2

The Importance of QI Reform and Demand Assessment

INTRODUCTION

Measurement standards have been around for millennia, starting in the ancient civilizations of Egypt and Mesopotamia. Weights and measures departments have been around for centuries in the industrialized world. In low- and middle-income countries, weights and measures departments were often established around the turn of the 20th century.

Standards bodies were established in the early 1900s in industrializing countries—for example, the British Standards Institution (BSI) in 1901, the American National Standards Institute (ANSI) in 1916, the German Institute for Standardization (DIN) in 1917, and the Japanese Industrial Standards Committee (JISC) in 1921. Low- and middle-income countries followed, establishing national standards bodies in the aftermath of World War II as industrialization spread and as standards, testing, and certification became required. Accreditation is a much later phenomenon, starting in Australia and New Zealand after World War II, and spreading from there around the world.

In many countries, these elements of the quality infrastructure (QI) developed organically, frequently without coordination, resulting in overlaps and gaps in service delivery. In addition, QI organizations have become complacent because of perceived or real monopolies.[1] These arrangements are no longer tenable. Many countries feel the need to evaluate their QI holistically; to reengineer it to become effective and efficient; to support local industry productivity, innovation, and competitiveness; and to support the implementation of efficient and effective health, safety, and environmental controls for the country and its inhabitants.

2.1 WHY COUNTRIES NEED TO DEVELOP COMPETENT AND EFFECTIVE QUALITY INFRASTRUCTURES

Without a competent and effective QI system, it may be difficult to enhance productivity; implement proper technical regulation (important for consumer protection and for the safety and health of the population, fauna and flora, and the environment); and innovate successfully, resulting in the country being less

competitive in global markets. This then translates into challenges back home as a lack of socioeconomic development.

2.1.1 Role of QI in good governance

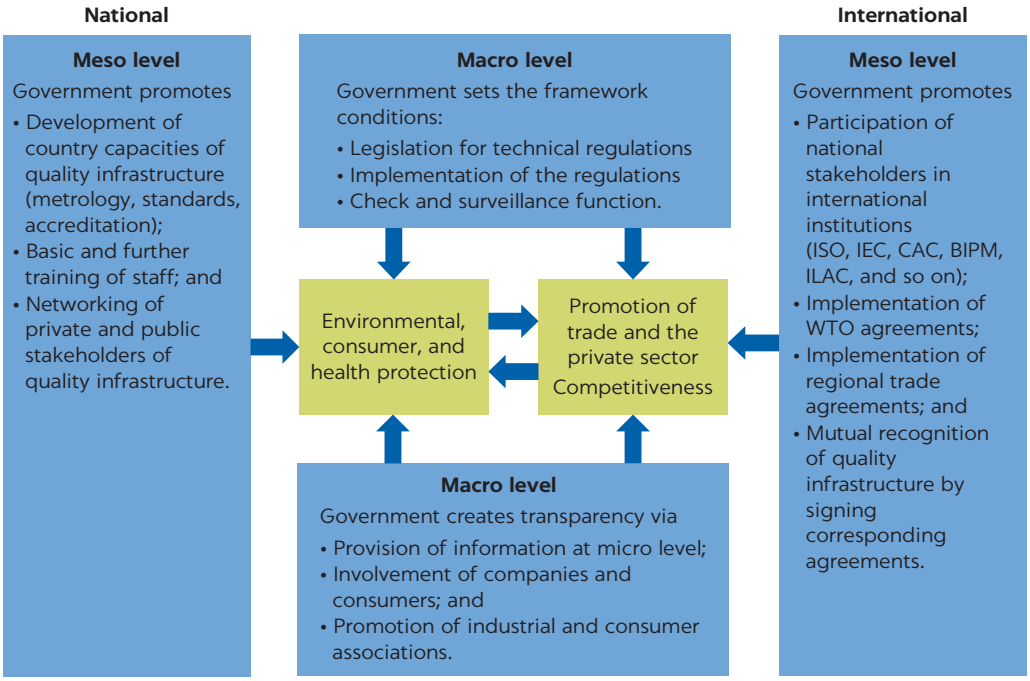
Good governance shapes the framework conditions of a country for its economy and its citizens. These include legislative tasks, linked with a corresponding administrative structure. It means acting in favor of a socioeconomic system that can be enjoyed by all. Hence, good governance is a vital factor for the reduction of poverty and for the promotion of economic development.

Good governance criteria include (a) respect for human rights; (b) public participation in political decision making; (c) the rule of law, signified by an independent judiciary, transparency, and predictability of state actions; (d) a market-friendly socioeconomic order; and (e) development-oriented state action, guided by government policies for ecologically, economically, and socially sustainable development, against corruption, and for an efficient public service.

An effective QI that complies with international agreements; supports the socioeconomic development of the country; supports the implementation of technical regulations for consumer protection and the safety and health of the population, fauna, and flora; and provides affordable services to the small and medium enterprises (SME) sector that makes up a large part of the economy, is a vital part of such a good governance system—and one that the state must foster (figure 2.1).

FIGURE 2.1

Quality infrastructure and government responsibilities: The levels of action



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Note: BIPM = International Bureau of Weights and Measures; CAC = Codex Alimentarius Commission; IEC = International Electrotechnical Commission; ILAC = International Laboratory Accreditation Cooperation; ISO = International Organization for Standardization; QI = quality infrastructure; WTO = World Trade Organization.

2.1.2 Role of QI in improving competitiveness and market access

The nature of participation in the global economy has changed dramatically over the past three decades. Selling to a global market has become increasingly complex. Research and development (R&D), design, production, marketing, and sales now involve a chain of interrelated contractual relationships.

In most parts of this chain, standards and their implementation are used to reduce transactional costs and ensure interchangeability among the modular parts, thereby giving control to the lead firm over the quality of goods produced throughout this chain (Racine 2011). Standards and compliance with them (through conformity assessment, the proficiency of which is assured by metrology and accreditation) have emerged as one of the main drivers for suppliers to gain a competitive edge and in this manner gain market share.

Accessing global markets

Standards have become the lingua franca of world trade. International and regional standards provide a common technical language for trading partners throughout the world. For businesses active globally, these standards are major criteria for assessing the suitability of potential business partners and suppliers. They also ensure the compatibility and quality of products and services. The results of studies on the economic benefits of standardization have shown that 84 percent of manufacturing companies in Germany, for example, use European and international standards to gain access to global markets.[2] Compliance with these standards obviously is possible only with a well-developed QI system, including metrology traceable to the International System of Units (SI) and accreditation that is internationally recognized.

One reason for standards' general importance to trade is that they help lower nontariff trade barriers, thus promoting global trade. In the World Trade Organization's Technical Barriers to Trade Agreement, this is codified in that (a) member states are obliged to adopt international standards as national standards with as little change as possible, and (b) technical regulations should be based on international standards. In many of the regional trade agreements, similar notions are demanded of member states, which have to adopt regional standards as soon as they are published while withdrawing any national standards of similar scope.

Controlling global value chains

The lead firms in global value chains (GVCs) make the key decisions over how production is organized, *who* participates, and *how* (that is, the conditions of participation, such as number and delivery times of outputs, price, quality, and other requirements). The lead company enforces these conditions through standards and their implementation. It demands this not only from its first-tier suppliers, but also from the second- and lower-tier suppliers, to ensure compliance throughout the value chain (Humphrey and Schmitz 2000).

Hence, GVC participation is tied to increasing compliance with a variety of technical requirements, contained in both voluntary standards and technical regulations, covering both product and processes. Demonstrable compliance (for example, inspection, testing, and certification supported by accreditation and metrology) with product and process standards signals to lead firms and their buyers the capability of suppliers down the value chain. Without such demonstration of compliance, the opportunities of getting involved in such

GVCs are limited. An effective and efficient QI, appropriately recognized internationally, is a precondition for delivering such demonstrable compliance.

