



European Standardisation Panel Survey

Final report

Independent
Expert
Report



Research and
Innovation

European Standardisation Panel Survey

European Commission
Directorate-General for Research and Innovation
Directorate E
Prosperity Unit E.2 – Valorisation Policies and IPR
Contact Gergely Tardos
Email Gergely.Tardos@ec.europa.eu
RTD-PUBLICATIONS@ec.europa.eu

European Commission
B-1049 Brussels

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European Standardisation Panel Survey

Knut Blind, Fraunhofer Institute for Systems and Innovation Research and
Technische Universität Berlin

Luzie Kromer, Technische Universität Berlin

Peter Neuhäusler, Fraunhofer Institute for Systems and Innovation Research

Daniele Rosenberg, Technische Universität Berlin

Torben Schubert, Fraunhofer Institute for Systems and Innovation Research

Edited by: Federica Baldan and Gergely Tardos, Directorate-General for Research
and Innovation, European Commission

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ABBREVIATIONS

CEN	EUROPEAN COMMITTEE FOR STANDARDISATION
CENELEC	European Committee for Electrotechnical Standardisation
DIN	Deutsches Institut für Normung e.V.
ESPS	European Standardisation Panel Survey
ETSI	European Telecommunications Standards Institute
EU	European Union
FP	Framework Programme
GSPS	German Standardisation Panel Survey
HEI	higher education institute
ICT	information and communications technology
IEC	International Electrotechnical Commission
IPR	intellectual property right
ISO	International Organisation for Standardization
IT	information technology
ITU	International Telecommunication Union
OECD	Organisation for Economic Co-operation and Development
NGO	non-governmental organisation
PRO	public research organisation
R & D	research and development
R & I	research and Innovation
SDG	Sustainable Development Goal
SDO	standard development organisation
SMES	small and medium-sized enterprises

EXECUTIVE SUMMARY

This pilot project aimed to develop and implement a European Standardisation Panel Survey (ESPS), that is, to collect data on the standardisation activities and needs of EU organisations in general and related to R & I-based standardisation and standards in particular. The analysis of this data contributed to:

- identify the demand from industry and other stakeholders for standards as potential results of R & I projects;
- assess how the EU R & I framework programmes could tackle the standardisation needs of industry;
- raise awareness of the importance of standardisation as a knowledge valorisation channel for industry.

The insights from this analysis form the basis for developing strategies for the involvement of R & I-performing actors in European and international standardisation, reflecting in particular the industry demand to eventually generate standards to match the supply of R & I-based standards.

The final report is structured as follows:

- Chapter 2 provides a review of the relevant literature;
- Chapter 3 describes how the survey was implemented;
- Chapter 4 displays the results of the survey;
- Chapter 5 presents the recommendations derived from the survey. These recommendations take into account the literature review and the discussion that took place in the final workshop.

The survey

The survey questionnaire was developed on the basis of the insights gained from the literature, the experience of the German Standardisation Panel Survey, and the feedback from the European Commission, industry experts and the presidential committee of the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (Cenelec) – jointly known as CEN-Cenelec. Based on the answers of more than 3 700 respondents, we provide some insights from the answers to the main questions of the ESPS and derive recommendations.

Sample characteristics

The large majority of the respondents work for industry, mainly mechanical and electrical engineering companies. However, other stakeholders, such as experts from non-governmental organisations, higher education institutes (HEIs), public research organisations (PROs) and the public sector, also answered the questionnaire. Overall, we achieved a balance between large organisations with over 250 employees and small

organisations, particularly small and medium-sized enterprises (SMEs). More than 80 % of the experts are male, and more than 60 % are aged over 50.

General relevance of standards

Formal European standards followed by international standards were found to be most important. However, European technical specifications, such as CEN workshop agreements, and national standards have almost the same relevance. For respondents, formal standards are most relevant for legal security, but they also facilitate market access or achieve technical interoperability, for which technical specifications are almost equally relevant. Internal company standards are essential for firms to improve quality. Other types of standards are of limited relevance.

Research and development collaboration partners

More than half of the responding organisations perform research and development (R & D) and have introduced product or process innovations. Collaborations with PROs and universities are relevant. After further education and informal contacts, common standardisation activities are rated as the most effective form of cooperation with scientific institutions for knowledge transfer.

Research as input into standardisation

Policy initiatives, including regulations and customers' requirements, particularly for industry, as well as organisations' own and collaborative research, are the most relevant sources for standard development. Research input is most important for measurement and testing standards, followed by quality and environmental standards. The most significant advantage of research as input for standardisation is free access to scientific content and the ability to keep track of scientific progress. Challenges include the lack of validation of research results, but the need for R & D staff to have expertise in standardisation is also a problem. However, overall, the advantages of integrating research results into standardisation are much greater than the disadvantages.

Approaches to the integration of research in standardisation

There are various approaches to improving the integration of research results as input for standard development. Increasing knowledge by HEIs and PROs was found to be most effective, followed by more companies' involvement in publicly funded research projects, particularly SMEs. However, funding standardisation as a means of exploiting research results seems also to work. Lastly, including research into standards, which are the basis of innovation, fosters the primary function of standards, such as facilitating market access, strengthening consumer confidence in innovative products, wider use of recognised methods and better documentation of R & D results.

Organisations' engagement in standardisation

The most critical needs to increase organisations' engagement in standardisation are related to a lack of awareness of the benefits of standardisation, particularly the financial returns. Involvement in standardisation processes requires adequate resources and a time commitment. More specifically, financial facilitation, such as tax reductions for companies active in standardisation or public funding for companies' projects, were mentioned very often. In addition, there is a need – also supported by SDOs – to make companies more aware of the benefits that standardisation brings so that they change their internal

structures to foster employee engagement in standardisation, which is also required for HEIs and PROs.

Furthermore, there is a need for clearer, more realistic, more understandable and more accessible information on standardisation. In addition, there is room for improvement in the work of SDOs, particularly the diversity of committee composition and the speed of processes. Lastly, a reduction of membership fees for those participating in standardisation committees is mentioned.

Companies' competitiveness can be strengthened if their participation in standardisation brings benefits, for example by lowering costs, but also facilitates market entry or increases consumer confidence. Furthermore, training for personnel developing standards and the provision of consultancy by SDOs are mentioned as helpful. Since standards are often closely linked to the regulatory framework in the EU, they should be well aligned with governmental regulations to foster companies' competitiveness.

Related to the need for companies to foster closer cooperation with research in standardisation, better coordination between SDOs, research institutions and industry is required, which could be enhanced by networks that need to be created. HEIs and PROs need to increase their standardisation-related knowledge, capacity and incentives. However, the capability to get effectively involved in standardisation must also be strengthened within companies. Furthermore, communication capacity is needed to support and exploit opportunities for interdisciplinary collaboration to develop comprehensive and easily implementable standards. Here, project-based funding for collaborative research related to standardisation and the inclusion of standardisation as a work package in research projects are suggested. These approaches would also improve the practical applicability and the market orientation of research results. Lastly, education and continuous internal training are needed to cooperate with research organisations effectively.

