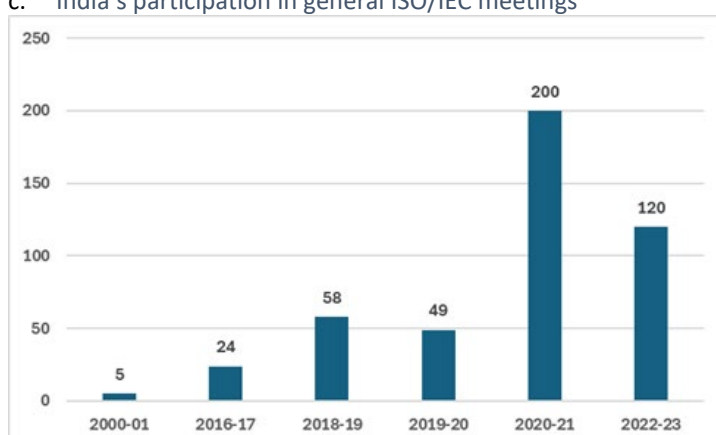
a. India's participation in ISO technical committees



b. India's participation in IEC technical committees



c. India's participation in general ISO/IEC meetings



Sources: Compiled from data in Indian Standards Institution (ISI) and Bureau of Indian Standards (BIS) annual reports.

Note: IEC = International Electrotechnical Commission; ISO = International Organization for Standardization; TCs = Technical Committees.

Linking standardization with sectoral priorities

The examples that follow depict how standardization has supported priority sectors identified in recent years.

Electronics and IT sector. The IT software industry as well as telecommunications started growing rapidly in the late 1990s. Both sectors presented unprecedented needs for standardization. BIS established the Electronics and Telecommunications Division Council (LTDC) in 1974. To keep pace with the developments, the scope of the Division was enhanced as it transitioned into Electronics and Information Technology Division Council (LITD) in 2004 (refer to figure 4). As a matter of strategy, LITD focused on harmonization of Indian standards with ISO/IEC standards and has since been one of the most active participants and contributors in the ISO/IEC Joint Technical Committees (JTCs).

The technical committees were restructured to focus on developing specifications and test methods for electronics equipment, components, and software systems, as well as IT products and services, safety, and security.

The government of India has established several national policies to address emerging needs. These have included:

- National Cyber Security Policy, 2013
- National Digital Communications Policy, 2018
- National Electronic Policy of India, 2019 (establishing India as the hub for Electronics System Design & Manufacturing [ESDM])
- National Policy on Software Products, 2019
- Smart Cities Mission
- Digital India

LITD oriented its work program to address these evolving policy challenges. While its earlier work focused on data privacy, biometrics, mobile security, closed circuit television (CCTVs), printed circuit boards (PCBs), data governance, and market developments related to the future network like 5G, it switched attention to emerging challenges of safety, cyber security, interoperability, system integration and optimization, ethical and societal concerns across IT infrastructure, smart technologies, and reference architectures for smart cities and smart manufacturing. In its strategic plan formulated in 2020, the Division also identified subjects such as the Internet of Things (IoT), blockchain, and distributed ledger technologies, artificial intelligence, wearable devices, cloud computing, smart manufacturing, and active assisted living.⁵

Based on its work at the national level, India was designated as the convenor of Working Group 3 of the IEC Committee SyC Smart Cities on Reference Architecture, which is responsible for developing and maintaining a reference architecture model and standards mapping tool for smart cities.

Telecommunications. The National Telecom Policy of 1994 promoted private sector participation, necessitating interoperability with International Telecommunications Union ITU-T standards for networks and services. In 1997, the Telecom Regulatory Authority of India (TRAI) was set up. One of its policy measures was alignment of regulatory frameworks with international standards. The harmonization with ITU communication protocols became even more necessary with the liberalization of long-distance international calling after 2000. In 2004, the Broadband Policy enabled the adoption of ITU-T's broadband quality and service standards. More recently, the introduction of Mandatory Testing and Certification of Telecom Equipment (MTCTE) by the Telecom Engineering Centre (TEC) under the Department of Telecommunications has further aligned testing parameters of the equipment with ITU standards. In addition, in 2015 the Department established the Telecommunications Standards Development Society, India (TSDSI), a standards development organization that develops standards for access, back-haul, and infrastructure systems, solutions, and services for specific telecom/ICT needs, based on research and innovation in India. TSDSI works closely with global standards bodies such as 3GPP and OneM2M to reflect Indian requirements into international telecom/ICT standards. As per its Annual Report 2023–24, TSDSI had published 9,452 standards, including transposed and adopted standards from 3GPP, OneM2M, and ETSI.⁶

Precious metals. India is the world's second largest consumer of gold, with gold and silver jewellery constituting an integral part of traditional wear. Due to scarce domestic production, the dependence on imports and recycled jewellery had led to large-scale market malpractices. A market survey conducted by BIS in 2001 revealed widespread under-reporting of the purity of gold in products being sold. Taking note of consumer protection in this sensitive area, the government advised BIS to develop a gold hallmarking scheme. In response, BIS developed a suite of standards for gold purity marking and assaying (testing). A voluntary scheme was launched in 2001 that was well accepted by the jewellery industry as well as consumers. The scheme continued to operate on a voluntary basis until 2021, after which it was made mandatory. With more than 200,000 hallmark certifications issued to jewellery

establishments, India now operates one of the largest hallmarking schemes worldwide. Parallel standards and voluntary hallmarking schemes have been established for silver and gold bullion. However, the Indian hallmark is not yet recognized in overseas markets because India is not a member of any international convention.

Services. With a view to unleashing the full potential of the services sectors and achieving their sustained growth, and to enhance global competitiveness of India's services sectors and position India as a services hub of the world, the government of India identified 12 champion sectors in services in 2018. Among other policy initiatives, the scheme recognized that the role of standards in shaping the export competitiveness of various services sectors is becoming an increasingly important aspect in shaping global trade in services (India, Department of Commerce 2019). The action plan included specific recommendations for developing standards in services, advising the departments and ministries concerned, supported by BIS, to develop service standards—including both cross-cutting horizontal standards and sector-specific vertical standards—in all champion sectors, and to support their adoption in a time-bound and systematic manner through mandatory routes as well as voluntary means, so as to enhance competitiveness, service delivery quality, and consumer welfare.