Reducing costs: Standards

Standards and their implementation, demonstrated through trustworthy QI services, can help a company reduce costs in all areas of business—from purchasing, production, and sales to R&D, quality assurance, environmental protection, and occupational health and safety—in the following ways:

- R&D can use the fundamental knowledge contained in standards as a basis for further developments.
- Standards can help rationalize production and boost efficiency.
- Standardizing interfaces enhances compatibility, leading to lower transaction costs.
- Compatible products and systems are in greater demand and are more successful on the market.
- Standards improve quality, which is essential for good customer relations.
- Standards ensure safety, which not only enhances customer trust, but also reduces liability.

By actively taking part in the development of standardization, companies can help shape these technical rules to better reflect their own interests. At the same time, safety interests such as environmental and consumer protection and occupational health are given due consideration. Plus getting involved in the standards development process brings companies in direct contact with specialists in other areas—and with potential competitors. Such companies therefore gain new knowledge ahead of time, and working together with those shaping R&D helps them bring new technologies to market earlier than those that do not.

Reducing costs: Metrology

Sound measurements can have a major impact in a business and can lead to cost savings, as these examples illustrate:

- Energy is a major input cost for many manufacturers. Measuring the volume of heating gas to a higher degree of accuracy can save the company vast sums of money, which otherwise would have to be paid for inaccurate higher readings.
- Accurate measurements regarding time and temperature during heat treatment of specialized materials ensure the heat treatment is optimally conducted, reducing the amount of nonconforming materials after heat treatment.
- Accurate measurements of parts that are provided to the next manufacturer for inclusion in the final product will ensure a seamless integration of the various parts, whereas inaccurate measurements may result in parts that do not fit.
- More accurate measurements of the dosage of fertilizer per surface area can save the farming community millions of dollars per year compared with the cost of spreading too much, and it will result in less stress on the environment as well.

Companies that implement sound measurement practices therefore have the advantage over others that do not, an advantage that reduces production of nonconforming parts or products and hence lowers overall production costs.

Meeting consumer expectations and rights

Standards and their implementation touch every person. From enabling the use of a bank card abroad to ensuring that children's toys do not have sharp edges that could hurt them, from enabling cellular phones to connect to networks all over the world to buying new tires to fit the vehicle, the list is endless. These standards are implemented by companies all over the world to ensure that products and services work as expected.

The right to an informed choice—and to redress, when expectations are not met—is fundamental to effective customer relations, and is a basic right, as outlined in the United Nations Guidelines for Consumer Protection (UNCTAD 2016). Products and services that demonstrably meet standards help to improve customer satisfaction, and in a world where the customer's voice is increasingly prominent, this has become an essential business requirement, for several reasons:

- *Product safety*. Standards and their implementation play a major role in ensuring product safety, covering aspects such as product safety requirements, product recall procedures in the case of product failures, codes of conduct for handling complaints and disputes, food safety and security, child-related safety, requirements for the elderly and infirm, and consumer product guidance for suppliers.
- *Product quality assurance*. Product certification marks have been around for a long time, but their influence in the market has not diminished: customers are still looking for trusted product certification marks in the more expensive products, products for which they cannot easily discern the intrinsic quality.
- *Service quality assurance*. The same applies for services. The International Organization for Standardization (ISO) has even developed and published a guide for developers of standards for services: "ISO/IEC Guide 76, Development of Service Standards—Recommendations for Addressing Consumer Issues" (ISO/IEC 2008).
- *Societal guidance and support*. Public and private standards help societies in areas such as dealing with natural disasters and living in a sustainable way, or provide guidance on social responsibility.

The state also gets involved in the relationship between the QI and consumers to exercise some of its fundamental responsibilities, namely, the protection of country's population, fauna and flora, and environment. Many of the above-noted standards in which consumers have an interest find their way into the technical regulations and sanitary and phytosanitary measures implemented by the state. Compliance with these is not a choice for the supplier but becomes a legal obligation benefiting the consumer.

In addition to transmitting information on the quality and technical specifications of products, compliance with relevant standards is increasingly required to meet social and environmental criteria for both the product and production processes. Consumerism, particularly in high-income countries, is increasingly tied to social and environmental norms; standards on health, safety, ethics, fair trade, labor practices, and environmental sustainability have become important. Leading firms have responded to these pressures and demand the same from their first- and lower-tier suppliers in the value chain. In this respect, relevant standards are used in a self-regulatory mode by the lead firms in GVCs throughout their value chains to convey their responsible practices to customers and critics.

With the views and perceptions of consumers becoming ever more important from a business perspective, even in low- and middle-income countries, the role

of standards and their implementation demonstrated through QI services can only increase. This means that low- and middle-income countries must be even more vigilant in ensuring that their QI is effective, efficient, and recognized internationally to ably support their socioeconomic development.

2.1.3 Role of QI in innovation and technology diffusion

Innovation can be seen from more than one perspective. On the one hand, something that is new to a company or country—like a more modern design of a product or a new cost-saving production process—can be seen as innovative (see module 10, section 10.10). On the other hand, however, innovation is equated with "destructive" technologies: new products that initiate the demise of existing products. Typical examples include the rapid demise of the long-playing record when the compact disc arrived or the equally rapid demise of the film camera when digital technology hit the market.

Catalyst and support for innovation

Whatever the case, the ability to implement new ideas and research findings as innovative products, methods, and services is decisive for competitive ability. Standardization can serve as a catalyst for innovations and helps bring solutions to the market.

To begin with, standards define interfaces, compatibility requirements, and uniform methods of measurement. For example, testing standards and terminology standards are important for new fields of technology and for developing innovative products and services, as are quality standards and safety standards, because they provide the evidence that the innovation requires to be marketed. Just as important are other QI services such as trustworthy (for example, accredited) testing and certification services. And without accurate measurements (metrology), it will be impossible to determine the true attributes of innovative products.

Innovative companies use standardization in its broadest sense (including the implementation of standards) as a strategic instrument for increasing the marketability of their products. Standardizing the right aspects of an innovative product, and demonstrating the same, can play a key role in preparing the product for the market. Thus, deciding on how to use standards for innovative solutions is a fundamental aspect of any company strategy. Standards and their implementation bring transparency and trust to the innovation process (ISO 2015). Not only is it companies that embrace innovation, but the state can also play an important role by providing the framework conditions, as can technical institutions and the educational sector by fostering innovation (see module 10, subsection 10.10.3).

Mutual recognition arrangements

An important vision of the global QI environment is the long-accepted concept, "Inspected, tested, and certified once, accepted everywhere." This notion gained some traction in the early days of accreditation. When the International Laboratory Accreditation Cooperation (ILAC) and the International Accreditation Forum (IAF) were established, it was the outcome many believed would be possible. Once a conformity assessment service provider was accredited by an accreditation body recognized by these organizations, its services should have been recognized all over the world. This has not come about for many reasons, among others that governments still wanted to have the last say in

