

Standardization ecosystems, standardization strategies and transformative innovation policy

An increasing number of countries have published national standardization strategies. We review the content of a selected set of standardization strategy documents and argue that national innovation policy could benefit from an ecosystem perspective on standardization activities. Standardization may promote digital and green transition, but more impact assessment and empirical evidence is needed.

National standardization strategies focus on specific standardization priorities.

Standards are ubiquitous but quite invisible to consumers.ⁱ In the era of increasing geopolitical tensions, standardization can function both as a technical barrier to trade and as an enabler for trade. We review and compare the content of a selected set of standardization strategy documents. Consistent with recommendations of ISO (2020) most national standardization strategies focus on standardization priorities, for instance, by listing important emerging technologies. For an EU member state, such as Finland, the connection between national standardization strategy and the EU standardization strategy (European Commission 2022) is important.

Standardization impacts the rate and the direction of technological progress.

We claim that a major challenge in both traditional and transformative innovation policy is low awareness of standards and standardization – in Finland and elsewhere. Standardization should be considered an important innovation policy instrument and a key factor in the evolution of innovation ecosystems. Standardization can be viewed as mission-oriented open, transparent and consensus-based search and coordination mechanism for best possible solutions that may direct technological progress. There is a need for impact assessment of the role of standardization as the driver of digital and green twin transition.

All Finnish companies should be aware of the evolving standards and standardization environment, particularly in their target markets. They must make strategic decisions on whether they should actively participate in standardization activities in their own field. Investing in standardization education and making a closer link with innovation and standardization policies are potential means to boost standardization awareness. Finland's status as a forerunner of digitalization makes the country well-positioned to raise its standing in the field of digitalization of standardization related activities.



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Introduction

One definition for a standard by the ISO is that it is “a formula that describes the best way of doing something”.ⁱⁱ Standardization systems (standardization laws, regulations, standardization organizations) are institutions that may impact the rate and direction of technological progress at different regional levels (Grégoire-Zawilski & Popp 2024, Heikkilä & Rajavuori 2024). Yet, they seem to be marginalized in the context of innovation policy.

Empirical evidence indicates that national and international standards may have contradictory impacts: national standards may act as technical barriers to trade and, thus, often international standards are preferred as enablers of trade (Swann 2010). It has been estimated that international standards have contributed up to 13 % of the growth in global trade between 1995-2014 (Schmidt & Steingress 2022). From the perspective of a small open economy, such as Finland, it is natural to promote the role of international standards as enablers of trade since they are crucial for the scaling of Finnish export companies in their target markets.

In an era of geopolitical polarization and strategic competition, standardization organizations provide a platform in which stakeholders across the world gather together to coordinate possible (technical) solutions to various recurring technical challenges. The World Trade Organization’s (WTO) Technical Barriers to Trade Committee lists six standardization principles that should guide the development of international standards by its members: transparency, openness, impartiality and consensus, effectiveness and relevance, coherence and development dimension.ⁱⁱⁱ

In the 2000s, an increasing number of countries have published “national standardization strategies” (Hemphill 2009, ISO 2020, Heikkilä & Rajavuori 2024) or “standardization agendas” (e.g., the Netherlands), which aim to foster general standardization awareness, promote local standardization activities and competitiveness (Hemphill 2009). Currently, the Finnish government is planning to develop a national standardization strategy.^{iv}

According to ISO (2020) a national standardization strategy (NSS) is a “Strategy developed under responsibility of the NSB [National Standardization Body] and formally approved by its governing body. The NSS identifies priorities for the development of national standards based on an identification of national needs and priorities, to whose attainment standards may contribute key services.”

Briefly put, the ISO approach to the development of a national standardization strategy puts emphasis on identification of “national priorities for standardization” by stakeholders. A key component in the ISO approach is “national standardization plan” that contains “a list of priority standards for development (through adoption, national development or participation in regional or international standardization projects), together with a project plan and deadlines for the implementation, as well as a resource plan” and it can be a core element of the NSS document and typically lasts for three years (ISO 2020, pp. 76, 163). In the EU contexts, the EU-level strategies and priorities

National standardization strategies are becoming more common.

(European Commission 2022) impact more or less the scope of national standardization strategies of member states.