BIS responded by setting up the Services Sector Division Council (SSDC) in 2019 with 11 technical committees aligned with the champion sectors. Even though most work was greenfield, the response from the services industry has been encouraging. The number of committees has since grown to 20, including one committee dedicated to writing cross-cutting horizontal/basic standards that will support the work of all sectoral committees. SSDC has published more than 200 standards to date. In 2025, BIS approached the ISO to set up a technical committee under BIS leadership for developing fundamental standards in services (currently under country ballot).

Pursuing standards focused on societal benefits

Indian Standards have played a critical role in meeting several societal needs, including the following.

Diesel engines. In 1960, the ISI published a set of standards covering performance requirements for diesel (internal combustion) engines. In the early 1970s, a major oil crisis during the OPEC oil embargo and a subsequent surge in oil prices led to severe scarcity of fuel in India, which curtailed the use of internal combustion engines. Moreover, the engines being supplied were not energy efficient. With a view to enhancing efficiency and conserving fuel, the Ministry of Agriculture, in collaboration with the National Agricultural Bank for Rural Development, introduced an incentive scheme to finance the purchase of the diesel engines, provided they met the efficiency standards laid down in the Indian Standard IS 1601. In response, the ISI developed a certification scheme in 1970 and granted the first four certifications in 1971–72. The success led to systematic growth of one of the first engineering clusters in Rajkot, a city in Gujarat. By the early 1980s, more than 50 certified units were in operation, which in turn spurred the growth of a larger ancillary industry of parts and subassemblies. The operation of the standards-led scheme not only generated skills-based employment but immensely benefited the agricultural sector through robust and efficient pumping systems. As the industry developed, it became an exporter of the diesel engine sets to African and other nations.

Safe drinking water. Only about 30 percent of rural areas had safe drinking water as of 1981 (India, Planning Commission 2010). Following the International Drinking Water Supply & Sanitation Decade from 1981 to 1991, the government of India launched the National Drinking Water Mission, which was later renamed the Rajiv Gandhi National Drinking Water Mission. The Mission issued comprehensive guidelines for the Accelerated Rural Water Supply Programme and National Water Policies (in 1987 and 2002) and introduced the Sector Reform Project in 1999.

BIS worked in close collaboration with the National Drinking Water Mission and made useful contributions in providing guidelines for the location, installation, and operation of tube wells and guidelines for selection of pipe and pipe materials. A separate Directorate, the Quality Assurance for Water Supply Mission, was created to execute the projects on quality assurance in this area. It coordinated the activities required for standardization and certification, testing, and for the promotional effort. BIS developed several standards and handbooks under the project (1987–92) in three broad categories related to equipment, water treatment, and borewells.⁷

BIS also undertook a series of awareness programs and trainings for public health engineers in the state government aimed at providing information on the standards and certification schemes related to the mission.

The standards, product certification of products such as deep well handpumps, submersible pumps, pipes and fittings, and the manuals, combined with trainings, played an important role in the success of the mission. The Planning Commission instituted an impact assessment study in 2010 and reported major outcomes such as access to safe drinking water to 93 percent rural population in the target states and year-round supply of drinking water to 66 percent of households. More than 70 percent households reported improved sanitation and reduction of women's workloads. These results demonstrate the role of standards in generating very positive outcomes to meet a critical societal need affecting the health of the rural population.

Low voltage direct current (LVDC) initiative. In the 1990s, the electric power microgrid was pioneered in India by renewable energy development agencies in rural areas in the state of West Bengal, followed by Chhattisgarh. By the time of the 2001 census, 25,000 rural villages were considered too remote and warranted off-grid electrification. Subsequently, several microgrid installations took place under the umbrella of government of India, including the Remote Village Electrification Programme, the Village Energy Security Programme, and the Decentralized Distributed Generation scheme across various states including Bihar, Chhattisgarh, Karnataka, Madhya Pradesh, Odisha, Sikkim, Uttarakhand, Uttar Pradesh, and West Bengal.

Yet despite their known advantages for communities and their technical feasibility, microgrids in India were not scaling up, mainly due to financial and operational challenges in developing a functional commercial model. Creating a micro-grid requires building a micro distribution network with wires and meters.

BIS recognized the potential of LVDC technology to enhance energy access, particularly in remote and underserved regions of India. The initiative to develop LVDC standards began with the formation of dedicated committees under the Electrotechnical Division Council (ETD), focusing on standardizing LVDC distribution and utilization systems; establishing guidelines for safety, efficiency, and interoperability; and aligning with global advancements in LVDC technology while considering local requirements.

The pioneering work carried out by BIS was the development of the Indian Standard IS 16711:2017–Guidelines for LVDC Distribution Networks, which set up the basic concepts of LVDC supply and distribution grid. The standardization efforts addressed various aspects of LVDC systems such as ensuring safe and reliable connection to existing electrical infrastructure; defining efficiency and safety norms for appliances operating on LVDC; and enabling seamless integration of renewable energy sources like solar PV into LVDC systems.

The adoption of LVDC technologies has had a profound impact on local communities, particularly in rural and peri-urban areas. More than 45,000 LVDC installations have been made in the states of Assam, Jammu and Kashmir, Manipur, Meghalaya, and Rajasthan. The key benefits include:

- *Enhanced energy access.* LVDC-based microgrids provide electricity to remote villages where traditional grid extension is unfeasible.
- *Improved efficiency.* LVDC systems minimize conversion losses, leading to better energy utilization.
- *Cost-effectiveness.* Infrastructure costs are reduced because the need for complex AC transformers and distribution networks is eliminated.
- *Support for renewable energy.* The direct use of solar power and energy storage solutions without the need for multiple AC-DC conversions.
- *Safety and reliability.* LVDC systems operate at safer voltage levels, reducing risks associated with electrocution and fire hazards.

The development and adoption of the LVDC standards has strengthened India's position as a thought leader in global standardization efforts; facilitated international harmonization of LVDC technologies; and enabled cross-border compatibility of LVDC systems and appliances.

Recognizing India's leadership in LVDC standardization, and on its proposal, the International Electrotechnical Commission (IEC) set up the IEC SyC LVDC (System Committee for LVDC) focusing on global LVDC standardization efforts. It has published several IEC standards related to LVDC.⁸ Currently, the Committee is working on LVDC industry applications and use-cases for LVDC systems for public electricity distribution and distribution microgrids.

