Europe Economics

Steptoe

Value of the Testing, Inspection and Certification Sector

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Executive Summary

This study looks at the value of the testing, inspection, and certification (TIC) sector. It illustrates, using data, how the sector benefits a variety of stakeholders across a large number of sectors around the world. In thinking about the sector's value, we look at the scale and scope of activities that it performs, the various ways that the sector can benefit different kinds of stakeholders, and provide a few case studies to demonstrate that the value arising from the sector can be significant.

Overview of the TIC sector

TIC companies offer conformity assessment services to a diverse range of industry sectors – from energy and utilities to food and agriculture and chemicals – as well as with respect to matters that cut across industry sectors, such as climate change and artificial intelligence. Conformity assessment may comprise a variety of activities, ranging from testing and inspection, through validation and verification, to certification, and pre- and post-market surveillance or some combination thereof. Applications of conformity assessment to products, services, and systems enhance trust and confidence that required or desired characteristics are consistently met in the fields of public health, safety and welfare, environmental protection, agriculture and food safety, data privacy and cyber security, and consumer protection, and can enable market access for businesses large and small.

The sector is large and growing. Current estimates of the size of the conformity assessment sector globally, including first, second- and third-party activities with all their constituent applications, are about $200bn, and are expected to surpass $260bn by 2025. The independent TIC sector is currently estimated to account for 40 per cent of this amount. A trend of increased outsourcing of TIC services to third parties – coupled with a diverse range of regulatory, standard, procurement, and other requirements – has contributed to the growth of the independent share of the market from approximately 36 per cent in 2017. There are one million TIC employees (often in high-wage STEM jobs) scattered in more than 160 countries around the globe offering conformity assessment services. Between 2009 and 2016, revenue growth of the TIC sector outperformed general income growth experienced in the major developed economies.

Table 1: Summary of regional conformity assessment sectors in terms of annual revenue

Region	Forecast annual revenue ($m, 2020)	Outsourced / independent market share (%, 2017)	Outsourced / independent market share (%, 2025 forecast)
Europe	70,749.4	35.6	36.6
North America	55,249.9	35	35.9
Asia-Pacific	37,222.4	37	37.9
Middle East and Africa	28,535.4	37.7	38.7
Latin America	22,472.7	37.7	38.7

Source: Transparency Market Research (2017) for market revenues and shares. Note that figures were projected before the onset of the COVID-19 pandemic.

The broad range of applications for TIC services means that the industry is exposed to an equally varied set of global trends. The industry has historically played an important role in enabling trade, which may be increasingly relevant given concerns about a possible slowdown or reversal in globalisation as reflected in new trade, national security, and onshoring/reshoring policies that are impacting global supply chains. And it is already helping stakeholders in growth areas, such as the Internet of Things and the circular economy.

The benefits of the independent TIC sector to various stakeholder groups

The varied activities of the independent TIC sector can generate numerous advantages for stakeholders, and those advantages are innately tied to the sector's reputation for competence, impartiality, and consistency. In addition, the activities of third-party TIC are crucial for helping to meet various policy goals set by policymakers, such as those related to ensuring consumer safety and stimulating competition, as well as wider objectives concerning the environmental sustainability of production and consumption.

•Benefits to Consumers

- Most importantly, the **products and services** consumers use **are safer, true to their advertised claims, and consistently reliable and high-quality**.
- Easier for consumers to compare and contrast products and services, hence **reducing 'search costs'**.
- Indirectly, **enhanced competition** among products and services, which may result in lower prices (for a given quality) and a greater variety of products.

•Benefits to Businesses

- Higher levels of **regulatory compliance**.
- Businesses may achieve medium- and long-term **cost savings** through reliance on independent third-party conformity assessment services (despite the upfront cost generated).
- **Enhanced demand** from the trust and confidence that the use of such services generates in the marketplace.
- **Enabling market entry and market access,** as well as potentially even market creation.

•Benefits to Policymakers

- Scarce public resources may be saved when the safety or security of products improves.
- Assistance with **designing regulations** and other government programs.
- **Ensure compliance** with requirements (potentially at a lower cost to the taxpayer);
- **Increase** the volume of **trade**.

Not all of the advantages will accrue in all instances, of course. For instance, a governmental authority deciding on the appropriate levels of independence and rigor and the types of TIC activities to employ in a particular context, has to establish it all comes down to what a ministry or agency has referred to as the "confidence point", namely "the agency's level of confidence that an objective(s) has/have been achieved, weighing the risk of non-conformity (or non-compliance) and its associated consequences with the anticipated costs of demonstrating conformity (including time and resources) to the producers, suppliers, consumers, and the agency."[1]

[1] Carnahan and Phelps, pages 8-9.

Nevertheless, given the focus of this study is on the value that the TIC sector can provide, we set out the many ways that stakeholders – namely consumers, businesses and policymakers – might benefit from independent third party conformity assessment activities in appropriate circumstances in the figures above.

Case studies illustrate the benefits from independent third party conformity assessment

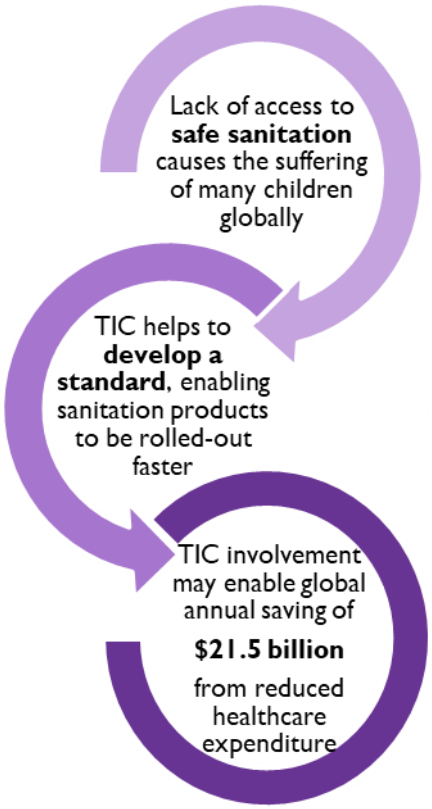
Quantifying all the benefits is beyond the scope of this paper given the scale of the industry, the immense range of sectors in which the TIC sector operates, and all the different ways that the sector benefits stakeholders and the public good. Instead, we seek to illustrate that these benefits can be material by looking at three case studies, and comparing outcomes with what might happen in a counterfactual where there are no independent TIC firms or services.

Our three case studies relate to sewerless sanitation systems, payment cards, and so-called 'smart products'. All three examples highlight how the TIC sector offers much more value than simply testing and certifying that a product meets a given requirement. The sector proactively helps to identify and address complex public policy problems with major global implications, and in the process provides significant, and sometimes massive, net benefits to society.

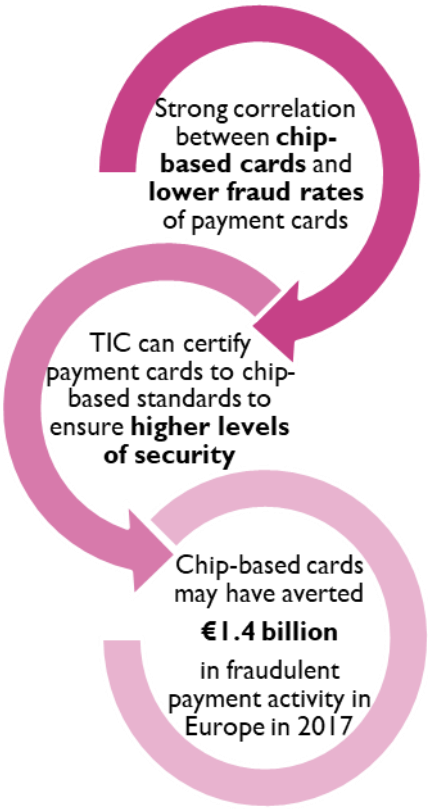
They also illustrate that the relevance and importance of the TIC sector is likely to grow into the future. The sewerless toilets case study is an example of how the sector is contributing towards the realisation of one of the UN's sustainable development goals (SDGs) relating to public health. The other two case studies (payment cards and smart products) are in the areas of cybersecurity where data protection and product safety issues arising from the use of connected consumer devices are expected to become even more important in the years to come. Figure 1 below summarises the main quantified benefits for each case study.

Figure 1: Summary of the three case studies

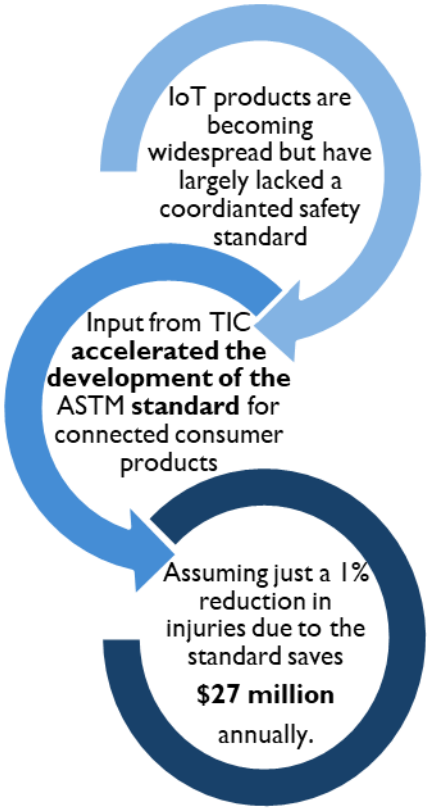
Case Study 1: Reinventing the toilet



Case Study 2: Cybersecurity and payment cards



Case Study 3: Consumer safety in the Internet of Things



1 Overview of the TIC Sector

The Testing, Inspection and Certification (TIC) sector is a major contributor to the global economy and the quality of daily life around the world by providing trust and confidence that products are safe, secure, effective, reliable, of quality and sustainable.[2] This chapter first explains the activities performed by the TIC sector (hereafter referred to as "conformity assessment" or "conformity assessment services"), then describes the size and the scope of the sector (globally and in different regions), and finally outlines developments on the horizon that are likely to influence its continued growth.

1.1 What is Conformity Assessment?

Conformity assessment is the demonstration that a specified standard or requirement relating to a product, process, system, person or body is fulfilled.[3] For greater clarity, this definition can be broken down into the following components:

- First, there is a standard or requirement that sets out how an object of conformity – whether a product, process, system, person, or body – should perform.
- Second, activities must be undertaken to examine and then determine how the object of conformity performs with regard to the terms of the standard or requirement. Conformity assessment can be undertaken through a variety of activities, ranging from testing and inspection, through validation and verification, to certification, or some combination thereof, and there are international standards for different types of conformity assessment.[4]
- Third, a person or body must attest to the fulfilment of the terms of the standard or requirement by the object of conformity, using information obtained from one or more conformity assessment activities. The attestation could come from: a first party (e.g., a seller, manufacturer, or supplier), which is called a Supplier Declaration of Conformity (SDoC); second party (e.g., a purchaser or user); or third party (e.g., a person or body that is independent of the first two parties), which is called a certification. [5]

  For every conformity assessment scheme, there is an organization that structures and administers it.[6]

The TIC industry provides independent third-party conformity assessment services in a variety of contexts – e.g., to support regulatory frameworks or industry oversight programs – using technical experts to carry out impartial testing and evaluation, audits, inspections, and other services on products, systems, or personnel against various private, national and international standards and regulations.[7] TIC companies can also certify

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2 This study was commissioned by the TIC Council.

3 ISO/IEC 17000 (2020) paras. 4.1, 4.2, 5.1. Para 5.1 defines a specified requirement as a "need or expectation that is stated".

4 These include: ISO/IEC 17065: 2012 (Conformity Assessment - Requirements For Bodies Certifying Products, Processes And Services); ISO/IEC 17025: 2017 (General Requirements For The Competence Of Testing And Calibration Laboratories); ISO/IEC 17020: 2012 (Conformity Assessment - Requirements For The Operation Of Various Types Of Bodies Performing Inspection); ISO/IEC 17021-1: 2015 (Conformity assessment — Requirements for bodies providing audit and certification of management systems — Part 1: Requirements); and ISO/IEC 17024: 2012 (Conformity Assessment - General Requirements For Bodies Operating Certification Of Persons).

5 Carnahan and Phelps (2018). Some jurisdictions recognize surveillance – ensuring performance on an ongoing basis – as a fourth component of conformity assessment.

6 Carnahan and Phelps (2018). The scheme owner, which sets and manages the rules and procedures of the conformity assessment scheme, could be a government body (e.g., a regulator or a procurement agency), but it could also be a standards body, certification body, trade association, consumer group, or other entity.

7 TIC Council (2020a)

for consumers, patients, workers, regulatory authorities, governments, and firms up- and down-stream in the chain of production, that a product meets a set of specified requirements – whether to address a specific hazard or risk, ensure quality, or meet some other objective – and that it will consistently do so for as long as it holds the relevant certification. TIC firms can also support enhanced market access by providing related services such as measurement of volumes and weights, sampling of commodities, and laboratory analysis of cargo.[8]

Accreditation bodies assess TIC service providers to ensure that they meet the applicable international standards and specific programmatic requirements for conformity assessment bodies and activities.[9] They also check whether TIC providers meet competency requirements and have the necessary qualifications and facilities to perform conformity assessment activities. For brevity, this report hereinafter refers to the "product" to capture the object of conformity assessment, whilst the statements apply equally to processes, services, systems, persons or bodies unless otherwise indicated.[10]

The applications of conformity assessment include consumer products, medical devices, food and agriculture, petroleum, mining and metals, among others, and enhance trust and confidence in the fields of:[11]

- **Health, safety, and welfare** – through providing services such as laboratory analysis of drinking water; medical diagnosis and testing; certification of safety equipment; and testing air quality of indoor spaces,[12] conformity assessment services are crucial for addressing hazards and risks and providing confidence to patients, doctors and other health professionals, workers, employers, health authorities

- **Environment** – Environmental protection can be supported by TIC services, including those that detect trace pollutants and other potential environmental contaminants and help stop the importation of harmful organisms that threaten ecosystems.[13] Further, as the risks associated with climate change grow, the TIC industry is well positioned to improve the use of companies' data to measure their vulnerability to related risks, validate mitigation strategies, and help demonstrate compliance with emerging regulatory and market requirements.[14]

- **Disruptive technologies** – The TIC sector is supporting the development and safe adoption of innovative technologies for both consumer and commercial uses, including artificial intelligence, autonomous transport and connected devices. It also uses these technologies to improve its own service provision: examples include using drones to conduct inspections by remotely accessing physical infrastructure,[15] and using driving robots to act as obstacles when testing autonomous vehicles.[16]

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8 See, for example, SGS's webpage: www.sgs.co.uk/trade/commodity-trading/oil-gas-and-chemicals/trade-inspection

9 ISO/IEC 17000 (2020) defines *accreditation* as a 'third-party attestation related to a conformity assessment body conveying formal demonstration of its competence to carry out specific conformity assessment risks' and *accreditation body* as an 'authoritative body that performs accreditation'. See also page 5, Carnahan and Phelps (2018) "Accreditation provides confidence by assessing an organization's competence, conformity assessment process, infrastructure and results to ensure that conformity bodies meet requirements". The international standard for accreditation bodies is ISO/IEC 17011: 2017 (Conformity Assessment - Requirements For Accreditation Bodies Accrediting Conformity Assessment Bodies).

10 ISO/IEC 17000 (2020) para. 4.2 specifies that the object of conformity assessment may cover, *inter alia*: "product, process, service, system, installation, project, data, design, material, claim, person, body or organization, or any combination thereof".

11 European Accreditation (2015)

12 See, for example, UL's webpage: https://www.ul.com/services/testing/indoor-air-quality-testing

13 See, for example, Intertek's webpage: https://www.intertek.com/testing/environmental/

14 TIC Council (2019)

15 See, for example, Applus's website: https://www.applus.com/global/en/what-we-do/solutions/drone-inspection

16 DEKRA (2017)

- **Agriculture and food** – robust conformity assessment systems, as well as national and international standards, help to ensure the safety of food for human consumption and improve consumer confidence. Some TIC firms offer "farm-to-fork" conformity assessment services that seek to ensure that food safety requirements and standards are met at each link of the supply chain using innovative techniques such as live data feeds on crops to more traditional inspections of truck and ship containers.[17]

- **Privacy and security** – telecommunications providers and users rely on TIC services to demonstrate that the reams of personal and commercial data they handle are kept confidential and that telecom systems are secure and resilient. TIC services also ensure that security equipment (such as CCTV and intruder alarms) meets national standards and have helped to facilitate the use of biometric identification, which is now required by EU aviation regulations.[18]

The rules set by governmental bodies regarding who must test and certify products to meet any legal or programmatic requirements in a jurisdiction vary both within and across jurisdictions, and it is important to note that, in some cases and jurisdictions, there may be additional de facto *market* requirements for conformity assessment. With respect to government conformity assessment requirements, in some circumstances the manufacturer is permitted to self-declare that its products comply with the requirements (SDoC) after performing its own conformity assessments. First-party assessment is typically used when there is a lower level of risk associated with non-compliance and with the product.[19] In other cases, products must be tested and certified by an accredited independent third party conformity assessment body to demonstrate compliance (see Box 1 for a high-level overview of this process). In other words, an SDoC cannot be used to satisfy a third-party certification requirement. This might be due to a higher risk from the product, an industry history of non-compliance and a high risk associated with such non-compliance, and/or a need for higher levels of confidence by the relevant ministry or agency. In developing countries, in particular, there may be resource constraints facing regulators and/or limitations to legal systems, enforcement capabilities, or product liability laws. These are just examples, and there are many potential combinations of these and other conformity assessment procedures that a ministry or agency may deem to be necessary in a given context to provide sufficient confidence that its objectives have been met. As one jurisdiction has put it:

> "The confidence point is the agency's level of confidence that an objective(s) has/have been achieved, weighing the risk of non-conformity (or non-compliance) and its associated consequences with the anticipated costs of demonstrating conformity (including time and resources) to the producers, suppliers, consumers, and the agency."[20]

A government's determination of the type(s) of conformity assessment activities to require in a given circumstance should be a function of two factors. It should base its decision on (a) the appropriate level of rigor of conformity assessment activities and (b) the degree of independence of the conformity assessment bodies that are performing those activities that would provide it with sufficient confidence that a standard or requirement is being fulfilled.[21]

For illustrative purposes, the Annex to this report provides an overview of the structure and operations of the conformity assessment systems of four major jurisdictions: China, the European Union, India, and the United States.

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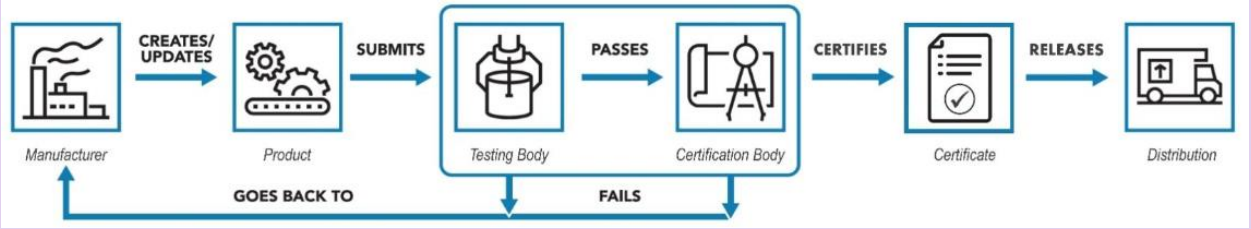
17 See, for example, Bureau Veritas's webpage: https://www.bureauveritas.co.uk/agri-commodities
18 Ecorys (2011)
19 IFIA & CEOC (TIC Council) (2016). But note that first-party assessment may include third party components.
20 Carnahan and Phelps (2018b), p. 8
21 Carnahan and Phelps (2018b), p. 9

Box 1: An illustration of the third-party testing and certification process

When utilising third party conformity assessment, a manufacturer submits its product to a third party to be tested and certified. A third-party testing laboratory reports whether the product has met the applicable testing requirements. If the product does not satisfy the requirements, the manufacturer must take corrective action to ensure that the product meets the requirements and then re-submit the product for re-testing. Once the product has satisfied the testing requirements, a third-party certification body (which may or may not be the same body as the testing laboratory) evaluates the test results. If the product meets the applicable requirements, the certification body approves the product and issues a certificate.



There may be other requirements that are not covered by the certification but against which products can be tested by a third-party TIC firm. Furthermore, sometimes third-party certification relates to a market requirement or a voluntary government programme that is not mandatory.

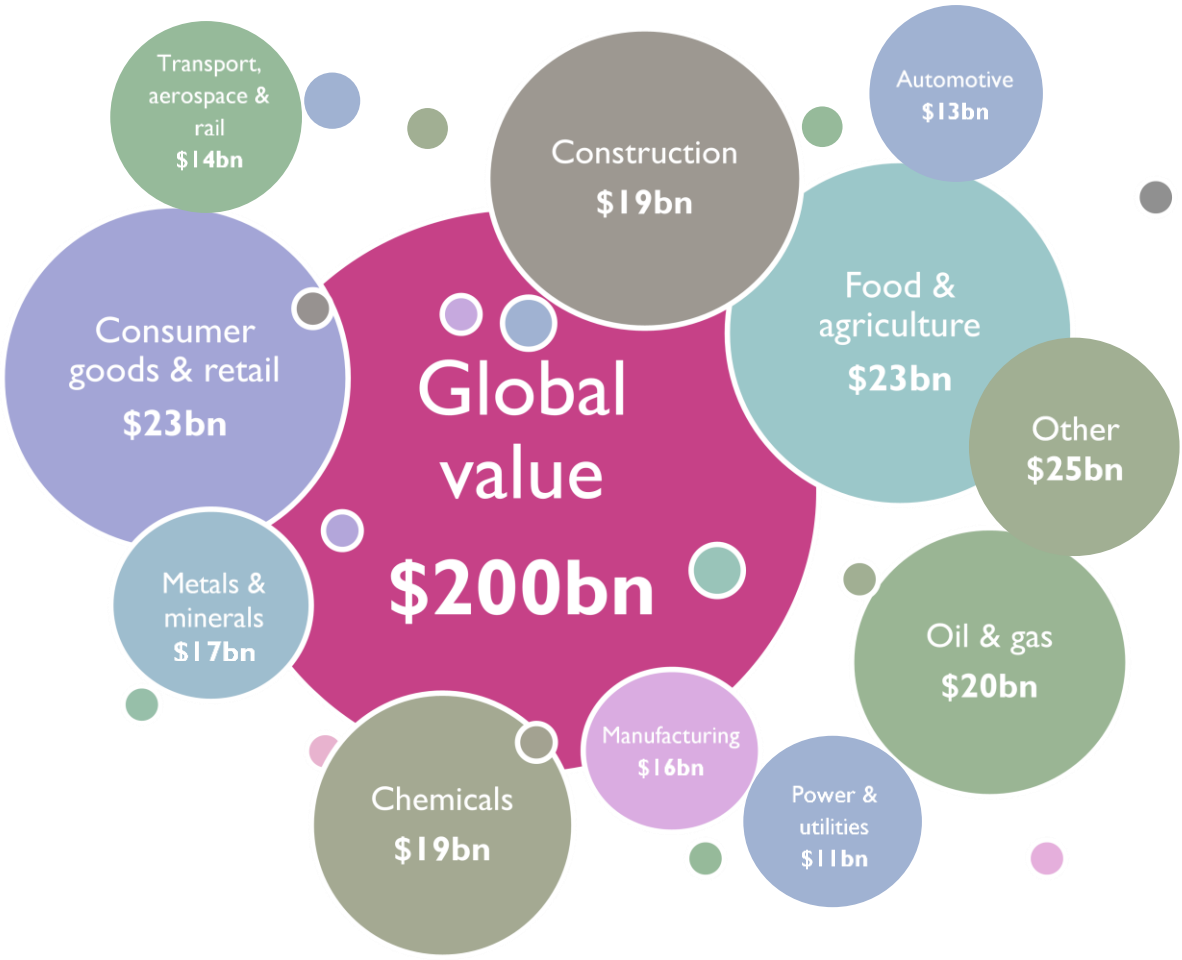
Source: TIC Council (2020a)

1.2 The Size and Range of the Sector

The one million TIC employees (often in high-wage STEM jobs) scattered in more than 160 countries around the globe offer conformity assessment services that are vital for the quality infrastructure of the countries they serve.[22] Current estimates of the size of the conformity assessment sector globally, including first, second- and third-party activities with all their constituent applications, are in the order of $200bn,[23] and it is expected to surpass $260bn by 2025.[24] The independent TIC sector is currently estimated to account for 40 per cent of this.[25] A trend of increased outsourcing of TIC services to cost-effective third parties, coupled with a diversified range of product and standard requirements, has contributed to the growth of the independent share from approximately 36 per cent in 2017.[26] The estimated global annual revenues of conformity assessment services in the full range of applications is shown in the following diagram.

[22] European Accreditation (2015)
[23] Bureau Veritas (2020) estimate: $200bn. Transparency Market Research (2017) estimate: $214bn. Research and Markets (2020) estimate: $218bn. EY-Parthenon (2019) estimate: €140-150bn.
[24] Market Study Report (2019a)
[25] Bureau Veritas (2020)
[26] Transparency Market Research (2017)

Figure 2: The size of TIC in areas of application globally



Note: The figure shows Bureau Veritas's estimates based on end-user expenditure.
Source: Bureau Veritas (2020). "Other" includes Public authorities, Marine, Health, Banking & insurance, and Process (which may include TIC services applied to the conformity assessment of end-users' internal processes).

Between 2009 and 2016, revenue growth of the TIC sector outperformed general income growth experienced in the major developed economies.[27] The overall size of the TIC sector is influenced by the economic dynamics of different geographic regions. In Europe, North America and the Asia and Pacific (APAC) region, firms and governments are increasingly outsourcing conformity assessment activities to third parties to allow them to focus on their core business and to reduce pressure on the public purse, respectively, according to recent market research.[28] The TIC sector is also growing in the Middle East, Africa and South America. TIC services in developing countries are helping to facilitate the sustainable transition from developing to industrialised economies.