ISO (2020, p. 80) suggests one model of a possible structure of an NSS document to be as follows:

- Introduction
- Role of the NSB in the country and main benefits expected from standardization
- Rationale and development process of the standardization strategy, time validity of the strategy, and approach to keeping it up-to-date
- National priority areas and priority topics identified
- Description of how standardization can benefit these priorities
- National standardization plan (NSP) with a list of national projects, the types of the project, timeframes, and responsible body for the development
- The resources needed by the NSB to implement the NSP

While the presented structure focuses on national strategies, ISO (2020, p. 100-103) discusses also alternative models of regional cooperation ranging from “only national initiative” to “full-scale regional or international engagement with a priority given to the development of standards through regional or international standards organizations” where the exclusive development of national standards is an exception. Presumably, the latter reflects the approach of the EU members such as Finland. Next, we provide a comparison and an overview of a selected set of national and regional standardization strategies and discuss their policy implications.

Data: Standardization strategy documents

We collected information about seven country’s national standardization strategies and conducted a simple content analysis following Hemphill (2009) and ISO (2020). The focus is on G7 countries with standardization strategy documents and countries that are particularly important trade partners of Finland (see Table 1). In addition, we reviewed the standardization strategies of the EU (European Commission 2022) and China. It should be noted that China has significantly increased its contributions to international standardization in the 2000s (Zhu 2024).

Previously, Heikkilä and Rajavuori (2024) listed visions and mission of specific standardization strategies illustrating that standardization is in practice a mission-oriented activity. Here the focus is rather on priorities presented in the standardization strategy documents. We acknowledge that the content analysis is selective. However, the material is publicly available online for other researchers to replicate or extend the content analysis and cross-check the observations.

Observations

Based on the content analysis, there is no standard for a national standardization strategy. The observation is consistent with Hemphill (2009) who reported that no convergence was observed among national standardization strategies. Rather, different countries focus on different aspects and “national priorities”.

There is no standard for a national standardization strategy.

Table 1 summarizes some selected priorities (incl. goals, targets, themes, etc.) presented in the standardization strategy documents. Interestingly, all the documents emphasize the importance of international standards to some extent. It also shows that majority of the documents relate standardization activities to the twin transition, the development of digital technologies and the role of standards in promoting ecologically sustainable economy (green).