Other social impacts. Standards have played a critical role in aiding the development of micro, small, and medium enterprises (MSMEs) and cooperatives in various sectors. One of the important sectors has been the pesticides/insecticides industry. Government in several states, such as Kerala and Tamil Nadu, supported the setting up of small-scale manufacturing units in the early 1960s, provided they acquired ISI certification. The collaborative effort led to the evolution of the country-wide pesticides industry, which was vital in the early 1960s and 1970s to support India's Green Revolution and a substantial increase in foodgrain production and crop survival rates. BIS developed a full suite of standards for the pesticides in use for different crops and has backed it with a certification program that ensures the quality of products as well as safety during use.

Standardization by other Indian standards development organizations

In addition to BIS, 15 voluntary bodies are engaged in development of standards in India. These were established at different times over more than a century. Table 1 lists the standards development organizations, together with their area of work.

Table 1. Standards development organizations in India (other than BIS)

Standards development organization	Year established	Scope of standardization
Indian Roads Congress	1937	Standards relating to roads and bridges.
Directorate of Marketing and Inspection,	1937	Grading standards for foodgrains and other foods (AGMARK).
Research Design & Standards Organization	1957	Specifications for railways equipment, accessories, and infrastructure.
Directorate of Standardisation, Ministry of Defence	1958	Adoption of BIS standards, coding of inventory, preparation of joint service specifications.
Standardisation Testing and Quality Certification (STQC), Department of Information Technology	1980	e-governance standards on network security, metadata, biometrics, digital preservation, language technology, and e-governance architecture.
Indian Society for Heating, Refrigeration and Air Conditioning (ISHRAE)	1981	Standards on HVAC, air handling, refrigerant flow.
Telecommunication Engineering Centre (TEC)	1989	Standards and technical specifications for telecom equipment and services.
Building Materials & Technology Promotion Council (BMTPC)	1990	New and alternate building materials.
Agricultural & Processed Food Products Export Development Authority (APEDA)	1996	Standards for organic food production and systems.
Automotive Research Association of India (ARAI)/Automotive Industry Standards Committee (AISC)	1997	Automotive industry standards on vehicles, components, test methods, type approvals, road safety, intelligent transport systems.
Quality Council of India (QCI)	1997	Standards for hospital accreditation, schools accreditation, scheme-specific standards
National Medicinal Plants Board	2000	Good Agriculture Practices, Good Field Collection Practices for medicinal plants.
Bureau of Energy Efficiency (BEE)	2002	Energy performance standards for appliances.
Department of AYUSH	2014	Ayurvedic pharmacopoeia of India, including standards for substances used in the Indian traditional Ayurvedic medicines.
Telecommunications Standards Development Society, India (TSDSI)	2014	Transposition of telecommunication standard relating to 3GPP, oneM2M; IoT, interoperability and portability of cloud services, standards for cloud computing interoperability, fiber optics products and network.

Source: Compiled from information available in respective websites.

Note: 3GPP = 3rd Generation Partnership Project; BIS = Bureau of Indian Standards; HVAC = heating, ventilation, and air conditioning; IoT = Internet of Things; ITS = Intelligent Transportation Systems. oneM2M sets the standards for the Internet of Things.

In addition, several regulatory bodies notify technical regulations containing essential requirements or by reference to national or international standards. Table 2 lists prominent regulatory bodies that have notified regulatory technical standards.

Table 2. Regulatory bodies in India that notify regulatory technical standards

Regulatory body	Standards/essential requirements notified
Central Boilers Board	Standards for all types of boilers and boiler components. The standard are closely aligned with PED and ASME BPVC.
Tea Board	Standards for black, green, kangra, and instant tea (defined in Tea (Distribution and Export) Control Order, 2005).
Central Pollution Control Board	Lays down standards for quality of air, water for multiple uses, environment pollutants, and vehicular exhaust; codes and guidelines relating to treatment and disposal of sewage and trade effluents.
Petroleum and Natural Gas Regulatory Body (PNGRB)	Technical standards and specifications including safety standards for petroleum and petroleum products pipelines, city or local natural gas distribution networks, and liquified natural gas facilities. Codes of Practices for Emergency Response and Disaster Management Plan (ERDMP), 2010.
Ministry of Environment, Forest and Climate Change (MoEFCC)	Effluent and emission standards for different industry/service sectors under the Environment Protection Act.
Food Safety and Standards Authority of India (FSSAI)	Lays down standards for articles of food, their manufacture, storage, distribution, sale and import; food safety and standards (food or health supplements, nutraceuticals, foods for special dietary uses, foods for special medical purpose, functional foods and novel food, organic foods.
Petroleum and Explosives Safety Organization (PESO)	Essential requirements and regulatory standards for explosives, petroleum, calcium carbide, flammable and nonflammable compressed gases and other hazardous substances, non-fired pressure vessels, factories, transport, storage installations, dispensing stations, bottling plants, refineries, gas filling plants and stations, petroleum storage and retail outlets, cross-country pipelines, flame-proof equipment.
Central Drugs Standard Control Organization (CDSCO)	Standards for drugs, vaccines, and so on: Indian pharmacopeia, homoeopathic pharmacopeia, standard for disinfectant fluids, standards for cosmetics in finished form, standards for condoms and contraceptives, standards for medical devices.

Source: Compiled from information available in respective websites.

Note: ASME BPVC = American Society of Mechanical Engineers Boiler & Pressure Vessel Code; PED = Pressure Equipment Directive notified by the European Union.

Among these standards development organizations, the Building Materials & Technology Promotion Council (BMTPC) and Automotive Research Association of India (ARAI) have an understanding with BIS to offer their standards for publication as Indian standards. The Directorate of Standardization in the Ministry of Defence adopts Indian standards for defence production applications without change. The Research Design & Standards Organization (RDSO) adopts Indian standards and integrates them with the RDSO specifications. TSDSI works in cooperation with the LITD Division of BIS for convergence of telecom standards in smart systems.

Foreign standards development organizations in India

Several foreign standards development organizations whose standards are widely used by industry, have established support and marketing divisions in India. Prominent among these are ASME, BSI, IAPMO (the International Association of Plumbing and Mechanical Officials), IEEE, NACE (the National Association of Corrosion Engineers), and UL. While IAPMO has developed an understanding with its Indian counterpart, the Indian Plumbing Association, and has brought out the India Plumbing Code, other foreign standards development organizations operate independently and have created a significant membership base in India. Indian experts in their individual capacity are also members of the technical committees of these bodies, which are responsible for developing the relevant standards and codes. IEEE and UL collaborate in the development of Indian standards in electrotechnical field through participation in the BIS technical committees.