Regional TIC sectors: Size and trends

Owing to a high level of regulation and complexity across different counties in the region,[29] the European TIC industry is generally considered to be the world's largest. With a third of the global TIC market in 2017,

[27] EY-Parthenon (2019)
[28] See, for example, the press release of *Global Newswire* (2019) on the publication of the Market Study Report analyses cited in this section.
[29] Transparency Market Research (2017)

the European conformity assessment sector in 2020 is estimated at approximately $71bn[30] – of which the independent TIC sector accounts for approximately 35.6 per cent[31] – and is expected to grow to $85-98bn by the end of 2024.[32] TIC activities are in greatest demand in the energy and utilities (14 per cent), food and beverages (13 per cent), and chemical (12 per cent) sectors.[33]

According to market research, this European TIC growth forecast reflects a trend in the increased outsourcing of conformity assessment services to independent accredited third-party conformity assessment bodies.[34] In addition, a continuous increase in the development of international standards to replace regional, national, and private standards has been further contributing to the demand for TIC services recently.[35] In addition, a growth in product-safety related standards development activity may be a consequence of an observed increase in the incidence of non-compliance scandals which have triggered central authorities to implement more stringent requirements.[36]

With approximately a quarter of the global market share,[37] the North American TIC industry in 2020 is valued at between $30bn[38] and $55bn in revenue,[39] with approximately 35 per cent accounted for by the independent TIC sector.[40] As is the case in Europe, the largest shares of TIC revenue are generated in the energy and utilities (15 per cent), food and beverages (13 per cent), and chemical (12 per cent) sectors.[41]

Government regulations that appear to be emphasising consumer safety, and a ballooning volume of imports that do not comply with regional applicable safety standards, are expected to contribute to the North American TIC sector's growth.[42] Combined with a higher level of consumers' awareness of the products they purchase, it is perhaps not surprising that a significant percentage of TIC services in North America is in the area of consumer products (another study suggests over 36 per cent of all TIC services[43]), which has a forecast compound annual growth rate of 9 percent between 2018 and 2024.[44]

According to market research, the growth of the Asia-Pacific TIC sector in recent periods reflects rapidly changing consumer preferences as countries in the region transition from agricultural to industrial economies.[45] A greater demand for safe and reliable consumer products as populations grow, coupled with infrastructure development fuelled by the industrialisation of China and India, are increasing demand for independent TIC services.[46] This currently accounts for approximately 37 per cent of overall TIC revenue.[47] Some market research studies estimate the consumer products applications of TIC services to experience a compound annual growth rate of 11 per cent from 2018 to 2024.[48] The Asia-Pacific TIC sector's current

30 Transparency Market Research (2017). The 2020 value projected in 2017. These and other estimates are naturally subject to additional uncertainty due to the impact of the COVID-19 pandemic.
31 Transparency Market Research (2017). The 2020 proportion projected in 2017.
32 Market Study Report (2019b)
33 Transparency Market Research (2017).
34 Market Study Report (2019b)
35 Global Newswire (2019)
36 Market Study Report (2019b) (sample of report)
37 Transparency Market Research (2017)
38 Capitalmind (2020)
39 Transparency Market Research (2017). The 2020 value projected in 2017.
40 Transparency Market Research (2017). The 2020 proportion projected in 2017.
41 Transparency Market Research (2017).
42 Market Study Report (2019c)
43 Transparency Market Research (2017). The combined shares of Food & Beverages (13%), Information Technologies (2%), Healthcare & Pharmaceuticals (11%), Travel & Tourism (1%), Education (1%), Textiles (7%) and Cosmetics (2%).
44 Market Study Report (2019c)
45 Market Study Report (2019d)
46 Market Study Report (2019d); Transparency Market Research (2017).
47 Transparency Market Research (2017). The 2020 proportion projected in 2017.
48 Market Study Report (2019d)

$37bn in annual revenue[49] may reach between $53bn and $80bn by 2025,[50] potentially overtaking the North American TIC sector as the world's second-largest. The pattern of the three largest sources of TIC revenue is repeated in the Asia-Pacific. Asia-Pacific TIC has the highest share of revenue in the infrastructure and construction sector across the three regions, which may reflect the more rapid pace of development in these countries (4.5 per cent against 4.3 and 4.1 per cent in Europe and North America, respectively).[51]

The following table, Table 2, presents the market values in terms of the forecast annual revenue in 2020 in the three regions as well as for the Middle East and Africa and Latin America.

Table 2: Summary of regional conformity assessment sectors in terms of annual revenue

Region	Forecast annual revenue ($m, 2020)	Outsourced / independent market share (%, 2017)	Outsourced / independent market share (%, 2025 forecast)
Europe	70,749.4	35.6	36.6
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Sources: Transparency Market Research (2017) for market revenues and shares. Note that figures were projected before the onset of the COVID-19 pandemic.

Conformity assessment in developing countries: a facilitator of sustainable development

TIC services are provided globally and by a multitude of large, medium-sized, and small service providers and can promote economic development. It is well established that the "soft infrastructure" of developing countries, and in particular their standards-related capacity,[52] plays a central role in contributing to sustainable development, especially by facilitating trade.[53]

The international development community embraced voluntary sustainability standards (VSS) and certification procedures over forty years ago[54] and formally recognised the standards-as-catalyst approach to fostering sustainability in the UN's adoption of Agenda 21 in1992.[55] Standards adopted in some of the highly-traded commodities largely produced in developing regions, such as coffee, palm oil and soy, have been credited with boosting their production. For instance, a 2014 review estimated an impressive 41 per cent growth overall for trade in the group of VSS-compliant commodities studied, vastly outpacing the 2 per cent growth observed in the conventional commodity markets.[56] The share of global production of standards-compliant coffee reached 40 per cent in 2012, up from a mere 15 per cent in 2008.

1.3 Developments Expected to Impact the TIC Sector

The broad range of applications for TIC services means that the industry is exposed to an equally varied set of global trends. Of these, three may be considered especially pertinent:

1. a slowdown or potential reversal in globalisation;
2. the increased digitisation of products, services, and economies more generally; and
3. the growth of the circular economy.

[49] Transparency Market Research (2017). The 2020 value projected in 2017.
[50] Market Study Report (2019d)
[51] Transparency Market Research (2017).
[52] Moon and Lee (2020)
[53] See, for example, Blind et al. (2018)
[54] Andrew (2017)
[55] UN (1992)
*[56] Potts et al. (2014)

1.3.1 Slowdown and potential reversal in the globalisation trend

A long process of globalisation, facilitated by the historical easing of trade restrictions through successive rounds of multilateral trade liberalization and technological progress, has resulted in highly interconnected global supply chains. These global supply chains create challenges for producers to ensure the safety, quality, and reliability of the end product. This, in turn, widens the scope of work for the TIC industry[57] and has been met by the adaptation of TIC services to testing, inspecting and certifying products, processes, production methods, services, systems, bodies, and personnel throughout the supply chain.[58] It also means that supply chains have become more vulnerable to disruptions, whether due to recessions, natural disasters, or increasing trade frictions.[59] In providing services along these complex supply chains, TIC firms can be negatively affected when those chains are disrupted.

The COVID-19 pandemic has illustrated the sensitivity of supply chains to disruptions in one of the links: many TIC end-markets depend on Chinese imports for intermediate inputs and final products and struggled to source them when China went into lockdown. When China's ports reopened after the lockdown-induced hiatus, a surge in port calls outstripped port capacity.[60] When COVID-19 spread to other countries, they also experienced reductions in manufacturing output, as well as supply-chain disruptions. As a result, research suggests that TIC providers in the worst-hit sectors (such as those not deemed critical by governments) experienced a collateral negative impact on their revenues.[61]

The pandemic is one extraordinary example of the potential fragility of the interconnected global supply web and the resulting impact on the TIC industry when this web is disrupted. Other regional and international developments bring their own risks and opportunities. The increasing levels of tariffs and other measures being erected in the two largest import and export markets, China and the US, have begun to stem the upward trend in trade volumes.[62] A slowdown in international trade may therefore have a knock-on impact on the demand for TIC services.[63] On the other hand, a slowdown in global interconnectedness and disruptive events may create new opportunities for the TIC sector to provide value. For example, some commentators argue that the UK's withdrawal from the European Union may lead to lower restrictions on trade with non-EU partners, prompting the entry of firms that may require TIC services to gain a sure footing.[64] And the COVID-19 pandemic surely provides an opportunity for TIC service providers to assist companies and governments to protect public health.

1.3.2 Digitisation of products and economies

The speed of technological change and the resulting capabilities of consumer and commercial products have had a profound impact on the types of services offered by TIC firms. New technologies are enabling increased automation in a number of products that give rise to risks that must be managed, whilst a critical mass of data flowing between a multitude of newly-connected products and services in the Internet of Things is creating cybersecurity and resiliency risks for manufacturers and end-users and privacy and safety risks for

[57] EY-Parthenon (2019)
[58] CEOC (2015)
[59] OC&C (2020)
[60] OC&C (2020)
[61] OC&C (2020)
[62] International trade in goods and services based on UN Comtrade data shows that US imports of Chinese products fell by $90.7bn in 2018-19 after both countries imposed tariffs in 2018, and US exports to China continued a trend since 2017 by falling $14.5bn. For a discussion of the impacts on bilateral trade between the US and China, see Li et al. (2019). For the negative consequences for trade between third countries in global supply chains, see Mao and Görge (2020).
[63] Barclays (2018)
[64] Market Study Report (2019b)

end-consumers. The range of services offered by the TIC industry is likely to continue to expand as a result of these changes.

Furthermore, e-commerce has been embraced by some in the TIC sector: an online marketplace for inspection and asset verification services allows clients to directly book an audit with a certified independent provider.[65] This kind of disruption can reduce the barriers to entry faced by potential TIC sector firms. For example, the online marketplace may enable customers to select TIC firms without being constrained by the firms in their local vicinity, which may reduce the need for physical capital such as offices in jurisdictions where the regulatory system permits it. Competition is consequently enhanced.

More generally, the digitisation of products and economies has been generating new kinds of risks which, in turn, have introduced new applications for TIC services.[66] This is particularly the case for the North American TIC sector as the growing demand for tech-enabled TIC solutions and the Internet of Things are two of the main contributors to US TIC market growth.[67] The rollout of drones to conduct inspections by remotely accessing physical infrastructure (where this is permitted by law) demonstrates that certain TIC services can continue even when the physical distancing measures for COVID-19 are in place.[68] For example, an independent inspection start-up founded by aircraft engineers deploys a swarm of drones to inspect aircraft cabins following a lightning strike. The firm managed to cut the time required to inspect an aircraft cabin following such an event from eight days to 20 minutes by replacing human maintenance teams.[69] Tech-enabled TIC services such as these can be more-cost effective by augmenting physical inspection (which can be prone to human error) and reduce inspection times by removing the need for inspectors to be always physically present, whilst also creating opportunities for new innovative firms to enter the market.[70]

Increasingly complex technologies enabling blockchain, as well as modern telecommunications infrastructure such as 5G, require new conformity assessment programmes (or schemes). The risks created by new telecommunications networks have been met by the services of TIC players, which have invested in 5G facilities that can test 5G-enabled devices against national and regional regulatory requirements. For example, TIC firms have facilities to test and certify to worldwide standards in areas such as electromagnetic compatibility, specific absorption rate, interoperability, quality of service and radio frequency.[71] Other facilities offer testing environments based on real-world infrastructure to assess the interoperability of devices that is expected when products are released to consumers.[72]

These technological developments are global phenomena that are rapidly changing traditional sectors and the TIC services they require. For example, with respect to autonomous vehicles, the free-flow of data that partially enables automated and machine learning-based technologies raises the risk of digital intrusion, tampering and failure of the systems.[73] The need to ensure that data is kept secure and that autonomous vehicles do not injure passengers and bystanders elevates the importance of TIC services with respect to these new technologies. To help address these issues, one TIC firm has begun to establish a testing network for autonomous vehicles and tests new driving technologies at the *Lausitzring* racetrack in Germany.[74] This was announced as the largest independent centre for automated and networked driving in Europe, and it

[65] EY-Parthenon (2019)
[66] EY-Parthenon (2019)
[67] Capitalmind (2020)
[68] See, for example, Applus's website: https://www.applus.com/global/en/what-we-do/solutions/drone-inspection
[69] EY-Parthenon (2019)
[70] EY-Parthenon (2019)
[71] See, for example, UL's website: https://www.ul.com/offerings/5g-compliance-testing
[72] See, for example, DEKRA's website: https://www.dekra-product-safety.com/en/dekra-launches-advanced-5g-testing-and-certification-solutions
[73] EY-Parthenon (2019)
[74] EY-Parthenon (2019)

allows the comprehensive testing of automated driving functions by simulating complex scenarios.[75] These scenarios involve testing equipment such as driving robots, self-driving platforms and mobile traffic infrastructure installations. It is likely that the rollout of automated systems and other technologies into consumer and commercial applications will be a key driver of the breadth and importance of TIC services during the next decade.

1.3.3 Growth of the circular economy

The term "circular economy" has been defined by the Ellen MacArthur Foundation as "the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems".[76] The growing circular economy, and its applications in product design, manufacturing processes and business models, has been, and will continue to be, supported by the TIC industry.

For instance, TIC service providers support the growth of the circular economy by offering the certification of environmentally-safe building materials, of products used in agricultural production (such as soil)[77], and to international standards such as the Cradle to Cradle measure of products made for the circular economy.[78] There are also frameworks to help companies audit the sustainability of their business models[79] and standards for maintaining and improving products such as wind turbines and electric vehicle batteries,[80] among other services offered by TIC firms. Demographic changes in many countries are being accompanied by changes in consumer demand for products that are traditionally owned, as people opt instead for shared and multi-use amenities.[81] Continued consumer support for circular economy may mean that the TIC industry will have a more prominent role to play in testing and certifying related best practices.

The TIC industry is well-placed to assist the diffusion of circular economy methods because of its extensive expertise in materials[82] and the existing standards against which products can be tested for their environmental impact. Future buildings may need to be modified and adapted to suit evolving demands in a circular economy framework to allow for the dismantling of construction materials without loss. The existing networks of specialist laboratories of large TIC players offer assessment capabilities to the supply chain, as well as assistance to manufacturers in meeting the applicable regulations.[83] Moreover, they can test (and consequently help to improve) a product's environmental performance by performing life cycle assessment (LCA) against ISO's existing standards[84] and provide manufacturers with an Environmental Product Declaration (EPD).[85] EPDs describe the environmental footprint of a product throughout its life and thereby demonstrate a product's commitment to the circular economy model.

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75 DEKRA (2017)

76 https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy

77 See, for example, Normec Group's webpage: https://www.normecgroup.com/en/life-safety-environment/

78 See Cradle to Cradle: https://www.c2ccertified.org

79 See, for example, Bureau Veritas's webpage: https://group.bureauveritas.com/newsroom/bureau-veritas-launches-circular-new-approach-corporate-sustainability

80 See, for example, UL (2020).

81 UL (2020)

82 See, for example, SGS's webpage: https://www.sgs.com/en/news/2019/10/moving-to-a-circular-economy-in-the-netherlands

83 See, for example, SGS's webpage: https://www.sgs.com/en/news/2019/07/electrical-products-circular-economies-and-waste-management

84 ISO 14044:2006, which specifies requirements and provides guidelines for life cycle assessment (LCA). See https://www.iso.org/standard/38498.html

85 See, for example, SGS's webpage: https://www.sgs.com/en/sustainability/facilities-and-production/product-and-packaging/ecodesign-lca-epd-and-circular-economy-certification

2 Rationale for TICs

The varied activities of the TIC sector generate numerous advantages for the stakeholders involved. This section identifies how conformity assessment can provide benefits to consumers, workers, businesses, patients, farmers, policymakers, and the general public. Whilst some benefits are experienced exclusively by one stakeholder, the benefits accruing to one stakeholder often 'spill' into the realm of another, passing-through the same impacts (and potentially multiplying the overall benefit) or producing new ones. Equally, aspects of conformity assessment that may be less advantageous for one stakeholder may benefit another.

2.1 Benefits to Consumers

Where third party TIC services are required by law or market forces or otherwise appropriate, the end-user of the relevant products – the consumer – stands to benefit for three main reasons.

1. As the end-users of products, it is natural that the consumer will benefit if the products they use are safer, true to their advertised claims, and consistently reliable and high-quality. As discussed below, consumers can have a high level of confidence that products subject to third party conformity assessment to ensure compliance with particular product attributes in the areas of, e.g., safety, security, and sustainability, actually satisfy the requirements.
2. Third-party TIC services can make it easier for consumers to compare and contrast reliable products; they can reduce what economists refer to as "search costs".
3. More generally, third-party TIC services can enhance competition among products, with the traditional benefits associated with enhanced competition flowing through to consumers – lower prices (for a given quality) and greater variety of products.

2.1.1 Safe/secure/compliant products

The most important potential benefit from third-party TIC services is that consumers value such services, because the involvement of TIC firms engenders trust.

The TIC sector can provide confidence to consumers that products meet the relevant regulatory requirements and standards for safety, security, sustainability, and other attributes. There is little contention that consumers can benefit from conformity assessment in general because it increases access to products of consistent, recognised and reliable quality.[86] However, many consumers may put additional stock in products that have been subject to conformity assessment services by a party independent of the manufacturer. In other words, under certain circumstances third-party TIC services may provide consumers with a level of confidence in products that would not be achieved to the same extent by conformity assessment services performed by other parties.

In some contexts, third-party TIC firms may be the only bodies capable of providing this confidence. In most countries, the majority of firms do not have their own facilities for conducting conformity assessment.[87] This appears to have been confirmed in recent interviews with companies that use TIC services, with respondents noting that firms may perform standard types of in-house conformance but not the full range of services usually required for conformity assessment.[88] The issue is most acute in developing countries where both expertise and facilities may be lacking and where national governments must play a significant role in

[86] European Accreditation (2015)
[87] Tippmann and Racine (2013)
[88] To aid this study, TIC provided us with notes from a number of interviews with TIC suppliers, users and regulators.

establishing the proper facilities. In these contexts, the consumer benefits from access to safe, effective, and high-quality products that might not have been placed on the market if conformity assessment by independent TIC firms was not sought.

The importance of having access to compliant products is shown by the willingness of consumers to pay safety premiums. A survey conducted in 2012 across China, India, Japan, the UK and the US found that more than 90 per cent of consumers reported that independent third-party testing is important to them and the vast majority of consumers were willing to pay a premium for products whose safety has been independently verified. [89] The survey identified this premium to be 16 per cent on average. The highest premium consumers were willing to pay was for children's products, which shows the value consumers place in the independent testing of these products.

In many cases, third-party conformity assessment may result in the placement of products on the market that are safer, or more energy efficient, or less prone to cyber-attack, or less toxic, or higher quality. For some products, such as foodstuffs and health-related products, the value that consumers may attach to safety may be especially high. In some cases, a difference in quality may be fundamental to whether the consumer will even consider using the product or service. In other cases, consumers may be willing to pay a premium for a higher-quality product.

Box 2 below provides an example of a study from the electrical safety context showing that third-party conformity assessment resulted in demonstrably safer products.

Box 2: Regulatory compliance and levels of electrical safety with and without third-party conformity assessment

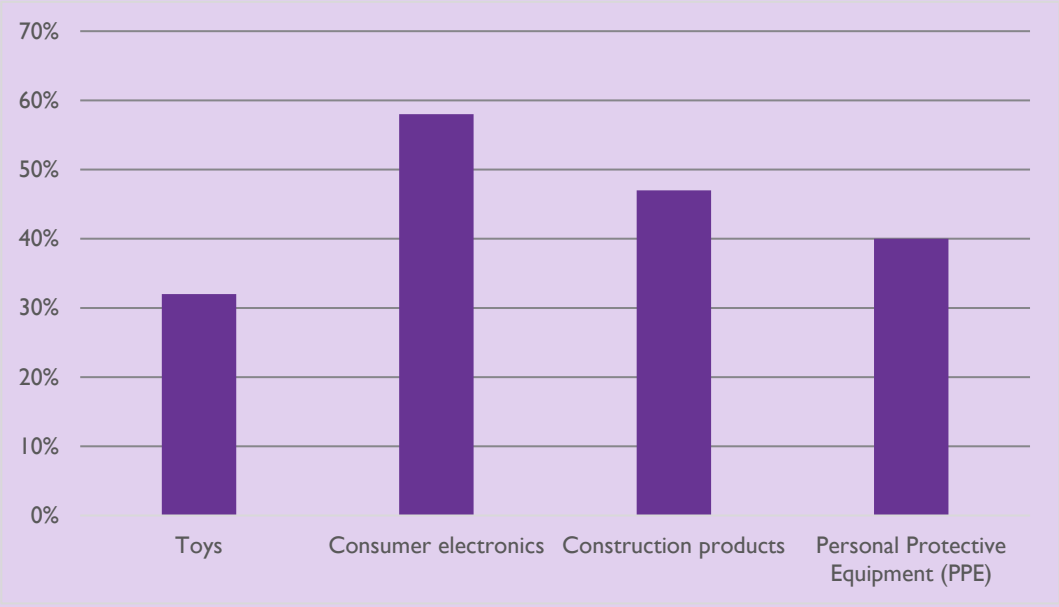
According to the European Association for Injury Prevention and Safety Promotion (EuroSafe), in 2011 half of all fatal injuries and over three quarters of hospital-treated injuries occurred in the home and in leisure time, the vast majority of which resulted from consumer products and services (as opposed to foul play and transport-related injuries, for example).[90] Survey evidence shows that, in some circumstances, third-party conformity assessment can have a nontrivial positive impact on product safety.

For instance, between 2014 and 2016, an IFIA/CEOC survey was carried out by a non-member laboratory that investigated the regulatory compliance of a sample of electrical consumer products on the market, of which some were self-declared to meet the relevant regulations and others were tested and certified by third parties. The survey revealed that as much as 17 per cent of the self-declared products in the sample posed safety critical failures.[91] Meanwhile, the same issue was found to be the case in less than one per cent of those products that had been tested and certified by a third party. The results of this survey suggest that a product is less likely to be unsafe if it has been tested and certified by third-party conformity assessors. The differences in conformity assessment practices in the sample reflected differences in legislative frameworks between the US and the EU, as 95 per cent of surveyed products in the US were tested and certified by independent third-party TIC providers, whilst only 10 per cent were in Europe.

The differences in the approaches to conformity assessment observed in Europe and the US may have some bearing on the prevalence of unsafe products in these areas. In 2017, the European Commission noted that as many as 32 per cent of toys, 58 per cent of electronics, 47 per cent of construction products, and 40 per cent of personal protective equipment inspected did not meet the requirements for safety or consumer information set out in EU legislation.[92] Such a high prevalence of potentially unsafe products may endanger consumers and place compliant businesses at a competitive disadvantage. In the US, on the other hand, where the third-party model is more prevalent, the survey showed that less than one per cent of the consumer electronic goods were potentially unsafe.

[89] TÜV SÜD (2014)
[90] EuroSafe (2011)
[91] IFIA & CEOC (TIC Council) (2016)
[92] European Commission (2017)

Figure 2: 2017 Survey on the proportion of products that do not meet EU requirements for safety or consumer information



Source: European Commission (2017)

2.1.2 Reduced search costs

A second set of benefits to consumers that the TIC sector can provide is help with deciding what products to buy – specifically by providing information that reduces so-called search costs. The analysis of market mechanisms often assumes that market participants have access to all available information. This is a simplifying assumption that makes it easier to build tractable models, but it assumes away imperfections that characterise markets. One such imperfection is the difference in the amount of information about a product held by the producer and the consumer. These "information asymmetries" can contribute to an inefficient allocation of resources, as consumers make suboptimal decisions based on their limited information. For example, a consumer foregoing an organic food option for want of information comparing the stringency of organic standards among different options. The presence of a sales intermediary can exacerbate the problem, since the intermediary may be unable to provide the information about a product that a consumer wants and that the producer would have.

There are ways in which consumers can overcome these information asymmetries that are likely to be costly. For instance, multiple interactions between market participants, such as repeated purchases from different producers over time to compare their performance and other characteristics, will be especially costly for high value, infrequently purchased or safety critical items.[93] On the other hand, consumers may rely on the reputation of a producer as a signal of quality and confidence,[94] but gaining such a reputation can be costly and time-consuming for the *producer*. The TIC sector can reduce information asymmetry by providing reliable indicators of trust and confidence to consumers.

[93] Frenz and Lambert (2013)
[94] Frenz and Lambert (2013)

The active consumer

Conformity assessment is an important "marketplace communication mechanism", or signal, providing a means of information exchange.[95] Some consumers will actively seek out the mark of a TIC services provider on a product due to the trustworthiness they perceive in it: the mark provides the consumer with knowledge that the product has met certain safety, environmental, quality or other criteria, and that the producer's claims can be substantiated, without the consumer needing to spend time and resources in acquiring that knowledge herself.[96]. Doing so would entail what economists call "search costs", which are the costs incurred by a consumer in identifying a firm's product and price, regardless of whether the consumer then buys the product from the searched firm or not.[97] Search costs are an example of a market friction that can act to limit competition and restrict the downward pressure on prices, to the overall detriment of consumers. The effort of locating a product in the marketplace that possesses some specific characteristics is substantially reduced when there are regulations and/or standards that specify those characteristics and one or more TIC services is performed to demonstrate conformity with those characteristics.[98]

Box 3: The difference between third-party certification marks and the European CE mark

Certification marks in the TIC sector

In the TIC sector, certification marks are the visual labels that a TIC firm provides to a manufacturer to indicate that a product has met the necessary requirements of a certain standard. Certification marks are issued at the discretion of the certification body, after having demonstrated that the product fulfils the relevant requirements (be they environmental, safety, quality, or other). Consistent with regulatory requirements, the manufacturer may choose whether to use the certification mark on the product or its packaging, thus influencing the extent to which active consumers would be able to identify independently-certified products.

The CE mark

The CE mark is a common marking seen on products. The "CE" is an abbreviation of the French "Conformité Européenne," which translates to European Conformity. It is primarily used within the European Economic Area and is an indication that the product manufacturer (or importer) has claimed compliance with the appropriate European Union legislation applicable to the product. Importantly, the mark is affixed to the product by the manufacturer or importer, and so it does not necessarily indicate that the product has been independently assessed for conformity.

The important distinction between these two types of marks is that one demonstrates independently-verified compliance to requirements, and the other coveys that the manufacturer has self-declared compliance with legislation.