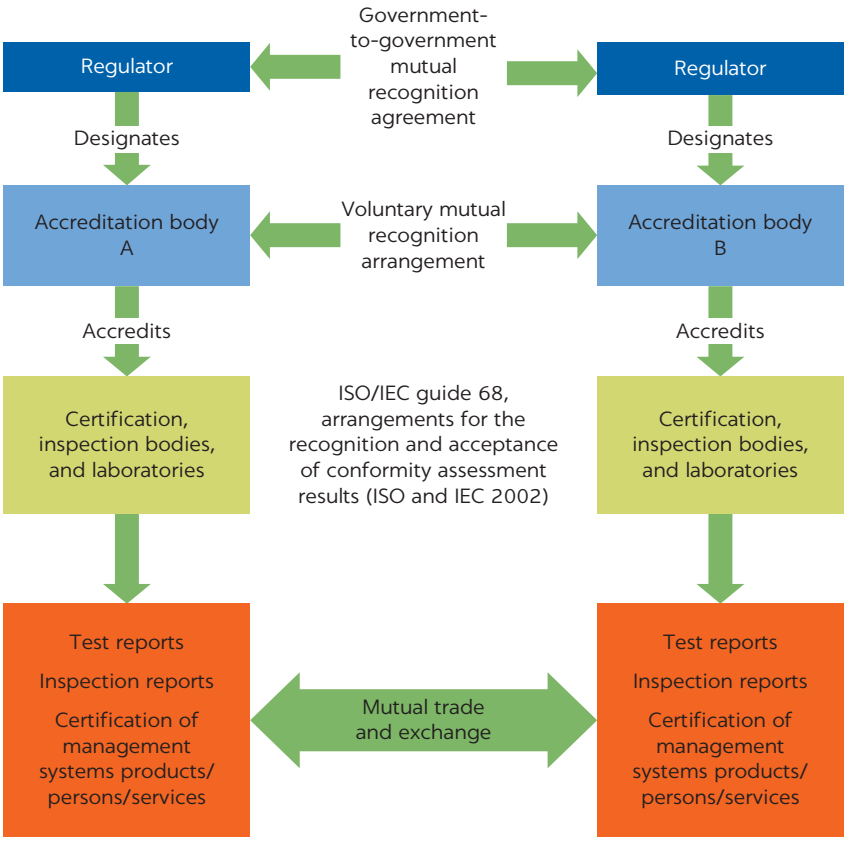
who was going to provide such services in the regulatory domain because of the consequences of any errors, for which the governments were ultimately accountable.

Hence the "accepted everywhere" notion has not been achieved yet and may never be achieved. But the international QI organizations and many governments are endeavoring to bring about coordination. This is done though bilateral or multilateral recognition arrangements and agreements. Governments would agree among each other to accept conformity assessment results from their respective countries if the service provider is accredited by bodies recognized by the ILAC or IAF and thereafter designated by the relevant governments (figure 2.2).

Another possibility, although of a lower level, would be a bilateral or multilateral arrangement among the accreditation bodies or certification bodies themselves. In this case, one body recognizes certificates issued by the other as equal to its own. The international certification schemes operated by the International Electrotechnical Commission (IEC) or International Organization of Legal Metrology (OIML) for electrical and measurement equipment, respectively, are typical schemes of this nature. Participants in these schemes recognize test certificates issued by the others as equal to those issued by themselves and grant certification in their own countries based on the test reports of the other countries, even certification required for regulatory purposes.

FIGURE 2.2

Sample model of accreditation use to recognize conformity assessment results



The final possibility in this respect would be recognition arrangements that are in place in common markets. These recognition arrangements are based on the rules included in treaties, protocols, and agreements relating to trade within the common market. The whole system of "notified bodies" in the European Union (EU), for example, operates on such principles, which include accreditation. A product tested and certified by an appropriate "notified body" in one EU member state for compliance with a specific directive (such as an EU Technical Regulation) can then be legally marketed in all EU member states without having to be retested in another member state.

2.1.4 Quantitative research on the correlation between QI and economic performance

Various studies have considered the relationship between the economic performance of a country and its QI and have shown a positive correlation between performance and QI efficacy. Two examples are discussed here.

Correlation between QI and key economic indicators

QI/Population index. Harmes-Liedtke and Di Matteo (2011) provided a comparison between a QI/Population (QI/POP) index—calculated from publicly available data on accreditation, metrology, standardization, and certification for 55 countries—and various economic indicators such as the World Economic Forum's (WEF) Global Competitiveness Index; World Bank data on gross domestic product (GDP) per capita; Transparency International's Corruption Perception Index; and a few others. Although the authors state clearly that the indexes developed by them are not to be considered as fundamental or definitive, the story they tell is significant.

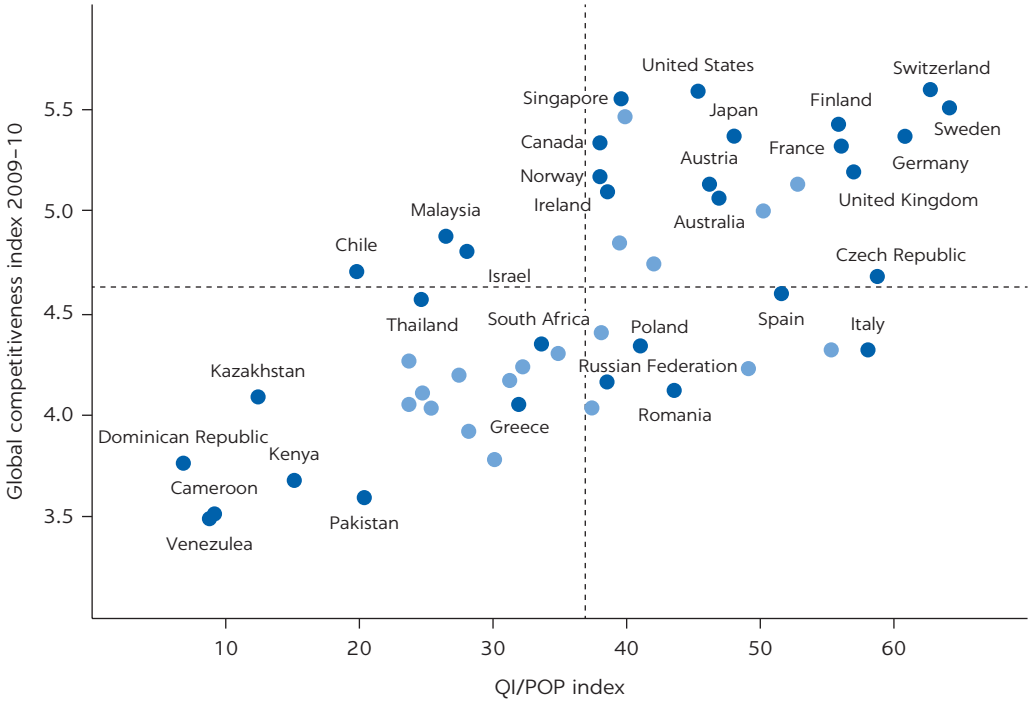
Global Competitiveness Index. The elements considered for the WEF's Global Competitiveness Index include the following: infrastructure, macroeconomic stability, health and primary education, higher education and training, goods market efficiency, labor market efficiency, financial market sophistication, technological readiness, market size, business sophistication, and innovation. Because none of these is used in calculating the QI/POP index, any relationship could be considered causal.

Considering figure 2.3, a trend can be discerned that the more competitive countries have the better-developed QI, whereas the less competitive countries have a less developed one. The relationship tends to be linear, with a moderate-to-strong correlation coefficient of almost 0.7. There are, however, countries with large differences in the competitiveness index that have a similar level of QI/POP or vice versa (for example, Romania and the United States, Chile and the Czech Republic, and Canada and Sweden), indicating some uncertainty as to an absolute relationship between competitiveness and the QI, both as measured for the specific country.

GDP per capita. The GDP per capita is a common indicator used in economic research and is considered to represent a standard of living. The relationship between the GDP per capita and the QI/POP index shows a moderate-to-strong correlation, with a Spearman coefficient of 0.705 (figure 2.4). The tendency for countries to show similar rankings for their performance and their QI remains, as in the earlier example of the Global Competitiveness Index versus the QI/POP index. But there are also large dispersions. For example, China

FIGURE 2.3

Relationship between Global Competitiveness Index 2009–10 and QI/POP index, selected countries



Source: Harmes-Liedtke and Di Matteo 2011.
Note: QI = quality infrastructure. The World Economic Forum's Global Competitiveness Index presents a framework and a corresponding set of indicators in 3 principal categories (subindexes) and 12 policy domains (pillars); the 2009–10 index covered 133 economies. The QI/Population (QI/POP) index is calculated from publicly available data on accreditation, metrology, standardization, and certification for 55 countries. Horizontal and vertical lines designate the median Global Competitiveness and QI/POP values, respectively.

and the Dominican Republic have a similar GDP per capita but a totally different QI/POP index. It is obvious that, in this case, the population sizes, being vastly different, have a marked influence on the results. In a similar vein, China and Norway also have vastly different population sizes, but Norway has the higher GDP per capita by far.