Securing wider stakeholder engagement

With a view to engage wider stakeholder groups, India has pursued the practice of setting up state-level committees on standardization and quality systems since the 1960s. Through these committees, the state governments/union territories get updates on the recent developments on standards. The committees also act as the policy committee for the implementation of the standards in the states in such areas as government procurement, quality upgrading of local industry, and enhancing cross-border trade. The committees meet annually and are usually chaired by the Chief Secretary or Industries Secretary of the state government.

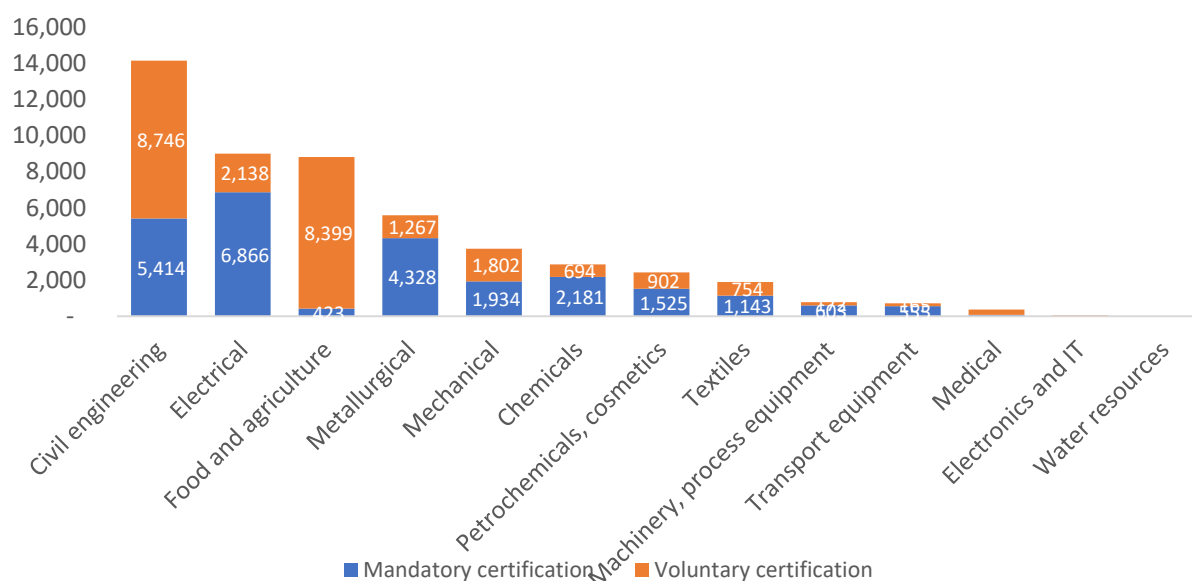
To further broaden the base of the standardization process, especially for identification of new subjects, standardization cells have been established in 42 central government departments and ministries. Similar outreach has been made to industry associations across all sectors. A total of 102 standardization cells have been created in industry associations. Many cells have already started contributing, especially in proposing new subjects to BIS.

Conformity Assessment and Accreditation

The BIS Product Certification Scheme continues to remain the most popular and well-recognized conformity assessment program in India. Launched in 1955 as a voluntary scheme, it is currently being used as the principal instrument for enforcing mandatory standards through Quality Control Orders issued by different wings of the central government. As a result, the number of certifications has swelled in the last decade to more than 50,000 in India and more than 1,600 overseas. About half the standards under regular certification are mandatory (692 out of 1,401). In addition, 73 products have been placed under compulsory registration, a scheme based on self-declaration of conformity. More than 25,500 product models have been registered under this scheme.

Figure 7 presents the distribution of 50,422 certifications issued by BIS by product category, as well as the split between mandatory and voluntary certifications. In addition to BIS, the Bureau of Energy Efficiency enforces mandatory standards and certification on energy labelling.

Figure 7. Distribution of BIS certifications by product category and by whether certifications are mandatory or voluntary, 2025



Sources: Information provided by BIS on request.

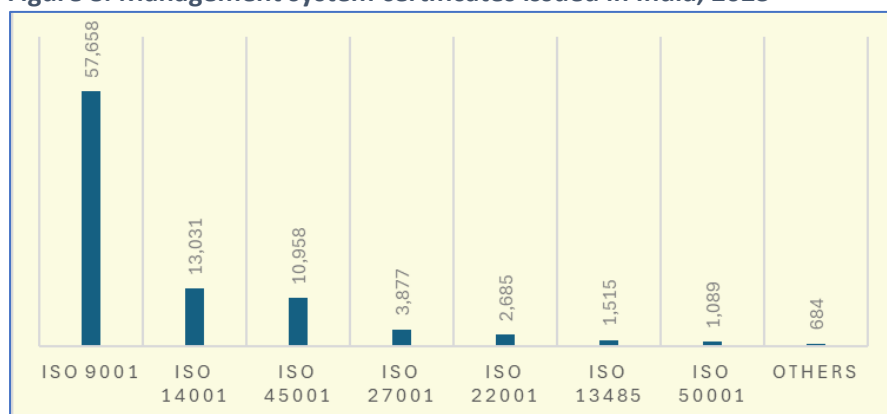
Note: Data are as of July 28, 2025. BIS = Bureau of Indian Standards; IT = information technology. “Food and agriculture” also includes equipment.

Management systems certification

With the introduction of management systems conformity schemes in early 1990s, conformity assessment developed into a structured and widespread activity. Adoption spread quickly and within the 1990s and early 2000s, the number of certifications swelled to more than 50,000. Environment and occupational safety certifications also became quite popular, leading to the emergence of integrated management systems. The demand spurred the spread of certification bodies, initially led by overseas bodies such as Bureau Veritas, Lloyd’s Register, SGS, and TUV. Later, many domestic conformity assessment bodies (CABs) sprang up in both the private and public sectors. Downstream demand for certification came primarily from organized purchasers as prequalification for vendor registration, as well as from overseas buyers. Over time, importers have switched to dedicated management schemes such as the AITF-led certification to Automotive Standard (TS 16949), aviation products under the AS 9100 series of standards, and consortium-led schemes such as WRAP for textile products.⁹

In 2023, there were 91,497 management systems certifications in India; their distribution is shown in figure 8. India has issued the third-highest number of certificates globally, behind China (246,213) and Italy (154,762).