TIC Council (2020)

Third party conformity assessment activities, and the regulations and standards underlying them, may also be described as "credence goods" for the same purpose of reducing search costs. The information provided by a mark or label that is supported by TIC services can be accepted on face value as the basis for making consumption decisions without requiring the consumer to directly acquire this information.[99] This can be important not just for consumers to discern whether products are safe but to make informed decisions with regards to the wider implications of their consumption choices. An example is the energy efficiency of consumer products. In a nod to the quantity of information that can be gleamed from certification labelling, a review of four major European projects focusing on market surveillance of energy labelling noted that it is essential for energy labels to be correctly displayed at the time of purchase for consumers to make the most energy-efficient purchases.[100]

Furthermore, in sectors in which it is mandatory, third-party conformity assessment services may help to sustain consumer trust in the market. For example, manufacturers or importers of products for use by

[95] Carnahan and Phelps (2018), p.5.
[96] Gonçalves and Peuckert (2011)
[97] Wilson (2012)
[98] Gonçalves and Peuckert (2011)
[99] Nadvi (2008)
[100] Krivošík and Attali (2015). The four projects are ATLETE I, ATLETE II, Come On Labels, and Ecopliant.

children in the US must subject those products to testing to the applicable consumer product safety requirements by a third-party laboratory that has been accredited by a signatory to the International Laboratory Accreditation Cooperation Mutual Recognition Agreement and is accepted by the US Consumer Product Safety Commission (CPSC). Without providing test results from such labs to support its declaration of compliance, producers cannot bring their products to market and consumers would not be able to purchase them. By contrast, in settings where enforcement is weak and some producers may be tempted to bypass the regulations and sell in the black market, third-party conformity assessment may be crucial to maintaining demand from active consumers. Absent the knowledge of which goods have been subject to third-party conformity assessment, consumers may decide to forego purchase notwithstanding the fact that all such products are supposed to comply with standards that the consumer values.

The passive consumer

Third-party conformity assessment may also be implicitly valued by consumers that do not actively seek out conformity assessment signals in the marketplace. These consumers probably constitute the majority, since most consumers will not usually seek out (or notice) evidence of third-party conformity assessment, which typically consists of a discreet label or mark of certification. And consumers may simply become confused when faced with numerous conformity assessment labels, and will therefore not infer the information the labels are supposed to convey.[101] However, TIC activities continue to offer benefits to passive consumers – including the reduction of search costs in some instances.

In some cases, passive consumers may (implicitly) assume that the retailer only stocks materials that have been checked. Due to the rise of non-compliant products on the market,[102] some product distributors and wholesalers – as well as 'brand' chains such as large department stores – may decide to purchase only products that have been subjected to one or more TIC services over and above the regulatory requirements. For example, seeking voluntary third-party certification for a product is commonly listed as a method of improving the chances of a supermarket choosing to carry the product.[103] This is common in US markets due to the apportionment of liability in cases where carried products are found to be unsafe, which can then result in stringent penalties imposed on retailers. The consumers that patronise these outlets and select from the pre-screened range of products will thereby indirectly benefit from not having to search for this information themselves. And, given that the distributor has incurred lower search costs in identifying the certification or other conformity assessment services for the reasons previously described, consumers may further benefit from a lower intermediary mark-up on the final product.

Furthermore, there is evidence that whether a certification is noticed or unnoticed by a consumer can be determined by the consumer's perception of a given product. An example is organic food products, whose organic certification may go largely unnoticed by all but a niche market of well-informed or concerned consumers.[104] An organic certification label has almost no effect on consumers' purchasing decisions for a product with a brand perceived as high-quality, whilst the same certification of a perceived lower-quality product does influence the decision. Consumers may put more effort into searching for certifications on these perceived lower-quality products. Third-party certification can thus bolster the perceived quality of smaller brands that have not yet generated a strong market reputation (which is discussed further below).

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[101] Heyes et al. (2020)

[102] For example, the number of import safety seizures in the US increased by 30 per cent 2019-20, which reflects various consumer goods being non-compliant with federal standards and regulations of agencies such as the Consumer Product Safety Commission and the Food and Drug Administration (US Customs and Border Protection, 2020). In Europe, increased non-compliance has recently been detected amongst consumer products due to non-compliant chemical contents (CEFIC, 2019) and amongst lighting products (Lighting Europe, 2020).

[103] See, for example, in the UK: The Entrepreneur Handbook (2020) "How to sell your products to supermarkets and retailers" https://entrepreneurhandbook.co.uk/sell-to-supermarkets-and-retailers/

[104] Larceneux et al. (2012). Research published in 2020 appears to confirm the continued existence of this subset of consumers, albeit potentially a larger group than in 2012 (Heyes et al., 2020).

2.1.3 Enhanced competition

More competition is beneficial for consumers: meaningful competition between firms encourages innovation, and greater efficiency in product manufacturing, development and related processes, which can result in better products and lower prices for consumers. A larger number of firms in the market may lend itself to a greater choice of products for consumers (and also more employment opportunities for workers).

As will be explained under the next subheading, independent, third party conformity assessment can serve to enhance competition in the market for consumer products. The signalling characteristic of TIC outputs improves the information held by consumers, who can therefore direct their purchases to the consumer products that offer the lowest prices for the equivalent level of safety, quality, effectiveness, or other relevant attributes and away from products that are deficient in one or more of these areas. Some firms can also use third-party certification with respect to specific attributes that are above regulatory requirements to position themselves at higher price points for consumers who value those attributes and are willing to pay a price premium. In promoting a level-playing field for businesses, one in which it is clear that all products on the market meet a certain baseline, third party conformity assessment can enable transparent and competitive commerce and trade.

Merely having the option to outsource TIC services may enhance competition. Some firms, including small and medium-sized enterprises (SMEs) may find the costs of undertaking all conformity assessment in house prohibitive, making them uncompetitive. Consumers may benefit from cost savings that companies may realise from outsourcing TIC services to qualified firms, in the form of lower prices. It is recognised that cost savings are not always possible, and indeed cutting production costs (in a narrow sense) is not the purpose of third-party TIC services. Their primary purpose is to ensure that only safe and high quality products reach consumers. TIC services can, however, reduce the likelihood that a company would need to carry out a costly recall of faulty or unsafe products, thus reducing production costs in a wider sense. We expand more on this point in the following subsection.

Furthermore, firms minded to carry out in-house TIC services will need to make sure that their own conformity assessment costs are not out of line with the costs that third-party providers charge to provide the same level of service that is necessary to demonstrate conformity with relevant requirements. It is possible that an incentive problem emerges here. As a component of such a firm's production process, the in-house conformity assessment stage may be exposed to cost-cutting exercises when the firm attempts to make its prices more competitive. This may jeopardise aspects of the conformity assessment, potentially endangering consumers. Third-party TIC firms are bound by industry standards to either assist in the design of products or carry out conformity assessment of the final product – not both. For third-party TIC, therefore, no such incentive problem appears.

2.2 Benefits to Businesses

TIC firms are contracted by businesses to conduct conformity assessment services with respect to their products. Such services can provide businesses with a host of benefits. This section describes the benefits relating to

1. higher levels of regulatory compliance;
2. the cost savings that may be achieved;
3. the enhanced demand that can result from such cost savings and other factors; and
4. market entry and potentially even market creation.

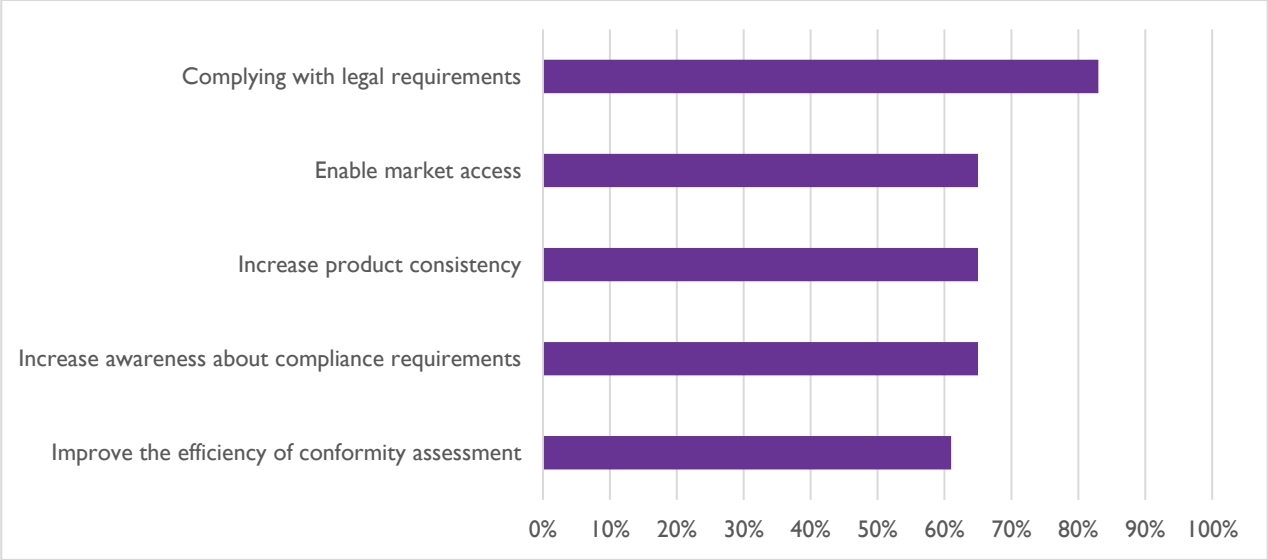
2.2.1 Regulatory compliance

For firms in many sectors, the use of TIC services provides firms with a method of satisfying consumers, authorities and themselves that they comply with the relevant regulatory (and even market) requirements. For certain products, the use of third-party TIC may be mandatory.

Academics and industry players have for many years extolled the benefits of third-party conformity assessment services for ensuring greater levels of regulatory compliance. For example, McAllister (2012b) suggests that regulated firms tapping private resources and expertise can significantly enhance regulatory compliance if the right incentives and opportunities for it to take place exist.[105] Having a third-party TIC firm put a "second set of eyeballs" on a product can scrutinise prototype design and early production samples to screen out any errors that the producer itself might miss.[106] Whilst this does not mean that a third-party TIC firm will provide advice on the product it assesses for conformity (industry standards prevent this), the conformity assessment process provides information to the producer that can help as it proceeds through its design and build phase prior to final compliance testing and market entry.

In assessing a product for compliance with standards and regulatory requirements, third-party TIC firms may also act as a conveyor of up-to-date information pertaining to standards and regulations, which change over time. Remaining current on the latest regulatory and standards developments can be difficult and resource-consuming, especially for smaller firms. A recent survey of conformity assessment firms found that awareness of legal requirements was cited as one of the most important benefits of third-party TIC services.[107]

Figure 3: The most important benefits of third-party TIC that firms report based on their clients' responses



Source: TIC-commissioned survey. Sum of responses answering "Important" and "Very Important".

Having access to the regulatory knowledge of third-party TIC firms is especially important for bolstering the level of compliance of smaller businesses. These businesses may not have the time nor the resources to independently monitor the compliance landscape of their products in their destination markets and then ensure that their products meet them. They would therefore be unable to carry out in-house conformity assessment effectively. The participation of third-party TIC firms, which do monitor compliance requirements in various markets, can help smaller businesses in ensuring that their products comply with the relevant ones.

[105] McAllister (2012b)
[106] Curtis (2006)
[107] TIC-commissioned survey.

2.2.2 Cost savings

Conformity assessment obviously generates an upfront cost, regardless of whether it is conducted in-house or by a third-party. Whilst costs savings may not be possible at the stage of conformity assessment *per se*, this does not necessarily mean that third-party TIC firms have no role to play in realising cost savings and improving profitability for firms. In their capacity of independently checking products for compliance, quality, safety, and other parameters, their services generate a higher degree of confidence in the final product, as well as reducing the search costs faced by firms. There are costs associated with not using third-parties as well: if the equivalent work is done in-house and the resulting products are less compliant than they would otherwise be with third-party TIC, there are potential consequential costs that will make any savings on conformity assessment a false economy. These points are discussed further below.

Third-party TIC firms are a valuable source of regulatory insight for businesses. Providing clients with the information needed to meet regulatory and other requirements in different markets means that companies can avoid the costs of trial and error with their products as well as the costs associated with collecting that information themselves. This subheading explores these and other potential costs savings that can result from contracting independent TIC services.

Reduced search costs for companies

Whilst consumers benefit from reductions in the costs of identifying safer, effective, higher-quality products, so might companies benefit from the signalling characteristic of independent conformity assessment. Most companies source intermediate inputs from other suppliers along the chain of production for their final products and, in a sense, "consume" the products made further up the supply chain. The knowledge that the products offered by a supplier have been subject to third party conformity assessment with respect to the desired characteristics means that the purchasing business does not need to source this information itself. Having sourced only independently certified intermediate inputs, the business may be able to realise costs savings in not having to verify (independently or in-house) that the inputs meet the desired characteristics at a later stage.

Avoidance of false economies / saving on recalls

It is reported that greater cost savings can be achieved by businesses the earlier in the production chain the conformity assessment is carried out.[108] This is because any serious defects in product design can be identified and resolved before the majority of production expenditure is committed. Early use of testing and other types of conformity assessment can help prevent these defects from being discovered only after having been distributed or sold on the market. Depending on the context, a failure to prevent distribution of a defective product could involve costly product recalls, destruction of property, injuries, and even fatalities. Between 2008 and 2013, for instance, product recalls cost companies a nontrivial 9 per cent of annual revenue on average.[109] The resulting potential impacts on brand reputation and the knock-on effects on demand and revenue can potentially be avoided in some circumstances through the use of third-party conformity assessment. In other words, the perception of a financial saving from *not* contracting independent TIC services may, over a longer time horizon, actually be costly for the business – this is a "false economy".

More generally, third-party TIC can help businesses to avoid false economies at all the stages of bringing a product to market. At the research and development stage in some sectors, TIC firms can work with businesses to generate the initial understanding of the product market and design features.[110] They then certify products and production processes so that they are in-line with their purchasers' expectations.[111] And TIC firms may continue their involvement after a product is released to market in a monitoring and

[108] See, for example, Curtis (2006) and CEOC (2012).
[109] TÜV SÜD (2014)
[110] Notes from interviews with TIC-using companies 1 and 6.
[111] Notes from interviews with TIC-using companies 2, 4, 6 and 8.

surveillance capacity.[112] As a consequence of their involvement, independent TICs can contribute to reduced times to market of new products, assist with opening doors to new markets, and even generate savings on insurance premiums.[113]

Further below, we document an example of third-party TIC helping to open new markets to innovative firms. The example is of the Dutch start-up Mippaa, which won the European Commission's 2019 Product Safety Award for its handrails designed for children to minimise the risk of falls on stairs. Third-party TIC helped with the development of standards for the children's handrail because none existed at the time of the innovation. Mippaa suggests that, without the help of third-party TIC, it would have had to invest time and resources to understand the complex web of legislation and safety requirements, potentially preventing the business from attaining the growth trajectory that it did. The company is now using this initial assistance to help it break into the US market.

Liability and due diligence

Another important false economy that may be avoided is that of the costs of liability should a fault or error emerge in the product. Whilst contracting conformity assessment to third parties does not relieve a business of liability for its products, having contracted for independent conformity assessment to ensure that safety and other requirements have been met before a product is placed on the market demonstrates that the business has taken reasonable care and precautions and performed its due diligence. For example, in US markets the avoidance of litigation and product liability costs is an important driving factor in the use of third-party TIC services.[114] This is because the use of such services provides independent confirmation that the product was found to meet regulatory requirements. Of course, the value of avoiding this particular false economy depends on the laws of the particular jurisdiction.

Specialisation and economies of scale

The previous subheading ("Regulatory compliance") described how the specialisation of independent TIC firms can be an effective way of ensuring regulatory compliance. They commit more resources to updating themselves on regulatory and industry developments and have generated experience in assessing numerous products throughout their lifecycles. The former entails costs that are borne by independent TIC firms, and the latter implies that tacit knowledge of sectors and products has been gained – which would be difficult to obtain without the experience. A fraction of these costs will be passed on to TIC clients as the fee for the services, but this cost will pale in comparison with the alternative of clients' generating this specialised knowledge themselves.

For smaller businesses, the sunk costs borne, and knowledge of requirements amassed, over time by TIC firms may be crucial for reducing threshold costs of production. Establishing a product line, or expanding into a new geographic market, can entail a web of regulatory requirements and industry standards. Becoming informed of them may be costly and meeting them even more so. Third-party conformity assessment services can offer a cost-effective way to comply with such requirements since they have already borne the sunk costs of becoming familiar with them.[115] Some of the large TIC players have a presence in locations across the globe, which can help businesses expanding their geographical scope (through accessing export markets, for example).

[112] Notes from interviews with TIC-using companies 4 and 7.
[113] See, for example, the example of Italy's Workers' Compensation Authority offering discounts of 28% on the cost of insurance premiums for businesses that hold accredited certification to the Health and Safety management systems standard. https://business-benefits.org/case-study/28-insurance-premium-reduction-health-safety-certification/
[114] Notes from interview with TIC-using company 3.
[115] CEOC (2012)

Increasing confidence in suppliers

Businesses may also benefit from third-party TIC services when they serve to reduce the risks faced when making transactions with suppliers. Self-declaration of conformity against the relevant requirements may suffice for certain transactions, where there is a low level of risk associated with noncompliance, for instance.[116] But when large transactions are being carried out, where the risks of making a mistake can be higher, third party TIC firms may provide "unbiased and factual assurances to both parties".[117] As well as facilitating the exchange of products between companies, the use of independent conformity assessment services can reduce the likelihood that unforeseen costs resulting from, say, inconsistencies in a shipment of purchased inputs, will be incurred. For instance, an impact assessment of introducing a large-scale third-party certification regime for security products in Europe identified that users of such products would face less of a need to conduct their own product trials, thus saving these costs. Having a prior independent verification that products meet the relevant performance requirements would free the procurer's staff from being "tied-up in conducting product trials."[118]

Reputation-building

It was previously mentioned that one way in which market participants can gain confidence in a product is for the producer to build its reputation, and that this can be costly and time-consuming. Whilst end-consumers might not always seek out products for the reputation of the brand (and may not always pay attention to market signals such as certifications and labelling), for producers in the supply chain these characteristics can be highly sought-after in their sourced inputs. Reputation can be built through investment in branding and trademarks, and it usually involves the firm simply being established for a sufficient period of time. This reputation-building process is so costly for companies that it can also restrict the entry of new firms to the market and therefore limit the level of competition.[119] The conformity assessment activities offered by third-party TIC firms enables businesses up-stream in the chain of production to develop a trustworthy, reliable, or otherwise quality brand for their inputs without the same level of time and expenditure costs.

Verification of in-house conformity assessment

An important but generally unidentified benefit of independent TIC firms is that they can also assist businesses that perform some of their own conformity assessment in-house. Some businesses that have onsite testing laboratories may be able to test their own products and then contract an independent third-party to evaluate the test results and issue certifications.[120] This model of conformity assessment may be best suited to businesses that keep an especially close guard of their intellectual property, even if maintaining the testing facilities is costly for them. These businesses are also known to approach independent TIC firms for general advice on achieving compliance with the relevant requirements.[121] A mixture of first- and third-party conformity assessment can therefore have its own benefits in certain scenarios.

2.2.3 Enhanced demand

Use of third-party TIC to create a level playing field

Third-party TIC services can create a level playing field for companies through the impact of independent conformity assessment on brand reputation. Use of TIC services to check a product's conformity with regulatory requirements can strengthen public trust in the product and sustain the reputation and brand of

[116] CEOC (2012)
[117] ISO & UNIDO (2010), p. 23
[118] ECORYS (2011)
[119] Frenz and Lambert (2013)
[120] Notes from interview with TIC-using company 2.
[121] Notes from interview with TIC-using company 2.

the company.[122] In subsection 2.1.2, we described how consumers may actively seek out independently certified products for the increased reliability and safety they offer. It therefore follows that the businesses that use third-party TIC will benefit from increased demand for their independently certified products.

A survey conducted by TÜV SÜD found that the presence of product safety certification gives a strong indication of safety to consumers even when they are unfamiliar with the brand. Such certification is considered a key purchase decision factor for 65 percent of surveyed consumers with unfamiliar products, whilst 85 percent stated that safety certifications would have some influence or a big influence on their preference for known brands.[123] This suggests that the majority of consumers can have the same level of confidence in unknown, and potentially new, brands as they have with brands that they know due to conformity assessment. In this way, reliance on independent TIC services can support a level playing field in cases when some local market participants, which enjoy certain built-in advantages, are not utilizing such services.

Use of third-party TIC to enhance product differentiation

Demand for a business's products may be further enhanced by the differentiation between conforming and nonconforming products enabled by TIC services. For example, a business that demonstrates conformity by certifying a product or process in a market of competitors that do not certify theirs gives it a technically differentiated product. Furthermore, it is not necessarily true that this benefit dissipates in the event that many businesses independently certify their products.

In a "perfectly competitive" market, many producers compete in selling an undifferentiated product, which means that if one producer were to raise its price it would cede all its demand to its competitors. On the other hand, a differentiated product has characteristics that mark it as distinct from the rest of the competition, as demonstrated by certification. This enables it to command a higher price *without* necessarily losing all its demand. In the economics jargon, differentiation through certification produces a new demand curve for the differentiated product.[124] This process may have added economic benefits as it creates incentives for firms to invest in the quality of their offerings, which can benefit end-consumers as well as other businesses in the supply chain.

Recognising the gains that can be made from independent third party certification, an increasing number of businesses may choose to certify their products. On the one hand, this eventually may reduce the extent of this benefit. In a market where all products are independently certified to meet certain requirements, the certified product may not be distinguishable on the basis that it is certified. On the other hand, independent conformity assessment may continue to enhance product differentiation as businesses develop new aspects of their products, which can then be certified independently to distinguish the products along different quality or sustainability dimensions, for example.

Use of third-party TIC services to boost consumer demand

A number of studies have investigated the demand-boosting effect for businesses of using third-party conformity assessment services. With innovative products in particular, third-party certification can create incentives for further innovation related investment.[125] One study formally modelled this idea and found that firms can signal their pollution abatement efforts with an independent third-party labelling system and a private standard to voluntarily reduce pollution and attract "green" consumers, which is found to be a profit-maximising strategy.[126] In a critical review of methods of testing against food requirements, another study suggests that third-party food safety audits against established national and international standards is a

[122] CEOC (2012)
[123] TÜV SÜD (2014)
[124] Gonçalves and Peuckert (2011)
[125] Frenz and Lambert (2013)
[126] Kirchhoff (2000)

necessity for the vast majority of firms wanting to continue to sell their products to major retailers.[127] As a consequence, food safety standards that are voluntary become *de facto* mandatory due to strong consumer demand for food products that meet them.[128]

Accreditation of TIC service providers can also increase consumer demand for products, since it enhances trust and confidence in the competence and infrastructure of the conformity assessment provider, as well as its processes and results.[129] A study into accreditation services prepared for the UK's Department of Business, Innovation & Skills produced estimates of the value of accreditation both to TIC firms that receive it and the users of the services of accredited suppliers 'downstream'. The study estimates the value of additional sales of UK conformity assessment businesses that may be attributed to the status of being accredited by the United Kingdom Accreditation Service (UKAS). By asking participating TIC companies if they could quantify the economic value to their businesses of being accredited by UKAS, using the median figure and scaling it based on employment in the sector, the study found the national impact to be £70m per annum.[130] Further, once the study accounted for the full range of conformity assessment services offered by UKAS (e.g., calibration, testing, inspection and certification) as well as the willingness to pay for products that were subject to conformity assessment by accredited TIC firms, the study estimates a total impact of £600m per annum. In other words, whilst conformity assessment is valued by consumers, it is more valued when performed by accredited third-party providers. The conformity assessment process itself may also enable the growth of the firm using conformity assessment through the tacit knowledge transferred during the process.

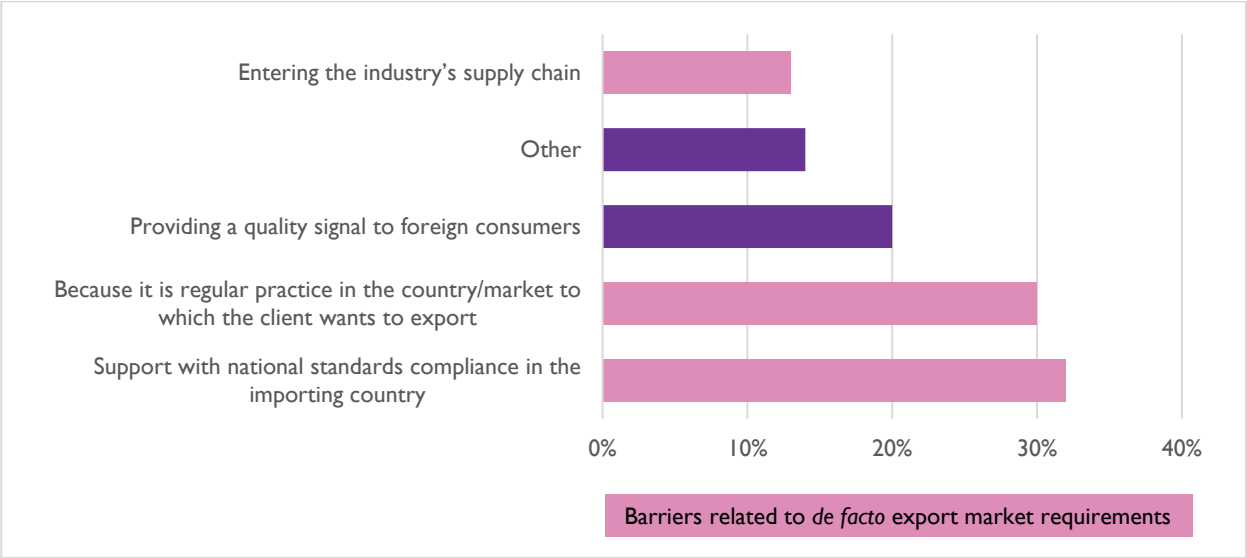
2.2.4 Access to new markets

Independent TIC services are important for businesses because they can enable access to new markets. This is especially true for smaller firms, for whom the potential informational and cost barriers associated with market entry may be too substantial relative to their size. Conformity assessment by third party TIC firms can enable access to new product and geographic markets, assist with the creation of new markets, and contribute to levelling the international playing field for businesses of all sizes.

First, independent conformity assessment can enable a firm's access to overseas markets as well as the markets of other goods and services in the origin country. Responses to a recent survey of independent third-party TIC firms indicated that supporting their clients to overcome obstacles based on specific requirements in export markets was the most important factor when enabling market access for over 70 per cent of the firms.[131] It can be costly for firms to gain market access, especially when the requirements in the destination country are fluid and confusing.[132] Therefore, conformity assessment activities conducted by independent third-party TIC firms is an important mechanism for firms to break into new markets by offering a cost-effective way of understanding the relevant requirements.