Table 1. Selected national standardization strategies

| Country/ region | Standardization strategy (publication year) | National (regional) standardization priorities | Promotion of international standards* | Link of priorities to the twin transition* | | Finnish exports by country/region (2022) | |
|-------------------|---|--|---------------------------------------|--|-------|--|------------------------|
| | | | | Digital | Green | Gross exports (B€) | Share of gross exports |
| European Union | An EU Strategy on Standardisation Setting global standards in support of a resilient, green and digital EU single market (2022) | Leveraging the European standardisation system – to deliver on the twin green and digital transition and support the resilience of the single market; Upholding the integrity, inclusiveness and accessibility of the European standardisation system – putting good governance principles in place; Global standards-setting: supporting the EU's leading position as a forerunner in key technologies and promoting EU core values; Cutting-edge innovation that fosters timely standards; Ensuring future standardisation expertise – the need for education and skills | X | X | X | 64.5 | 53.4 % |
| Sweden | The Swedish Standardisation Strategy (2014) | Three pillars and related targets: 1. Proactivity and focus (Targets: Swedish work with standardisation shall satisfy the cross-functional requirements necessary for societal development; Global standards shall be the preferred alternative for Swedish standardisation; Swedish innovations shall become new global standards; Strengthened Swedish influence in international standardisation; Stakeholder needs shall guide the development of standards; Standards are considered as support in implementing laws) 2. Accessibility and usability (Target: Standards must be easy to access, understand and use) 3. Knowledge and commitment (Target: Swedish stakeholders know how standards and standardisation can be used to strengthen their operations) | X | X | | 16.5 | 13.7 % |
| Germany | German Standardization Strategy (2016) | Six goals: 1. International and European trade is facilitated by standardization. 2. Standardization is an instrument of deregulation. 3. Germany is at the forefront in bringing future-oriented topics into standardization on a worldwide scale through the networking of stakeholders and the establishment of new processes and open platforms for coordination. 4. Industry and society are the driving forces in standardization. 5. Standardization is used in particular by companies as an important strategic instrument. 6. Standardization is highly regarded by the public. | X | X | | 9.7 | 8.0 % |
| The Netherlands | Normalisatieagenda 2021-2023 (2021) | Specific themes: Digital transformation, Climate and sustainability, Living & Working Environment, Mobility, Key Technologies | X | X | X | 8.1 | 6.7 % |
| France | The French Standardization Strategy (2019) | In a perspective of sustainable development, the French Standardization Strategy is structured around three challenges facing our societies today: the fight against climate change, controlled digitization and a more inclusive society. | X | X | X | 3.3 | 2.7 % |
| The United States | Unites States Standards Strategy (2020) | Twelve strategic initiatives: 1. Strengthen participation by government at all levels in the development and use of voluntary consensus standards through public-private partnerships. 2. Continue to address the environment, health, safety, and sustainability in the development of voluntary consensus standards. 3. Improve the responsiveness of the standards system to the interests of consumers. 4. Actively promote the consistent worldwide application of internationally recognized principles in the development of standards. 5. Encourage common approaches by governments to the use of voluntary consensus standards as tools for supporting regulatory needs. 6. Work to prevent standards and their application from becoming technical trade barriers to U.S. products and services. 7. Strengthen international outreach programs to promote understanding of how U.S. voluntary, consensus-based, market-driven standards can benefit businesses, consumers, and society as a whole. 8. Continue to improve tools for the efficient and timely development and distribution of voluntary consensus standards. 9. Promote cooperation and coherence in standards activities. 10. Promote and encourage a standards-literate workforce by building standards awareness and competence among various communities. 11. Respect diverse funding models for the U.S. standards system. 12. Address the need for standards in support of emerging national priorities. | X | | | 13.7 | 11.3 % |
| | United States Government National Standards Strategy for Critical and Emerging Technology (2023) | The United States will prioritize efforts for standards development for a subset of CET (critical and emerging technologies) that are essential for U.S. competitiveness and national security. Objective 1: Investment, Objective 2: Participation, Objective 3: Workforce, Objective 4: Integrity and inclusivity. | X | X | | | |
| Canada | Development of a National Standards Strategy (2022) | System priorities: Strengthen diversity, equity, inclusion and participation in the standards system; Support facilitation of trade in goods and services through harmonized standards solutions; Standards system sustainability; Strengthen engagement with Indigenous Peoples. Sector priorities: Climate change mitigation, adaptation and resilience; Environmental social and corporate governance; Health, well-being and safety; Digital economy and advanced manufacturing; Supply chain stability. | X | X | X | 1.5 | 1.2 % |
| China | National Standardization Development Outline (2021) | Promote the interactive development of standardization and scientific and technological innovation; Improve the level of industrial standardization; Improve the standardization of green development; Speed up the process of standardization of urban and rural construction and social construction | X | X | X | 5.4 | 4.5 % |

Notes: The source of export data is Statistics Finland, see: <https://stat.fi/tup/kokeelliset-tilastot/arvonlisapohjainen-ulkomaankauppa/2024-03-28/index.html> *Links to the twin transition are interpreted broadly: digital is positive if standardization in the field of ICT is highlighted, green is positive if standardization is linked to climate action, promotion of green standard, etc.

A reoccurring section in the standardization strategies was the focus on specific national priorities (themes, technologies, etc.). This is in line with ISO's recommendations (2020). Some of the reviewed strategies list specific technologies that are considered to be of particular importance. For instance, the National Institute of Standards and Technology (NIST) of the US was in charge of forming the National Standardization Strategy for Critical and Emerging Technologies.^v On the other hand, another reoccurring theme in multiple strategies was the important role of standardization in promoting the United Nations' Sustainable Development Goals (SDGs).^{vi} Thus, standardization can be viewed as a process of developing global public goods (Heikkilä & Rajavuori 2024).