The following policy recommendations are derived from the survey responses and the discussions at the online workshop.

Recommendations addressing industry

Raising awareness

It is recommended that awareness within companies of the benefits of participating in standardisation in general and of its coordination with research is increased.

Resources for standardisation contributing to shaping regulatory frameworks

It is recommended that adequate resources for standardisation activities are provided to exploit the opportunities offered by research but also to direct future regulatory developments.

Specific focus on small and medium-sized enterprises

It is recommended that research-active SMEs join standardisation efforts, because they benefit from research-driven standardisation, for example by keeping track of scientific and technical progress and using their research results to develop innovative products, including improving their quality. Furthermore, standards can prevent proprietary dominant designs from hampering SMEs' market entry.

Recommendations addressing higher education institutes and public research organisations

Raising awareness

It is recommended that awareness about the relevance of standardisation is increased, for example for organisations performing their own research.

Resources for standardisation

It is recommended that adequate funding is provided for involvement in standardisation activities.

Performance indicators

It is recommended that performance indicators for standard development, similar to those for scientific publications and patents, are developed and established.

Education about standardisation

It is recommended that HEIs expand their education and training activities on standardisation, particularly engaging female students to address the gender imbalance in the domain of standardisation.

Recommendations addressing standard development organisations

Standardisation processes

It is recommended that the agility of standardisation processes is increased to allow the timely release of standards.

Service portfolio

It is recommended that the service portfolios for R & I actors are expanded and that new ways are examined to align their activities with R & I, which would be particularly appreciated by smaller research organisations.

Awareness of products

It is recommended that the limited awareness of workshop agreements is increased, as their impact was found to be similar to that of standards.

Open source software and hardware

It is recommended that open-source software and hardware is considered explicitly within policies on intellectual property rights, but also closer collaboration with open source communities to speed up the processes, including increasing the agility of standard development, and include research-performing SMEs.

Monitoring implementation of standards

It is recommended that the implementation of standards-based certification is monitored to collect feedback to be considered in revising or withdrawing existing standards to maintain an up-to-date stock of standards that enhance firms' competitiveness.

Recommendations addressing research funding organisations

Funding at the EU level

It is recommended that new funding schemes are established, for example dedicated calls focusing on standardisation, or that the financial support for standardisation as a means of knowledge valorisation is continued and expanded through the uptake of research results generated within framework programmes.

Funding at the Member State level

It is recommended that existing funding programmes to align with national research programmes are continued or expanded and that Member States without similar funding programmes establish such schemes.

Higher education institutes and public research organisations

It is recommended that HEIs and PROs are explicitly considered in the public funding schemes to improve their knowledge about standardisation and increase their representation in standardisation activities.

Smaller organisations

It is recommended that smaller organisations, particularly SMEs, are considered in support programmes on standardisation because of their greater need for support from SDOs in integrating research results into standardisation.

Recommendations for other areas of innovation policy

Including standardisation in the definition of research and development and innovation

It is recommended that the comprehensive integration of standardisation is discussed in the upcoming revisions of the Organisation for Economic Co-operation and Development Frascati and the Oslo manuals to allow the development of indicators and evaluation systems.

Research tax credit

It is recommended that Member States with a research tax credit system expand the tax base to expenditure arising from participation in standardisation, in particular for the benefit SMEs. Furthermore, SMEs do not benefit in the same way as large organisations from public research funding programmes.

Research and innovation funding programmes

It is suggested that standardisation is considered in further R & I-related support programmes targeting SMEs.

Regulation

It is recommended that *ex ante* regulatory impact assessments screen the existing standards landscape and use the existing scientific evidence base to avoid potential duplication contradiction.

Public procurement

It is recommended that research-based standards are considered in updating the public procurement directive and the relevant EU funding programmes.

Considering that the R&I ecosystem involves a variety of stakeholders, governance levels, strategies and policy areas, the effective implementation of the above-mentioned recommendations lies in the close collaboration among various actors and alignment of instruments across multiple levels.

1. INTRODUCTION

This report is the final report of the project 'European Standardisation Panel Survey', undertaken for the European Commission Directorate-General for Research and Innovation.

The objectives of this pilot project were to develop and implement the European Standardisation Panel Survey (ESPS), that is, to collect data on the standardisation activities and needs of EU companies in general, and those related to research and innovation (R & I) standardisation and standards in particular, to generate empirical evidence for analyses to:

- help identify industry's and other stakeholders' demand for standards as potential results of R & I projects;
- contribute to an assessment of how EU R & I framework programmes tackle the standardisation needs of the industry;
- raise awareness of the importance of standardisation in general and its interface with R & I for industry.

These insights form the basis for developing strategies for the involvement of R & I-performing actors in European and international standardisation, reflecting, in particular, the industry demand to eventually generate standards to match the supply of R&I-based standards. Therefore, it is essential to increase understanding of the challenges of and obstacles to integrating R & I results in standardisation processes, considering the future implementation of standards. Lastly, more insights are needed into the complex effects of standardisation and standards on entrepreneurial and commercial success.

Comprehensive proposals have to be developed to increase the involvement of R & I actors in European and international standardisation in general, particularly with a special focus on the potential role of R & I results. They must address the various stakeholders, namely industry, research organisations, standardisation bodies and policymakers. Furthermore, the various policy areas beyond research policy must be considered, for example regulation of formulating mandates from the European Commission addressing the European standardisation organisations. Undertaking the European Standardisation Panel Survey (ESPS) represents a significant challenge because such an attempt has not been made before. Furthermore, the study has the character of a pilot. Therefore, it has to reveal both the options that exist and which limitations must be considered. Lastly, the available budget and the limited time frame mean exploiting previous experiences and available synergies. Against this background and the study's objectives, we proposed the following methodological approach for designing and implementing the ESPS.

Since the ESPS should generate a sound database that would allow analyses to identify the industry demand for standards as outputs of R & I projects, we focused on a pilot survey of those organisations already active in standard development because they either have already gained experience of the role of R & I findings as input for standardisation processes or can assess their relevance based on their past involvement in standardisation. Confronting organisations without experience of this specific topic would be neither effective nor efficient because they are probably neither willing to nor capable of responding correctly and extensively to such a survey.