Figure 8. Management system certificates issued in India, 2023



Source: ISO Survey of Certifications to Management System Standards, 2023

(<https://www.iso.org/committee/54998.html?t=KomURwikWDLiuB1P1c7SjLMLEAgXOA7emZHKGWyn8f3KQUTU3m287Nxn pA3Dluxm&view=documents#section-isodocuments-top>).

Note: ISO = International Organization for Standardization.

In addition to product and management systems certification, other well-recognized certification programs include hallmarking of gold jewellery (operated by BIS), energy labelling (operated by the Bureau of Energy Efficiency), and green building certification (operated by CII Green Building Centre and US GBC). Table 3 summarizes the number of certifications issued by each of these programs.

Table 3. Type and number of BIS and other certifications in India

Type of certification	Number
BIS product certifications	50,422
BIS Overseas Certifications	1,960
BIS Hallmarking certifications	185,005
Green Building certifications	20,640
SA 8000 Certifications	1,877
BEE Star Label (models) certifications	25,598

Sources: Compiled from latest available information from websites, published annual reports of the respective organizations.

Note: BEE = Bureau of Energy Efficiency; BIS = Bureau of Indian Standards; SA = Social Accountability.

Accreditation

The Quality Council of India (QCI) was established in 2000 to provide accreditation services to the growing demand of certification services. Among the first initiatives of QCI was the establishment of the National Accreditation Board for Certification Bodies (NABCB). Over the years, NABCB has kept pace with global developments in accreditation programs and has signed 21 Multilateral Agreements (MLAs) under the Asia Pacific Accreditation Council and by extension with the International Accreditation Forum. This includes MLAs for environmental certifications (2007), product certifications (2013), inspection bodies (with the International Laboratory Accreditation Cooperation, ILAC, in 2013), and personnel certification (2019).

Laboratory accreditation services in India predate the establishment of the Quality Council of India and commenced in 1981 under the aegis of National Coordination of Testing and Calibration Facilities (NCTCF), which later transitioned to the National Accreditation Board for Testing and Calibration Laboratories (NABL). NABL operated as an independent autonomous society reporting to the Department of Science and Technology until 2016, when it was merged with the Quality Council of India based on a Cabinet decision of the government of India, with a view to bring all accreditation activities for conformity assessment under one umbrella. NABL is now a constituent board of the QCI.

It has been a Mutual Recognition Arrangement (MRA) signatory member of APLAC (now APAC) and of ILAC for testing, calibration, and medical laboratories since 2000.

NABL provides accreditation services to laboratories in India and overseas that are performing tests/calibrations in accordance with ISO/IEC 17025 and ISO 15189/ISO/IEC 17043/ISO 17034 in testing laboratories, calibration laboratories, medical laboratories, proficiency testing providers, and reference material producers. Table 4 presents information about the number of accreditations granted by NABL.

Table 4. Laboratories and other bodies in India accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL)

Fields	Accredited laboratories and other bodies
Testing	5,920
Calibration	1,196
Medical	2,168
Reference material producers	73
Proficiency testing providers	24
Total	9,381

Source: NABL website.

Note: Data are as of April 30, 2025.

Between 2023 and 2025, three more laboratory accreditation bodies in India were granted MLA signatory status. The number of accreditations issued by the new accreditation bodies is not significant yet, but demonstrates that accreditation in India has entered into a competitive domain as in the United States and unlike in the European Union (EU), which allows only one accredited body in each member country.

Use of Quality Infrastructure for Technical Regulations

Even though some of the elements of national quality infrastructure already existed—such as product certification of BIS, the metrology capability of the National Physical Laboratory, and the existence of a laboratory accreditation program—a formally structured quality infrastructure in India can be said to have emerged only over the past 25 years, following the establishment of the Quality Council of India and the accreditation boards for conformity assessment bodies. In a limited manner, these elements were used sporadically for technical regulations, such as the direction by government for the mandatory product certification of BIS for about 115 products. However, the potential for wider use of conformity assessment emerged only when adequate number of accredited conformity assessment bodies were available for management systems certification, product certification, and third-party inspection and testing.

One of the first bodies to engage third-party inspection bodies was the newly established Petroleum & Natural Gas Regulatory Body through a formal empanelment process that included accreditation by NABCB. The empanelled bodies are used for assessment of oil & gas installations for safety, as well as for inspection of equipment such as pipelines.

The Ministry of Health & Family Welfare notified Medical Devices Rules in 2017 that came into effect on January 1, 2018. The new rules have been framed in conformity with the Global Harmonization Task Force (GHTF) framework. They classify medical devices based on risk: Class A (low risk), Class B (low to moderate risk), Class C (moderate to high risk), and Class D (high risk). The rules introduce third-party conformity and certification through Notified Bodies (NBs). NABCB will serve as the accreditation body

for the certification bodies that will be designated as Notified Bodies by the Central Licensing Authority (CLA). These Notified Bodies undertake verification and assessment of quality management systems of the medical device manufacturers of Class A and Class B devices and may, on required basis, render assistance for regulation of Class C and D medical devices. The Rules stipulate that the quality management system of all manufacturing units must be in conformity with ISO 13485.

Several regulatory bodies and bodies supporting enforcement of technical regulations have established recognition schemes for test laboratories that are used for conformity testing of products as part of their regulatory programs, including product approvals as well as surveillance. These bodies include the Food Safety and Standards Authority of India (FSSAI), Bureau of Energy Efficiency, Department of Telecom, Export Inspection Council, and Bureau of Indian Standards.

Due to sudden increase in the notification of products for mandatory BIS Certification (from 115 products in 2017–18 to 692 in 2024-2025), BIS has outsourced the entire surveillance inspection operations for more than 50,000 product certification licenses issued to accredited third-party inspection bodies.