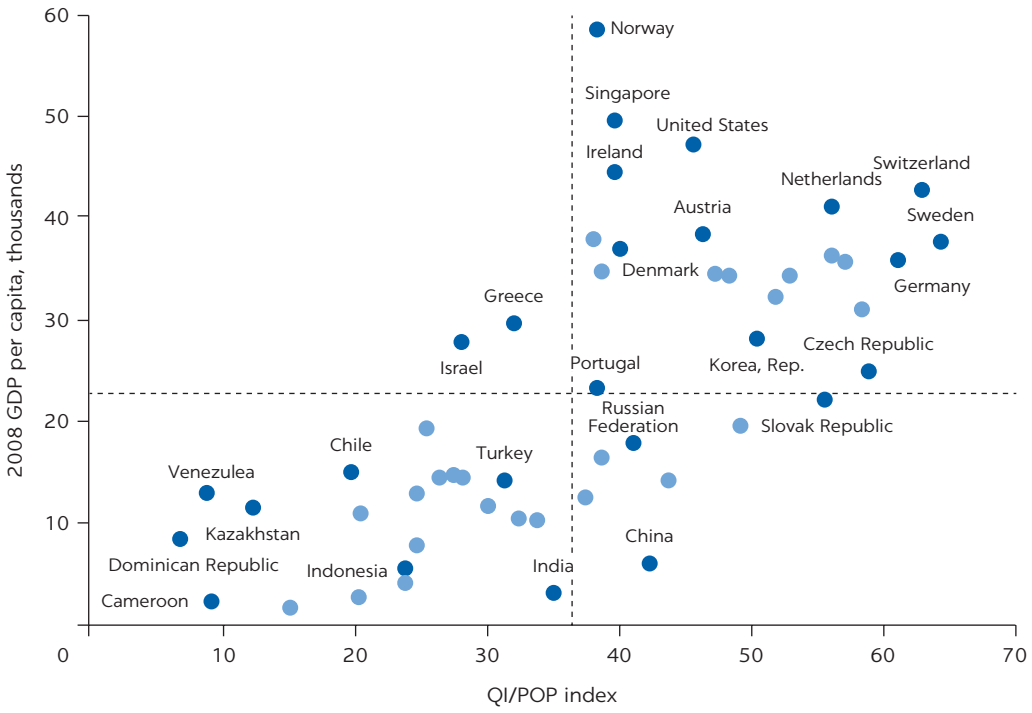
The Harmes-Liedtke and Di Matteo (2011) study concludes that even though one could argue about the absolute values of the indicators used, the examples seem to indicate the need for low- and middle-income countries to establish an effective and efficient modern QI if they wish to increase their GDP per capita and become more competitive in the global economy.

Correlation between QI and compliance with trade standards

The United Nations Industrial Development Organization (UNIDO) commissioned the Institute for Development Studies (Brighton, U.K.) to conduct a study named "Meeting Standards, Winning Markets" in 2010. This was repeated and enhanced in 2015 (UNIDO 2015). This latest study used a three-pronged approach to determine the capabilities of a selection of low- and middle-income countries to comply with "trade standards," which UNIDO defines as any technical requirements a supplier has to comply with to gain access to a specific market. These include public standards, private standards, and technical regulations. The three "lenses" used in the study were the following:

FIGURE 2.4

Relationship between 2008 GDP per capita and QI/POP index, selected countries



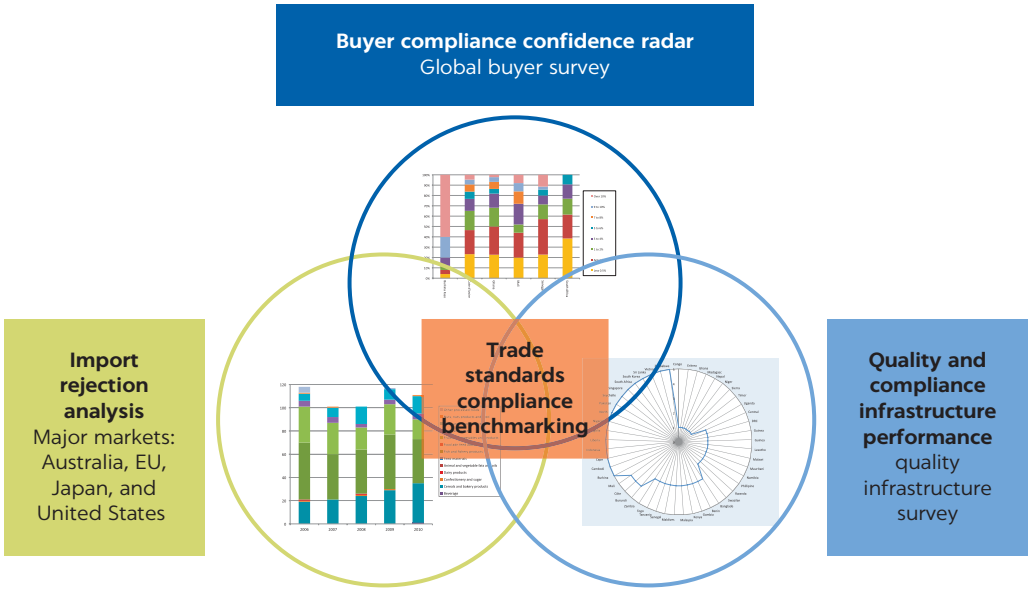
Source: Harmes-Liedtke and Di Matteo 2011.
Note: QI = quality infrastructure. The QI/Population (QI/POP) index is calculated from publicly available data on accreditation, metrology, standardization, and certification for 55 countries. Horizontal and vertical lines designate the median Global Competitiveness and QI/POP values, respectively.

- *Import rejection analysis.* Rejection data of imports of agrifood products into Australia, the EU, Japan, and the United States were used to indicate the scale and root causes of compliance challenges that low- and middle-income countries face when exporting to these major markets. The economic impact of these rejections was estimated.
- *Buyer compliance confidence radar.* Data from a corporate buyers' compliance confidence survey among companies in the export markets provided indicative information on the compliance performance of low- and middle-income countries for particular products. Their perceptions of the compliance capacity of certain countries and the producers in those countries matter for their decisions about where to source from. The study was able to conduct pilot studies in only a few selected countries.
- *Quality and compliance infrastructure performance.* Data from a QI survey provided the perspective of the exporting countries' (mainly public but also private) QI institutions. The QI of 49 African and Asian countries were reviewed, and the status of QI capacity across 10 compliance functions for the countries relative to each other was determined rather than a fixed benchmark.

Together, these three sets of data provide a picture of the importance of the QI in the low- and middle-income countries surveyed for their export performance (figure 2.5).

FIGURE 2.5

Three lenses on the importance of QI in trade standards compliance and challenges



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Note: EU = European Union.

The rejection data from the four major import markets surveyed showed that all had higher import rejection rates from the same exporting countries. These findings largely correlated with low capacities of QI services as measured in these exporting countries. Among the most important factors for the buyers were those related to supply chain performance, particularly issues related to the safety, quality, traceability, and consistency of supply. The strength of the food safety compliance infrastructure was ranked highly among the factors that determined not only the buyers' choice of country, but also how suppliers succeeded in retaining their position within the buyers' supply chains.

Therefore, the conclusion of the UNIDO (2015) study is that poor standards will lead to fewer buyers choosing to source from a particular country and an increased likelihood that the buying relationship will be terminated in a given period. This performance is determined by both enterprise-level competences and the broader public and private compliance infrastructure. This study, even though it focuses on the agrifood business, considers an effective and efficient QI to be a necessity in general for low- and middle-income countries wishing to access global markets and, once accessed, to retain and enhance their market shares in this sector.