[127] Busch (2011)
[128] Powell et al. (2013)
[129] Carnahan and Phelps (2018)
[130] Frenz and Lambert (2013)
[131] TIC-commissioned survey.
[132] See the National Electrical Manufacturers Association's (NEMA) webpage: https://www.nema.org/Technical/The-ABCs-of-Conformity-Assessment/Pages/Conformity-Assessment-and-Market-Access-Consulting-Service.aspx

Figure 4: Of survey responses saying facilitating access to markets is an important factor in contracting TIC services, conformity assessment helps the majority of TIC clients to overcome requirement obstacles.



Source: TIC-commissioned survey.

Second, conformity assessment services assist innovative small firms that are *creating* new markets. This was illustrated – and the subsequent innovative product awarded – at the European Commission's 2019 Product Safety Award.[133] The Dutch start-up Mippaa, which has designed handrails for children to minimise the risk of falls on stairs, had to invent the standards for the children's handrail because none existed at the time of the innovation. The independent TIC firm that Mippaa contracted assisted this process by "looking into everything, including regulations in other countries".[134] The company is now using this initial assistance to help it break into the US market. This reflects the larger point that smaller businesses stand to benefit from third-party TIC services because they can help fill the information void that may exist for such businesses when entering new markets. The following quotation from a technology start-up illustrates this point:

> "For us, the choice when we started was to either produce just for one company and have their people instructing us what standards we needed to follow or to find this out ourselves. We realised soon that we needed to go for the second alternative because in the first alternative we would have become too dependent on just one client. But it was difficult and time consuming for us to learn about all these standards. We are engineers and we don't understand this world. The solution was that we contracted a certification company that would make sure that our products followed all the standards and would help us to fill in all the documents. If we hadn't done that, we would still be a small start-up with five employees and only one customer. Now we have 30 customers and a staff of 30 people."

Source: Interview with TIC-using company.

Third, independent TIC services enhance the ability of smaller firms to compete with larger, international competitors by allowing them to advertise their equivalence in meeting the relevant requirements. In doing so, independent conformity assessment can make products comparable on world markets regardless of production location,[135] which is particularly important for smaller firms in developing countries. It offers a

[133] EC 2019 Product Safety Award page: https://ec.europa.eu/product-safety-award/winners_2019_en.htm
[134] Patrick Degenkamp, founder of Mippaa, in European Commission (2019), pp. 4-5.
[135] CEOC (2012)

declaration of quality and trustworthiness that might otherwise be difficult to garner without years of firm existence and the reputation of a firm crossing multiple borders. The TIC sector can level the playing field on which firms compete internationally.

2.3 Benefits to Policymakers

Policymakers in regulatory bodies and other agencies can benefit from TIC services both directly and as a collateral result of the benefits to other stakeholders. For example, scarce public resources may be saved when the safety or security of products improve. This section describes three key benefits for policymakers of third-party conformity assessment:

1. assistance with designing regulatory and programmatic requirements and policies;
2. ensuring compliance with governmental requirements (and potentially doing so at a lower cost to the taxpayer); and
3. increasing trade.

2.3.1 Assistance with designing regulations and other government programs

An advantage of third-party TIC for policymakers described in a recent survey of regulators is that it can be crucial in designing regulations and other government programs.[136] There are many advantages for policymakers to use conformity assessment approaches in use in the private sector as a basis for regulatory, procurement, and other programmatic requirements, either in whole or in part, where it makes sense to do so after evaluating the relevant criteria. The alternative, creating government-unique approaches, may result in approaches that deviate from relevant international standards, guides, and recommendations in certain contexts, which would increase costs and decrease efficiency in the market.

First, if third party TIC services are working where they are used in the marketplace and the issue is that a small subset of the market is not using such services and placing defective products on the market as a result, a sensible approach could be to require all suppliers to utilize the TIC services that most players are already using and/or increase enforcement and levy penalties so that the rogue suppliers must exit the market. In markets where post-market surveillance and enforcement are suboptimal (e.g., due to a lack of funds), self-declaration of conformity is unlikely to result in a system that adequately safeguards the safety of consumers or incentivizes compliance with requirements. In this case, third-party TIC may offer a viable solution to address the risk of a potentially large number of non-compliant products being placed on the market.

Second, it is less costly for a ministry or agency to incorporate existing conformity assessment practices by reference than to create new procedures from scratch. TIC firms have the technical knowledge and have developed and refined the requisite conformity assessment processes already, so the government should take advantage of that expertise and allow accredited TIC firms to perform the relevant services, where doing so would enable policymakers to achieve their objectives. Using independent TIC firms instead of relying on SDoC may also save public resources from the significant market surveillance obligations that would be required under the SDoC approach.[137]

Third, using existing private sector conformity assessment schemes as the basis for government requirements and other programs will help avoid creation of market distortions. Establishing government-unique conformity assessment requirements in a jurisdiction, which would likely differ in certain respects from relevant international standards, guides, and recommendations could create barriers to entry for foreign companies and also make domestic companies, particularly smaller firms, less competitive internationally.

[136] TIC-commissioned survey.
[137] Department of Labor (US) (2010)

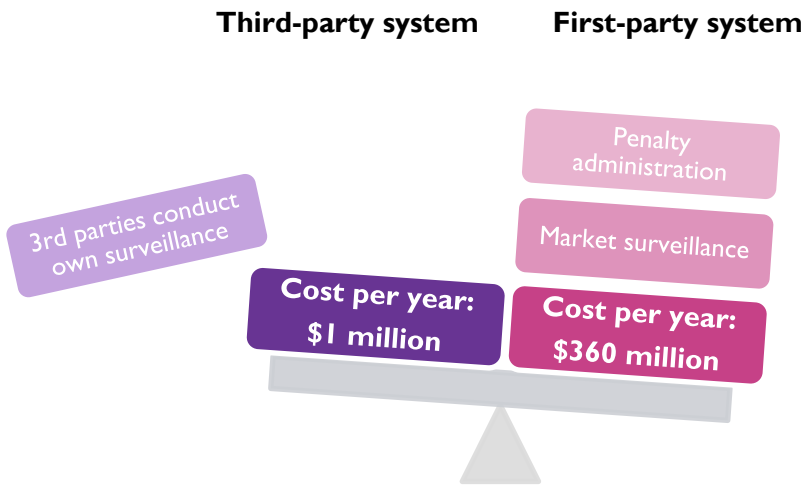
2.3.2 Help to ensure compliance and protect citizens

Conformity assessment activities carried out by the TIC sector can help policymakers to ensure compliance with laws, directives, and regulations, as well as with standards or voluntary government programs that help achieve policy objectives. In the US, reliance on third party conformity assessment providers is sometimes often used by policymakers to provide confidence that requirements in legislation, regulation, policy, and procurement are met.[138]

Importantly, the third-party TIC sector is a driver of compliance when public authorities do not have the resources or necessary competence to carry out the requisite conformity assessment activities.[139] In the US, for instance, certain federal agencies have used private third parties for a number of years to carry out inspections and other types of conformity assessment to help ensure that regulated entities are in compliance with federal requirements.[140] Using the specialisation of expertise from third-parties can make resources available for public authorities to pursue other activities.

In post-market surveillance activities, policymakers may be exposed to further resource constraints. Under an SDoC system, the burden of conducting market surveillance to detect counterfeit certification marks falls on a governmental body. This is not the case in systems that outsource conformity assessment to independent third-party providers, such as the Nationally Recognized Testing Laboratories (NRTL) in the US. The NTRLs are independent laboratories that meet requirements set by the Occupational Safety and Health Administration (OSHA) for performing safety testing and certification of products used in the workplace. Under this system, each NRTL may conduct market surveillance to ensure that manufacturers use only its mark on certified products – in other words, each NRTL is responsible for ensuring the integrity of its mark. A US Department of Labor study in 2008 estimated that implementing an SDoC system in the US could cost OSHA approximately $360m annually compared with the existing budget associated with operating the NRTL Program of $1m per year.[141] Based on this estimate, operating an effective SDoC post-market surveillance system would require OSHA to incur substantial additional costs, thus saving money for the taxpayer under a third-party system.[142]

Figure 5: Comparison of potential costs of conformity assessment systems in the US



[138] Carnahan and Phelps (2018b)
[139] McAllister (2012a); CEOC (2012)
[140] McAllister (2012a)
[141] Department of Labor (US) (2010)
[142] Under a third-party system, TIC firms bear the majority of surveillance costs instead, but arguably this system is more efficient given that the TIC firms have an interest in ensuring the legitimate use of their respective certifications.

Source: Department of Labor (US) (2010). Third-party system refers to the US system of Nationally Recognized Testing Laboratories.

This point can be further understood by contemplating the counterfactual in which the third-party TIC sector is absent. Without sufficient resources to carry out the full range of conformity assessment activities itself, including the post-market surveillance required with a system relying on SDoC, the public sector may be unable to sustain adequate oversight and monitoring of compliance. This could result in the spread of faulty or otherwise noncompliant products in domestic markets from the lack of post-market surveillance and third-party certification that TIC firms can offer, or simply from producers knowing that it is unlikely their products will be checked for conformity. This would increase the need for product monitoring and hence raise the necessary level of public expenditure on conformity assessment, which was the issue to begin with. If left unchecked, this scenario could have damaging consequences for consumers.

The case of federal agencies increasingly relying on TIC activities from independent third parties has been a response to a number of recent challenges facing public authorities, with which independent TIC firms are well-placed to assist. The following box describes these challenges in the US context, but they may be equally important in other jurisdictions.

Box 4: The independent third-party TIC sector helps to conserve public resources and address emerging regulatory challenges in the US: the case of food safety

Federal agency resources can be inadequate to address the increasing number of problems and entities subject to regulation. Some academic scholars have characterised the last few decades as a period of increasing regulatory demands and diminishing public resources. [a,b,c] This has been a particular cause of concern in food regulation. For example, in 2010 the Food and Drug Administration (FDA) managed to inspect only 115,000 (1.2 per cent) of the 9.1m shipments of food imports to the US. [c] The 1,000 FDA inspectors charged with inspecting the 254,000 foreign food facilities and 167,000 domestic food facilities managed to cover only 6 per cent of the total in 2010.[a] Third-party TIC firms may enable a wider coverage of the necessary inspections, which would help with compliance on its own as well as having the effect of encouraging compliance amongst companies that would now see a higher probability of being inspected (a behavioural effect of monitoring).

Sources: [a] McAllister (2012a); [b] McAllister (2012b); [c] Bamberger and Guzman (2010).

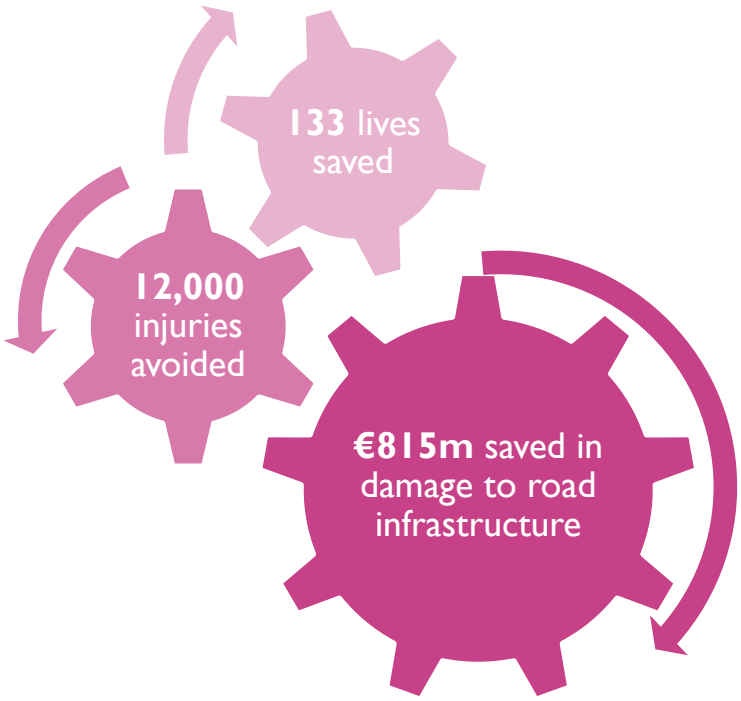
Overall, conformity assessment activities, and those performed by the third-party TIC sector in particular, can contribute to an increased level of compliance across the board, which itself carries many benefits. Businesses that do not comply with standards and regulations can undercut those that do, to the detriment of the latter and the wider public. The businesses that comply may lose sales and resulting revenue, which may eat into government tax revenues, whilst consumers exposed to a higher risk of dangerous and noncompliant products may increase the burden on public health services. As network goods, the value of adopting certain standards increases with the number of businesses adopting them.[143] If the cost of adopting the standard is high, a market may never reach the critical mass of adopters necessary for the benefits of standards to exceed their costs. In instances where third-party TIC firms are able to offer lower cost services, they may help a market to reach this critical mass, at which point the aforementioned wider impacts of noncompliance (consumer exposure to dangerous products and public health burden) are less likely to materialise.

Recent research on the impact of road vehicle testing on the safety of citizens provides an important example of the impact TIC can have. The Motor Vehicles Security Institute in Spain reveals that the ITV vehicle inspection regime (Inspección Técnica de Vehículos) can reduce road mortality and injury and save society nearly €330m in accident costs each year (see 6). ITVs are compulsory in Spain and can be conducted by garages accredited by ENAC (the Spanish Accreditation body). Services provided by these garages were found to have prevented 133 deaths, nearly 12,000 injuries and at least 17,700 traffic accidents per year. By preventing these casualties, vehicle technical inspection entities contribute around €330m to road safety and an overall sum of €815m annually due to reduced losses of value in involved vehicles, goods, and public

[143] Tippmann and Racine (2013)

infrastructure such as roads and roadside furniture. Approximately 406 early deaths caused by exposure to air pollutants per year have also been prevented by these tests.

Figure 6: The Spanish ITV vehicle inspection regime saves the lives of citizens and millions in damage to public infrastructure



Source: Business Benefits (2018)

2.3.3 Enable a level playing field for trade

Trade is important to policymakers for a number of reasons, including by promoting economic growth and job creation. The trade enabling aspect of conformity assessment has long been recognised as one of its main benefits, largely owing to its role of increasing reliance on international standards, guides, and recommendations in global markets. Differences in demonstrating compliance to regulatory requirements across jurisdictions can be a major cost for companies that can even deter market entry for some firms. Governmental use of independent TIC services, as well as the other aspects of national quality infrastructure – standardisation, metrology and accreditation –, can help better align compliance activities in different jurisdictions and reduce the cost and complexity of trade.

When regulatory requirements and standards vary across jurisdictions, conformity assessment provides a method for enabling trade to commence across borders. In such circumstances, a country may decide to unilaterally or mutually recognise the results of certain conformity assessment activities in other jurisdictions. Mutual recognition of conformity assessment bodies and acceptance of conformity assessment results has been used successfully in the telecom sector.[144] Jurisdictions can negotiate 'national treatment' provisions in trade agreements, under which a party agrees to provide conformity assessment bodies in the other party's territory treatment that is no less favourable than the treatment it provides to conformity bodies located in

[144] See, e.g., https://www.nist.gov/mutual-recognition-agreements-mras, for a discussion of the benefits of telecom Mutual Recognition Agreements (MRAs) and a list of the MRAs to which the United States is a party.

its own territory,[145] as well as equivalency agreements (see Box 5). Jurisdictions can also rely on private sector conformity assessment equivalency agreements (e.g., the IECEE CB scheme[146] – see Box 6) and other private sector conformity assessment schemes as a means of facilitating trade by reducing the cost and complexity of obtaining duplicative test reports and certificates and multiple accreditations, respectively.

Box 5: The use of equivalency agreements in the organics sector to enable trade and competition and increase consumer choice

A number of countries have negotiated bilateral equivalency agreements with respect to trade in organics products. Under these agreements, Jurisdiction A recognizes Jurisdiction B's organics standard as equivalent to its own (sometimes with a few exceptions), and vice versa. As a result, Jurisdiction A allows a product of Jurisdiction B that meets Jurisdiction B's organics standard to be placed on Jurisdiction A's market and to affix Jurisdiction A's organics label on the product, and vice versa.

Such equivalency agreements are enabled by governmental designation of independent or governmental TIC service providers that test and certify organic products and inspect organic farms as meeting the relevant national organics standard. Reliance on TIC services provides trust in scheme integrity to the relevant ministries/scheme owners in both jurisdictions, provides consumer confidence in the organics label and increased consumer choice; and ensures a level playing field for organics producers in the market.

Moreover, by eliminating duplicative conformity assessment, such agreements help organics farms export their products by allowing a demonstration of conformity to one organics standard to unlock market access for multiple countries. For example, in its 2020 Industry Survey, the Organic Trade Association (U.S.) found that, since implementation of U.S. organics equivalency agreements, 30 per cent of organics producers indicated that their exports to Canada had increased; 26 per cent indicated that their exports to Europe had increased; 22 per cent indicated that their exports to Japan had increased; and 30 per cent indicated that their exports to Korea had increased.

Box 6: The use of private sector conformity assessment schemes to promote sustainability and enable trade in the electronics sector

EPEAT (Electronic Product Environmental Assessment Tool), a global ecolabel for the information technology (IT) sector, is an example of a private sector conformity assessment scheme that enables trade. The use of EPEAT-registered IT products (e.g., computers and displays, imaging equipment, mobile phones, servers, and TVs) yields significant environmental benefits by reducing solid and hazardous wastes and greenhouse gas emissions.

Under the EPEAT program, which is voluntary, accredited independent third-party certification bodies are recognized by the non-profit Green Electronics Council (GEC) to verify on an ongoing basis claims by suppliers that they meet globally-recognized sustainability standards developed by standards bodies such as UL, IEEE, and NSF. Such standards are developed through a "Dynamic Standards Development Process." The DSDP integrates a "continuous maintenance" process under which sustainability criteria are updated on an iterative basis "to reflect product innovation and purchaser feedback."

According to EPEAT, "public and private entities in more than 42 countries use EPEAT as a uniform purchasing specification." By providing confidence to public and private institutional purchasers of IT equipment -- due in no small part to the rigorous third party verification program -- EPEAT has helped create a global procurement market for sustainable IT products. In doing so, it has also helping to achieve UN SDG Goal 12 to "ensure sustainable consumption and production patterns."

Developing countries, in particular, can benefit from the trade facilitation characteristic of TIC services. In Box 7 below, we have described some of the instances in which third-party TIC can support the development

[145] See, e.g. Article 11.6 of the Chapter on Technical Barriers to Trade in the United States-Canada-Mexico Agreement and Article 8.6 of the Chapter on Technical Barriers to Trade in the Comprehensive and Progressive Agreement for Trans-Pacific Partnership.

[146] See: https://www.iecee.org/about/cb-scheme/

of markets and national economies as noted by interviewees from a consultation carried out by the TIC Council.

Box 7: Benefits of TIC services to developing countries

Developing countries can experience the benefits of the third-party TIC sector to a greater extent than developed countries. In some cases, TIC companies assist with the **design and simplification of national standards** in developing countries. In other cases, developing country public sectors have leveraged the expertise, resources, and cost-efficiency of third-party TIC firms in various areas. For example, the Indian Ministry of Civil Aviation outsources drone certification to an accredited third-party, and its Bureau of Energy Efficiency outsources part of the certification for the Star labelling programme. Public sectors are looking to increasingly collaborate with the third-party TIC sector, because they do not have the capacity to carry out all conformity assessments in a centralised way.

Given the extent to which a system relying on SDoC was expected to vastly increase public expenditure on market surveillance in the US (see Figure 5), the benefit of being able to save public funds with a third-party system is likely to be amplified in countries where public resources are more constrained. The ability to support **surveillance and enforcement capacity** is therefore another area in which the benefits of third-party TIC accruing to jurisdictions are likely to be even greater in developing countries.

Trade, in particular, is a key area where the independent TIC sector plays a central enabling role. Many developing countries have successfully pursued economic growth through exporting products to wealthier countries. And boosting exports can also contribute to improving a country's balance of payments with the rest of the world by influencing the level of net exports (exports less imports), which may be a policy goal. TIC firms can provide expertise to reduce the barriers faced by exporters in foreign markets. In India, for instance, TIC firms are a valuable provider of conformity assessment services for Indian products bound for export. On the import side, developing countries without sufficient resources and the technical skills to check product compliance at the border may require a TIC certification because it is a mark of basic quality. Such requirements can be trade facilitating, provided that a TIC firm or government agency is not given a monopoly over the relevant TIC services by the government.

Third-party conformity assessment can also **improve the trust** in products in contexts where national services are perceived as less reliable. For example, in China consumers and producers are reported to perceive third-party TIC services as a "gold standard" because they are viewed as more accurate and go into greater detail than the public equivalent.

Source: Europe Economics analysis of material commissioned by TIC Council.

3 Discussion of the Benefits

3.1 Rationale for Approach to Measuring Benefits

The previous chapter has indicated the many different ways that the TIC sector can benefit many different types of stakeholders. Quantifying all the benefits is beyond the scope of this paper. Instead, in this chapter we seek to illustrate that these benefits can be material by looking at three case studies and attempting to value some of the benefits that might be attributed to the TIC sector in these examples.

3.1.1 Impact assessments

Our approach is similar conceptually to the methodology that policy makers might use when assessing the likely impact of a proposed new regulation or evaluating how well a policy has worked in practice.[147] We first seek to identify mechanisms through which benefits might accrue because of the contribution of the TIC sector. There will often be a mix of direct and indirect impacts. For example, third-party testing may directly lead to more goods that are compliant being produced and sold, and may indirectly lead to fewer injuries from the sale of the good (the greater share of compliant goods leads to a fall in the number of accidents associated with the good). Having identified the various links in the 'chain of causation', it is possible to estimate the likely magnitude of each link in isolation. For our purposes, it is sufficient to focus on a few of the key chains to demonstrate that the value of the TIC sector is material, far in excess of the costs that might be incurred engaging TIC firms.

A key component of the exercise is identifying the counterfactual. In this case, what would happen or would have happened absent the TIC sector? Valuing a world without the TIC sector is different to valuing the contribution of a single TIC firm. In the latter case, the counterfactual may well involve the use of a rival TIC firm. This may lead to the conclusion that the value of the individual TIC firm is only slightly greater than the price it charges its clients, since we might expect the differences in price and service offering from competing TIC firms to be relatively small. Most customers would switch to a different TIC provider, but otherwise carry on as they were if their current TIC provider ceased to exist.

However, for our purposes we want to consider a counterfactual where the option of employing a different TIC firm does not exist. The options available will include parties conducting the work in-house, be that a producer performing their own self-declaration or a Government setting up its own testing facilities or developing new standards, or potentially foregoing some of the service altogether. An assessment of the net value of the TIC sector versus the counterfactual of no TIC sector therefore will include any cost differences between outsourcing and conducting the work in-house (or relying on a non-TIC outfit to conduct the work), and any benefits foregone that arise because of differences in the quality of service that a non-TIC firm is able to achieve. The latter consideration becomes especially important.

In our three case studies, just assuming modest delays in the time it will take to perform tasks that TIC firms currently assist with can lead to large estimates for the quantum of benefits foregone as a result of no third-party TIC firms. Such an assumption does not seem unreasonable. For example, the typical timeframe for establishing a standard from the first proposal submitted to ISO to the published document is three years.[148] In some cases, it can take much longer. TIC firms are able to call upon the sectoral experience not just of their own experts but of their networks, including industry, NGOs, national standards bodies (NSBs) and

[147] See, for example, the European Commission's "Better Regulation Guidelines" https://ec.europa.eu/info/sites/info/files/better-regulation-guidelines.pdf

[148] ISO (n.d.)

local expertise, in providing relevant input to standards development and, in some cases, driving the work. Absent such support from the TIC sector, it seems reasonable to assume that the publication of standards would be delayed, a key issue in two of our case studies. Our assumption that the development of a standard would have taken one year longer absent TIC sector involvement is further explained in Annex 3.

3.1.2 Choice of case study

Our three case studies relate to deployment of sewerless toilets to improve public health, the security of payment cards, and consumer safety of so-called 'smart products'. We have deliberately chosen three case studies that are very different, reinforcing a key message in our paper that the TIC sector works across a wide array of industries, providing a variety of services all along the supply chain, to the benefit of many different stakeholders. All three examples show how the TIC sector offers much more value than simply testing and/or certifying that a product meets a given standard.

All three case studies illustrate that the TIC sector is likely to remain relevant and important into the future. The sewerless toilets case study is an example of how the sector is contributing towards the realisation of one of the UN's sustainable development goals (SDGs). [Annex 2 sets out examples demonstrating that the sector has a role to play in realising all of the SDGs.] The other two case studies (payment cards and smart products) relate to cybersecurity and the Internet of Things, respectively, both areas expected to grow in the years to come.

3.2 Case Study: Reinventing the Toilet Challenge

3.2.1 Background

As of 2019, two billion people did not have access to basic sanitation facilities such as toilets or latrines.[149] UN Sustainable Development Goal (SDG) target 6.2 calls for adequate and equitable sanitation for all by 2030.[150] Poor sanitation is linked to the transmission of diseases such as cholera, diarrhea, dysentery, hepatitis A, typhoid and polio and exacerbates the stunting of growth.[151] Unsafe sanitation is responsible for approximately 293,000 deaths of children suffering from diarrheal diseases.[152] To tackle the issue, in 2011 the Bill & Melinda Gates Foundation launched the "Reinvent the Toilet" challenge to stimulate innovative approaches to meeting the need for sanitary bathroom facilities across the developing world.

One important element of this drive was the development of a standard for toilets that do not need to be connected to a sewer system: sewer*less* toilets. The hypothesis was that having an internationally-recognised standard that allowed innovative products to be tested and certified against it, would provide confidence to government ministries and other organizations to purchase products that meet the requirements and provide them to those in need, with fewer concerns over safety and operability issues.

The standard that was ultimately published with the critical support of third-party TIC – ISO 30500 (Non-sewered sanitation systems) – seeks to help realise a number of UN SDGs. In addition to encouraging access to proper sanitary facilities in the developing world, with particular attention to women and girls (SDG 6.2), it also helps promote the adequate treatment of wastewater (SDG 6.3) and ensure that sanitary facilities minimise the use of water (SDG 6.4). The box below summarises all the sub-goals that SDG 6 targets.