Therefore, we relied on the experience gained since 2012 from the undertaking of the German Standardisation Panel Survey (GSPS). In that survey, more than 30 000 experts involved in the technical committees and working groups of the German Institute for Standardization, DIN, are approached once a year and asked about their activities in standardisation and their use of standards and a specific topic such as trade issues with the United States and China, as in recent issues, or the role of the Sustainable Development Goals (SDGs) in general or specifically on climate change (SDG 13) or affordable and clean energy (SDG 7) in their activities. A response rate of up to 10 % generated a database representative of German organisations active in standardisation at DIN, based on validation checks with the universe of all active organisations to identify sector or size bias.

For undertaking the ESPS, the member countries of the European Committee for Standardization (CEN) and the European Committee for Electrotechnical Standardization (Cenelec) – jointly known as CEN-Cenelec – and the European Telecommunications Standards Institute (ETSI) supported the distribution of the survey among companies in the EU and the other European countries covered by CEN-Cenelec. ETSI has also committed to sending the ESPS questionnaire to its members. In addition to the English version of the questionnaire, versions in French, German, Italian and Spanish have been provided.

The experts and organisations were asked for their current and future needs for standards resulting from R & I projects in general and those funded within the EU R & I framework programmes in particular. In addition to a set of closed questions, we allowed answers to open questions, collecting ideas for challenging questions about the standardisation landscape without providing specific solutions. The survey questions were drafted to allow the development of strategies for the involvement of R & I actors in European and international standardisation activities related to the R & I-based standards demanded by industry. In particular, the questions were drafted to help us understand drivers of and obstacles to integrating R & I results in standardisation processes and implementing the resulting standards and the impacts of standardisation and standards on organisations' performance.

The report is structured as follows:

- Chapter 2 provides a review of the relevant literature;
- Chapter 3 described how the survey was implemented;
- Chapter 4 displays the results of the survey;
- Chapter 5 presents the recommendations derived from the survey, considering the insights gained from the literature and the discussions at the workshop.

2. LITERATURE REVIEW

Within the analysis of the literature, scientific publications in the field of standardisation with a link to R & I were systematically screened and evaluated. Suggestions made at the inception meeting were integrated into an update of the literature review and new publications screened until December 2023.

In the first step, the extensive literature collections in Hermann et al. (2020), Blind (2022), and Blind et al. (2023) were checked for publications relevant to the study as was the scoping study for the code of practice on standardisation (European Commission et al., 2022). The analysis of these papers revealed that previous work has been focused on Europe and the United States. This focus is explicitly laid out by Baron and Spulber (2018), looking at different SDOs, which have – in addition to the international bodies – their origin in either the United States or Europe. However, their review summarises SDOs with a strong focus on information and communication technologies. Recently, studies have also investigated the situation in China. Other countries are rarely addressed.

Based on these findings, first, the state of the literature on the importance of standardisation for knowledge and technology transfer was summarised. Second, an overview of the drivers of and obstacles to standardisation in companies and research organisations was compiled. Then, a few studies on the role of standards for R & I were identified and summarised. The results of the literature analysis are presented below.

First, we start with a brief section about the general functions and benefits of standards and standardisation for R & I. Standards are commonly agreed reference documents that help to bring order to the world, officially defined as documents ‘established by consensus and approved by a recognised body that provides common and repeated use, the rules, guidelines or characteristics for activities or their results, aimed at achieving the optimum degree of order in a given context’ (1). Formal technical documents usually define criteria, methods, processes and practices. Most standards have been around for some time, but many new standards have been developed in the last few years. In addition, existing standards have to be revised and updated to ensure that they remain fit for purpose as new materials, technologies, products and processes become available. External factors can also prompt new standards, such as an increased need to protect the environment or to address concerns on the part of consumers or public bodies about products or services.

2.1. Benefits of standards and standardisation for research and innovation

Standards can support R & I (2). Moreover, they promote the adoption of new technologies in several ways. Importantly, they can codify and spread state-of-the-art research in various areas and bridge the gap between research and end products or services. When knowledge of innovations is codified in standards, it is accessible to everybody, so firms, universities and research organisations can use it to perform research, generate new ideas and adopt innovations.

Moreover, standards are commonly used as inputs to research but can also be an output of research activities. Multiple studies have explored the role of standards in supporting and driving R & I (see, for example, Blind and Gauch, 2009; Technopolis, 2013; Optimat, 2015; Hermann et al., 2020; European Commission et al., 2022), and these have identified various benefits flowing from the integration of standardisation within research.

Significantly, standards improve the research process by providing common terminologies, harmonised methodologies and comparability between research activities. They can also enhance the marketability of R & I results. Standards also contribute to bridging the gap between research and the market by:

(1) ISO/IEC Guide 2: 2004.

(2) See, for example, the recent reviews by Blind (2022) and Blind et al. (2023).

- fostering dissemination and long-term exploitation of research results;
- accelerating access to the European market for new products, methods and services;
- facilitating networking between stakeholders in the R & I system

In a study for CEN-Cenelec on the role of standardisation in research projects funded within various framework programmes (FPs), project coordinators indicated that using standards as inputs – the most common way by which framework programme projects use standards – was of significant importance to the overall success of their research (Technopolis, 2013), which has been confirmed by a follow-up study (European Commission et al., 2022). Standards were found to improve the research activities (improved understanding of the state of the art, efficiency of project activities, quality of outputs), as well as helping to ensure that project activities and outputs would be applicable, interoperable and widely accepted. In projects that proposed new or revised standards and/or contributed to their development, the studies found that the benefits included improved dissemination of results and increased opportunities to network and access complementary expertise.

Despite these findings, standardisation is addressed in only a subset of research projects. For example, according to Technopolis (2013), less than 10 % of all FP6/7 projects indicated their intention to work with standards or otherwise address standardisation in their research at the proposal stage. Similarly, the study estimated that only 10 % of FP6/7 projects eventually proposed or contributed to developing new or revised standards.

For activities linked to standardisation, CEN-Cenelec members are generally eligible to participate directly in framework programme projects. Their role might be to help project partners contribute to developing standards in a particular field. This might involve giving an overview of existing standardisation documents, providing access to them or advising on how existing standards could be further developed. In addition, they may identify relevant technical committees (or similar) in the CEN-Cenelec or International Organization for Standardization (ISO)/ International Electrotechnical Commission (IEC) systems and support researchers' participation in them. CEN-Cenelec members can also participate indirectly in framework programme projects as members of project advisory boards or as subcontractors for specific standardisation tasks. The projects with CEN-Cenelec involvement often also produce standardisation documents (e.g. European standards or technical specifications). However, most R & I projects are carried out without the participation of CEN or Cenelec members. While at least 2 000 R & I projects funded under Horizon 2020 mention standardisation, CEN-Cenelec members have been directly or indirectly involved in less than 5 % of them (approximately 100 projects across FP7 and Horizon 2020).