In addition to the EU strategy, the need for standardization education was mentioned in some of the national strategies. Standardization education is a tool to increase standardization awareness. ANSI's strategy states *that "Standards developers, industry, academia, technical and trade schools, ANSI, and government should collaborate to develop new or enhance existing standards education programs that build awareness of the value of standards and the standardization process to U.S. prosperity and quality of life"*. Meanwhile the EU strategy on standardization notes: *"There is no formal education nor vocational training on standardisation. Many EU companies – whether large or small – lack a structured and strategic approach to standardisation capturing its relevance for various economic operations, whether it is legal compliance, market access or general business strategy."*

There is no reason to believe that the situation significantly differs in Finland. Heikkilä et al. (2024) provide anecdotal preliminary evidence that Finnish companies do not often have explicit standardization strategies although they have specific practices that have emerged via "learning by doing" business (in particular due to customer requirements). The Finnish Standardization Panel pilot study (as part of the StandardEdge project) confirms this, as most of the interviewed stakeholders have noted the lack of systematic standardization education in Finland and stated that "the learning of the role of standards for businesses has happened via 'learning by doing' in companies and other organizations" (Heikkilä 2024).

Challenges for (transformative) innovation policy and twin transition

Standardization is a blind spot of innovation policy; standardization awareness could be improved.

One important challenge for innovation policy is the low level of standardization awareness and lack of ecosystem perspective on standardization. While standardization may impact technological progress and productivity like innovations and patent systems do, innovation policy researchers often neglect standardization when considering innovation policy instruments (cf. Schot & Steinmueller 2018, Bloom et al. 2019, Heikkilä & Rajavuori 2024).

Is standardization a focal transformative innovation policy instrument and a driver for twin transition?

The transformative innovation policy (TIP) approach (Schot & Steinmueller 2018, Lemola 2021, Haddad et al. 2022) has gained traction in recent years, but like the mission-oriented innovation policy (Haddad et al. 2022, Gronchi et al. 2023) it also lacks the link to standardization ecosystems. TIP emphasizes the need for multi-stakeholder collaboration - that is, collaboration among policymakers, researchers, industries, communities, and civil society to co-create innovative solutions. Open and consensus-

based standardization is such a platform for diverse stakeholders to find (technical) solutions to reoccurring problems.

There have also been attempts to link standards to Sustainable Development Goals, which illustrates how standardization may impact directionality and focus on solving grand challenges. Haddad et al. (2022) urged TIP scholars to develop more concrete models and guidelines for practitioners. Could standardization be considered a focal transformative innovation policy instrument? As a factor of quality infrastructure (Blind 2024), could standards be utilized more effectively in promoting the green and digital twin transition? Recent geopolitical developments challenge the green transition (cf. Deschryvere & Rouvinen 2024).

Table 2 illustrates the potential links between standardization and different innovation policy instruments. Standards may have significant impacts and both positive and negative externalities, but quantification of these, including the role of standards as enablers of or barriers to trade is quite challenging, as their impacts spill over to standardization stakeholders across standardization ecosystems internationally.

Table 2. Potential links of innovation policy instruments to standardization

| Innovation policy instrument | Bloom et al. (2019) | Takalo & Toivanen (2021) | Potential links to standardization |
|---|---------------------|--------------------------|--|
| Direct R&D grants | X | X | Link to standardization as one R&D grant criteria. How does the publicly funded R&D project contribute to (international) standardization? |
| R&D tax credits | X | | The salary of R&D employees participating and contributing to standardization impacts the amount of R&D tax credits. |
| Intellectual property reform | X | X | Standards organizations have IPR policies that determine the licensing terms related to IPR. |
| Patent box | X | | |
| Innovation prizes and inducement prize contests | | X | Standardization as a collaborative alternative method to solve grand challenges. |
| Skilled migration | X | X | International mobility and migration of standardization experts promotes the diffusion of standardization know-how and knowledge about market-specific standardization environments. |
| Universities: incentives | X | | Education on standardization (knowledge on technical substance of standards, standardization processes and strategic standardization) |
| Universities: STEM supply | X | | Standards are related to all fields, but they are particularly important in STEM fields. Standardization education promotes awareness, efficient use and development of standards. |
| Education and basic research | | X | |
| Trade and competition | X | X | An essential goal of international standardization is to reduce technical barriers to trade (WTO TBT). |
| Public procurement | | X | Standards as criteria in the tendering processes and in the selection of suppliers. |
| Mission-oriented policies | X | | Standardization is in itself mission-oriented search for solutions to reoccurring problems. |

Notes: Adapted and translated from Heikkilä & Rajavuori (2024).