[149] WHO (2019)
[150] UN Water (n.d.)
[151] WHO (2019)
[152] Dadonaite and Ritchie (2018)

Box 8: Sustainable Development Goal 6 – Clean Water and Sanitation

SDG 6 aims to "ensure availability and sustainable management of water and sanitation for all". It contains six specific targets:

6.1 – By 2030, achieve universal and equitable access to safe and affordable drinking water for all.

6.2 – By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

6.3 – By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

6.4 – By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

6.5 – By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.

6.6 – By 2020, protect and restore water- related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.

These goals recognise the interlinkages of the problems that can result from unsafe sanitation facilities. Cropland the size of Germany is irrigated by mostly untreated urban wastewater, which can reduce agricultural productivity and spread diseases. Poor sanitation is linked to the transmission of diseases such as cholera, diarrhoea, dysentery and others. Besides the devastating health impacts, it also reduces human wellbeing, and social and economic development due to impacts such as anxiety, the risk of sexual assault and lost educational opportunities. And sharing sanitary facilities with other members of the household is damaging for the personal security of women and girls.

SDG 6 is interlinked with other SDGs, including poverty reduction, equality and governance (1, 10, 16), agriculture (2), health (3), education (4), gender (5), energy (7), the economy and infrastructure (8-12), climate change and resilience (13) and the environment (14, 15).

Sources: UN Water (n.d.); UN Water (2016) ; WHO (2019).

3.2.2 The Problem TIC solves

Third-party conformity assessment has played an important role in the reinventing the toilet initiative, both directly and indirectly.

Directly:

- **Efficiencies in developing the standard**. The development of a standard often entails a technical knowledge of the subject area, many years of research, seeking consensus across a range of stakeholders, and international cooperation. So, whilst national governments face the public health problems of lack of sanitation, the Gates Foundation had the vision, the expertise in water, health, and sanitation issues, and the funding and the innovators could generate the inventions, the collaboration of another party was needed to develop the portion of the standard relating to conformity assessment. The input of an experienced TIC firm brought to the table relevant technical expertise and experience and enabled efficiencies that would have been unavailable if policymakers or the Foundation had attempted to develop the standard themselves.
- **Help with establishing a network of conformity assessment bodies.** As well as helping to develop the standard, the TIC firm is helping to ensure a network of testing facilities are in place in China and other jurisdictions. Demonstrating conformity to the standard requires a variety of different tests that no one organization can conduct; consequently, a network of laboratories will be needed. As with

developing the standard, the input of an experienced TIC firm was indispensable in aiding the process of establishing a conformity assessment network and in foreseeing that creating a network was necessary.

Indirectly:

- **Stimulating the market.** Without an internationally recognised standard for sewerless toilets, demand for such products may have been muted considerably as would-be buyers, including governments and development organisations, may have felt they had insufficient information on which to make a purchase. Simultaneously, the anticipated problems convincing buyers to purchase the product may deter parties from attempting to develop and supply a sewerless toilet. The third-party TIC's help developing a standard is an important enabler for a market to exist. On the demand-side, parties now have the ability to commission the deployment of sewerless toilets that consistently meet agreed operational requirements. This expected demand should encourage entrepreneurs that there is a promising market opportunity. The standard serves a purpose even if no toilets fully meet all the requirements of the standard, since it serves as a benchmark and allows sellers to set out the extent to which their current products fall short of the standard and for buyers to make informed decisions.
- **Reducing the risk of disease**. The consequence of the above impacts – the efficient introduction and development of a standard and the enabling environment this creates for commercial opportunities – holds out the prospect of material improvements in the lives of users, reducing the risk and spread of disease, as well as protecting the environment.

3.2.3 Counterfactual

In this case study, it is unlikely that the Reinventing the Toilet Challenge would have not strived to achieve its goals absent the support of TIC. Nevertheless, all stakeholders would likely have suffered adverse consequences.

- **Efficiencies in developing the standard.** The use of third-party TIC services saves time and money in trying to develop a standard and get it adopted. Given the assumed counterfactual that it would have taken longer to get to a final workable standard, but one would have been adopted eventually, then ideally we would quantify the cost savings that may have been experienced by the Gates Foundation. This can be explored by understanding the work that went into the standard's development, and discussing whether another actor could have done the same (and in the same time).
- **Stimulating the market.** In this case, the standard created a market that producers could confidently develop/sell products into, potentially earlier than would otherwise have been the case. We analyse what the market for sewerless toilets may look like with a conservative one-year delay in getting the standard published (which assumes that no TIC firm had been involved in its development).
- **Reducing the risk of disease**. Having a standard that produces confidence in innovative sewerless toilets, a market with promising opportunities for their deployment – and potentially having both of these just a year earlier – may contribute greatly to reducing the risk of disease faced by millions globally. Assuming that the goals of the Reinventing the Toilet challenge are ultimately realised and sewerless toilets are accessible to many people, there should be consequent significant reductions in the prevalence of disease and its associated costs. These anticipated benefits can be indirectly attributed to the TIC sector to the extent that its involvement has brought forward the date when end-users had access to a sewerless toilet. As above, we assume that there would have been a one-year delay in roll-out absent TIC-sector involvement.[153]

[153] This estimate is also conservative in the sense that, absent TIC firm involvement, there was a much greater likelihood that the resulting standard would not have contained conformity assessment procedures or the conformity assessment procedures contained in the standard would have been unworkable or biased (whether inadvertently or

3.2.4 Quantifying the Benefits

Efficiencies in developing the standard

In 2015, the Bill & Melinda Gates Foundation contracted a TIC firm to help develop and establish an international standard for safe and sustainable sanitation technologies for use by vulnerable people in the developing world, with a focus on non-sewered sanitation systems as part of the "Reinvent the Toilet" initiative. To kickstart the project, the TIC firm initially developed a private technical standard in collaboration with a selected group of experts. Its Water Services-Sanitation team had a number of advantages that would be hard to replicate outside the TIC sector. It routinely applies interdisciplinary knowledge and international experience to ensure the safety and reliability of innovative technologies and solutions through testing, inspection, and certification. In its work, it also regularly engages with all the key stakeholders, providing services to support governments, standards developing organisations, investors, development organizations, manufacturers, and owners of manufacturing facilities.

This experience provided a clear advantage for navigating the route to developing an international standard. Any draft standard submitted to ISO needs to demonstrate that it meets a market need within a specific area.[154] It is then shared for comment, discussion, and revisions among ISO members, and finally a vote is taken to generate a consensus opinion that the draft is suitable for development into a full ISO standard.

The private technical standard developed by the TIC firm was used as the basis for an ISO International Workshop Agreement document (IWA 24:2016, published on 1 September 2016).[155] The ISO IWA 24 followed soon after the establishment of an ISO Project Committee (number 305), put together by the TIC firm and national standards bodies in May 2016, which was due to convene for the first time in October 2016. The Committee's mission was to support the development of an international standard for sustainable non-sewered sanitation systems and aimed to consider systems that would cost less than $0.05 per user per day.[156] The American National Standards Institute (ANSI) published a call in September 2016 to encourage further global participation in the Committee.[157] By the time the standard was published, Committee 305 comprised 31 participating member countries and 16 observers.[158]

Over the following year, the TIC firm assembled an Expert Advisory Group (EAG) to accompany the standard-writing process through active review and content contribution. The first EAG meeting convened in Singapore in March 2017.[159] With further support from the Association Sénégalaise de Normalisation (ASN) and the Gates Foundation as the Chair of ISO Project Committee 305, the effort succeeded when IWA 24 became an ISO standard (30500) in October 2018.[160]

The size of the grant provided by the Foundation to the TIC firm was $2,983,348.[161] Whilst this is a nontrivial sum, it is likely small relative to what it would cost to replicate this effort if building one from scratch (i.e., without assistance from a TIC service provider). There is a lot of accumulated and relevant experience that a TIC firm would have acquired over many years of work in the field of conformity assessment in general and with regard to water and sanitation specifically. Given the project's global scope, the firm was able to call on its international network of specialists to assist in the standard-writing process and help lead the work in

deliberately) towards one technology solution over others. Both of those outcomes would have made it difficult, if not impossible, for companies to demonstrate compliance, which would have required the standard to be revised, further delaying the timeline.

[154] ISO (n.d.)
[155] ISO (2016)
[156] Engineering for Change (2017)
[157] SuSanA (2016)
[158] STeP (n.d.)
[159] SuSanA (2017)
[160] ISO 30500 (2018)
[161] SuSanA (2018)

Committee 305. In other words, a government department, non-governmental organisation or other entity without TIC firm's experience would have carried out the same project probably at a cost many orders of magnitude higher.

The TIC firm continues to assist the drive to meet UN SDG Goal 6.2. In August 2020, it successfully contributed to the publication of ISO 31800 for community scale non-sewered sanitation systems.[162]

Stimulating the market

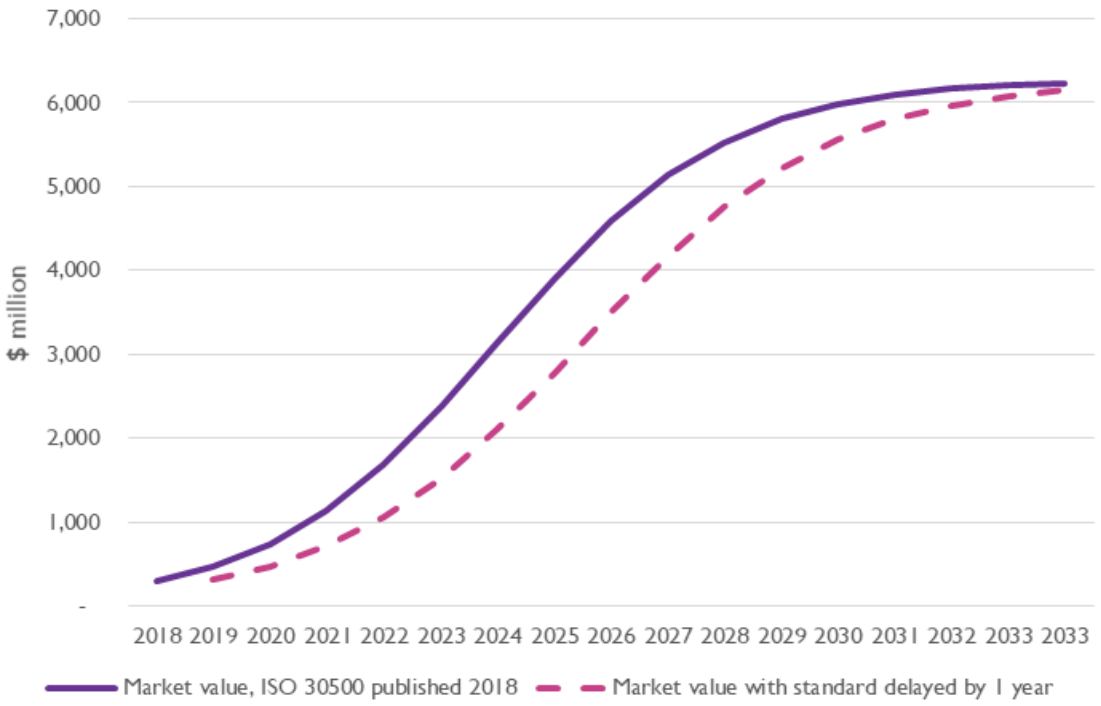
The Gates Foundation's motivation in funding efforts to develop an international standard was the belief that its contribution would help to realise economies of scale. The goal was to have affordable sewerless toilets deployed throughout the developing world. Having a standard would help to generate confidence and trust on the part of would-be suppliers and purchasers. Suppliers able to develop products that met the standard, or most elements of it, could have more confidence that they would be able to market the product globally. Purchasers would be more willing to purchase products they knew met important sanitary, noise, and environmental standards, and could make informed decisions about products on the market. The help a TIC firm has provided establishing conformity assessment procedures and ensuring a network of testing facilities are in place is also significant in helping to develop the market for sewerless toilets. The standard's usefulness would be seriously undermined if the capacity to demonstrate that products conformed to the standard were not in place.

In 2018, the Gates Foundation's Reinvented Toilet Expo was launched, showcasing 11 designs produced by entrepreneurs and researchers. By this time, the Foundation's portfolio of investments included 20 reinvented toilet and omni-processor technologies and products that were available for commercial licencing and production. Many of these products and technologies were expected to be able to meet the recently published ISO 30500.[163] As a result of these developments, the reinvented toilet market is conservatively estimated to become a market of $6.1bn in terms of global annual revenue by 2030, including $0.5bn in Africa and $1.1bn in South Asia.[164] And the market is not just confined to developing economies. There is an expectation that there will be demand from mature economies, for example to meet environmental goals or to be used in locations such as road-side rest stops or camping sites where access to sewage systems may be expensive.

We assume that absent the TIC sector, development of the standard would have been pushed back at least a year, with a corresponding delay in the time-to-market of products that meet the standard.[165] Assuming that the standard helps realise UN SDG 6.2, this could represent significant foregone market revenues each year out to 2030 (the target date for achieving the SDGs). This is illustrated in the stylised chart below, where we assume an S-shaped adoption of the new toilets. In the early years, relatively few early adopters purchase such facilities, but interest grows rapidly in the middle years such that by 2030 the full market size of $6.1bn is realised. If the standard had been adopted a year later, the roll out of the product into the market is similarly assumed to be delayed a year.[166] An innovator who might have pitched the product to a development organisation in 2018 might have missed out on the commission because of prevailing uncertainty about the consistency of its safety and operability. And some innovators may have chosen not to enter the market at all because of that uncertainty.

[162] ISO 31800 (2020)
[163] Bill & Melinda Gates Foundation (2018)
[164] Bill & Melinda Gates Foundation (2017)
[165] Refer to the methodological appendix for a discussion of the choice of the one-year delay.
[166] Based on the expectation of Boston Consulting Group (2018) that in 2018 there were a number of promising opportunities for the early adoption phase of sewerless toilets across the globe. We assume that the standard 'sparks' the growth of the market to reach the $6.1bn valuation in 2030.

Figure 7: Stylised development of sewerless toilets to 2030, with ISO 30500 published in 2018 (actual) and in 2019 (counterfactual delay by one year).



Within this framework, the conservative one-year delay equates to economic activity in the market that is $1.4bn less out to 2025 than it might be given the ISO standard's publication in 2018. This is a significant amount of economic activity, with the associated lost profits and fewer jobs. Of course, much of the activity is deferred rather than lost in the counterfactual, so valuing it would depend on the discount factor adopted. Moreover, we might expect that some of the economic activity that might have been associated with earlier adoption of sewerless toilets would instead have been employed in other sectors of the economy (and to the extent that activity associated with building and installing such facilities occurs in developing economies with high levels of unemployment, the gains from bringing forward economic activity may be greater).

Reducing the risk of disease

The most important indirect effect of the efficiency with which the standard was developed is the potential for reducing the risk of disease to women, men, and children from poor sanitation. ISO 30500 sets safety and performance requirements for sewerless sanitation systems, whilst also ensuring that those tested and certified against its criteria are compatible with public health and environmental protection goals.[167] This reduces the search costs for governments and other organisations aiming to deploy non-sewered sanitation systems, potentially reducing the time before people can benefit from having access to safer, cleaner, and environment-friendly sanitation. The end result is that the risks of diseases to vulnerable populations from open-air defecation and the issues of untreated household wastewater may fall and thereby contribute to realising SDG 6.2. Delays in developing the ISO 30500 standard would have pushed back the dates when these benefits are realised.

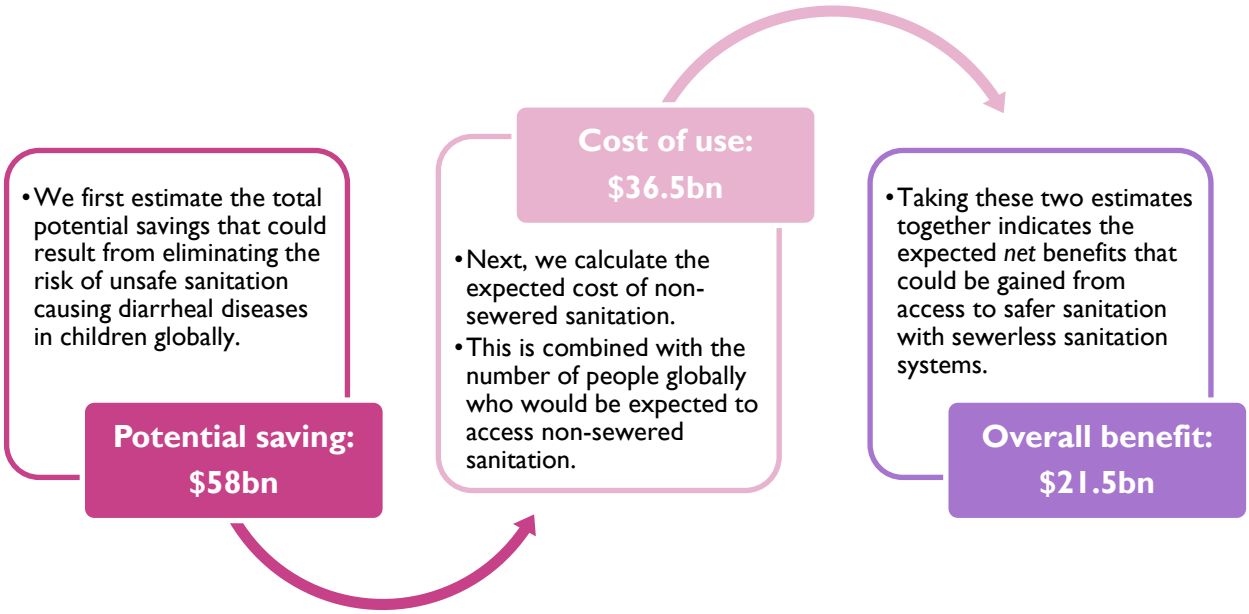
The costs of treating the diseases that can spread as a result of poor sanitation is estimated to account for significant sums in lower- and middle-income countries. As an example, poor sanitation costs the equivalent of 6.3 per cent of GDP in Bangladesh, 7.2 per cent in Cambodia, 6.4 per cent in India, 2.4 per cent in Niger, and 3.9 per cent in Pakistan annually.[168] A World Health Organization study in 2012 for the Millennium

[167] ISO (2018)
[168] ISO (2018b)

Development Goals mission calculated that for every $1.00 invested in sanitation, there was a return of $5.50 in lower health costs, more productivity, and fewer premature deaths.[169] The return varies significantly: the same $1 would yield as much as $7.30 in benefits in Latin America and the Caribbean and $8 in benefits in East Asia.

Just focusing on the benefits from reducing the spread of diarrheal diseases, we estimate significant annual savings that could be realised from access to better sanitation. Our conservative estimate of **$21.5bn** is based solely on the prevalence of diarrheal diseases in children globally. We ignore the prevalence of diarrheal diseases in adults and all the other health problems associated with poor sanitation. Our calculation is described in the figure below. We control for the fact that poor sanitation is only one of the causes for diarrheal diseases in children, with unsafe water and stunted growth from undernutrition (child growth failure) being other major contributors.[170] For illustration purposes, we assume that having access to reinvented toilets eliminates poor sanitation as a risk factor contributing to diarrheal cases in children.

Figure 8: Estimating net annual savings to uses of reinvented toilets from lower risk of diarrheal death in children



Europe Economics analysis.

3.2.5 Lessons learned

The estimated value of rolling out sewerless toilets one year earlier includes realising a net benefit of $21.5bn just from eliminating a year's worth of childhood diarrheal cases, if the project succeeds in providing clean sanitation to the global population. This benefit is huge relative to the cost of engaging with the TIC sector. Moreover, we have not quantified the indirect benefits associated with tackling other health and safety

[169] WHO (2012)
[170] Dadonaite and Ritchie (2018)

problems associated with poor sanitation, nor have we quantified the environmental benefits, the benefits to adults, or the number of children's lives saved.[171]

Even if we had assumed that the TIC sector only brought forward the roll-out of sewerless toilets by one month, we would have an estimate of benefits in the billions. The indirect benefits that might be attributed to the TIC sector would be large even if we assume a more modest take-up of sewerless toilets and that they are less effective in tackling diseases associated with poor sanitation.

Third-party TIC firms can generate large benefits even without testing and certifying products, as this example illustrates. The development of a standard can play a critical role in stimulating a market for innovative solutions. Third-party TIC firms have the expertise and experience to help ensure that such standards are developed and published efficiently, technically sound, performance-based, and capable of being implemented. They can also foresee what needs to be done on roll-out and help with ensuring that processes and infrastructures are in place to test and certify products to demonstrate that they conform to the standard so as to avoid delays in placing new products on the market. Finally, the combination of an international standard and the expertise of the TIC sector creates the trust and confidence that is necessary to create a new market and stimulate demand for an important public good.

3.3 Case Study: Cybersecurity and Payment Cards

3.3.1 Description

Innovations in the payments industry have accelerated in recent years. The first credit-card terminal was introduced by Visa in 1979, yet just forty years later many people use neither cash nor cheques to make payments. Instead digital payments have evolved, with concepts like m-payments, e-wallets and cryptocurrencies.

Many of the more popular payment systems rely on chip-based solutions, whether that is a Smart Card or a chip embedded in a mobile handset. The TIC sector can test and certify that chips comply with functional and interoperability specifications and meet a well-defined conformity assessment scheme that includes security evaluations against malicious operations. For products that have become standardised, the demand for TIC services will be 'commoditised' as vendors will know what is needed to manufacture a secure product. However, when there are innovations in the payments industry, the demand for specialised TIC services can be high as the challenges of understanding what security risks the new innovation poses – both now and over time – and how those risks might be assessed become critically important.

One example of an innovation in the payments sector where the TIC sector has been involved is the transition to EMV chip payment cards from ones using magnetic stripes. The EMV standard was created by three companies (Europay, Mastercard and Visa) in the 1990s. It is now managed by EMVCo, a consortium that also includes Discover, JCB and China UnionPay. By 2016 EMV cards accounted for more than half of all card-present transactions globally.[172] The cards are credited with reducing certain forms of payment fraud globally.

EMV integrates a computer chip into the payment card, and transactions using EMV commonly require the use of a PIN for additional security. The chip-based, or "smartcard", technology means that each card is capable of carrying data which constantly changes, thus making it more difficult for criminals to clone. The

[171] The calculation uses the proportion of diarrheal deaths in children attributed to unsafe sanitation to proxy for the proportion of child diarrheal cases caused by unsafe sanitation. It does not directly estimate the number of lives that could be saved.

[172] EMVCo (2017)

EMV developers established a standard with multiple sets of specifications which can be used by manufacturers to demonstrate that their products are EMV compliant. These specifications are highly configurable, allowing a range of card authentication mechanisms, cardholder verification methods and transaction types.[173]

With chip-based EMV payment methods becoming the norm (if it is not already in some places), manufacturers must demonstrate that their products continue to meet the specifications of the EMV standard as criminal methods evolve. It is now relatively commonplace for third-party TIC firms to have developed the requisite testing facilities and accreditation in the time since the first EMV specifications were published in 1996.

The EMV Specifications set out data formats and protocols for the interaction between a smartcard and a payment terminal and the certification process involves three levels.[174] The first level certifies the hardware (such as the payment terminal); the second certifies the software; and the third involves testing against brand-specific criteria set by the established payment organisations that maintain the standard (Visa, Mastercard, JCB, etc.). Many third-party TIC firms are accredited to conduct such security evaluations of smartcards.

Tests can be performed by TIC firms at the pre-certification stage to ensure that the manufacturer's product performs as intended. This reduces the risk that the manufacturer pays for EMV certification and receives a negative result, incurring losses in terms of time and resources. TIC firms may also offer products that streamline the certification process by simulating test cases. Third-party testing facilities therefore offer manufacturers a less costly means of speeding up the adoption of secure EMV payment cards globally, which could entail some dramatic reductions in the prevalence of card fraud as illustrated by what could happen without such adoption.

3.3.2 The Problem TIC solves

The involvement of third-party TIC firms arguably solves two problems. First, TIC service providers help overcome problems of trust that are especially important in a sector such as payments. Payment systems are notable examples of the two-sided network effect: the more merchants accept a given payment type, the more consumers are likely to adopt that payment type, and the more likely consumers are to pay with a given payment type, the more likely it is that merchants will accept that payment type. A payments system operator cannot afford to develop a reputation for offering a system that is not secure or operable if it wants to encourage both users and merchants to adopt its payment system. This means that providers need to demonstrate that their products are secure and operable.

Secondly, the use of new technologies to make payments creates challenges for firms producing the new technologies and for payment systems operators. Companies used to producing chips for mobile telephones, for example, may not be familiar with all the security threats that need to be addressed in a payment system, whereas parties in the payments industry may have little familiarity with all the security issues associated with mobile devices. This asymmetry of information is likely to be greatest in periods when new and especially innovative products are being developed, the sorts of innovations that offer the greatest potential upside. TIC firms can bridge this divide, drawing on their experience accumulated advising both the payments industry and technology providers in other sectors. More generally, they can draw on experience learned from conformity assessment work on chips in other sectors, such as national ID cards, where they are accustomed to working on security issues assuming (i) attackers with potentially unlimited resources and (ii) the need to ensure system security over long periods of time as technology and threats evolve. The cost of replicating this experience in-house may be prohibitive.

[173] Van den Breekel et al. (2016)
[174] Burnette (n.d.)

3.3.3 Counterfactual

In a world without third-party TIC, where individual companies carry out their own conformity assessments, there are a variety of different outcomes that might arise. In the worst-case scenario, the innovation may never come into fruition as payments-systems operators are risk averse and conclude that there are unknown risks that will be too expensive to resolve and the costs of failure too high, while developers conclude that their efforts are better spent trying to offer products into a different market. Alternatively, it may be that in-house conformity assessment is done, but it takes longer with consequent delays in the product entering the market.

It is also possible that the conformity assessment is inferior and results in less effective security designs, in the sense that it does not check for compliance with standards that have been developed in other cyber-security settings. Conformity assessment does not entail statements that this product is secure, since that is not verifiable (except in the negative sense of finding a breach). Instead, the assessment is to establish whether the chip meets provable standards. Some of the standards that have to be met will differ depending on the product, since the appropriate level of security will vary by product and in some cases the cost of testing and certifying to certain standards would be disproportionate. These standards will evolve over time, to reflect a mix of newly identified security risks and advances in the state-of-the-art for cybersecurity testing. It is likely that in a counterfactual without TIC firms with substantial cybersecurity expertise and experience, the standards will be updated more slowly, since lessons from the payments sector and other settings will not be learned, compiled, and implemented as rapidly. In-house conformity assessment teams are less likely to know about relevant developments in other sectors. It is likely that in this case confidence in new products will be reduced, and there is an increased risk that security breaches will arise that result in substantial detriment to consumers, retailers, and the payment sector.