Despite the evidence for the role of standardisation in creating marketable products and solutions, researchers and innovators often consider that standardisation is still not a priority (Blind et al., 2018, 2022a, 2022b). Factors include a lack of awareness of standardisation's benefits, insufficient resources allocated to standardisation activities and insufficient reward for the time spent on standardisation activities (Blind and Gauch, 2009). The lack of visibility and recognition given to researchers engaged in standardisation does not encourage them to be more active in these activities. They do not always include standardisation activities in their initial work plan, and they identify the need for standardisation only at the end of the project when the research project delivers exploitable results (Technopolis, 2013). The lack of strategic thinking on standardisation too often

results in limited resources and time being given to addressing these needs during the lifetime of R & I projects.

2.2. Importance of standardisation for knowledge and technology transfer

Knowledge and technology transfer is generally described as the transfer of know-how, technical knowledge or technology from one organisational environment to another, with many variations depending on the research discipline and purpose (Bozeman, 2000). Knowledge and technology transfer typically occurs between universities, research institutions and companies – but also within companies. However, standardisation has only recently been considered an option for university–industry relations (Perkmann et al., 2021). In contrast, a decade ago, it was still ignored (Perkmann et al., 2013.), although the first studies funded within EU framework programmes were published 15 years ago (e.g. Blind and Gauch, 2009).

Generally, companies consider the patenting of new technological developments before engaging in standardisation (e.g. Abdelkafi et al., 2016). Großmann et al. (2016) investigated the link between the product development process and standardisation in three companies (two automotive manufacturers and one automotive supplier). Although they consider this integration relevant, the two automotive companies have not explicitly integrated their standardisation strategies into their product development. The product development process requires a review of existing standards. In addition, internal technologies developed by the company are brought into standardisation late in the product development process, that is, after the company has a good command of these technologies. A survey of engineers in two automotive companies revealed quite different and contradicting motivations to get involved in patenting, standardisation or even the publication of scientific papers. Such conflicts might reduce engineers' involvement in standardisation.

Companies also work on internal standards, which may transfer into SDOs' processes (Blind and Müller, 2020). Furthermore, the employees involved in the standardisation process are responsible for transferring knowledge from the committees back to the companies.

Within internal R & I processes, companies perceive standardisation as a synchronised development tool, for example in biotechnology (Lorenz et al., 2019), that involves and brings together all functional units involved in the innovation process. Standardisation, therefore, forms a platform for knowledge and technology transfer during the process of developing new products and makes it easier to scale up complex product prototypes and transfer them to industrial-scale production. Standards promote the exchange of knowledge and the coordination of research and development (R & D) efforts and enable the (organisational) discrepancies between laboratories and production processes to be overcome. By harmonising terminology in the standardisation process and standards themselves, as is generally the case in knowledge transfer activities, good communication between the **front end** (the practical application) and the **back end** (the scientific work behind it) is crucial. An open corporate culture and the participation of different disciplines are necessary for this exchange to happen (Lorenz et al., 2019).

Complementary to this internal perspective, standard-setting is an opportunity to exchange information and access complementary external R & D assets (Bar and Leiponen, 2014). Furthermore, the positioning of a company within standardisation alliances can influence its

performance in developing new products (Wen et al., 2020). Overall, companies being in central positions and bridging structural holes can increase their influence in standardisation processes and eventually speed up the introduction of their products to the market.

Scientists from research institutions tend to be under-represented in SDOs; for example, in the German standardisation body DIN less than 10 % of experts are from public or private research institutes (Blind and Heß, 2023). Zi and Blind (2015) show that researchers who publish in highly renowned journals are less involved in standardisation processes than in industry-related and technical journals. The reason for this is the prioritisation of the respective research groups and the corresponding weighing of opportunity costs: researchers who focus on highly rated journals invest a great deal of time in the quality of an article because of the demanding peer review processes (Blind et al., 2018). However, researchers who publish in practice-oriented journals often come from an applied research background and usually cooperate with practice partners in their research projects or work towards a defined practical goal. Consequently, their research topics are of greater importance for standardisation. The participation of scientists from applied research in standardisation committees is correspondingly higher, which is also confirmed by Blind and Fenton (2022), who reveal a relatively greater involvement of applied research-focused organisations based on the standard-relevant publications cited in ISO standards.

Having revealed the general importance of research as a driver for standardisation, there is limited work on its specific relevance, starting with Blind and Gauch (2009). They attribute different types of standards, that is, terminology, measuring and testing, quality and interoperability, to various phases in the R & I process ⁽³⁾.

However, the above-mentioned conceptual approach has not been further developed into a quantitative assessment. Overall, robust empirical evidence shows that companies rely on standards as an information source for their innovation activities (e.g. Swann, 2005). Around half of the companies surveyed in the UK edition of the Community Innovation Survey provided a source of information for innovation. However, the degree to which standards inform innovation depends on the sector in which a company operates, but this increases as its innovation activities rise (Swann, 2005). In contrast, in a more recent German edition of the Community Innovation Survey, slightly more than 10 % of innovative firms reported that standards support their innovation activities (Rammer, 2020).

Furthermore, standards have a more positive impact on innovation efficiency, that is, success based on investment, for German companies than government regulations (Blind et al., 2017). Furthermore, Foucart and Li (2021) show that implementing standards increases companies' likelihood of developing relatively more incremental than radical innovation. Based on survey data, Blind and Müller (2020) reveal a positive correlation between companies' assessment of the relevance of company internal standards for R & D and their likelihood of product and process innovation.

Overall, the empirical evidence on the impact of the implementation of standards on R & I is quite limited at the company level. Only the impact of implementing management standards related to innovation (see Manders et al., 2016) has been intensively investigated.

⁽³⁾ This is further explained in various publications, for example Egyedi and Ortt (2017).

2.3. Overview of drivers and barriers to standardisation

The literature analysis by Hermann et al. (2020) identified driving and inhibiting factors of standardisation for research institutions and companies (see also the summary in European Commission et al., 2022). We took into account that some drivers are not relevant in all phases and not for all participants in the R & D process. Based on these sources, other literature was identified by searches in Scopus and Web of Science to identify the main drivers and barriers for organisations' involvement in standardisation based on their general characteristics and insights from specific surveys.

Drivers for involvement in standardisation

Without providing empirical evidence, Featherston et al. (2016) claim that policy and regulation, business and services, markets and customers, systems such as supply networks, and generic technology, infratechnologies and research are the themes influencing standardisation processes. Similarly, Moon and Lee (2022) claim that technology, the market, intellectual property rights (IPRs) and certification influence standardisation dynamics.

However, at the organisational level, leverage and network effects are the main drivers for companies and research institutions to participate in standardisation processes (Wakke et al., 2016). They can orient themselves to the emerging standards already in the development process and thus leverage their technologies and products to gain a considerable time advantage and eventually exploit various network effects via the standardisation process of innovative technology.