2.2 DEMAND ASSESSMENT

Gaining a clear understanding of demand and supply for QI services in the country or region is important because it provides the data to base decisions on—for example, whether QI development programs are needed and what their scope should be. On the demand side, it is important to identify priority needs of both public and private sector clients. In practice, it is advisable to also look at

information that has already been collected, either by other development partners; government agencies responsible for "managing" service providers (such as standards, metrology, and accreditation); or nongovernmental organizations (NGOs) (such as laboratory or metrology associations).

It must be noted that just as QI is not an end in itself, the QI demand assessment should always be aligned with the broader development partner intervention in a country. Hence, it either follows after interventions to strengthen the economy have been identified, or the QI demands are identified simultaneously with higher-level evaluations. The latter is the more efficient methodology. It is also possible that the intervention is solely focused on the QI capacity development. But such a decision will in any case have been made within the context of a broader evaluation of the country's situation.

There are many facets in establishing the demand for QI services. They are interrelated, and it is important to gain a holistic picture at the beginning of any project and make some preliminary decisions before embarking on a more detailed demand assessment, which could be resource-intensive. In general, a demand assessment should consider an appropriate combination of the following types of demand in both the regulated and nonregulated areas:

- *Industrial development for the local and export markets*, which mostly relate to conformity assessment (that is, what is required to satisfy the clients and regulatory authorities on both sides)
- *Potential for future exports,* similar to the preceding point
- *Increases in productivity, efficient use of resources, and promotion of innovation* in national industry and manufacturers
- *Safety and health* of people and the environment in the country regarding QI services, including alignment of technical regulation and food safety regimes with those of major trading partners, thereby enhancing industries' competitiveness in exporting their products to markets of interest
- *Trade equity* in the country (for example, legal metrology protecting both the consumer and the supplier through accurate measurements in trade).

Assessing the demand for QI services would not be complete if the fundamentals of the QI are not considered. This means that over and above the demand emanating from the users for QI services, an assessment of the status quo of the QI fundamentals—namely, standards, metrology, and accreditation (that is, what do we have on the ground in terms of capacity and compliance with good practices?)—has to be conducted to determine whether there is a need to enhance these as well.

2.2.1 Identifying priority sectors important for the country's growth

Many low- and middle-income countries have promulgated industrial development strategies, export policies, rural development policies, and the like. These will inevitably indicate sectors where capacity development is required for the country to grow. In such countries, these sectors frequently include major infrastructure, such as transportation systems, supply of water and electricity, and the like. Such infrastructure development is always in need of QI services over and above all the other issues that need to be addressed. Mapping these will quickly indicate the specific demands regarding QI services.

Making choices regarding the QI services that need to be established or developed is not a simple exercise. Many factors have to be considered, not least the stated demands of the government of the low- or middle-income country. It is also quite obvious that a single project cannot address all the demands identified; some strategic choices will have to be made in allocating the limited resources of the development partner for the maximum impact. In this respect, alignment with the QI capacity building programs of other development partners is important because it will prevent duplication of effort and will benefit the recipient country more.

It is also clear that the development of priority sectors does not depend on the establishment of an effective QI alone; it is but one of many elements that have to be in place for the sector to succeed. In this respect, different development partners have different approaches to determine the level of their involvement in a country. These could relate to the development of a specific industrial sector, development of products for export, implementation of a proper technical regulation regime, and many more. Once these have been identified, the concomitant QI service demands can be ascertained and the appropriate development projects planned. It should be understood that establishing only the QI without considering the greater development environment may lead to redundant QI services being established that may sooner or later flounder.

Industrial development of target sectors

Industries in most low- and middle-income countries are in need of enhancing the quality of their products and services as well as increasing their productivity to be competitive in the marketplace in relation to competing with imported products in the local market or to gain a foothold in export markets. The SME sector is usually worthy of special attention in this regard. The country may have already decided to focus on specific sectors such as the leather trade, food, textiles, and any others where the country may have an identified competitive advantage in world markets.

On the other hand, development partners may wish to identify opportunities for intervention to achieve development of the private sector and to categorize the constraints to achieving that growth, including the QI services required themselves. The World Bank, for example, has developed a Country Private Sector Diagnostic (CPSD) tool that is a useful mechanism to identify sectors for development (World Bank 2017).

Development of current and potential future exports

Low- and middle-income countries may be exporting products to markets that do not place high demands on safety, health, and quality. The negative of this situation is that the price that can be realized is usually on the low side. Enhancing the quality of the products, and especially being able to demonstrate such compliance, may open the door to more discerning markets where higher prices can be realized. Internationally recognized QI services will play a major role in this regard. The identification of priority export markets and the concomitant industrial sectors to be developed can be conducted in many ways, two of which are discussed briefly.

Country Private Sector Diagnostic (CPSD). Domestic suppliers in low- and middle-income countries often find it difficult to access foreign markets on their own. Integrating a country's domestic suppliers into GVCs increases the possibility for local companies to export to a buyer abroad or to supply a multinational

company in the country. The World Bank Group's CPSD methodology, for example, focuses on strategies to help low- and middle-income economies maximize their gains from participation in GVCs (Taglioni and Winkler 2016).

To develop an effective and sustainable strategy of GVC participation, governments must identify key binding constraints and design the necessary policy and regulatory interventions as well as the infrastructure and capacity building that will allow them to achieve distinct objectives and address specific challenges. All in all, GVCs offer a role to play for economies at different levels of development at any point. Economies that have in place a supporting environment and well-functioning institutions (for example, the QI) can, in addition, move along the value chain, strengthen participation, and achieve higher added value in a sustainable way.

Export Potential Assessment. The International Trade Centre has developed an online Export Potential Assessment tool (Decreux and Spies 2016) that is supported by a massive amount of trade flow information in its database with which countries can assess their Export Potential Indicator (EPI) or their Product Diversification Indicator (PDI), the difference being as follows:

- *The EPI serves countries that aim to support established export sectors* in increasing their exports to new or existing target markets. It identifies products in which the exporting country has already proven to be internationally competitive and that have good prospects of export success in specific target markets.
- *The PDI serves countries that aim to diversify and develop new export sectors* that face promising demand conditions in new or existing target markets. It identifies products that the exporting country does not yet export competitively but that seem feasible based on the country's current export basket and the export baskets of similar countries.

Implementation of a technical regulation regime

The technical regulation regime of a country has a marked effect on trade regarding not only imported products, but also exported products. If the technical regulation regime is aligned with that of main trading partners, for example, local companies will find it easier to comply with the technical regulation regimes in the export markets; that is, products destined for the local markets may be able to be exported to foreign markets without any change to the product.

Large differences in the technical regulation regimes may result in local products not being allowed in foreign markets without changes to those products. This is expensive and renders the local industry less competitive. The technical regulation regime is dealt with in detail in module 7.

Application of legal metrology

Consumer protection regarding trade equity (that quantities paid for are actually received) is a major issue for many low- and middle-income countries. The establishment of a QI frequently starts with trade metrology measures as the state endeavors to protect consumers in this regard.

Trade metrology and the wider application of legal metrology requires appropriate fundamental QI services. Establishing proper trade metrology services where these are lacking often means focusing on "low-hanging fruit" that can make a major difference to consumer protection in a low- or middle-income country. Legal metrology and its subset of trade metrology are dealt with in detail in module 4: Metrology, section 4.3.

2.2.2 Necessity for generic capacity building

An issue that needs to be carefully considered is the level of the generic capacity building that would be required before a much more demand-driven approach is followed. In this respect, it is useful to consider the maturity level of the various QI services such as standards, metrology, accreditation, and conformity assessment. The three fundamentals—standards, metrology, and accreditation—need to start with generic capacity. For conformity assessment, a more focused capacity-building trajectory may be appropriate, depending on the need. This will be different from country to country and by specific service, but some general statements can be made (table 2.1).

Once the QI services have developed past the basic QI maturity level, then capacity building should be focusing more on the demands of the country; it is not useful to establish high-level QI services if there is no demonstrable demand for such services. The same applies if regional services are available and appropriate. Such services will only sap resources and slowly deteriorate to the point where they are no longer operational. The identification of the real demands of the country is therefore important; capacity development should not be based on the "nice to have" syndrome of the QI entities.