We do not take a definitive position on whether and how the adoption of EMV-cards may have evolved absent the TIC sector. Instead, we generate estimates that allow the reader to form their own view depending on which of these scenarios they consider most likely.

3.3.4 Quantifying the Benefits

This case study, which involves transition to EMV chip payment cards from ones using magnetic stripes, gives rise to most of the benefits of the TIC sector discussed in the preceding chapter, as set out in the table below. We focus on three areas. First, the potential direct benefits to producers of lower conformity assessment costs, which presupposes that the worst-case scenario of no EMV cards is avoided. Then we look at two indirect benefits – reduced incidences of fraud and product recalls – from the TIC sector's conformity assessment work relating to EMV cards.

Table 3: Benefits of the TIC sector to stakeholders in the Card Payments Industry

Benefits mentioned in Chapter 2	How the case study illustrates the benefit
	TIC services lower risks of fraud, financial theft, identity theft.
	Assisting alternative payment option providers overcome cybersecurity hurdles may offer consumers more cost-effective means of transferring money abroad and domestically. Helping to level the playing field for start-up firms can in turn help to challenge incumbent payment providers, whose prices may fall as a result.
	TIC firms help ensure that alternative payment methods meet stringent requirements set by regulators and payment systems.
	Businesses are able to focus on their core business without the need to devote resources to costly and time-consuming testing regimes. Based on interviews with TIC firms involved in this field, it is understood that for

	mobile payment providers, their core business typically concerns other technologies, where payment services are a supplementary addition to the capabilities of their technologies. So outsourcing payment cybersecurity work could be more cost-effective than gaining the experience themselves.
	TIC firms may offer smaller, start-up firms the credibility their payment methods require to meet consumers' and regulators' expectations.
	The case of mobile payment option providers suggests that TIC can help other firms to expand into horizontal markets.
	Extensive prior experience of TIC firms makes them well-placed to collaborate with public administrators to maximise the cybersecurity of payment systems. They can help set the cybersecurity requirements that must be met by vendors through participation in relevant standards development activities.
	Cards that meet stringent cybersecurity requirements may reduce the risk of card forgery and financial and identity theft.
	By offering consumers more cost-effective means of transferring money, TIC firms bolster international trade, as well as in-country economic activity.

Economies of scale brought by third-party TIC firms

As we have discussed, payment option providers need to convince the established payment organisations that their services comply with the security and operability requirements of those organisations, including relevant standards, and any applicable legal requirements. Many third-party TIC firms operate laboratories recognised and accredited by the main payment facilitators (Visa, Mastercard, American Express, EMVCo, etc.). Their EMV certification experience means they can also offer independent evaluations at the earliest stages of product development to manufacturers wishing to understand the level of security demonstrated by their products before they are sent for the necessary EMVCo and Common Criteria certification.[175] This speeds up the certification process, as does related project management and preparation of the necessary documentation by TIC firms. There are arguments to be made that TIC firms can provide these services at a lower cost than if they were performed in-house with a better result that is obtained more efficiently.

Recently, third-party TIC firms have been assisting innovative mobile payment providers meet the cybersecurity specifications of international payment organisations such as Visa and Mastercard. In this instance, where TIC firms are helping a new product become adopted, the mobile firms may be less informed about the security needs in the payments sector, and the payments firms may be less familiar with the security gaps associated with mobiles. Experienced TIC firms can bridge those knowledge gaps across sectors. Whilst such firms cannot guarantee the absolute impenetrability of the payment services they test and certify, they provide vendors with provable statements. Over time, the nature of those statements evolves as (a) the state of technology changes and (b) the relative importance of different risks change (e.g., if card cloning becomes a major issue, purchasers will place more value on statements that give some idea of how secure the item is against that form of attack).

The high level of sophistication needed to understand the vulnerabilities of a payment system can be hard to obtain, whilst established independent TIC firms will often have more knowledge about potential security risks than the vendor. A company bent on bypassing the TIC sector altogether would need to incur the costs of constructing in-house testing facilities, understanding the specifications of the EMV (for contact smartcards, they cover four complete books)[176] and receiving recognition from the major payment organisations.

[175] See, for example, Applus+'s website: https://www.appluslaboratories.com/global/en/what-we-do/service-sheet/emvco-certification

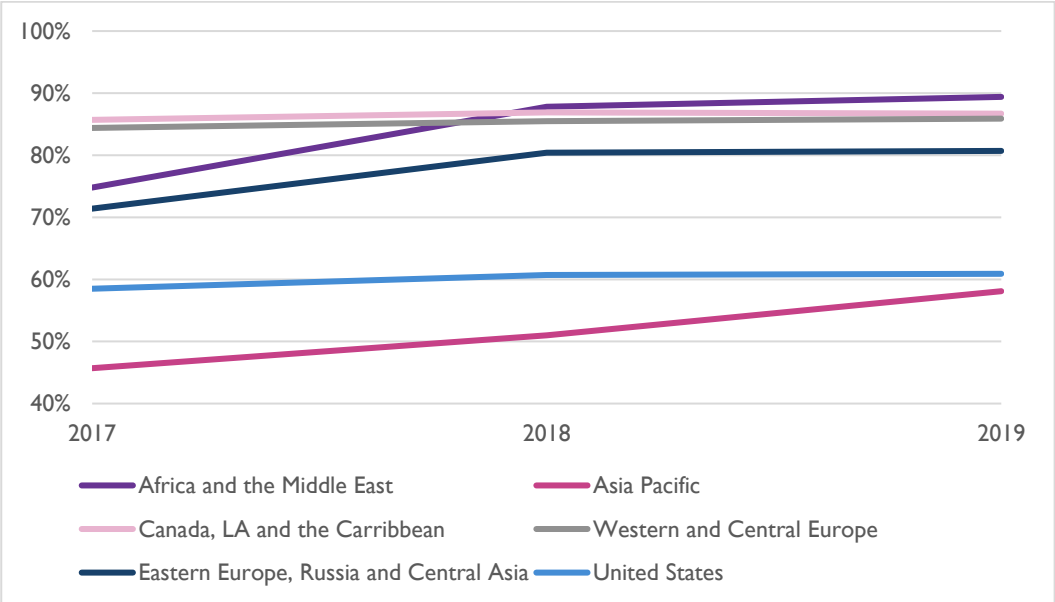
[176] Van den Breekel et al. (2016)

Given the life of payment cards, certifying that one is secure is a commitment that it is secure against attack today and over the next few years. Therefore, there is a need for the tester of a new payment product to be at the technical frontier to remain ahead of the attacker. The cost of acquiring the knowledge to do the testing may be many times higher than the cost of actually testing a vendor's chip once that knowledge is in place. Now that EMV testing is a routine operation performed by many TIC firms, the element of learning and the tacit knowledge acquired in the testing process is incalculable. However, such learning has led to innovations that generate efficiencies in the testing process and reduce the overall costs of a smartcard becoming certified. Such innovations are only possible with the knowledge gained of the relevant regulations, standards, and certification requirements but also the details of the tests that a manufacturer is most interested in. The users of payment card conformity assessment services therefore benefit from the experience accumulated by TIC firms over many years of performing these kinds of tests in different contexts.

Lower rates of fraud

EMV cards, and the additional security they offer over the previous generation of magnetic stripe cards, have been enthusiastically adopted by much of the world. In 2019, these cards accounted for more than 90 per cent of card-present transactions in Africa, the Middle East, Canada, Latin America and the Caribbean, Europe, Russia and Central Asia.[177] The US payment industry did not begin migrating to EMV technology until 2015,[178] and its EMV adoption rate has lagged behind that of other regions (only 63 per cent of card-present transactions were with EMV). The figure below shows that the adoption of EMV-secure cards in the US has just recently surpassed 60 per cent, whilst in many other developed regions the rate is closer to 90 per cent.

Figure 9: EMV chip card adoption rates



Source: EMV adoption rates and numbers of EMV cards from EMVCo "Worldwide EMV® Deployment Statistics". Based on stats reported in Q4 of each year by American Express, Discover, JCB, Mastercard, UnionPay and Visa.

A large volume of research has demonstrated that the US's slow adoption of EMV cards and the additional security layers offered by associated security infrastructure (e.g. PINs) have kept rates of card fraud high. As recently as 2016, the vast majority of credit card chip transactions and some debit card chip transactions in the US were made with no card verification or a weak card verification method, such as a signature.[179] In late 2019, 77 per cent of US merchants reported that they had experienced some type of card fraud and that

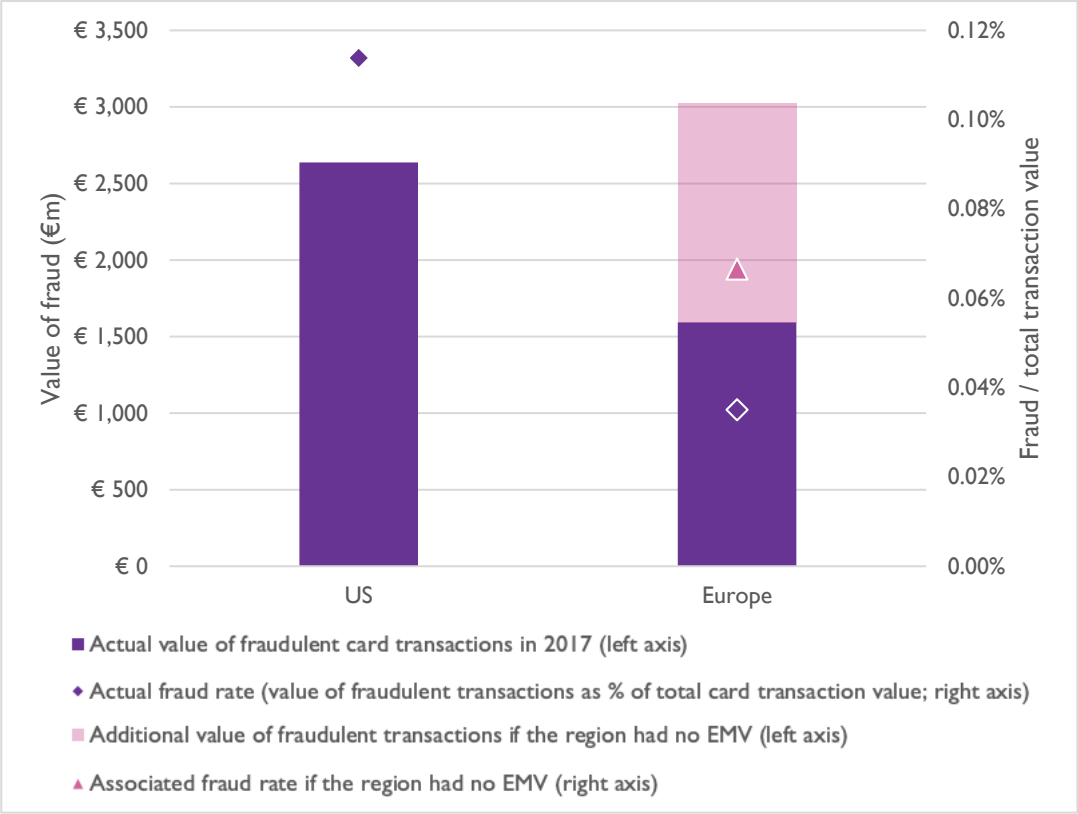
[177] EMVCo (n.d.), Worldwide EMV® Deployment Statistics
[178] Hayashi (2019)
[179] Hayashi (2019)

their efforts to mitigate it had impacted profitability.[180] In contrast, the UK's introduction of chip and PIN technology in 2004 was associated with a 13 per cent drop in financial losses due to the fraudulent use of credit and debit cards.[181] The loss from skimming fraud in the Netherlands declined from its peak of €39m when EMV was rolled-out in 2011 to €1.7m by 2015.[182] There were more than seven fraudulent transactions for every 10,000 transactions in the US in 2017 (the most recent year for which data are available) in comparison with Europe's two.[183]

What might have happened to the prevalence of payment card fraud if we supposed that Europe, with its relatively high level of EMV adoption and relatively low fraud rates, were to be without EMV cards? Since smart cards were rolled out in European counties at different times between the late 1980s and the early 2000s, data are not available to observe a Europe-level fraud rate prior to EMV. It is more feasible to construct a counterfactual "no-EMV" scenario from a region where data are available on the pre-EMV situation. According to the Federal Reserve Bank of Atlanta, the first EMV card was issued in the US in October 2010. For the counterfactual scenario, we use data for the US to calculate a fraud rate (defined as the value of fraudulent transactions relative to the value of all card transactions in the area) equal to the average rate experienced in the US in the five years preceding 2010 – 0.066 per cent.[184] Applying this to the value of card transactions in Europe in 2017, the value of fraudulent transactions increases from €1.6bn (observed[185]) to above €3bn. In other words, the high prevalence of EMV cards in Europe averted approximately €1.4bn in fraudulent activity in 2017. The chart below shows how the prevalence of fraud at this level would compare with the observed level in the US in 2017.

[180] Pike (2020)
[181] Pike (2020)
[182] Van den Breekel et al. (2016)
[183] Data used are from the Board of Governors of the Federal Reserve System (2018) and from the ECB (2020).
[184] This corresponds to the average fraud rate on bankcards in the US. The US does not have a single entity that collects and reports comprehensive card fraud data, making this kind of analysis sensitive to the type of card with which fraud rates are calculated. We have chosen bankcards since they accounted for a large proportion of MasterCard and Visa-branded consumer and commercial credit cards issued by financial institutions. The fraud rate associated with debit card transactions is closely aligned with the fraud rate of bankcards. See King (2012).
[185] ECB (2020)

Figure 10: Estimated increase in the prevalence of fraud in Europe in 2017 if the region did not have EMV cards

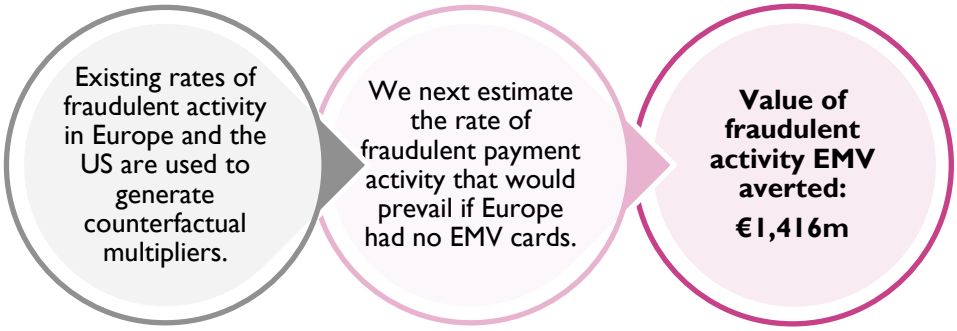


The chart uses data on the volume of all card fraud activity in the Single Euro Payments Area (SEPA) in Europe (ECB data) and debit card fraud in the US (Board of Governors of the Federal Reserve System data). The fraud rate assuming no EMV cards are present in Europe is obtained from the prevalence of fraud in bankcards in the US (0.066%)[186], rather than the rate that would be obtained from the data on debit card fraud only. US level of fraudulent transactions converted to euros using 2017 average exchange rate 1.1297 (Bundesbank Eurosystem).

This estimate of an additional €1.4bn of fraudulent transaction activity in Europe that would have occurred absent chip-and-pin cards sets an upper bound on the value of the indirect benefit of the TIC sector in terms of reduced levels of fraud in 2017. Such a value would be appropriate if we concluded that absent the TIC sector EMV would never have been rolled out. Conversely, a much smaller amount may be appropriate if we assumed a counterfactual where EMV cards were still rolled out, albeit at a later date and/or with poorer levels of security. This estimate is just for 2017. French banks issued the first chip-embedded smart cards in 1986, and both France and the UK migrated to EMV chip-and-PIN cards in 2002.[187] Between 2002 and 2017, EEMV cards have had many years to become a widely-used means of transacting, so it is not totally unreasonable to suggest that a great deal of fraudulent card transactions have been avoided during this period as a result.

[186] See Chart 17 ("U.S. Bankcard Fraud Rates") in King (2012)
[187] See King (2012)

Figure 11: Calculating the expected level of additional fraud if no chip-and-pin cards in Europe in 2017



Europe Economics analysis.

Other quantitative benefits: lower recall costs

As payment cards and other forms of non-cash payment become more prevalent globally, having secure payment options is becoming increasingly important for the ways in which people pay for goods and services. This, in turn, means that payment card providers must be reasonably certain that their products can be launched and used in the marketplace without having to recall them due to cyber and data security issues – often at a significant cost. In 2014, the costs associated with product recalls in the manufacturing, distribution and retail sectors amounted to 9 per cent of annual revenue on average, with as many as 10 per cent of firms estimating the cost to be more than 20 per cent of revenue.[188] These costs might include the logistical costs of product collection and remedying the fault and any paying legal penalties to consumers that may result, but it excludes the significant brand damage that can be wrought by a large-scale product recall.[189] A product recall may have enduring effects on the firm if it permanently damages its market share and reputation.

The migration to EMV cards has been associated with far fewer payment card recalls.[190]

3.3.5 Lessons learned

This case study provides another illustration of how the value of the benefits of the TIC sector can be material. A secure, functioning payments industry is fundamental to the global economy. Innovations in the sector can generate significant welfare gains. These might arise from greater convenience, such as the ability to make payments using a mobile phone, and from greater product security, which provides trust and predictability to the market. The roll out of the EMV payment card allows us to estimate the level of fraud that chip-and-pin payment cards may have averted in Europe - €1.4bn in 2017 alone. Even if only a small share of these savings were attributed to the TIC sector, it would represent a valuable contribution in helping the transition towards more secure means of making payments. And accreditation to EMV specifications is just one example of the many conformity assessment schemes that can be provided by TIC firms for suppliers wanting to demonstrate the cybersecurity of their products. TIC firms are often engaged by companies to test and certify an increasing volume of consumer products ranging from wearable technologies to connected consumer products to relevant security standards. For instance, many TIC firms are accredited to perform

[188] TÜV SÜD (2014)
[189] Bruccoleri et al. (2019)
[190] https://www.paymentssource.com/news/has-emv-card-issuance-already-run-its-course

tests to the Common Criteria, an extremely important framework for evaluating the cybersecurity claims of IT products more widely.

Nor is the TIC sector work in the field of cybersecurity confined to payments. TIC firms also play an important conformity assessment role in the area of passports and identify cards, which nowadays tend to have chips. Ensuring these are as secure as possible is clearly of paramount interest to governments and the public. It is also an area where specialist knowledge is at a premium. The lifetime of a passport means that, to the extent possible, the relevant authorities want to have confidence that it will be secure against attack in the next 20 years. They also have to be alive to the possibility that there will be state-funded attacks, so the resources the attacker has available may be high. Both of these factors point to the importance of being at the frontier of knowledge about cybersecurity when conducting conformity assessment.

3.4 Case Study: Improving Consumer Product Safety in the Internet of Things

The purpose of this case study is to illustrate the role and benefits brought about by the TIC sector in assisting regulators, organisations, and firms to develop an international standard that would address some of the safety hazards associated with connected consumer products.

While the case study in this report focuses on the standard that is being developed by ASTM International for connected consumer products, we note that the TIC sector plays a role in other forward-looking activities related to cybersecurity standards and regulations more broadly. This includes the support provided by the TIC industry towards the European Cybersecurity Act with its European Cybersecurity Certification Framework,[191] and towards new standards such as IEC 62443[192] or EN 303645[193] for consumer IoT devices, including TS 103701, which provides guidance for conformity assessment bodies.

3.4.1 Description

Internet of Things (IoT) products encompass both industrial (related to businesses or the workplace) and consumer technologies and devices. Connected consumer products are typically described as devices capable of connecting to the internet or other networks. Such products include, among other things connected children's toys, smart safety-related products such as smart smoke alarms or door locks, smart TVs, smart home appliances such as smart washing machines or refrigerators, and connected smart home assistants. The size of the global IoT consumer market is expected grow from $53bn in 2019 to an estimated $188bn in 2027[194], suggesting a rapidly increasing uptake and use of connected devices by consumers.

In recent years, various organisations and stakeholders have raised concerns regarding the potential safety hazards associated with connected consumer products. For example, potential hazards such as failed software updates that affect performance associated with emerging technologies (including IoT) were identified by the US Consumer Product Safety Commission (CPSC) in early 2017. Then in May 2018 the CPSC organised a public hearing seeking to gather views from various stakeholders, including the TIC Council, regarding the potential safety hazards and injuries that may be caused by connected devices, either due to user's fault or device malfunctioning.

In light of the expected increased uptake of connected devices and the potential safety hazards identified, ASTM International's Committee F15 on Consumer Products has been developing a "New Guide for Ensuring the Safety of Consumer Connected Products" to address some of the safety concerns identified in relation

[191] European Commission (n.d.)
[192] ISA (2020)
[193] ETSI (2020)
[194] Total Telecom (2020)

to connected consumer products.[195] The publication of the standard is currently expected in late 2020.[196] Throughout the development and drafting of the standard, the TIC sector, including the TIC Council, has been deeply engaged and playing a lead role in the process.

3.4.2 The Problem TIC solves

For policymakers in regulatory bodies, the TIC sector plays an important role in assisting with the design and development of regulations and other programs, either directly or indirectly, such as through the TIC sector's contributions to the development of international standards, in cases where such standards are later incorporated into regulation (whether directly or by reference). TIC firms are uniquely well-placed to advise regulators and other organisations on these matters: Their work for various clients means that they are likely to become aware of the issues that a regulation or other policy might address before policymakers will, they are likely to have a fuller understanding of the various challenges and complications that will need to be addressed, and they can share their accumulated expertise without revealing proprietary information.

For manufacturers and service providers, the TIC sector may also help fill informational gaps since the firms may be applying smart technology to goods or services for which they previously were not involved. They may want help developing an international standard, either because they are unwilling to go to market absent such a standard (possibly for fear of reputational damage, lawsuits, and/or costly recalls) or because they believe that marketing their product or creating a new market will be harder and take more time absent such a standard that engenders trust in the market.

3.4.3 Counterfactual

The development of the ASTM standard on connected consumer products took significantly less than a year from initiation to ballot approval. This process included significant input from the TIC Council itself, in the form of considerations and recommendations for the standard.[197]

In the absence of the TIC sector, the development of an ASTM standard might not have taken place. At a minimum, the timing of standards development would have been significantly delayed. Further, the effectiveness of the resulting standard would have been reduced without TIC sector input, given that IoT is a new area and it is unclear whether any of the other participants in the standards development process would have the same level of in-house expertise. To the extent that they did, some company representatives in the standards development process would likely have sought to incorporate prescriptive provisions in the standard that would favour their own products and technologies over others.[198]

The potential hazards associated with connected consumer products were raised publicly by the CPSC as early as January 2017.[199] And the CPSC strongly suggested that the standards community develop a standard to address the potential product safety hazards associated with connected consumer products:

> "Participating in voluntary standards development is a key tool in CPSC's risk management toolbox. For many new and/or future products and technologies identified

[195] ASTM (2020a) The Committee's focus has been on "hazard assessment for connected products, not on data privacy or specific cybersecurity threats."
[196] ASTM (2020a). The standard has been approved and will be published as F3463-2020 according to ASTM (2020b).
[197] For further details regarding the input provided by the TIC Council, please see here: https://www.tic-council.org/application/files/5015/5679/7564/IFIA_Recommended_Guidelines_IoT_2018.08.23_RO.pdf
[198] For further details regarding the steps involved in the development and drafting of ASTM standards from creating a work item to publication, for example see: https://www.astm.org/MEMBER_TRAINING/LINKS/Editorial_Module_Dec_2010.pdf
[199] CPSC (2017).

> in this report, CPSC is likely initially to work to eliminate or reduce risk through active participation in voluntary standards committees and by collaborating with consumer and industry stakeholders and our federal partners…
>
> Using the tools in our risk assessment and risk management toolbox, including voluntary standards development and collaborative work with stakeholders, including our federal partners, CPSC can maintain an awareness of consumer product technology trends and position itself to protect consumers from potential product safety hazards that may be associated with those trends."[200]

As hinted at by these statements, the CPSC seemingly recognized two important points. First, standards development could potentially progress on a quicker timetable than developing a regulation and the products of concern to the agency were already being placed on the market. Second, the CPSC needed to collaborate with the private sector with regard to "new and/or future products and technologies" as such actors would have their finger on the pulse of technology trends in a way that the agency did not.

In May 2018, the CPSC held a public hearing in which it gathered views from the public regarding the potential safety issues related to consumer products connected to the internet.[201] The input received by the CPSC as part of the hearing included views from the TIC Council (formerly IFIA), represented by a member company.[202]

The idea of a new standard focusing on connected consumer products was further advanced in November 2018 at the International Consumer Product Health and Safety Organization (ICPHSO) Symposium where following various plenary and breakout sessions on international safety as well as more informal networking discussions,[203] ASTM proposed drafting an international standard for connected consumer products.[204] The new standard would be based on the TIC Council guidelines on IoT issued in August 2018, which included safety recommendations for IoT devices and/or their connected controllers, as well as for IoT device manufacturers/importers/retailers and for the CPSC itself.[205]

In January 2019, the CPSC published a framework of safety for the IoT[206], including considerations from the TIC Council guidelines.