Challenges in Integrating Quality Infrastructure with Economic and Trade Policies

By the mid-2000s, even as the elements of the quality infrastructure were well in place and fair degree of coordination had started to happen among the key players in standards development, accreditation, and metrology, the positive impact on economic growth, and more specifically on export performance, were missing. Some of the reasons for these gaps arose from:

- *Distance from policy planning.* For most part, standards and quality infrastructure have not been integrated with economic and trade policy making by government. There has been little incentive to adopt standards.
- *Awareness and implementation.* Widespread awareness and effective implementation of standards has been lacking among policy makers, as well as small and medium enterprises (SMEs).
- *Challenges of scale.* Even though the numbers of certifications and accreditations appear impressive, they affect only fraction of India's large manufacturing base.
- *Coordination.* Coordination among various quality infrastructure bodies and government agencies was missing.

Recognizing the importance of the role standards and the larger quality infrastructure could play in ramping up industrial and services growth, the Eleventh and Twelfth Five Year Plans made specific recommendations.

Recommendations of the Eleventh Five Year Plan (2007–12)

The Eleventh Plan¹⁰ identified several gaps in India's quality infrastructure and recommended the following:

- Harmonize standards to remove duplication of standards by different standards development organizations and regulators.
- Establish a National Quality and Standardization Authority to ensure uniformity of approach for the setting of standards and ensure regulation of conformity assessment.
- Develop a national system of conformity assessment and compliance to bring complete synergy in standardization, conformity assessment, and enforcement.

- Upgrade infrastructure in critical areas to support MSMEs in meeting national/international standards and regulations.
- Develop voluntary standards in the services sector.
- Make BIS the national standards body and repository of all voluntary standards.
- Recognize only one national accreditation body in each area.
- Require all conformity assessments bodies to obtain accreditation.
- Separate the functions of regulation, standardization, and conformity assessment.

Recommendations of the Twelfth Five Year Plan (2012–17)

The 12th Plan focused on enhancing technological depth in manufacturing. A working group discussed the subject comprehensively.¹¹ In relation to standards, the Plan report identified several issues:

- An absence of standards, which makes it easy to import poor-quality products into the country—which in turn hurts domestic industry because domestic companies are unable to match the price of these poor-quality products; it also exposes consumers to the harmful effects of spurious products.
- The lack of manufacturing standards and testing/sampling labs, which is prompting dumping by foreign manufacturers, such as for mobile phones.
- The lack of a clear framework for voluntary and mandatory compliances.
- The lack of mandatory compliances for safety of products such as toys.
- Dumping of poor-grade steel due to lack of requirements for certification.

The Plan report noted that standards constitute one of the important foundations for technological depth in manufacturing and are accorded high importance by the policy planners in developed countries. Accordingly, the report made the following recommendations:

- Develop a policy on technical regulations.
- Enhance resource capacity of regulators (BIS).
- Review technical regulations to identify gaps with respect to national standards.
- Sensitize industry regarding the need to provide scientific data to regulators to formulate effective technical regulations.
- Set up help desks in industry bodies and export promotion councils to disseminate information.
- Promote and fund a standards cell in industry associations and standards development organizations.
- Build the capacity of standards development organizations.
- Create capacity-building programs to carry out training of technical staff in industry to write company- and industry-level standards.
- Create a government-led, database-based/software-based system to track the changes in technical standards/voluntary compliances globally and alert Indian manufacturers of these developments.
- Promote the acceptance of Indian conformity assessment globally.
- Build capacity of inspection bodies/certification bodies
- Develop regulations on conformity assessment.

The recommendations indicate that important issues related to standardization, conformity assessment, and technical regulations were recognized at the apex level in both Plan documents. Even though these recommendations were not implemented immediately because responsibilities were not assigned, they became inputs to the later development of the Indian National Strategy for Standardization, as well as other policy initiatives that got implemented/enforced, as described in the sections that follow.

Review of India's Quality Infrastructure

In 2014, the Ministry of Commerce—in collaboration with BIS, the Export Inspection Council (EIC), the accreditation boards, and the industry chamber (Confederation of Indian Industry, CII)—initiated a dialogue forum called the National Standards Conclave with a view to assessing the current strengths and weaknesses as well as the threats and opportunities of the Indian quality infrastructure, and to discover ways to leverage its impact on national competitiveness and enhance bargaining position in trade negotiations.. The very first event attracted wide interest and participation from industry, standards development organizations, accreditation and certification bodies, technical institutes, and national experts. The event was a big success; outcomes included comprehensive documentation of issues and concerns across multiple sectors, including sanitary and phytosanitary (SPS) streams, with specific recommendations to be implemented by ministries and other stakeholders.

The Standards Conclave became an annual national event, attended by senior ministers and top-level officials from industry, commerce, consumer affairs, food safety, standards bodies, and state governments. At the 2016 Standards Conclave, the review included a comparative study of national standards strategy documents developed by different countries and the strategic importance accorded by them on standardization and quality infrastructure. Useful insights from these documents included the following:

- Using standardization to advance the social and economic well-being of citizens in a global economy.
- Using standardization to secure the country's position as a leading industrial nation.
- Promoting and obtaining agreement with national positions for the development of regional and international standards.
- Using standardization strategically by national businesses to create competitive advantage, spread best practices, enter new markets, and promote innovation.
- Working to prevent standards and their application from becoming technical trade barriers for products and services.

One of the recommendations at this event was to develop a strategic approach on how the standardization and related activities should progress for India that would enhance competitiveness of Indian industry, secure national and stakeholder interests, and position India as an influential player in standardization at the international level.

In the next Conclave (2017), a SWOT analysis of India's quality infrastructure was presented (summarized in box 3), as a part of a background paper prepared based on year-long consultations with multiple stakeholders. This led to the decision to develop an Indian National Strategy for Standardization (INSS).

Box 3. Analysis of the strengths, weaknesses, threats, and opportunities of India's quality infrastructure as of 2017

The SWOT analysis presented at the 4th National Standards Conclave in 2017 identified the following aspects:

STRENGTHS

- Established and experienced national standards body and accreditation infrastructure.
- Presence of a large number of conformity assessment bodies, several with international affiliations.
- A well-recognized national level product certification scheme.
- Dedicated pre-export quality control schemes in several sectors.
- Increasing level of world-class quality products and services to domestic markets.
- High proportion of harmonization of national standards with international standards.

WEAKNESSES

Standardization

- Limitation of resources to respond to emerging standardization needs.
- Lack of a framework to promote and consolidate standardization activity by other standards development organizations.
- Lack of forums/processes to articulate and prioritize needs for standards development in different sectors.
- Multiplicity of standards (national and foreign) in actual use.
- Lack of adequate participation and representation of micro, small, and medium enterprises (MSMEs) in standards development processes.
- Lack of leadership in international standardization—very few leadership positions.
- Lack of coordination among standards bodies and agencies responsible for trade promotion.
- Lack of research and development (R&D) to support standardization.