Empirical studies on firms' active participation in standardisation have been performed. However, they were mainly based on somewhat limited samples of companies, for example the studies by Blind (2006), Blind and Thumm (2004) and Blind and Mangelsdorf (2013) and, more recently, by Zhang et al. (2020a) and Wiegmann et al. (2022). Only Wakke et al. (2015) connected the large-scale Dutch edition of the Community Innovation Survey with information about the involvement of the national standardisation body. In addition, Blind et al. (2021) investigated the characteristics of companies in the German standardisation body DIN based on data from the German edition of the Community Innovation Survey. A positive relationship between active involvement in standardisation and innovation is revealed by Delcamp and Leiponen (2014), whereas Blind (2006), Blind and Mangelsdorf (2013) and Wakke et al. (2015) point to the inverted U-shaped relationship between R & D, innovation or patent intensity and firms' involvement in standardisation. This U-shaped relationship explains the tension between absorptive capacity as a driver and the barrier of uncontrolled knowledge spillovers within standardisation processes. Regarding sector-specific differences, Germany's high-tech and medium- to high-tech manufacturing firms are more likely to be involved than low-tech firms. Similarly, high-tech and knowledge-intensive service firms are more often involved, according to Blind et al. (2022b). They also confirm the findings from previous studies (e.g. Blind, 2006; Wakke et al., 2015; Rammer et al., 2016) that larger firms participate significantly more than smaller companies because of their greater availability of resources and the more significant benefits they expect.

Lastly, the few studies explaining the involvement in standardisation at the sector or macro-level reveal the significant influence of R & D and patent intensity (Blind, 2002). Furthermore, standardisation increases with the concentration of enterprises up to a certain threshold, from where standardisation activities decline again. In addition, export-intensive sectors tend to standardise more than other sectors. Blind and von Laer (2021) found a significant correlation between R & D measured by patents and standardisation work at ISO

for China and the United States. However, export activities showed no significant association with standardisation work.

Beyond the characteristics explaining companies' involvement in standardisation, several studies have investigated organisations' motives. First, Blind and Gauch (2009) revealed the following as most relevant for a small sample of companies active in nanotechnology: the creation of legal security in emerging science and technology, avoiding adopting proprietary solutions to enable the commercialisation of research results, and the interest in using common rules to exploit the advantages of interoperability. Blind and Mangelsdorf (2016) reveal that, in addition to pursuing specific company interests, solving technical problems, knowledge seeking, influencing regulation and facilitating market access are the major drivers for companies' involvement in standardisation. In the German electrotechnical and machinery sector, influencing the regulatory framework is most relevant for companies' involvement in standardisation. Blind et al. (2022c) are even more generic and conclude that standardisation can promote companies' cooperation and competitiveness. Furthermore, Blind and Gauch (2009) identify the commercialisation of results, the interest in using common rules to exploit the advantages of interoperability, legal security and preventing the use of proprietary standards as drivers for companies' engagement in formal standardisation.

At the individual level, Blind et al. (2022a) found that engineers confirm that pursuing the company's interest is most relevant, followed by integrating the state of the art into standards (see also Blind and Gauch, 2009), managing networks and interfaces, and, lastly, personal reputation and performance.

Since standardisation committees include representatives from all interest groups, scientists from applied research can come into contact with companies. Their joint work in standardisation creates mutual trust and thus increases the likelihood that companies and research institutions will network sustainably and work on common issues, for example in collaborative and contract research (Blind and Gauch, 2009).

Furthermore, organisations can gain new impetus for technology developments through standardisation (Abdelkafi and Makhotin, 2014; Blind and Mangelsdorf, 2016). Technologies do not necessarily have to be developed from scratch, but protected knowledge and technologies can be acquired, for example, through licences for standard-essential patents. Furthermore, standards represent the state of the art in a technology area and help companies establish dominant designs (Großmann et al., 2016).

Once technologies have been integrated into standards, they can no longer be patented (Großmann et al., 2016; Blind et al., 2018; Blind et al., 2022c). Accordingly, the strategic prevention of patents as a particular case can motivate companies to engage in standardisation activities. Another driver is the broader diffusion of research results (Blind and Gauch, 2009). The availability, accessibility and applicability of standards enables the widespread dissemination of the knowledge generated.

Turning to the drivers for research organisations to get involved in standardisation (see the review by Hermann et al., 2020), it has to be stated that the flow of knowledge from standardisation work into companies is by no means one-sided. Similarly, scientists active in both applied and basic research can find partners for research cooperation through trustful collaboration in standardisation (Blind and Gauch, 2009; Blind et al., 2018) and thus enter into a mutual exchange of knowledge. Furthermore, researchers use standardisation processes and the standards produced as channels to disseminate their research results. Lastly, the involvement in standardisation increases the reputation of the research

organisation involved (Hermann et al., 2020) and that of the individual researcher, who is also intrinsically motivated (Blind et al., 2018).

In summary, several driving forces for companies', research institutes' and countries' involvement in standardisation have been identified. However, only companies' and countries' R & D intensities are significantly associated with their participation in standardisation or the production of standards. In addition to knowledge-, research- and innovation-related motives, organisations take part in standardisation activities to pursue their specific interests and influence or comply with regulatory framework conditions.

Barriers to involvement in standardisation

To complete the picture, we summarise the insights gained about the barriers that prevent organisations and their experts from getting involved in standardisation. In general, the barriers mirror the positive drivers of organisations' involvement in standardisation presented above, that is, size and research and innovation intensity. In general, smaller organisations with no or little research effort and innovation activities are less likely to get engaged in standardisation ⁽⁴⁾. Furthermore, we know more about the characteristics of the organisations involved than about the organisations not involved, because, for the latter, we have representative but only general insights from the few Community Innovation Surveys mentioned above.

For more detailed information about the barriers to organisations getting involved in standardisation, we have to rely only on a few qualitative and small-scale quantitative studies, the insights from which we summarise below.

First, standardisation implies a financial burden, including membership fees to join SDOs and the resources required for the standardisation work, that is, workload, personnel costs and travel expenses (Blind and Gauch, 2009). Another important obstacle is the time it takes for standardisation processes to reach a consensus, usually several years (Blind and Gauch, 2009). Blind et al. (2022c) translate companies' barriers into internal and external alternatives. Complex and time-consuming processes trigger internal barriers. In contrast, externally determined obstacles are caused by a lack of potential for companies to implement their own technological content in standards and an already sufficient number of existing standards. Lastly, alternative strategies, such as defensive publishing or secrecy and patenting, might be more attractive than participation in standardisation (Blind et al., 2022b). These barriers are well reflected by the obstacles raised by scientists active in a public research organisation (Blind et al., 2018), added to complaints about the lack of appreciation for their work.