Considering the product or service value chains (see section 2.2.5) in sectors identified in official industrial development or export policies is a good start. If these are not available or are out of date, evaluations such as those discussed in section 2.2.1 on priority sectors for the economy and export markets would be indicated.

2.2.3 The food safety regime

For many low- and middle-income countries, food production and processing is a major industry. Food production and processing is controlled through mandatory food standards in most countries because of the immediate influence of food on health and safety. The food safety regime entails sanitary and phytosanitary measures, technical regulations, and voluntary certification. In many low- and middle-income countries, it is fragmented, uncoordinated, ineffective, and inefficient because of developments over the years as various ministries and their agencies have gotten involved.

The overlaps, gaps, and turf wars between various agencies are experienced starkly by the industry in that they rapidly escalate transaction costs, but these are seldom considered by the ministries involved, which have myopic vision in this regard. Reengineering the whole system is a worthwhile endeavor, because it not only provides the country with a more effective and efficient food safety regime while enhancing the competitiveness of the food industry, but also can become a major factor in supporting exports. The QI has a major role to play in such a reengineering. A schematic representation of a model food safety system for a low- to middle-income country is shown in figure 2.6.

From the schematic diagram of figure 2.6, the various elements of the food safety system and the role that QI services play in it can be deduced. The national standards body (NSB) provides the national standards on which the central food authority bases its food regulations. Various laboratories and inspectorates at the local level ensure that requirements are met in the marketplace. The national central laboratory is the final arbiter in cases of dispute. All of these are accredited, and their measuring equipment is traceably calibrated to the national standards held by the national metrology institute (NMI).

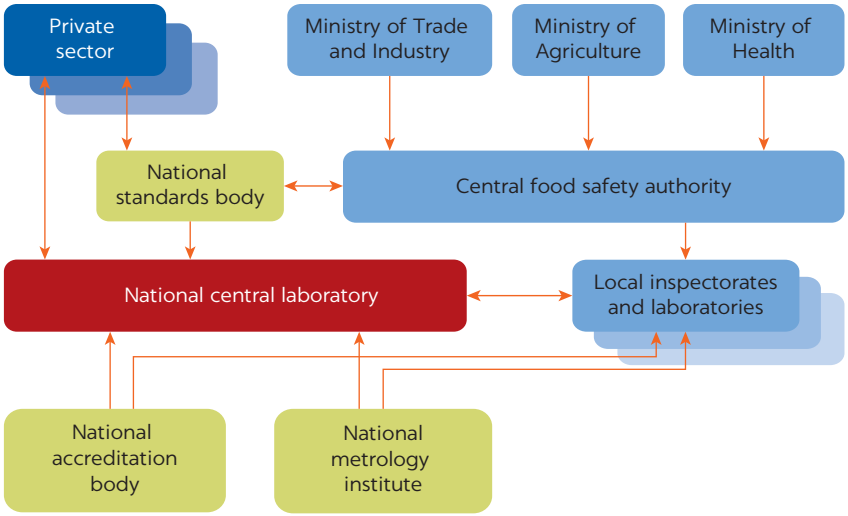
TABLE 2.1 Maturity levels of QI services

QI SERVICE TYPE	RUDIMENTARY QI (LITTLE QI IN PLACE)	BASIC QI (LOW- TO MIDDLE-INCOME COUNTRY OR LDC APPROACH)	ADVANCED QI (ECONOMYWIDE APPROACH, SECTORAL SPECIALIZATION)	MATURE QI (INNOVATIVE, CUTTING-EDGE TECHNOLOGY AND SERVICE DELIVERY)
Legal metrology	Weights and measures may be legally established, but the effect in the market is negligible.	Weights and measures for goods traded over the counter (such as mass and volume of consumer goods) with recognized services	As under basic QI but extended to prepackaged goods, water and electricity meters, selected law enforcement scopes	Measures covering the whole spectrum of trade, law enforcement, health, and safety
Scientific metrology or national measurement standards	The working standards of the legal metrology department are the de facto national measurement standards.	Small number of basic metrology laboratories (including the metrological level), with recognized services	Laboratories (including the CMCs) defined through economywide surveys and sectoral international benchmarks	High-level laboratories for innovative sectors
Standards	A government department is the de facto national standards body without any infrastructure to develop and publish national standards. It may have a rudimentary information service.	Basic infrastructure to adopt and publish international standards; rudimentary information service Correspondent member of ISO and involved in IEC Affiliate Country Programme	More-advanced infrastructure to develop and publish national standards; information service well developed Member of ISO, associate member of IEC; country a member of CAC	Mature processes to develop and publish any standard required by industry and the authorities; advanced information center Member of ISO and IEC; country a member of CAC and ITU
Accreditation	Accreditation not considered a necessity, hence no services obtained from outside the country, either	Accreditation provided by accreditation bodies from outside the country through a bilateral or regional arrangement	Accreditation body established and only recently internationally recognized; accreditation services still limited to main sectors	Accreditation body fully recognized by ILAC and IAF providing the full range of accreditation services
Inspection bodies	A few public sector inspection bodies	A few public sector inspection bodies, with recognized services	Mostly regulatory inspection but with private sector inspection services starting to take on regulatory work and work for major purchasers	Supply of inspection services fully determined by free-market principles
Testing laboratories	Maybe one or two public sector laboratories, understaffed and not accredited	A few public sector testing laboratories, with recognized services	Many public sector testing laboratories in various ministries and agencies; private sector laboratories starting to be established	Multiple private sector testing laboratories catering to the market; public sector testing laboratory importance diminished appreciably
Certification	No certification body in operation	NSB provides product and system certification, with recognized services	NSB provides product and system certification, in competition with a small number of private sector certification bodies	Supply of certification services fully determined by free-market principles, with multinational certification bodies much in evidence

Note: CAC = Codex Alimentarius Commission; CMCs = calibration and measurement capabilities; IAF = International Accreditation Forum; IEC = International Electrotechnical Commission; ILAC = International Laboratory Accreditation Cooperation; ISO = International Organization for Standardization; ITU = International Telecommunication Union; LDC = least developed country; NSB = national standards body; QI = quality infrastructure.

Once the system has been agreed to and the various agencies are established, the QI has to be aligned to provide the defined services. Developing an implementation plan based on an approved policy framework—for example, a national quality policy, a food safety policy, or a similar policy—to make the system work as a whole will be a huge and complex undertaking, and it will take a few years to complete. But in many low- and middle-income countries, it will make a big

FIGURE 2.6
Model food safety system for a low- to middle-income country



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difference in the level of food safety and will appreciably lower the transactional costs for the food industry, which is more often than not suffering from overlaps in regulations imposed by more than one regulatory authority.

2.2.4 Rapid demand assessment

Once the sectors that would need QI support have been identified (see section 2.2.1), the demand for QI services should be determined at a cursory level rather than a more detailed level, as would be the case in a comprehensive demand assessment. It would still be good practice to do this in terms of the elements of the QI as described in module 9 (the Rapid Diagnostic Tool and Comprehensive Diagnostic Tool) to facilitate the development of a concept note (see module 1: Executive Summary, section 1.2, the "Quick Start Guide").

Standards

Questions that need to be asked and answered regarding the need of standards include the following:

- Are the product requirements based on international or regional standards, or are they based on the national standards of the target markets?
- Are the product standards industry or private standards rather than public standards?
- Can the standards be used as is, or do they have to be adopted as national standards first? And if so, *can* they be adopted?
- Are the standards obtainable and reasonably priced, or are they expensive? If available, are they understood, and can they be implemented?

Although some of the questions are self-evident, one should keep the users in mind. It is especially the SME sector that is often challenged by the cost of international standards, in which case it would be useful to adopt these as national

standards and make them more readily available at lesser cost. Hence, does the NSB have the wherewithal to develop and publish these standards fairly rapidly? Private standards are often available free of charge because the organizations publishing them derive their income from the concomitant certification business. (For more about these private standards, see module 3: Standards, section 3.3.)