Conformity assessment

- Management system certifications are losing credibility.
- No domestic certification scheme has global brand value.
- Regulators lack awareness about how to utilize conformity assessment schemes for regulation.
- The procedures in many schemes are perceived to be cumbersome.
- Government agencies and buyers do not insist on accredited certification.
- No instrument are available through the government to control unscrupulous, fraudulent certifications.

Technical regulations

- Lack of a comprehensive regulation for notifying technical regulations.
- Lack of technical regulations in many sectors/areas in comparison to the European Union and the United States, among others.
- Lack of an agile response mechanism to deal with technical regulations issued by other economies.
- Regulatory standards are not up to date with international or foreign standards in some areas.
- Lack of dedicated regulators in many sectors. Line ministries are not equipped with sufficient resources.
- Lack of awareness of good regulatory practices and regulatory impact assessment.
- Inadequate resources for compliance, enforcement, and surveillance.

OPPORTUNITIES

- Growing interest in trade ties with India. A strong standards and quality infrastructure will enhance the value proposition of Indian goods and services.
- Low inputs and labor costs create the potential to expand exports in many service sectors based on service and professional standards.
- Benchmark good regulatory practices exist in sectors such as medical devices, food safety, oil & gas.
- Opportunity to benchmark world-class quality infrastructure exists in several sectors, such as automotive.
- Opportunity exists to leverage success of “Make in India” policy through standards and quality.

THREATS

- Many competing countries, especially in Asia/the South Asian Association for Regional Cooperation (SAARC), are becoming favored suppliers of goods and services.
- The MSME sector is increasingly challenged to meet quality/price requirements due to competition from cheaper imports.
- Increasing regulatory oversight in European Union (EU) countries and other economies poses stiff challenges for exports of Indian goods and services.
- Unchecked dumping of substandard products harms domestic industry and consumers.
- Fast-paced enablement of manufacturing and services with information technology (IT) will widen the gap if timely domestic standards are not developed and implemented.

Source: Kaul 2022.

Formulation of the Indian National Strategy for Standardization (2018)

The Ministry of Commerce and Industry set up a working group to develop the INSS, with representation from industry, BIS, national accreditation boards, the Export Inspection Council, and the respective line ministries. Based on the SWOT analysis, inputs gathered during previous consultations, the recommendations from the previous standards conclaves, and benchmarks from other national strategy documents, the draft strategy document was prepared. The approach of the INSS was to keep all recommendations realistic and achievable, bearing in mind the ground realities of India’s socioeconomic development, diverse needs, and state of technology.

After an initial round of interministerial consultations, the draft INSS was placed on the Department of Commerce website for global consultation and widely publicized on social media. Many interested organizations were invited to comment, including from major trade partner countries. More than 500 comments were received, including several from Europe and the United States. The Working Group reviewed these comments and addressed them appropriately. In general, the proposals garnered widespread approval. The Minister of Commerce and Industry approved a final draft, which was sent to the Prime Minister’s office for the Prime Minister’s concurrence and message. The INSS was formally launched and adopted in the 5th National Standards Conclave in June 2018.

The INSS is structured around four strategic pillars, each with specific goals:

1. Standards development

- Convergence of national standards development activities.
- Harmonization with international standards.
- Participation in international standardization efforts.
- Development of service sector and voluntary sustainability standards.

2. Conformity assessment, accreditation, and metrology

- Enhancing credibility of certification programs.
- Reducing conformity assessment costs, especially for MSMEs.
- Establishing a globally recognized “Brand India” label.

3. Technical regulations and SPS measures

- Strengthening Good Regulatory Practices (GRP).
- Creating an overarching regulatory framework.
- Enhancing market surveillance mechanisms.
- Addressing technical barriers to trade (TBT).

4. Awareness, counselling, training, and education

- Increasing awareness on standardization benefits.
- Training stakeholders on conformity assessment and regulatory compliance.
- Integrating quality-related subjects into educational curriculums.

Over the past six years, the INSS has emerged as the central policy document and is widely quoted, especially for government initiatives. Several recommendations have been implemented or are in different stages of implementation. These include the development of the Standards National Action Plan by BIS, which focuses on identifying standardization needs, making the standardization processes efficient, and increasing awareness and implementation of standards; achieving a high level of harmonization of standards; increasing participation in the international standards development process, including occupying convenorship positions and setting up 20 technical committees on service standards; launching an accreditation scheme for standards development organizations; setting up standards cells in ministries and industry bodies; creating awareness at the state level; setting up a Centre for Capacity Building by the Department of Commerce, with a focus on standards and technical regulations; and notification of regulations for toys, machinery safety, and chemicals safety.

The INSS has set in motion the transformational impact it intended to achieve. It is expected that subsequent versions will help India’s national quality infrastructure evolve to fully complement the ambitious growth plans.

How effective is India’s quality infrastructure?

While the processes of setting standards and operating conformity assessment schemes are well placed and reflect best global practices, important challenges remain in their translation into economic, social, and sustainability benefits.

Despite multiple efforts to link standardization efforts with critical areas of growth, in many sectors, BIS could not keep pace with the economic reforms beginning 1991 that saw a much faster pace of industrialization and adoption of foreign technologies. Both these factors prompted Indian industry to adopt various foreign standards of national bodies and private standards bodies. Several Indian standards remain outdated without incorporating the latest technology changes or global developments and their use by industry has been limited. The presence of standards published by foreign standards development organizations such as IEEE, ASTM, and ASME often take precedence over Indian standards in terms of market relevance, especially where it involves international trade.

India still must devise a policy response on how to accept or adopt such standards published by private bodies.

A key challenge lies in the composition of the technical committees that continue to draw most of their representatives from public sector organizations and academic institutes. In most cases, the nominated persons are not subject matter experts, and the number of seats reserved for industry are restricted. The participation of SMEs in the technical committees is particularly low, leading to gaps in recognizing their needs and constraints during the standards development process. As a result, the finalized standards are often biased toward the interests of large businesses (this phenomenon is not confined to India). Equally missing is representation from the younger age groups and women, despite the emerging culture of start-ups and women entrepreneurship.