Drawing on the TIC Council guidelines, by December 2019 ASTM International's Committee F15 on Consumer Products had initiated work on an international standard[207] to ensure the safety of connected consumer products. In May 2020, a draft of the standard was balloted with expectation for this to become a standard in late 2020.[208] The development of the standard has been overseen by the 50-plus-member Subcommittee F15.75 on Connected Products.[209]

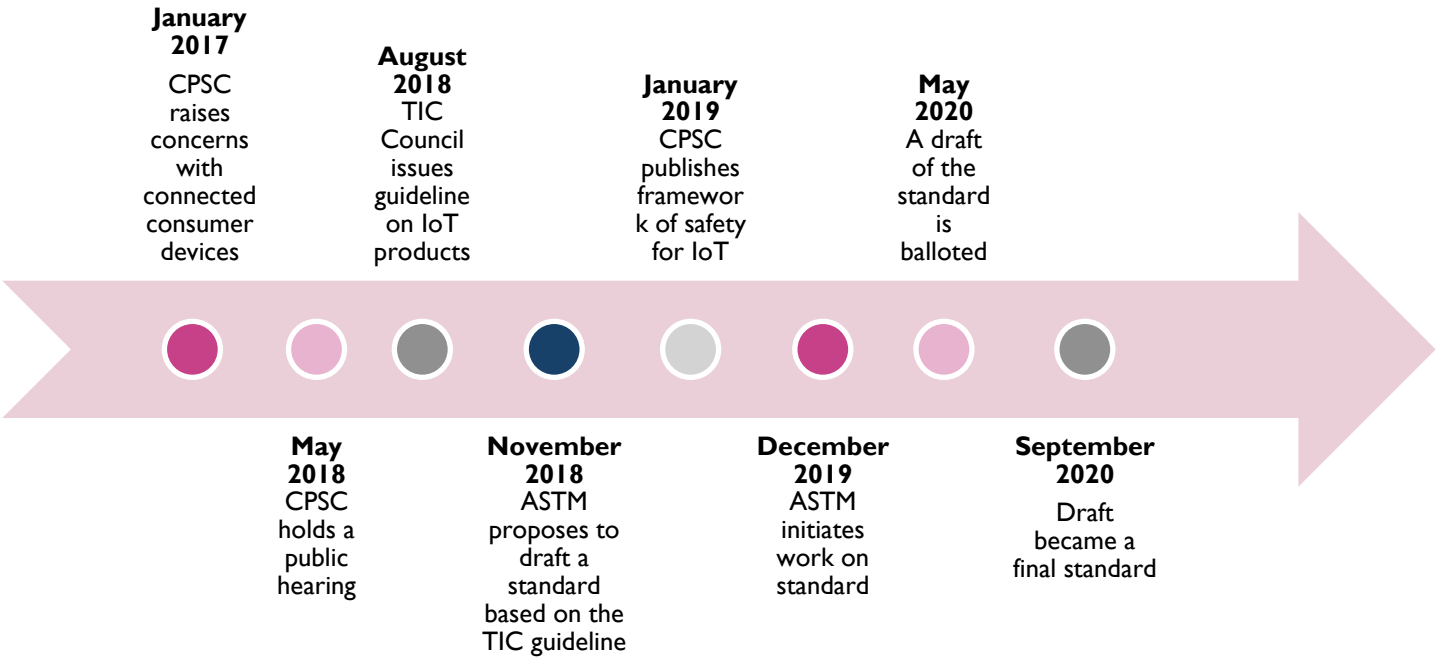
In the case of the ASTM standard on connected consumer products, the process to develop a new standard actively built on the guidance provided by the TIC Council both at the initial stages of standard development and at the later stages focusing on the drafting and balloting of the standard. The process has so far taken

[200] CPSC (2017). See Executive Summary and page 17.
[201] CPSC (2018)
[202] TIC Council (2018b)
[203] For example, the symposium included a session on the "The Impact of Digitization on Global Alignment of Product Safety Regulations". For further details, please see: https://icphso.org/page/2018International
[204] Interview with TIC company.
[205] TIC Council (2018a)
[206] CPSC (2019a)
[207] ASTM (2020b).
[208] ASTM (2020a)
[209] ASTM (2020a)

over three years since the CPSC publicly voiced its concerns regarding potential hazards associated with connected consumer products.

We assume that under the alternative scenario that would have prevailed in the absence of the TIC sector, the development and publication of the ASTM standard would have been delayed by an additional year. Given the factors previously discussed, we believe this is a fairly conservative estimate of the likely delay in a scenario where there was no input from the TIC sector.

Figure 12: Timeline of ASTM standards development process for the Standard Guide for Ensuring the Safety of Connected Consumer Products (ASTM F3463-20)



Source: Europe Economics analysis.

3.4.4 Quantifying the Benefits

Assistance with developing a standard

One direct benefit of the TIC sector in this case study is its assistance with developing an international consumer product safety standard at the strong suggestion of a leading regulatory agency. Using the counterfactual in which the TIC sector is absent from the process, a regulator such as the CPSC (or other agencies) would have to create the relevant standard from scratch through a regulatory process. This would likely take a few years and could require additional funding to ensure the agency has adequate resources and the necessary in-house technical competence to develop such a regulation (the alternative to hiring new staff would be the opportunity cost associated with re-assigning staff from working on other tasks, or to just accept delay). As an illustration, the CPSC's performance budget request to Congress for the 2020 fiscal year was $127 million, which included about $84 million in payroll to fund 539 FTEs (suggesting an average cost of around $156,000 per year per FTE).[210]

The value of having a TIC sector would be the cost of any additional FTEs in these other organisations, less the costs that the TIC companies no longer incur (given they no longer exist under the counterfactual). Given the on-the-job experience and knowledge that TIC employees acquire from working for various clients, we suspect that on balance the costs of developing an international standard would be higher in the absence

[210] CPSC (2019b).

of a TIC sector. Nevertheless, the quantum is small relative to the likely indirect benefits that might arise from having the standard completed a year earlier.

Reducing the number of injuries

The development and publication of a new standard leading to connected consumer products that are safer to use are also expected to bring benefits for consumers through reducing the injuries caused by these devices.

To calculate the potential reduction in costs associated with injuries caused by connected consumer products due to the introduction of the new ASTM standard, we took the following steps:

1. We collected data on the number of injuries reported for selected product categories in the US from the National Electronic Injury Surveillance System (NEISS) operated by the CPSC.[211] Selected product categories included those where at least a percentage of products are likely to be connected devices, namely: (i) television sets & stands, (ii) cooking ranges, ovens, etc., (iii) refrigerators, freezers, (iv) small kitchen appliances, (v) washers, dryers, (vi) air conditioners, (vii) heating stoves, space heaters, and (viii) electric fixtures, lamps, equipment. We estimated the number of injuries in 2020 using data from the 2011-2019 period.
2. We estimated the share of injuries that may have been caused by a connected consumer product using information on the penetration rate of smart devices in 2020.[212]
3. We gathered information on the typical cost associated with each injury.[213]

In the US alone, it does not require the standard to have a massive impact on injuries to generate large cost savings. If we conservatively assume that connected consumer products that were manufactured after publication of the ASTM standard had just 1 per cent fewer injuries than connected consumer products that were manufactured prior to this cut-off, then a delay of one year before the standard is finalized and published would result in costs associated with injuries of **$27 million**. This estimate assumes an average asset life time of eight years for connected consumer products[214] and that the standard is widely adopted voluntarily and used by industry – such that all new products manufactured after the publication of the ASTM standard are compliant. It also assumes that the penetration of connected consumer products will grow from 23 per cent in 2020 to 49 per cent in 2027.[215]

This estimate assumes that the standard has a modest impact on the safety of connected products – just a one per cent fall in injuries. Moreover, it does not cover all connected consumer products, and ignores the possibility that the standard will be adopted (officially or de facto as a market requirement) in other jurisdictions.

[211] CPSC (2020).
[212] For calculation purposes we used the percentage of 'smart homes' as a proxy for the market penetration of connected consumer products as identified by S&P Global (2019).
[213] We used an estimate cost per injury of $26,589 in lifetime costs based on information from the US Home Safety Council (2004) on unintentional home injuries between 1997 and 2001, and updating the costs for inflation.
[214] The average lifespan of consumer electronic devices ranges from around 1.5 to 13 years, based on Statista (2016).
[215] Europe Economics calculations based on: S&P Global (2019).

Figure 13: Calculating the cost savings associated with lower number of injuries due to earlier adoption of a standard

Europe Economics analysis.

Increased market size

Another possible indirect benefit feeding through from publication of the standard is that the market for connected consumer products will grow faster. Consumers may be more confident about purchasing such products, and there may be some manufacturers who are only willing to enter the connected consumer products market when there is a recognised international standard to which they can test and certify their products' compliance, perhaps through a third-party TIC firm, in order to reduce commercial, political, and legal risk.

Given the rapid projected growth in the global IoT consumer market, a modest change in the assumed growth rate on account of the existence of an international standard could represent a significant volume of foregone market activity, which would lead to reduced levels of economic growth, job creation, innovation, and consumer welfare. For example, if we assume that the growth rate of the connected consumer products market would be 5 per cent higher if there is an international standard than if there is not, then a delay in publishing the standard by one year could mean the market is $1bn smaller in 2021 than if the standard was published in 2020.

3.4.5 Lessons learned

This case study provides another example of how the TIC sector provides value in new and growing markets. It also illustrates how seemingly modest contributions can generate large indirect benefits. This case study focuses on the benefits that may accrue because of time savings in developing an international standard, savings that are possible because of the TIC sector's knowledge and experience. If the contribution from the TIC sector has saved just one year in the time to develop a standard for connected consumer products, and that standard reduces injuries from such products by one per cent, we estimate an indirect benefit of over $20 million.

By working with a variety of clients across a range of products, the TIC sector's conformity assessment work will enable its firms to proactively identify instances where existing requirements and/or standards are inadequate or non-existent. Moreover, in subsequent work developing international standards, it will be well

placed to advise on the design of the standard in a way that strikes an adequate balance between adequately addressing product safety while not hindering innovation in product development.

ANNEX 1: Survey of Major Conformity Assessment Systems

This Annex provides an overview of the structure and operations of the conformity assessment systems at central level of government of four jurisdictions: China, the European Union, India, and the United States.

A. China

A.1 Relevant bodies

In China, the State Administration for Market Regulation (SAMR) has overall responsibility to coordinate quality infrastructure nationwide. Within SAMR, the Standardization Administration of China (SAC) and the Certification and Accreditation Administration of China (CNCA) are two agencies with specific responsibilities on standards and conformity assessment, respectively. SAMR (and SAC and CNCA) also closely coordinate with other sector ministries that regulate their respective industries.

CNCA coordinates mandatory certification and testing activities in China, including drafting the catalogue of products subject to China Compulsory Certification (CCC), and formulating certification marks, conformity assessment procedures, and technical requirements. CNCA regulates the TIC industry at different levels. Administrative approval of a certification body and its scope is done at the central level by CNCA, while approval of an inspection and/or testing body is delegated to SAMR's provincial branches. CNCA also has responsibility for accreditation activities in China,[216] and it supervises the work of the China National Accreditation Service for Conformity Assessment (CNAS) on accreditation.

CNAS, which is China's national accreditation body, is responsible for accreditation and surveillance of accredited certification bodies, labs, and inspection bodies, which can only be established in China with CNCA's authorization.[217] Accreditation by CNAS is voluntary.[218] Pursuant to that role, CNAS issues rules, criteria, and guidance for accreditation.[219] CNAS also participates in international conformity assessment activities, which includes participation in the International Accreditation Forum (IAF), the International Laboratory Accreditation Cooperation (ILAC), and the Asia Pacific Accreditation Cooperation (APAC).

For a testing lab, if it operates as an independent third party, China Mandatory Accreditation (CMA) is also a must within China, and alignment between CNAS accreditation and CMA is on-going. In addition, China Certification and Accreditation Association (CCAA), another affiliate to SAMR, is in charge of certification of professionals' ability.

Sources indicate that participation of non-Chinese conformity assessment bodies in the CCC scheme appears to be very restrictive in practice.

> "Under conformity assessment law, all bodies that issue certifications must be accredited by CNAS, but only a few are designated to issue the CCC system. Many accredited organizations can perform multiple certifications, but only a select few can process CCC applications. The accredited bodies that certify products with the CCC Mark are known as "designated certification bodies" (DCB's).

[216] Article 3 of the Regulations for Compulsory Product Certification. See http://www.puntofocal.gov.ar/notific_otros_miembros/chn399s1_t.pdf

[217] Export.Gov (2019), China – Standards for Trade, retrieved from https://www.export.gov/apex/article2?id=China-Trade-Standards

[218] CNCA Announcement No. 11, 2016.

[219] China National Accreditation Service for Conformity Assessment (2019), Introduction, retrieved from https://www.cnas.org.cn/english/introduction/12/718683.shtml

> CNCA designates several accredited bodies and then issues them certification privileges within a specific product-scope. DCB's may only certify products that fall under their scope." [220]

CNCA also recognizes laboratories, inspection and certification bodies that are accredited by accreditation bodies other than CNAS. Nevertheless, while having a CNAS accreditation is not a requirement, practically speaking it is very difficult to be approved by CNCA without CNAS accreditation. While a number of foreign-invested laboratories have been approved as CCC designated laboratories, as of yet no foreign organizations have been approved by CNCA as certification bodies for the CCC mark.

A.2 Relevant conformity assessment systems

China's Product Quality Law sets the overall conformity assessment framework for products. [221] Article 15 of the Law provides that:

> "The State, with respect to product quality, applies a system of supervision and inspection with random checking as the main form. Products constituting potential threats to human health, to personal safety and to the safety of property, important industrial products which have a bearing on the national economy and the people's wellbeing, and products with quality problems as reported by consumers or relevant organizations shall be subjected to random checking."

There are several mandatory certification programs in China. The most prominent one is China Compulsory Certification (CCC), a program owned by the government and administrated by CNCA. CNAS and CCAA support CNCA. The CCC Mark is required for 17 categories comprised of approximately 100 products, including:

- wire and cable;
- switches for circuits and electrical devices for protection or connection;
- low-voltage electrical appliances;
- low power motors;
- electric tools;
- electric welding machines;
- household and similar equipment;
- electronic products and safety accessories;
- lighting appliances;
- vehicles and safety accessories;
- agricultural machinery;
- fire products;
- security products;
- building materials products;
- children's products;
- explosion-proof electrical products; and
- household gas appliances. [222]

[220] See https://www.standardsportal.org/usa_en/prc_standards_system/conformity_assessment/ca_used_in_china.aspx

[221] Ministry of Commerce, People's Republic of China, (2000), Product Quality Law of the PRC, retrieved from http://english.mofcom.gov.cn/article/policyrelease/Businessregulations/201303/20130300046024.shtml

[222] http://gkml.samr.gov.cn/nsjg/rzjgs/202004/t20200428_314776.html. See also NIST (2019), Compliance FAQs: China Compulsory Certification (CCC) Marking, retrieved from https://www.nist.gov/standardsgov/compliance-faqs-china-compulsory-certification-ccc-marking. See also Export.Gov (2019), China - Standards for Trade, retrieved from https://www.export.gov/apex/article2?id=China-Trade-Standards.

Administered by CNCA, the objectives of the CCC mark system include: protecting human health, safety, the environment, national security, and animal and plant life or health and preventing deceptive practices.[223] CNCA drafts the list of products (the 'catalogue') to be included in the CCC system. If a product is included in the catalogue, it may not be marketed, imported, or sold in China without the CCC Mark. The CCC certification module is a type 5 scheme according to ISO/IEC 17067, involving certification approval by type test plus surveillance inspection. Certification must be undertaken by a certification body designated by CNCA.[224] CNCA is also charged with conducting regular and surprise site inspections along with the Local Administration of Market Regulation.[225]

In addition to the CCC Mark, there are other product certification schemes. CNCA also administers the National Recommended Voluntary Certification (NRVC), which covers different products than the CCC scheme. SAMR administers two schemes dealing with requirements for boilers and pressure vessels and certain measurement equipment. There is also a China Energy Label (CEL), an energy consumption label for products placed on the market in China. Manufacturers of specified electronic devices must attach a CEL label to their goods to inform China-based consumers of the product's energy efficiency.[226] This label also requires third-party conformity assessment, a process operated by the China National Institute of Standardisation.[227] Producers and importers of energy using products listed in the catalogue may use their own testing laboratories or a third-party inspection and testing body that has obtained the qualification to test the products, and determine the energy efficiency grade of the products according to the compulsory national energy efficiency standards.[228]

B. European Union

B1. Relevant bodies

The regulatory system in the European Single Market Decision, which further specifies and is based on the New Legislative Framework (NLF), is composed of three regulations and one decision:

- Regulation (EC) No 764/2008 laying down procedures relating to the application of certain national technical rules to products lawfully marketed in another Member State;
- Regulation (EC) No 765/2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products;
- Regulation (EU) 2019/1020 on market surveillance and compliance of products and amending Directive 2004/42/EC and Regulations (EC) No 765/2008 and (EU) No 305/2011; and
- Decision No 768/2008/EC, on a common framework for the marketing of products

The NLF, also called the "Goods Package," is based on the principle that basic product-related (vertical legislation) or hazard-specific (horizontal legislation) safety requirements should be laid down and made mandatory in European directives or regulations. The technical design and concretisation of the essential requirements is primarily carried out via Europe-wide uniform standards, which are flexibly and continuously adapted to the state of the art. The technical state of the art and progress can be represented by harmonised

[223] Article 2 of the Regulations for Compulsory Product Certification.
[224] Article 5 of the Regulations for Compulsory Product Certification.
[225] Article 36 of the Regulations for Compulsory Product Certification.
[226] China Certification (2019), China Energy Label, retrieved from https://www.china-certification.com/en/china-energy-label-cel/
[227] The China National Institute of Certification (2019), retrieved from https://en.cnis.ac.cn/
[228] Order No.35 of SAMR, Article 8. The results have to be recorded on the energy label website: https://www.energylabelrecord.com/index.htm.

standards without defining the technical path or specifications. This is ultimately beneficial for innovations. In addition, the application of standards which do not have a legally binding effect is voluntary.

Decision 768/2008/EC is a significant innovation: It establishes a link with the legal framework for the creation of new directives/regulations and the revision of existing ones. In its structure and content, the Decision is a modular system, which serves to achieve greater harmonisation of all sectoral legislation.

It also sets out requirements for notified bodies and their notification, which are further elaborated on in the *Blue Guide on the implementation of EU products rules.* A notified body is an independent third-party body approved to undertake conformity assessment procedures - testing, inspection, and/or certification within its notification scope in order to assess the conformity of particular products before they are placed on the European market. Every notified body must be designated and notified under EU harmonisation legislation by a notifying authority, which has the remit to notify bodies established within its territory. Where a third party is required for conformity assessment under EU harmonisation legislation, a notified body must be used, unless the legislation selects a module that permits the use of an accredited in-house body that has met certain requirements.[229][230] The European Commission notifies and publishes a list of notified bodies in the New Approach Notified and Designated Organisations (NANDO) information system.[231]

Regulation EC (No) 765/2008 provides the legal framework for accrediting third-party conformity assessment bodies for a defined scope of specific conformity assessment activities. Regulation 765/2008 requires each Member State to appoint a single National Accreditation Body (NAB). It also appoints EA, the European co-operation for Accreditation, to develop and maintain a mutual recognition agreement – the EA Multilateral Agreement (MLA) facilitating cross-border trade in safe and reliable goods and services (2018) – of NABs that are officially recognized by their respective governments.[232] The purpose of the agreement is "to recognise the equivalence, reliability and therefore acceptance by the European market, of certification, verification, inspection and calibration certificates and test reports issued by accredited conformity assessment bodies."[233] While accreditation is voluntary in the EU, being accredited by an NAB is "favoured"[234] and can expedite the process of being designated as a notified body by a notifying authority.

B2. Relevant conformity assessment procedures

The EU adopts directives and regulations that set out essential health and safety requirements with which products placed on the market must conform. The European Commission then issues standardization mandates to European standardisation organisations – the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC), and the European Telecommunications Standards Institute (ETSI) – to develop standards for suppliers to meet the essential requirements and be able to apply the mark of the system – the CE mark – to their products under their responsibility and declare that all legislative requirements are fulfilled. These standards, otherwise known as harmonized standards or ENs, are not mandatory, but for products manufactured (and services provided) in

[229] Blue Guide at page 78.

[230] It is worth noting that, if a conformity assessment body is established in the EU, it needs to identify a notifying authority that has the scope for the notification. That may be the notifying authority in the member state in which the conformity assessment body is established, but it may be a notifying authority in another member state. If the latter, the notification can done by a notifying authority in another member state without the conformity assessment body needing to move its operations, in cases where the national notifying authority in which the CAB is established does not have the required scope.

[231] European Commission, DG Grow (2019), NANDO, retrieved from http://ec.europa.eu/growth/tools-databases/nando/

[232] European Accreditation (2017)

[233] European Accreditation (2017)

[234] Page 83, 2016/C 272/01, Commission Notice – The 'Blue Guide' on the implementation of EU products rules 2016.

conformity with them, there is a presumption of conformity with the essential requirements (though the manufacturer has a responsibility to verify that the requirements are being met). Those not using these standards must develop their own specifications and procedures, and a notified body will determine their conformity with the relevant legislative requirements.

There are numerous NLF directives and regulations for which the application of harmonized standards can result in a presumption of conformity with the essential requirements, including measures on: toy safety, machinery, civil explosives, restrictions of hazardous substances in electrical and electronic equipment (RoHS), pressure equipment, lifts, personal protective equipment, radio equipment, low voltage, measuring instruments, marine equipment, general product safety, medical devices, in vitro diagnostic medical devices, eco-design and energy labelling, packaging, electromagnetic compatibility, recreational craft, construction products, gas appliances, and fertilizing products.[235] The relevant product legislation specifies the conformity assessment procedures which are applicable to demonstrate the fulfilment of the essential requirements.

Decision 768/2008/EC compiles a common set of conformity assessment procedures, organized in modules, from which EU legislators must select one or two modules covering both the design and production phase of a product. Which module or modules they select will depend on several factors set out in the Decision, such as the appropriateness of a module to the product; the nature of the product's risks; and the need to avoid imposing procedures that are too burdensome in relation to the risks.[236] The *Blue Guide* further provides that:

> "—The legislator should avoid modules too onerous for the objectives of the Union harmonisation legislation concerned, without however compromising the protection of the public interest.
>
> —The complexity of the modules selected should be proportional to the risk (impact on public interest, health, safety, environment) of the product, its design complexity, the nature of its production (large series vs small series, custom-made, simple vs complex production mechanism, etc.)."[237]

The modules under Decision 768/2008/EC are as follows:

- Module A Internal production control
- Module A1 Internal production control plus supervised product testing
- Module A2 Internal production control plus supervised product checks at random intervals
- Module B EC-type examination
- Module C Conformity to type based on internal production control
- Module C1 Conformity to type based on internal production control plus supervised product testing
- Module C2 Conformity to type based on internal production control plus supervised product checks at random intervals
- Module D Conformity to type based on quality assurance of the production process
- Module D1 Quality assurance of the production process
- Module E Conformity to type based on product quality assurance
- Module E1 Quality assurance of final product inspection and testing
- Module F Conformity to type based on product verification
- Module F1 Conformity based on product verification
- Module G Conformity based on unit verification
- Module H Conformity based on full quality assurance
- Module H1 Conformity based on full quality assurance plus design examination

[235] See https://ec.europa.eu/growth/single-market/goods/new-legislative-framework_en.
[236] Article 4 of Decision 768/2008/EC.
[237] Page 74, 2016/C 272/01, Commission Notice – The 'Blue Guide' on the implementation of EU products rules 2016

According to the *Blue Guide*:

> "[t]he reason for providing variants within modules (this applies for all variants of all modules laid down under Decision No 768/2008/EC) is to enable the necessary level of protection to be ensured for products presenting higher level of risk while avoiding the imposition of a heavier module. The idea is to minimise the burden on manufacturers to the extent possible."[238]

Each module lays out its requirements with respect to technical documentation, conformity marking and declaration of conformity, manufacturing, product checks, surveillance, verification, and quality system elements, as applicable. Manufacturers of most products subject to New Approach directives[239] can place on the market upon self-declaration of conformity under Module A, but must assemble and submit upon a request a technical file containing comprehensive information on the design, construction, conformity assessment and use of the product to demonstrate how their products comply with all the applicable essential requirements. [240]In practice, Module B (EC-type examination) and Module D (Conformity to type based on quality assurance of the production process) are the modules that are most selected by manufacturers, depending on the intended uses and risks of specific products.

CE Marking on a product is a manufacturer's indication that the product complies with the essential requirements of any applicable directive(s). It is not a certification mark. (The mark does not mean that the EU or another authority has approved the product as meeting these requirements.) Affixing the CE mark is required for most products covered by New Approach Directives before a product can be placed on the European market. There are other national and European marks that can be affixed to products in the EU market.

In addition, under the EU system Member States are required to conduct effective market surveillance to ensure products do, in fact, meet the essential requirements and to eliminate unfair competition.[241] The rapid alert system (RAPEX) database provides information on product safety issues that could cause serious risks to consumer health and safety and assists the relevant Member State authorities with market surveillance.[242]

C. India

C1. Relevant bodies

The BIS Act, 2016 and its implementing regulations authorize the Bureau of Indian Standards (BIS), the national standards body, to operate India's conformity assessment system for products, services, systems, and processes. [243] In addition to operating India's conformity assessment system, BIS serves as India's national certification body. BIS, as the certification body and scheme owner, conducts all certifications under Schemes I & II.).

TIC service providers under the BIS Schemes can conduct testing only for products sold in India. BIS requires NABL accreditation and, in some cases, it recognises testing laboratories directly.

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238 Page 69, 2016/C 272/01, Commission Notice – The 'Blue Guide' on the implementation of EU products rules 2016

239 Page 14, 2016/C 272/01, Commission Notice – The 'Blue Guide' on the implementation of EU products rules 2016

240 Health and Safety Executive (2019), retrieved from http://www.hse.gov.uk/work-equipment-machinery/technical-file.htm

241 European Commission (2019), The Implementation of Market Surveillance in Europe, retrieved from http://ec.europa.eu/growth/single-market/goods/building-blocks/market-surveillance/organisation_en

242 https://data.europa.eu/euodp/en/data/dataset/rapex-rapid-alert-system-non-food. RAPEX does not cover food, medical products or devices, or pharmaceuticals.

243 Bureau of Indian Standards, (2019)

The Quality Council of India, a non-profit organization, operates the National Accreditation Board for Laboratories (NABL) and the National Accreditation Board for Certification Bodies (NABCB). NABL is the national accreditation body for laboratories and accredits labs as per ISO/IEC 17025 Standards. BIS recognizes conformity assessment bodies for NABL programs. NABCB accredits the Certification Bodies for various schemes as per ISO/IEC 17065 Standards. NABCB & NABL both participate in international conformity assessment activities, including those of IAF, ILAC, and the Asia Pacific Accreditation Cooperation (APAC). In addition, other accreditation bodies –the Global Laboratories Accreditation Board and Quality and Accreditation Institute Private Limited – participate in APAC.

Foreign accreditation bodies, such as ANAB and the Joint Accreditation System of Australia and New Zealand (JAS-ANZ), also provide accreditations to certify products in India for export. In addition, there are several CB's operating in India that certify products as per global certification programs, including the IEC-CB Scheme for Global Market Access for Manufacturers and exporters from India.