Metrology

Metrology is important in production control and in the testing of the products. The related measuring equipment needs to be calibrated. The question that should be asked and answered is whether the calibration capacities for these specific instruments and their accuracy classes are available in the country. Furthermore, can the NMI traceably calibrate the working standards of calibration laboratories to international measurement standards, or do these working standards have to be sent outside the country to be calibrated? This would entail delays and higher costs.

It may be appropriate for the NMI to establish the necessary capacity if it is not yet available or if it is necessary to increase its measurement accuracy capabilities, depending on a positive outcome of a cost-benefit study. But this will take resources and time because the national measurement standards have to be established and then calibrated by a higher-level NMI, and the NMI has to participate in interlaboratory comparisons to establish the relevant calibration and measurement capabilities (CMCs). In some cases, new laboratories may have to be designed and built, which takes even longer and requires additional resources. Metrologists have to be found and trained. Metrology, frequently under the radar of the responsible planners, must be carefully considered because it is costly and time consuming, yet it is an absolutely vital basis for production and many of the other QI services.

Accreditation

Conformity assessment and calibration services need to be technically competent and performed with impartiality—and demonstrably so, to engender trust in suppliers, purchasers, and regulatory authorities. This trust is achieved through accreditation by the relevant ISO or IEC international standards. The conformity assessment and calibration services identified through the demand analysis therefore need to be accredited. The questions that need to be asked and answered to determine gaps, if any, include the following:

- Has a national accreditation body (NAB) been established in the country, or is this still to be done?
- Is a regional accreditation body in place whose services could be used?
- Is the NAB or regional accreditation body a signatory of the ILAC and IAF multilateral recognition arrangements, is it still in the process of achieving this recognition, or has it not even started the process yet?
- Does the services scope of the NAB or the regional accreditation body include the conformity assessment services that need to be accredited?
- Has this NAB been recognized or officially appointed by the state where it is established?

Establishing an accreditation body and getting international recognition is a long process; anecdotal evidence indicates a period of five to seven years. If the country has not yet established an NAB, accreditation services may have to be

obtained from an NAB of another country or from a regional accreditation body if one is available. If the NAB is in the process of obtaining international recognition, does it have a "twinning agreement" with an NAB that is recognized? In that case, accreditation certificates may be issued jointly. Extending the scope of accreditation services of the NAB could also take some time, as assessors have to be trained, documentation has to be developed, and the approval of ILAC or the IAF needs to be sought.

Conformity assessment services

Conformity assessment services could entail a mix of inspection, testing, and certification, depending on the product or service requirements. Whereas the NSB, NMI, and NAB often have monopolies in the country for their core service delivery, conformity assessment services could be provided by any number of public or private sector operators. The challenge for most countries is that the extent of the conformity assessment services available, especially testing services, is unknown.

Before contemplating dealing with any perceived gaps, it is important to obtain quantitative information on the totality of laboratory services in the country—the capabilities, capacities, and technical competencies. A review to determine the overall picture would be indicated, and this should not take too long in a low- to middle-income country. Then meaningful decisions can be made as to the gaps and how they could be closed.

The spectrum of certification bodies (product as well as system) is much smaller and usually fairly well known. But the scope of services of the certification bodies and their technical competencies may need to be more closely looked at. It is the accreditation of local offices of multinational certification bodies that is frequently lacking, as these offices "ride" on the accreditation of their head office.

A major decision regarding the development of new capacity is whether the conformity assessment body should be a public or private sector body. This will depend as much on country customs and practices as on the advantages and disadvantages of public versus private sector business practices and funding sustainability. To gain accreditation for a newly established conformity assessment service provider also takes time; to do it in less than nine months is challenging.

2.2.5 Comprehensive demand assessment

There are many techniques to determine the QI demands of a country. Whereas market surveys are useful, they frequently result in a massive list of QI services that need to be established, which technical support programs just cannot support. Therefore, once the demand for generic QI services has been identified and the NSB, NMI, and NAB have been established and are operating in the basic QI mode (see section 2.2.2), it makes sense to look at QI services in a more detailed manner to move the QI services from the basic to the advanced and ultimately to the mature level. Table 2.1 lists general attributes of the advanced and mature levels, but much more detailed information would be required to identify the relevant higher-level attributes for a specific country situation.

The identification of priority sectors and possible export possibilities (see section 2.2.1) provides the entry point for a more focused needs analysis. Value chain analysis has proved to be a useful instrument to do so. Another useful

approach is to look at the infrastructure clusters that a major new industry could require to be established and become operational.

Value chain analysis

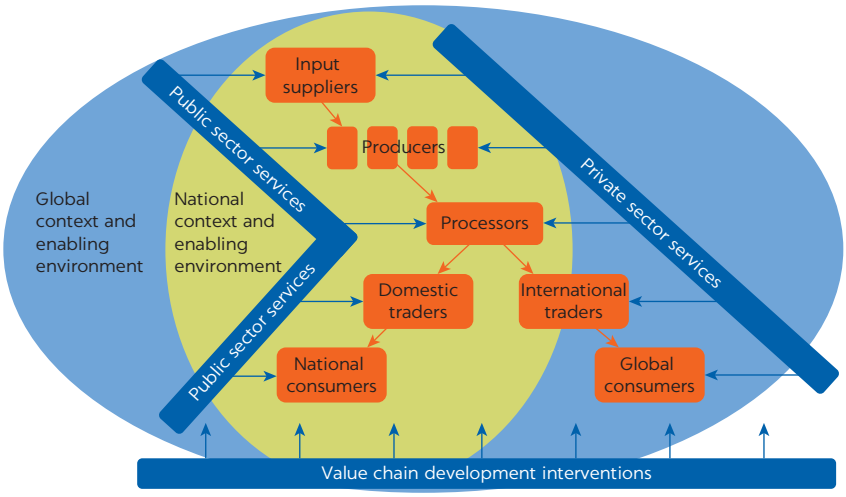
The range of activities that brings a product or a service from its conception to its end use in a particular industry is referred to as the value chain, a term originally coined by economist Michael Porter (Porter 1985). Value chains can be seen as mechanisms that allow producers, processors, and traders—separated by time and space—to gradually add value to products and services as they pass from one link in the chain to the next until reaching the final consumer (domestic or global).

In the globalized market, it is rather unusual for a single company to perform all the activities—from product design and production of components to final assembly and delivery to the ultimate user. Original equipment manufacturers source components from myriad subsuppliers, frequently across many countries. Agents handle the marketing and sales, and specialized freight haulers ensure the product is moved from the factory to the consumer. The manufacturers and suppliers draw from a range of technical, business, and financial service providers as well as public sector services. They depend on the national and global legislative context and sociopolitical environment. In a value chain, the various business activities in the different segments become connected and to some degree coordinated. The value chain analysis covers the whole system in which the organization operates (figure 2.7).

In each of the stages of the value chain, the required QI services can be mapped, and technical assistance can be designed to provide such services effectively and efficiently; otherwise, the suppliers of products and services will not measure up to the minimum requirements in the world markets—that is, they will remain in a suboptimal business environment. Worse, if a country's QI does not meet international requirements, its producers may be hard pressed to join international supply chains. For example, entire ranges of products such as food of animal origin cannot be exported, at least not to high-income markets.

FIGURE 2.7

Generic value chain



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By the same token, if the QI has to be reformed economywide, governments may be guided in the reform process by applying a value chain approach to competitive industries, thereby ensuring more focused action on the QI reform. A useful methodology to map the QI services required in a value chain is the CALIDENA instrument used by the National Metrology Institute of Germany (PTB, for Physikalisch-Technische Bundesanstalt) (Harmes-Liedtke and Schiel 2016).