Focusing on research organisations, Hermann et al. (2020) identify the following additional barriers from the literature review. Since standards are a joint product with no author attribution, they are a public good, knowledge that is freely available for a small fee, and therefore prevents capitalising on researchers' knowledge. In addition, they are challenged by the free rider problem of public goods, that is, their knowledge can be used without making a significant contribution to their development. Furthermore, technologies can no longer be patented if they have already been integrated into standards (Großmann et al., 2016). In addition to lengthy standardisation processes, research organisations perceive

⁽⁴⁾ See De Vries et al. (2009) for a review of the literature on problems specific to small and medium-sized enterprises related to the implementation of standards, for example lack of awareness, tracing standards, their cost, difficulty in interpreting and implementing them, and the resources involved in standardisation (e.g. lack of financial and human resources).

difficulties in reaching consensus and having limited influence on the final specification of standards (Blind and Gauch, 2009). Lastly, there is a lack of standardisation knowledge in research organisations and limited consideration given to the topic in the performance evaluation of researchers. These barriers were confirmed in the interviews by Hermann et al. (2020).

3. IMPLEMENTATION OF THE SURVEY

Based on the literature review, we adapted and expanded the heuristic model, which was developed for the GSPS (see Figure 1). This model is comprehensive enough to integrate a broad range of questions, including those that must be answered to meet the objectives of the ESPS. The model depicts the multidimensional relationships between standardisation participation, the implementation of standards and organisations’ performance. To characterise standardisation activities, the model primarily records the type and scope of standardisation work, such as time and personnel expenditure or involvement in standardisation committees. The implementation of standards is covered by collecting information about the number of standards implemented. As performance indicators, we consider innovation, turnover and export. The heuristic model suggests causal relationships. However, the ESPS allows only the collection of organisation-specific or individual expert assessments or the calculation of correlations.

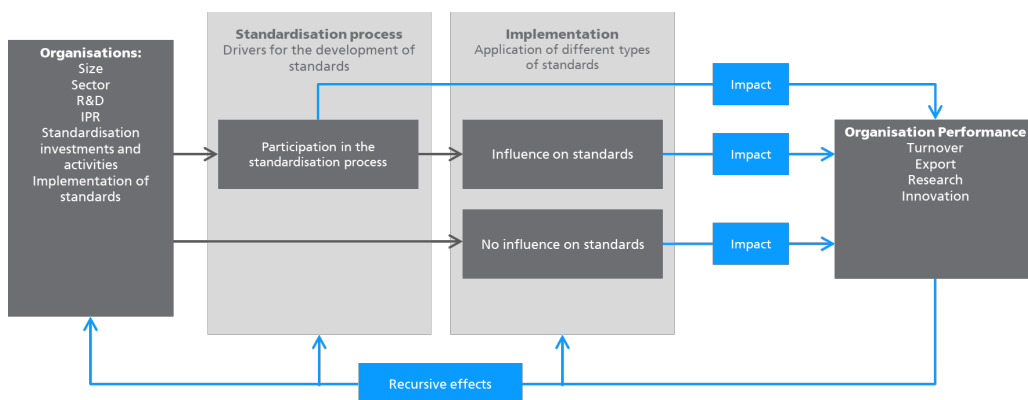


Figure 1. Heuristic model.

The survey questionnaire, which is reproduced in Annex 1, reflects both the insights from the literature, the experience gained from the German Standardisation Panel, the objectives of the project and the feedback received from the European Commission and collected from industry experts and the presidential committee of CEN-Cenelec. In May 2023, the draft survey was presented to the joint CEN-Cenelec Working Group on Standards, Innovation and Research so that feedback could be collected from the organisations’ members. After the inception meeting in May 2023, an exchange with the presidential committee of CEN-Cenelec was organised and feedback received and – where possible – incorporated into the revised questionnaire. In parallel, ETSI also commented on the questionnaire.

The distribution of the ESPS started on World Standards Day, 14 October 2023 and was closed on 31 December 2023.

4. SURVEY RESULTS

In the following sections, we present the results of the stakeholder survey. Overall, more than 3 700 respondents started to complete the ESPS. Almost 3 000 out of the more than 30 000 German experts directly approached via email answered the survey. However, the majority of respondents did not provide an answer to all the questions. For this reason, the total number of respondents per question varies in the figures.

4.1. Characteristics of the sample

In the first section, we describe the main characteristics of the sample. More than half of the respondents answered from their individual perspective, whereas one third answered from their business group, and another one quarter answered from their organisation's perspective. More than half of the experts are employed in industry. However, around one third work for non-governmental organisations, public organisations, HEIs, research organisations and governments ⁽⁵⁾.

In relation to the size of the organisations, slightly more than half of the respondents work in organisations with somewhat more than 250 employees and a little less than half in smaller organisations, according to the European Commission's definition of SMEs ⁽⁶⁾.

Looking at the respondents' position or department within their organisation, we observe that more than one quarter are active in R & D, whereas marginally more than 15 % are in executive management (Figure 2). Furthermore, slightly more than 10 % are working in standardisation management ⁽⁷⁾, whereas slightly less than 10 % are responsible for quality management ⁽⁸⁾.

⁽⁵⁾ Therefore, the diversity of the respondents' backgrounds is considerable compared with the strong industry focus of the GSPS. See, for example, Blind and Heß (2023) and Heß and Blind (2023).

⁽⁶⁾ This size distribution is very similar to that of the GSPS; see Blind and Heß (2023) and Heß and Blind (2023).

⁽⁷⁾ However, one third of the respondents claim that their organisation has a standardisation department.

⁽⁸⁾ Considering that the shares are almost identical to the values in the GSPS (Blind and Kromer, 2023), the ESPS is attracting more respondents active in R & D but less from the executive management level. The reasons are twofold. First, in the GSPS, the chief executive officers of small and very small companies are active in standardisation and will be reached directly via email. In contrast, the communication channel of the ESPS reaches more experts active in R & D. Second, the specific focus on the interface between research and standardisation might have attracted the attention of R & D-inclined experts.

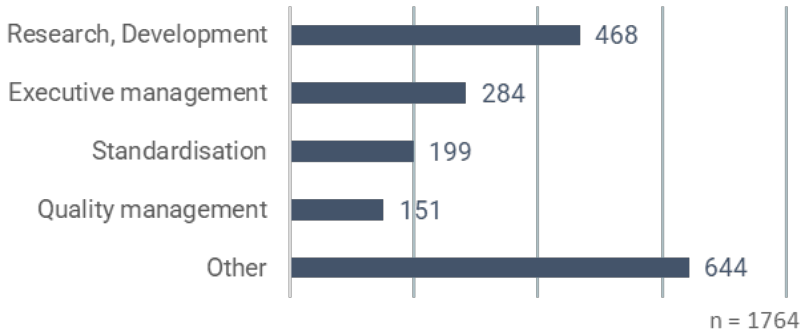


Figure 2. Distribution of respondents by position in their organisation.