C2. Relevant conformity assessment systems

Under the BIS Act, 2016 and implementing regulations, conformity assessment is conducted against mandatory Indian national standards, which are developed by BIS with the goal to harmonize them as much as possible with the relevant ISO, IEC, and ITU standards. (Standards are voluntary but compliance becomes mandatory through technical regulations which are issued by the respective Ministries.)

Over 260 products are covered by Scheme I (mandatory third-party certification) of the BIS conformity assessment system, including:

- cement;
- household electrical goods;
- batteries;
- food and related products;
- oil pressure stoves;
- automobile accessories;
- cylinders and valves;
- medical equipment;
- steel and iron products;
- electrical transformers;
- electrical motors;
- capacitators;
- chemicals and fertilizers;
- kitchen appliances;
- domestic water heaters;
- air conditioners and parts;
- plugs and socket outlets;
- gas stoves;
- pressure cookers;
- copier paper;
- cattle feeds;
- cables;
- aluminium foil;
- certain types of glass;
- woven sacks; bicycle reflectors; and
- toys.

Scheme I requires:

> "initial capability assessment of the manufacturing unit, pre-licensing testing of the product to Indian Standards, and post-licensing surveillance that includes reassessment of factory capabilities periodically and re-testing of the product samples taken from the factory or from the market."

The mark of Scheme I is the ISI certification mark, otherwise known as the Standard Mark.[244] Manufacturers of products that are not covered by Scheme I can still use the system in cases where it is a de facto requirement in the market or for public procurement.

BIS conducts post-market surveillance through surprise inspections, as well as the testing of samples from both the market and the factory.[245]

Over 60 products are covered by Scheme II, the Compulsory Registration Scheme," which is based on SDoC: 56 electronics and IT goods and five solar photovoltaics, systems, devices, and components. Scheme II:

> "allows products to be marked after registering the product and the company with BIS. Registration requires submission of a test report of the product demonstrating conformance to the applicable Indian Standard. These tests need to be conducted in a BIS approved laboratory and are currently limited to laboratories located in India. Often, foreign manufactures with products that fall under this scheme need to have their products re-tested and certified in India."[246]

The mark of Scheme II is the CRS Mark. BIS does not undertake the surveillance for products under Scheme II; rather, random surveillance testing of products placed in the market is conducted by the Ministry of Electronics and Information Technology (for electronics and IT goods) and the Ministry of New and Renewal Energy (for solar voltaics).

There is also BIS certification for management systems.

In addition, BIS operates a Foreign Manufacturers' Certification Scheme (FMCS) to ensure that imported products subject to Scheme I meet the relevant requirements. Under the FMCS:

> "[a]ll pre-certification and surveillance inspections are conducted by BIS inspectors on site. The foreign manufacturer is required to designate an authorized Indian representative who is responsible for compliance to the necessary provisions on their behalf."

Other national certification schemes in India include the following:

- the Bureau of Energy Efficiency runs the mandatory Standards & Labelling Programme for many domestic electrical products. Third-party conformity assessment is not required, and products are subsequently tested once on the market to check compliance. Recently, the Bureau has published an expression of interest to recognize third party certification bodies accredited by NABCB to perform documentation technical review under the Programme;[247]
- the Ministry of Communications has mandated certification requirements for various telecom equipment. This includes requirements for electrical safety, EMC, wireless, and interface. The new telecom equipment scheme requires that various equipment meet the requirements of the Mandatory Testing and Certification of Telecommunications Equipment (MTCTE). All tests need to be performed by TEC designated test labs within India;
- according to the new medical devices rules issued in 2017, all medical devices must be registered with the Central Licensing Authority through an identified online portal established by the Central Drugs

[244] Bureau of Indian Standards (2019)
[245] Bureau of Indian Standards (2019)
[246] Bureau of Indian Standards (2019)
[247] See Bureau of Energy Efficiency (2016) and Bureau of Energy Efficiency (2019).

Standard Control Organisation (CDSCO). Under the rules, there is a provision that permits Class A and B devices to be certified by notified bodies accredited by NABCB and recognized by CDSCO; and

- the Ministry of Civil Aviation allows drone certification to be performed by notified bodies accredited by NABCB.

In 2018, the Indian *National Strategy for Standardization: Evolving a Quality Eco-system* was published. Developed by the Ministry of Commerce & Industry and the Ministry of Consumer Affairs, with input from industry, members of the standards ecosystem, academia, and consumers, the Strategy set forth five goals for conformity assessment, accreditation, and metrology:

(1) enhancing the credibility of conformity assessment programmes in domestic and foreign markets;
(2) pursuing mutual recognition agreements (MRAs) in accreditation and sectoral fora for goods and services to secure and enhance equivalence;
(3) promoting Indian products through a "Brand India" label for global acceptance;
(4) minimizing costs of conformity assessment, especially to improve global competitiveness of MSMEs; and
(5) actively participating in international organisations dealing with conformity assessment.[248]

D. United States

D1. Relevant bodies

The National Technology Transfer and Advancement Act of 1995 (NTTAA) authorizes the National Institute of Standards and Technology (NIST) to coordinate governmental and private sector initiatives for the development of standards and conformity assessment procedures. The goal, as stated in the NTTAA, is "eliminating unnecessary duplication and complexity in the development and promulgation of conformity assessment requirements and measures." [249] NIST works closely with specific agencies to help them design conformity assessment measures for regulations, procurements, and other programmatic activities. It coordinates a network of Standards Executives throughout the federal government through the Interagency Committee on Standards Policy, which also covers conformity assessment issues in addition to standards. NIST also coordinates closely with industry, the scientific community, and the standards community on conformity assessment matters through formal means – such as its advisory committees and its memorandum of understanding with the American National Standards Institute (ANSI), the non-profit umbrella organization for the US standards system – as well as informal means. In addition, NIST serves as a designating authority for conformity assessment bodies under US. mutual recognition agreements.

The United States government does not have a single piece of legislation that sets out requirements and provides oversight of accreditation bodies or testing, inspection, or certification bodies. There is no single official US government list of such bodies. There are numerous accreditation bodies that operate in the United States. Some of them are governmental and some of them are private firms. Some accreditation bodies are sector-specific (e.g., the American Industrial Hygiene Association/Laboratory Accreditation Programs), and some operate across sectors (e.g., the American Association for Laboratory Accreditation). NIST operates an accreditation body, the National Voluntary Laboratory Accreditation Program (NVLAP), that participates in the ILAC MRA, but there are other many dozens of private sector accreditation bodies. There are three US accreditation bodies that are signatories of the IAF MLA and six US accreditation bodies that are signatories of the ILAC MRA.

While there is also no general legal requirement that conformity assessment bodies be accredited, TIC service providers will likely may be asked to present evidence of their accreditation by potential clients seeking to utilize their services. Further, to participate in certain regulatory schemes, an agency may require that

[248] http://nabcb.qci.org.in/pop/INSS%20Ver%206%20copy%20pdf.pdf, pages 20-24.
[249] https://www.nist.gov/standardsgov/national-technology-transfer-and-advancement-act-1995.

conformity assessment bodies be accredited to international standards, and it will publish a list of the relevant bodies and the approved scope of their respective accreditations (e.g., Telecommunication Certification Bodies recognized by the Federal Communications Commission). An agency may set out requirements for accreditation bodies as well (e.g., that they are ILAC MRA signatories) to participate in its regulatory program(s). An agency may also require IAF and/or ILAC signatory status to participate in voluntary programs such as Energy Star and WaterSense. In some cases, the accreditation function is performed by the agency itself, in whole or in part.

D2. Relevant conformity assessment systems

The US conformity assessment system includes government mandatory regulatory programs to protect health and safety, government voluntary programs to address policy objectives, and very robust private sector voluntary programs driven by market demands, insurance and retailer purchasing decisions. Private sector conformity assessment programs include the AHRI Product Performance Certification Program[250] and AHAM Certification Programs,[251] as well as retailer programs that rely on TIC services.

Federal policy on conformity assessment is contained in Office of Management and Budget (OMB) Circular A-119, "Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities," last updated in 2016.[252] The Circular reflects the fact that conformity assessment in the United States is conducted primarily in the private sector and urges agencies to coordinate their conformity assessment activities as closely as possible with those in the private sector. The Circular provides that agencies "should … design conformity assessment programs with the objectives of furthering outcomes that are closely aligned with market dynamics and otherwise maximize net benefits to society," seek to "conserve and leverage agency resources," minimize regulatory burdens, and enable commerce and exports. It also notes that "[f]lexibility is essential when devising an optimal conformity assessment system tailored to the missions of regulatory agencies."[253]

In addition, the Circular encourages agencies to work closely with NIST and OMB in identifying their conformity assessment needs in regulatory compliance and enforcement, procurement, and for other programs to determine whether they should use private sector and/or international conformity assessment systems *instead* of creating government-unique conformity assessment procedures, or alternatively *in concert with* government schemes. The Circular notes that: "[w]hen properly conducted, conformity assessments conducted by private sector conformity assessment bodies can increase productivity and efficiency in government and industry, expand opportunities for international trade, conserve resources, improve health and safety, and protect the environment." (This charge is caveated by the need to ensure that such approaches are feasible, appropriate, and consistent with law.) The Circular also notes that agencies "have the flexibility of choosing conformity assessment programs, whether private, public, or some combination thereof, to best achieve [their] objectives…" and compiles a list of factors for agencies to consider "when assessing the effectiveness of conformity assessment options and determining the type(s) of conformity assessment to employ" including:

(i) the objective(s) of the underlying regulation, procurement, or program activity;
(ii) the level of confidence required by the agency to ensure that the agency objective(s) has/have been achieved, weighing the risk of non-compliance and its associated consequences with the anticipated costs

[250] http://ahrinet.org/certification

[251] https://www.aham.org/AHAM/What_We_Do/Certification_Programs/AHAM/What_We_Do/Certification_Programs.aspx?hkey=f21f2894-3b5e-4ae9-bad4-19515b8a6159

[252] https://www.nist.gov/system/files/revised_circular_a-119_as_of_01-22-2016.pdf.

[253] Pages 29-30.

of demonstrating compliance (including time and resources) to the producers, suppliers, consumers, and the agency;

(iii) whether there are existing private sector conformity assessment activities, acceptance schemes or arrangements, that may work in conjunction with or, where appropriate, in lieu of governmental conformity assessment activities, except where such activities are inconsistent with law, unfit for regulatory or other agency purpose, or otherwise impractical;

(iv) their consistency with statutory and international obligations;

(v) consideration of the available scientific and technical information, as relevant to the selection of the appropriate conformity assessment program;

(vi) relevant industry practice and experience, and the industry's history of compliance;

(vii) the need to reduce duplication and complexity, and ensure consistency and coordination with the conformity assessment approaches of other agencies, where feasible, appropriate, and consistent with law;

(viii) the appropriateness of recognizing the results of private sector conformity assessment programs being utilized in State, local, and/or foreign government regulation, consistent with subsection (iii); and

(ix) the degree of transparency to stakeholders and the public of the conformity assessment activity."[254]

In September 2018 NIST issued "Conformity Assessment Considerations for Federal Agencies,"[255] to which the TIC Council contributed extensively. The NIST guidance lays out, consistent with Circular A-119, more detailed considerations for agencies on "developing, operating, using or relying on conformity assessment programs to meet Federal legislation or Federal government agency missions, regulations, or procurement requirements."[256] The guidance explains conformity assessment types and concepts and lays out initial considerations for agencies, such as understanding (i) US law and policy and international obligations; (ii) the agency's objectives and how conformity assessment could support those objectives; and (iii) the market, including conformity assessment programs in use and relevant international standards, guides, and recommendations. When selecting a conformity assessment scheme, NIST urges agencies to first determine the level of confidence they require, which should reflect the risks and consequences of non-conformity. Understanding the "confidence point" will help determine the type(s) of conformity assessment to employ and the level of rigor of the scheme, as well as the requirements for conformity assessment bodies, such as the level of independence that should be permitted and the amount of oversight required. NIST also urges agencies to identify resource needs; address communications, outreach, and engagement issues; and reflect on how to update and improve the conformity assessment scheme over time. At all stages, NIST counsels that agencies should engage stakeholders, leverage existing conformity assessment efforts, and be as transparent as possible.[257]

In September 2020, NIST updated its Guidance on Federal Conformity Assessment Activities, in order to ensure its consistency with the revised OMB Circular A-119 and to encourage agency reliance on the aforementioned Conformity Assessment Considerations when developing and implementing conformity assessment.[258]

In sum, US agencies are free to develop their own conformity assessment procedures for regulations, procurements, and other programs, taking OMB Circular A-119, NIST guidances, and international obligations into account, provided that the procedures are consistent with law. (In some cases, a US statute will dictate the conformity assessment procedure.) As a result, conformity assessment procedures in use vary widely, both between and within agencies and include, in no particular order:

- independent third-party testing, inspection, and certification;

[254] Pages 30-31.
[255] Carnahan and Phelps (2018b)
[256] Page i, Carnahan and Phelps (2018b)
[257] See pages 20-22, Carnahan and Phelps (2018b), for a summary of the relevant considerations.
[258] https://www.govinfo.gov/content/pkg/FR-2020-09-29/pdf/2020-18745.pdf

- SDoC, with testing conducted by an independent third party, governmental, or firewalled lab;
- SDoC, with post-market surveillance and inspection by a government agency;
- registration, with data provided by test labs that comply with Good Laboratory Practices, and post-market reporting;
- pre-market notification;
- pre-market approval, with testing and agency-accredited third-party review of a firm submission; and
- governmental determination of compliance or approval after evaluating test and other data that can be provided by the manufacturer or a third party.

There is no single US product safety mark such as the CCC Mark or Standard Mark, but specific regulatory or other programmatic schemes have their own marks, such as EnergyStar and WaterSense, voluntary third party certification schemes that are administered by the Environmental Protection Agency (EPA); EnergyGuide, a mandatory energy use and efficiency program administered by the Department of Energy; and the FCC (Federal Communications Commission) mark for FCC-approved equipment authorizations.

ANNEX 2: SDGs and Third-Party Conformity Assessment

The United Nations Sustainable Development Goals (SDGs) were adopted by all United Nations Member States in 2015 as a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030.[259]

Many third-party TIC firms have chosen to provide services in the areas of, and act in accordance with, the SDGs to promote prosperity and protect the planet for the benefit of current and future generations. This report has shown that the TIC sector's benefits to society often emerge from TIC firms' expertise across multiple sectors and service areas, and from enabling market participants to close market gaps and thus enable the benefits to spread more widely. This is directly comparable to the integrated nature of the SDGs: action in one area will affect outcomes in others.

Table 4 below lists the SDGs and a selection of the activities of the third-party TIC sector that are contributing to them. Each SDG conceals numerous sub-goals to help monitor progress against the broader overall objectives (there are as many as 169 targets in total).

Table 4: How TIC helps meeting SDGs

Sustainable Development Goal (SDG)	How TIC is helping to meet it
1. **No poverty** End poverty in all its forms	→ NGO certification → Social audits → Inspection of agricultural crops
2. **Zero hunger** End all forms of hunger and malnutrition	→ Food certification and tests → System certification → Product origin and traceability
3. **Good health and wellbeing** Including universal health coverage	→ All Testing, Inspection and Certification of quality, health and safety
4. **Quality education** Achieving inclusive and quality education for all	→ Health and safety training → Environment training
5. **Gender equality** Ending all discrimination against women and girls	→ Gender equality certification → Diversity certification
6. **Clean water and sanitation** Universal safe and affordable water and services	→ Water sanitation plant inspections → Water supply network inspections → Sustainable plastics certification → HSSE impact assessments → Development of standards – **see section 3.2**
7. **Affordable and clean energy** Enhancing energy infrastructure and technology	→ CO2 emissions certification → Certification of solar and wind farms → Certification of energy performance
8. **Decent work and economic growth** Technological innovation, job creation and eradicating forced labour	→ Social audits → HSSE audits and certifications. → Business continuity
9. **Industry, innovation and infrastructure**	→ Certification of buildings, materials and infrastructure

[259] See UNDP's website: https://www.undp.org/content/undp/en/home/sustainable-development-goals.html

Sustainable Development Goal (SDG)	How TIC is helping to meet it
Mass transport, internet access and renewable energy	→ Internet of Things standards – **see section 3.4**
10. Reduced inequalities Within and between countries; economic inclusion of all	→ Gender equality certification → Diversity certification
11. Sustainable cities and communities Make cities and human settlements inclusive, safe, resilient and sustainable	→ Certification of buildings, materials and infrastructure
12. Responsible consumption and production Transforming and managing urban spaces	→ Consumer products and agri-food conformity assessment → Commodities conformity assessment
13. Climate action Taking urgent action to reduce the climate footprint of humans and its impacts	→ Certification in numerous areas, including: → Greenhouse gas certification → Carbon footprint certification
14. Life below water Conserve and sustainably use oceans, seas and marine resources	→ Sea water quality certification → Responsible fishing certification → Ship certification → Control of effluent
15. Life on land Protect, restore and promote sustainable use of terrestrial ecosystems	→ Biodiversity impact assessments → Agricultural product testing → Control of airborne emissions → Control of waste management → Greenhouse gas certification → Carbon footprint certification
16. Peace, justice and strong institutions peace, stability, human rights and effective governance based on the rule of law	→ Social audits → Corporate social responsibility management certification → Corporate social responsibility reporting verification
17. Partnership for the goals Strengthen global partnerships and cooperation	→ Responsible supplier program → Corporate social responsibility management certification → Corporate social responsibility reporting verification

Sources: UNDP, Bureau Veritas (2019) "Non-financial Statement"

ANNEX 3: Methodology

This annex describes the key methodological tools used to prepare the study.

Desk-based research

Key methodological tool for the following chapters of the study:

- Overview of the TIC sector
- Rationale for TICs
- Survey of major conformity assessment regulatory systems

Our desk-research followed a systematic and well-organised process to ensure that relevant materials were identified and reviewed efficiently at all stages of the research.

As a first task, we **developed a framework to guide our desk-research**.

In the case of the 'Overview of the TIC sector' chapter, this involved identifying and reviewing reports in the public domain with a view to gather statistics on:

- the size of the industry,
- the range of services offered and their relative importance, and
- trends expected to affect the size and composition of different TIC services.

For the 'Rationale for TICs' chapter, this involved identifying the various economic arguments that can be made for why TICs are beneficial, from the perspective of different stakeholder groups, including consumers, businesses, and policymakers.

To inform these chapters, we then conducted a **systematic and well-organised literature review**. This started by identifying relevant publications (i.e., academic articles, institutional reports and policy documents) using Google Scholar and wider internet searches as a search tool to identify relevant papers, research studies, and other materials. Further, any relevant studies and materials shared by the TIC Council were also covered by the review. While scanning items of literature, we also looked at the list of references included in articles, as a means of identifying further literature to be considered in the study. From the above process, we constructed a "long list" of potentially relevant literature. We then carried out an initial sifting of the literature on the "long list" to identify the articles that were subsequently studied in more detail. This sifting involved scanning each piece of literature to assess: whether it contained material relevant when thinking about the rationale of TIC services and whether the article represented a credible source (e.g., from a respected peer reviewed journal or government source). Ultimately, the literature with the highest relevance and quality was selected and cited in the study. Once all the papers on the master list had been reviewed, we began writing up the results of the literature review in a thematic way, based on our analytical framework described above.

The 'Survey of major conformity assessment regulatory systems' annex was also informed by desk research into the relevant legal instruments and any supporting guidance documents in each jurisdiction in order to provide an overview of the structure and operations of the conformity assessment systems at central level of government. The survey covered four jurisdictions, namely: China, the European Union, India, and the United States.

Interviews with stakeholders

Key methodological tool for the following chapters of the study:

- Rationale for TICs
- Discussion of the benefits
- Survey of major conformity assessment regulatory systems

Overall 15 interviews were conducted by senior members of our team with relevant stakeholders, including TIC members, policymakers and other interested parties, with respect to the 'Rationale for TICs' and 'Discussion of the benefits' chapters.

The conversations gave us a chance to understand what the important issues are for these parties. This was used to inform our approach to selecting and developing the case studies (including the identification of relevant materials) in the 'Discussion of the benefits' chapter, and also provided additional considerations for the 'Rationale for TICs' chapter of the report.

Interviews were also conducted with TIC members that have expertise in the conformity assessment systems of China, the European Union, and India, in order to improve understanding of how those systems operate in practice.

Case studies

Key methodological tool for the following chapter of the study:

- Discussion of the benefits

As Chapter 2 of the report shows, there are many different ways that the TIC sector can benefit different stakeholders. Quantifying all of the benefits is beyond the scope of this study. Consequently, in the 'Discussion of the benefits' chapter we sought to illustrate that these benefits can be material by looking at three case studies and attempting to value some of the benefits that might be attributed to the TIC sector in these examples.

As explained in Chapter 3, our approach to valuing some of these benefits is similar conceptually to the methodology that policy makers might use when assessing the likely impact of a proposed new regulation or evaluating how well a policy has worked in practice.[260]

First, we began with identifying the **mechanisms through which benefits might accrue** as a result of the TIC sector's contribution. This often includes a mix of direct and indirect benefits. Once the various links in this 'chain of causation' have been isolated, it becomes more tractable to estimate the likely magnitude of each link in isolation. To demonstrate that the contribution of the TIC sector can be material, it is sufficient to focus on a few key impacts for the case studies. Data availability may also limit the extent to which some of the benefits may be valued. For the purposes of the study, we identified the key mechanisms of effect to focus on for each case study based on their likely significance and magnitude of impact. This was also informed by our desk research (including the availability of information) and stakeholder interviews.

[260] See, for example, the European Commission's "Better Regulation Guidelines" https://ec.europa.eu/info/sites/info/files/better-regulation-guidelines.pdf

Second, a key component of the exercise was to **identify the counterfactual**, i.e. what would happen or would have happened absent the TIC sector? This is a crucial step so that only the added benefits of the TIC sector are quantified, and that we do not include benefits that would have happened anyway.

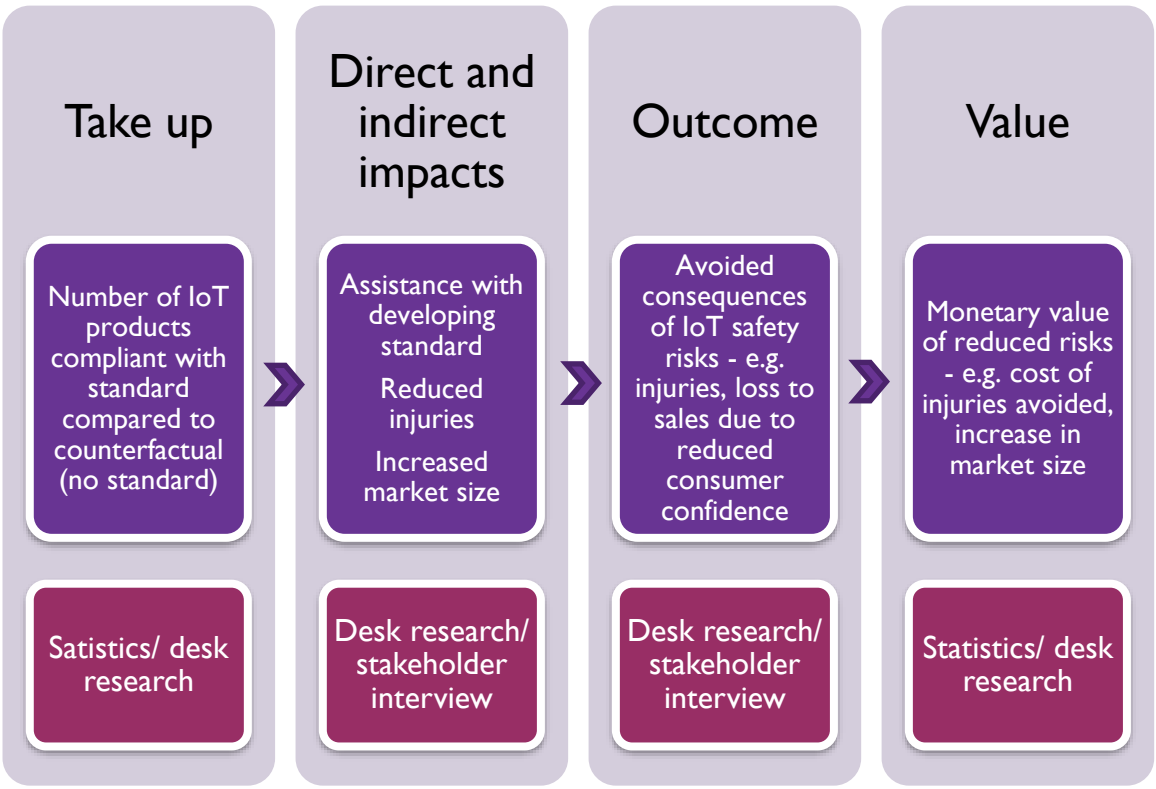
Our case studies considered that the options available absent the TIC sector will include parties conducting the work in-house, be that a producer performing its own testing or a government setting up its own testing facilities or developing new standards, or potentially foregoing some of the service altogether (i.e., the option of employing a different TIC firm does not exist). In particular, two of our case studies assume that absent the TIC sector the publication of the relevant standard (and any subsequent benefits provided by it) will be delayed. In our view, an assumption of a one-year delay appears both modest and reasonable. Our review of the literature suggests that the typical timeframe for establishing a standard can vary significantly between standards. For example, ISO notes that developing a standard from first proposal to final publication typically takes around three years.[261] At the same time, the development of the ASTM standard on connected consumer products took significantly less than a year from initiation to ballot approval. It included significant input from the TIC Council itself. [262] Based on these timelines, the assumption that the development of the standard would have taken one year longer absent the TIC sector does not appear unreasonable. Nevertheless, the estimated benefits obtained for a counterfactual involving a one-year delay may be scaled up or down to obtain broad estimates of the magnitude of benefits corresponding to any alternative timelines proposed – if the TIC sector expedites the development of helpful standards there are benefits.

Finally, using the information and data gathered through the desk research and stakeholder interviews, we **calculated the monetary value** of some of the benefits provided by the use of TIC services.

The figure below summarises our approach to quantifying some of the benefits of the TIC sector, along with the sources of information for each link in the chain, for the case study relating to 'smart products'. The other two case studies follow the same broad approach to quantifying some of the benefits provided by TIC.

[261] ISO (n.d.)
[262] See Chapter 3.4.3 of the study.

Figure 14: Approach to quantification for 'smart products' case study



Source: Europe Economics analysis.

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