Even though India is a permanent member of a sizable number of ISO/IEC committees, actual participation in the committee meetings has been low through the years and has only been catching up in recent years (refer to figure 6). A key reason for low participation has been the lack of policy to ensure continued participation at the Working Group level, as well as the requirement that private sector members must fund their own visits. More recently, a policy decision has been made to designate individual experts on the ISO/IEC working groups who will remain associated until the project is completed. BIS has also liberalized funding arrangements for individual experts and those from nonprofit organizations. It is expected that these measures will enhance participation and enable India to take more leadership positions at the international level.

The recent policy to mandate the use of voluntary standards through compulsory BIS certification is not aligned with the general practice followed worldwide of regulating products principally on safety aspects. Many Indian standards that are notified for mandatory compliance through the Quality Control Orders contain requirements for quality performance that are not necessarily linked with safety. Central government ministries have been notifying quality control orders on diverse subjects, many of which do not impose safety, health, or environmental hazards but are notified on the grounds of protecting consumers' interest against substandard products flooding the Indian market. However, no market surveys have been carried out to support this premise. The Indian standards cited in these notifications contain several technical requirements that are functional- or performance-based and may not contain any safety requirements, mainly because the standards were drafted for voluntary use. It may become necessary to rewrite the standards to segregate the safety requirements and align with wider global practices.

On a more positive note, the Global Quality Infrastructure Index (GQII) has awarded fairly high rankings to the elements of India's national quality infrastructure (refer to table 5).¹²

Table 5. India's ranking in the Global Quality Infrastructure Index (GQII)

Year	GQII score	Rank			
		GQII	Metrology	Standardization	Accreditation
2020	95.60	10	19	7	9
2021	0.932	10	21	9	5
2023	0.936	10	20	8	5

Source: Global Quality Infrastructure Index (GQII) Program, <https://gqii.org/programme/>.

Note: The GQII is a database and ranking that allows comparison of the quality infrastructure of different countries worldwide. It uses publicly available sources from official Quality Infrastructure Institutions worldwide. The GQII 2023 ranks 185 countries according to the relative development of their QI. A formula calculates a score for each country based on its position in the sub-rankings for metrology, standards and accreditation.

The GQI report presents different correlations between the GQI Index and economic performance parameters. One of the significant positive correlations has been found between the GQI Index and the Economic Complexity Index (ECI) published by Harvard University,¹³ which is a measure of the complexity and diversity of products a country is able to export. In turn, a nation's export capability is a reflection of its quality infrastructure. However, India's rankings make it an outlier: its GQI rank is 10 but its ECI rank is 42 (as of 2021), indicating that its quality infrastructure has not been able to enhance its export potential to the extent it has for other nations. This gap is worth investigating to identify the necessary steps to harness the strength of India's quality infrastructure.

Important Lessons from India's Experience

The size and diversity of India, and its history of independence from colonial rule, provide a good mix of positive and negative lessons for developing countries. Some of the important lessons can be summed up as follows:

- While early government support at the policy as well as the investment level is necessary, the national quality infrastructure matures only with active participation of the private sector (in standards setting, metrology, conformity assessment, capacity building, and self-regulation).
- It is important to align the standardization effort to sectors that are national priorities — for both domestic and international markets. Establishing the mechanisms to identify these needs are essential.
- While technical regulations play an initial role in disciplining supplies and the market, in the long term, voluntary compliance coupled with self-regulatory mechanisms work better in securing conformity levels and market acceptance, as well as achieving cost-effectiveness.
- Coordination among agencies is extremely challenging, but essential to make the overall quality infrastructure work efficiently.
- Harmonization of standards and participation in international standards development may be challenging but must be pursued by companies, industries, and countries to stay competitive and aligned with global value chains.
- Forming regional alignments for cooperation regarding standards helps in improving trade as well as amplifying voices in international forums.

In an encouraging development, India's quality infrastructure and standardization process is becoming increasingly proactive in meeting current and emerging challenges.

Notes

¹ "Notification" refers to the process of making voluntary standards mandatory, notably by publishing legal requirements in the government's official gazette.

² <https://rdso.indianrailways.gov.in/>.

³ Calibration and Measurement Capabilities (CMCs) for a National Metrology Institute (NMI) are the highest levels of measurement and calibration services available to customers. These CMCs are published in the [BIPM's Key Comparison Database](#) (KCDB) after undergoing interregional review, ensuring their availability, accuracy, and international equivalence under the [CIPM Mutual Recognition Arrangement \(MRA\)](#).

⁴ The Non-Aligned Movement (NAM) is a forum of 121 countries that are not formally aligned with or against any major power bloc. It was founded with the view to advancing the interests of developing countries in the context of Cold War confrontation.

⁵ Standards National Action Plan, 2022–2027, Bureau of Indian Standards, <https://www.bis.gov.in/wp-content/uploads/2023/05/SNPbookBilingual.pdf>.

⁶ 3GPP is the 3rd Generation Partnership Project. One M2M sets the standards for the Internet of Things. It is a global partnership project constituted by eight of the world's leading standards development organizations in information and communications technology (ICT). ETSI is the European Telecommunications Standards Institute.

⁷ Bureau of Indian Standards, annual reports, various years. Some of the important publications included "Specification for Deep Well Handpumps (Village Level Operation and Maintenance)," "Code of Practice for Installation and Maintenance of Deep Well Hand Pumps," "Guides for Defluorination and Removal of Iron from Drinking Water," and a "Manual on Location, Operation and Maintenance of Borewells."

⁸ These include IEC 63318:2022 (Specifications for SELV DC Systems Conforming to the ESMAP Multi-Tier Framework Tier 2 and Tier 3 Requirements for Household Electricity Supply) and IEC TR 63282:2020 (LVDC Systems Assessment of Standard Voltages and Power Quality Requirements).

⁹ AITF is the Automotive International Task Force. AS is Automotive Standard. WRAP is the Waste and Resources Action.

¹⁰ Eleventh Five Year Plan, Planning Commission of India.

¹¹ Twelfth Five Year Plan, Planning Commission of India.

¹² For more on GQII, refer to <https://gqii.org/>. The Program is supported by Physikalisch-Technische Bundesanstalt (PTB), the national metrology institute of Germany, and German Cooperation (Deutsche Zusammenarbeit).

¹³ For more on the ECI, refer to <https://atlas.hks.harvard.edu/rankings>.

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