There are several definitions for "innovation ecosystem". Fransman (2018, p. 103) defines it as "a group of players and processes who through their symbiotic interactions (both cooperative and competitive) make innovation happen and, by so doing, coevolve over time." More recently, Granstrand and Holgersson (2020, p. 3) made a comprehensive review of the concept and define an innovation ecosystem as "the

evolving set of actors, activities, and artifacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors”.

Given these definitions, it is clear that standardization institutions and actors participating in standardization activities fit these definitions and could be considered important elements of innovation ecosystems. In the Finnish context, Business Finland is a crucial actor in advancing mission-oriented innovation through funding and supporting activities aimed at addressing complex societal challenges, as noted by Martins et al. (2024). Business Finland can impact the incentives to participate (or not to participate) in standardization activities via the criteria of various funding instruments (e.g., “Leading companies and ecosystems”, Veturit).

Proposals for actions

In the Finnish context, anecdotal evidence indicates that many Finnish companies have not adopted strategic approaches to standardization (Heikkilä et al. 2024) and the standardization education in Finland is not systematic (Heikkilä 2024). Based on the content analysis of the selected national standardization strategies (of Finland’s important trade partners) and recent empirical research on the Finnish standardization ecosystem (Heikkilä 2024, Heikkilä et al. 2024), we derive the following managerial and innovation policy implications:

Standardization awareness and education. Given the level of current knowledge, national standardization strategy should focus on increasing standardization awareness and developing standardization education. The stakeholders of the Finnish innovation ecosystem could consider how standardization may help or hinder in achieving their objectives. Could public R&D funding (Business Finland) be more strongly linked to standardization?

Strategic approach to standardization. Stakeholders should acknowledge that it is a strategic choice to participate in standardization. In other words, it should be a conscious choice whether the aim is to be a standards maker (leader) or a standards taker (follower). Digitalization challenges and disrupts the business models of standards development organizations. As Finland is one of the global leaders in digitalization (e.g., by European Commission’s Digital Economy and Society Index, Digibarometri), could Finland also act as a forerunner in the field of digitalization of standardization related processes and activities?^{vii}

Standardization priorities and directionality. Standardization touches all industries, but existing standardization strategies direct attention to national priorities that are particularly important for a country’s competitiveness and/or to cross-cutting themes (e.g., environmentally friendly standards, SDGs). As national standardization strategy documents link standardization to the twin transition, the role of standards in promoting the digital and green transition should be evaluated more systematically.

Interaction between regional and international standards and regulations. For an EU member state, such as Finland, national standardization strategy is by default subordinate to the EU standardization strategy. Their interaction should not be ignored. Presumably, it is more efficient to cooperate in the development of European standardization education and there are already initiatives that aim to boost this.^{viii}

Stakeholders should acknowledge that it is a strategic choice to participate in standardization.

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ⁱ See Grillo et al. (2024) for a recent overview of standardization research trends.

ⁱⁱ <https://www.iso.org/standards.html> There are also other definitions, see, e.g., the definition by the International Electrotechnical Commission: <https://iec.ch/publications/international-standards>. International Telecommunications Union's Telecommunication Standardization Sector publishes Recommendations that are “standards defining how telecommunication networks operate and interwork.”. See <https://www.itu.int/en/ITU-T/publications/Pages/recs.aspx>

ⁱⁱⁱ https://www.wto.org/english/tratop_e/tbt_e/principles_standards_tbt_e.htm

^{iv} Section 6.1 of the Programme of Prime Minister Petteri Orpo's Government (20 June 2023) states: “The Government will draw up a national standardisation strategy that will define the national priorities for standardisation and strengthen the role of standardisation in supporting the competitiveness of Finnish companies.”

<https://julkaisut.valtioneuvosto.fi/handle/10024/165044>

^v <https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/04/fact-sheet-biden-harris-administration-announces-national-standards-strategy-for-critical-and-emerging-technology/>

^{vi} ISO – Sustainable Development Goals, <https://www.iso.org/sdg/>

^{vii} <https://www.etla.fi/julkaisut/muut-julkaisut/digibarometri-2023-data-tekoaly-ja-talouskasvu/>, <https://digital-decade-desi.digital-strategy.ec.europa.eu/>

^{viii} For recent initiatives, see High-Level Forum on European Standardisation, https://single-market-economy.ec.europa.eu/single-market/european-standards/standardisation-policy/high-level-forum-european-standardisation_en, Edu4Standards, <https://www.edu4standards.eu/>