For the geographical distribution of the organisations, we used the information respondents provided about their headquarters. Due to the different approaches used to contact experts, that is, via personalised email in the GSPS versus links distributed via mailing lists and newsletters in the ESPS, the results are very biased towards Germany, with almost two thirds of respondents' headquarters located there (Figure 3). In comparison, slightly less than 5 % of the organisations' headquarters are in the United States or France, followed by lower proportions in Switzerland and Austria.

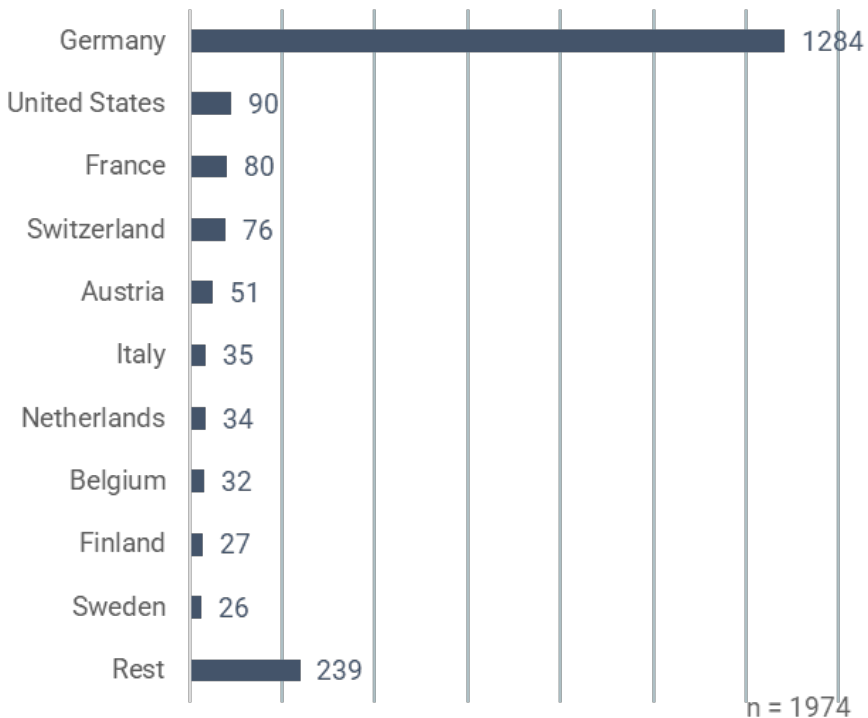


Figure 3. Distribution of respondents by country of headquarters.

Looking at the sectors, the distribution of the respondents is quite similar to that of the GSPS, with the highest number of experts from the mechanical and electrical engineering sectors, followed by the chemical and pharmaceutical industry and construction sectors

(Figure 4). A significant difference is the higher share (3.7 %) of experts from the information and communications sector in the ESPS compared with 2.5 % in the GSPS.

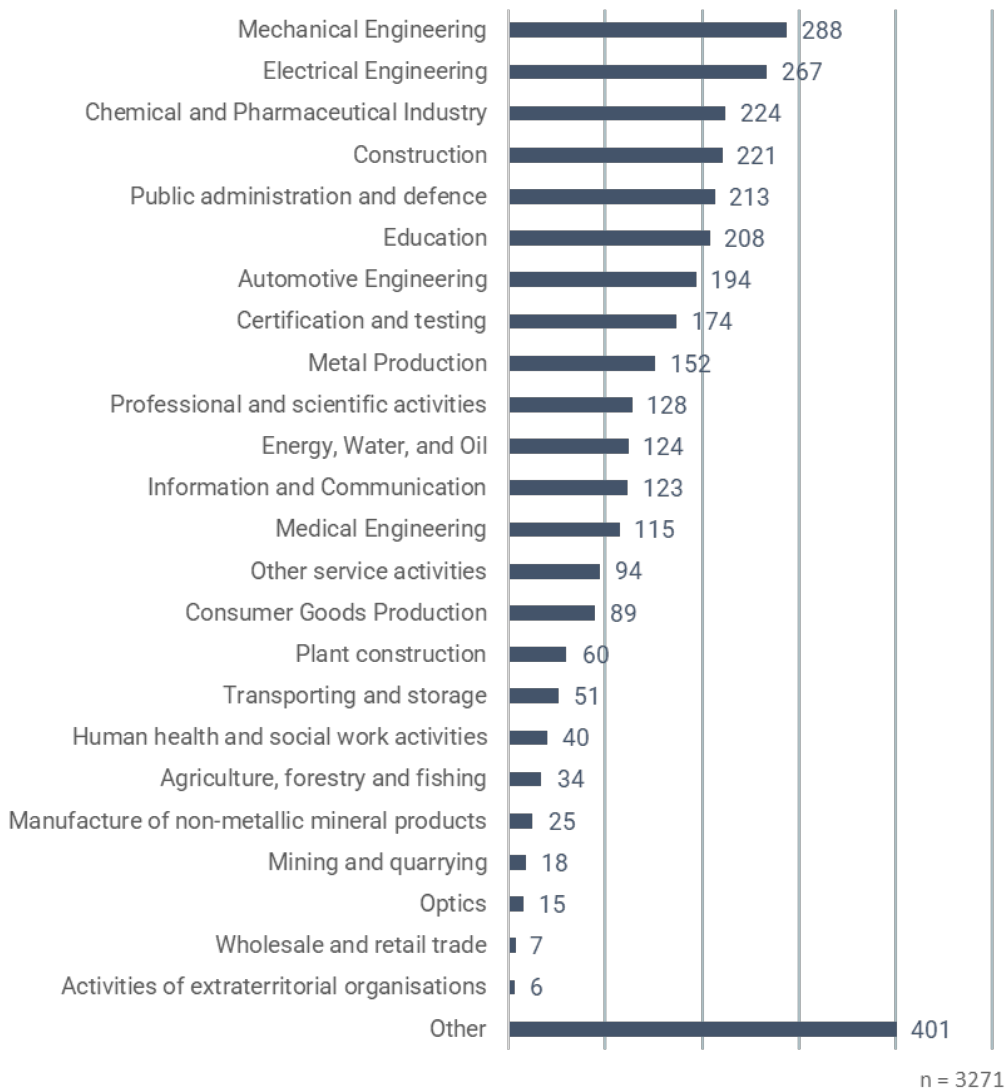


Figure 4. Distribution of respondents by sector.

Since the area of standardisation is dominated by older men, the experts were asked their age because such information is not systematically available in the SDOs. Figure 5 displays the age distribution of the participating experts. More than one quarter of the respondents will retire by 2030, assuming a retirement age of 67. Consequently, one quarter of the whole group of standardisation experts will have to be replaced by then, that is, at least

25 000, assuming that at least 100 000 European experts are currently active in standardisation ⁽⁹⁾.