CALIDENA is a process guided by a participatory methodology developed and implemented by the PTB since 2009. The CALIDENA objectives are twofold: (a) to help identify the quality gap in a value chain as well as to develop an action plan to close the gap, and (b) to help the QI to understand better the needs of value chains and to develop and improve the provision of QI services. CALIDENA can be used for the demand assessment for the preparation of a project or as an integral part of a project.

The CALIDENA process is organized in three phases (Harmes-Liedtke and Schiel 2016):

- *Phase 1: Preparation.* The relevant value chain is selected, the expectations are clarified, and the hosts of the process are defined.
- *Phase 2: Kick-off workshop.* At the main CALIDENA 2.5-day workshop, the relevant actors of the value chain and the QI institutions jointly analyze the quality gaps and challenges of the value chain and develop the action plan.
- *Phase 3: Follow-up.* A follow-up committee monitors the implementation of the action plan.

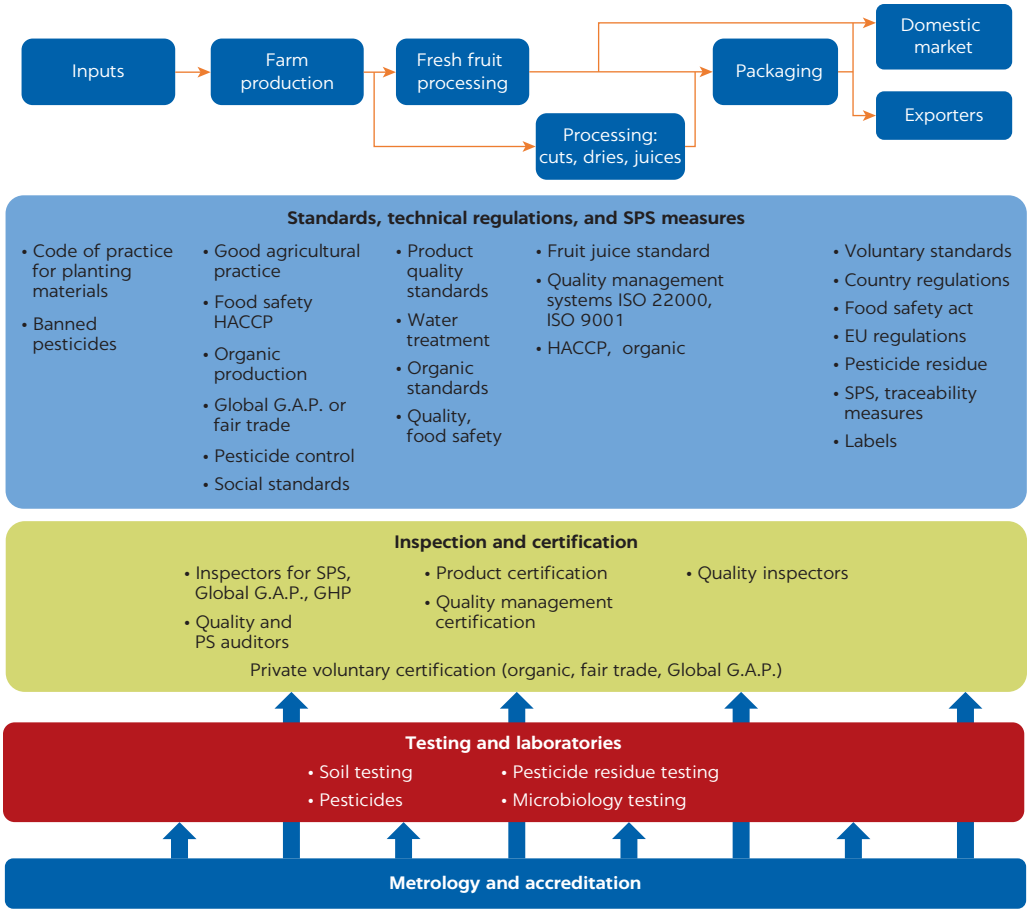
A typical example of a value chain analysis and mapping the required QI services is shown in figure 2.8 for mango farming, illustrating an analysis of how producers and marketers in a low- to middle-income country gain access to the EU market. The result of the value chain mapping indicates all the relevant standards and technical regulations as well as the inspection, testing, and certification requirements that have to be in place before mangoes can be exported to the more lucrative markets of the EU in this case. These have to be supported by appropriate metrology and accreditation services.

The example shows that the technical assistance program to establish the QI services for a simple product like mangoes is complex and will take time but will support the industry and the country in no small measure. This is a much better approach than a more general one that establishes a number of laboratories and gets them accredited, but the laboratories are unrelated to the market needs of the country.

Clusters in support of a new industry

When a new industry is being established, a large number of industry clusters may require capacity development to provide products and services during the construction phase and later during the operational phase of such an industry. A typical example of such an undertaking is the development of the liquified natural gas (LNG) industry in Tanzania after economically relevant gas fields were discovered off its coast. Whereas the LNG production plants would be constructed by the relevant international consortia, a vast array of products and services could be provided by local businesses and industry, provided they meet the standards and quality required by these international consortia (World Bank, EU, and DFID 2014).

FIGURE 2.8
Mango value chain



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Note: EU = European Union; Global G.A.P. = Global [standard of] Good Agricultural Practice; GHP = good handling practices; HACCP = hazard analysis and critical control points; ISO = International Organization for Standardization; PS = product safety; SPS = sanitary and phytosanitary.

In such cases, a comprehensive analysis of industrial clusters that could potentially get involved in the construction and operation of the new industrial plant is indicated. Once all the clusters have been identified, a short list of the more promising clusters can be selected in terms of their "desirability" in similar fashion as in the CPSD (see section 2.2.1). Thereafter, a value chain analysis can be performed to determine the QI service needs of the clusters.

Projection for future QI needs

Establishing QI services and gaining international recognition is a time-consuming endeavor in most cases. A newly established NAB will need about seven years to gain signatory status in the ILAC or IAF multilateral recognition arrangements. Establishing high-level scientific metrology services frequently requires new laboratories; metrologists have to be trained and gain experience in higher-level NMIs; and equipment has to be sourced, built, and put into operation. Thereafter, the NMI needs to participate in interlaboratory comparisons to determine the CMCs of the NMI. This may be a journey of 10 years or more. The NSB may have been established decades previously and have a working

standards development process, but comparing it with modern good standardization practices (GSP) may indicate some serious shortcomings. To reengineer a process that has been entrenched through custom and practice over many years is not an easy task and takes time.

It is therefore clear that establishing a modern QI system is time-intensive. This process is also indicated in part 2: The Quality Infrastructure (figure P2.1), where the interdependence of the QI services is detailed. Hence, it is extremely important that the country has a clear idea as to where it wishes to journey regarding its QI. A long-term strategy, usually laid down in the national quality policy, is important, as is the concomitant implementation plan. Without these, the country will not be able to develop an effective and efficient QI appropriate for its demands.

Countries with a weak QI face the challenge of establishing their QI and QI services from a low base. Countries in transition (for example, countries of the former Soviet Union) face a different challenge. They may have a well-established QI, but it may not comply with market-related international good practices. Hence QI development in such countries also includes the difficult journey of "unlearning" much of what the QI used to be. These could be systems that have been in place for decades—for example, all standards are mandatory, the implementation of which is supported by a large inspection force that now has to be abandoned. Over and above the massive organizational reengineering challenges, ensuring that a vacuum is not created by default in the marketplace regarding the regulatory domain needs to be considered. Otherwise, the safety and health of the population and the fauna and flora may be compromised during the reengineering process. Transitional arrangements are therefore important elements of project planning in such countries.

NOTES

1. The "organizations" of the QI ecosystem provide such things as national standards, calibration, test reports, certification reports, and accreditation certificates. The term "QI services" is used as a collective term to denote these outputs of QI organizations.
2. Data and findings from "Global Trade: Standards Are the 'Lingua Franca' of World Trade," website of the German Institute for Standardization (DIN), https://www.din.de/en/about-standards/benefits-for-the-private-sector/global-trade.

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