To put these relative and absolute figures into the wider context of the general demographic challenges for the workforce, we look at their distribution in Germany in the year 2020 ⁽¹⁰⁾. There, 53 % of the total workforce is older than 45. In contrast, that share of the standardisation workforce in our survey is more than 72 %, that is, 40 % higher than the share of the total work force older than 45. As already explained, standardisation has to tackle a massive demographic challenge, which goes well beyond the level of challenge faced in the total workforce.

This brings us to the last characteristic of our sample, the gender distribution. Although almost 85 % of our respondents are male, more than 15 % are female or identify as diverse. For comparison, Heß (2020) found that only around 10 % of females, based on a total of 28 000 experts, were active in the German SDO DIN 3 years ago. Motivating more females to get involved in standardisation is one necessary step, but it is certainly not sufficient to tackle the massive and increasing demographic challenge.

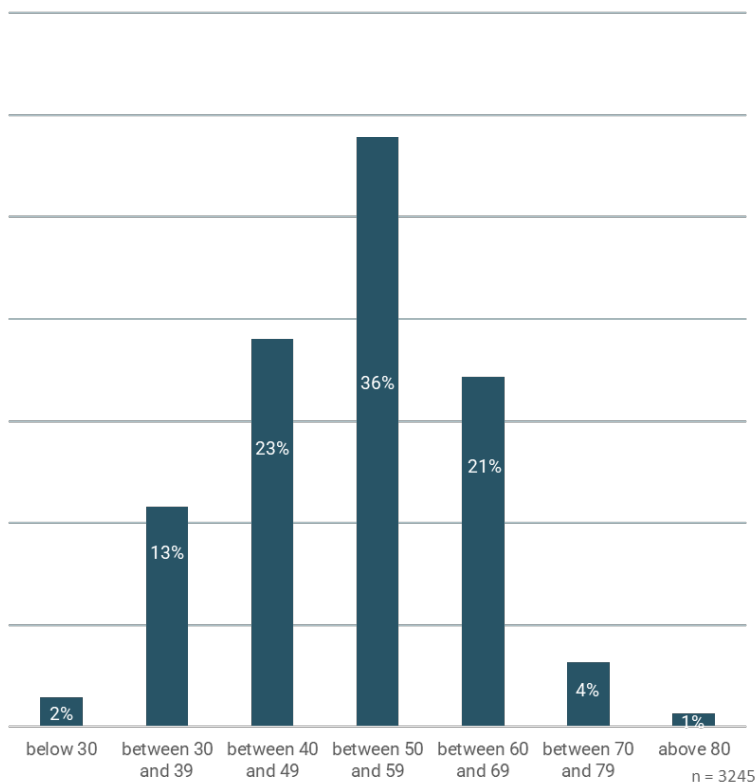


Figure 5. Age distribution of respondents.

⁽⁹⁾ According to the European Commission (2022b), there are over 150 000 experts in Europe, which means that almost 40 000 experts are to be replaced by 2030.

⁽¹⁰⁾ <https://www.demografie-portal.de/DE/Fakten/erwerbsbevoelkerung.html>.

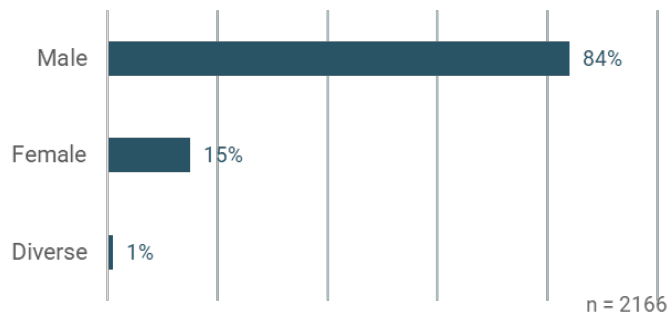


Figure 6. Gender distribution of respondents.

4.2. Importance of standards

Before we present the results related to R & I activities and their interfaces with standardisation, we display some general assessments of standards differentiated by type and impact.

Formal standards received the highest rankings from respondents, often active in formal SDOs. In detail, they attributed the highest level of importance to formal European standards, followed by international and national standards (Figure 7). Technical rules and specifications were ranked highest regarding relevance, with the European version of the rules and specifications receiving the highest grades, followed by the national and international versions. Internal company- or organisation-specific standards followed in third place before external company or organisational standards. A relatively low relevance is attributed to de facto and consortium standards, with the European versions receiving the highest grades. These rankings are aligned with earlier findings of the GSPS (see Heß and Blind, 2023).

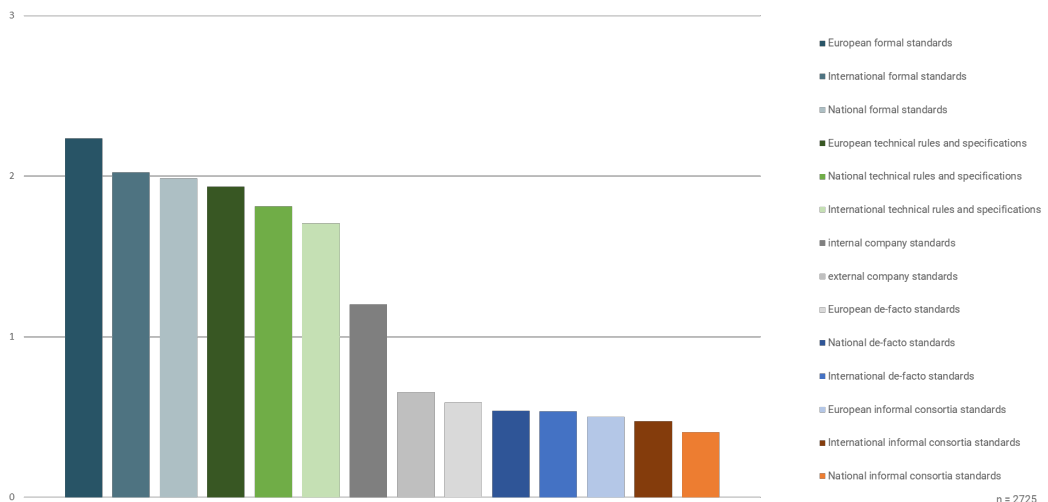


Figure 7. Importance of different types of standards.
NB. Scale from very unimportant (- 3) to very important (+ 3)

The number of standards implemented reflects the assessment of the relevance of the different types of standards. While nearly all respondents or their organisations have adopted formal standards or technical specifications, including over one third implementing more than 100 such standards, a similar proportion refrains from using consortium or de facto standards (Figure 8).

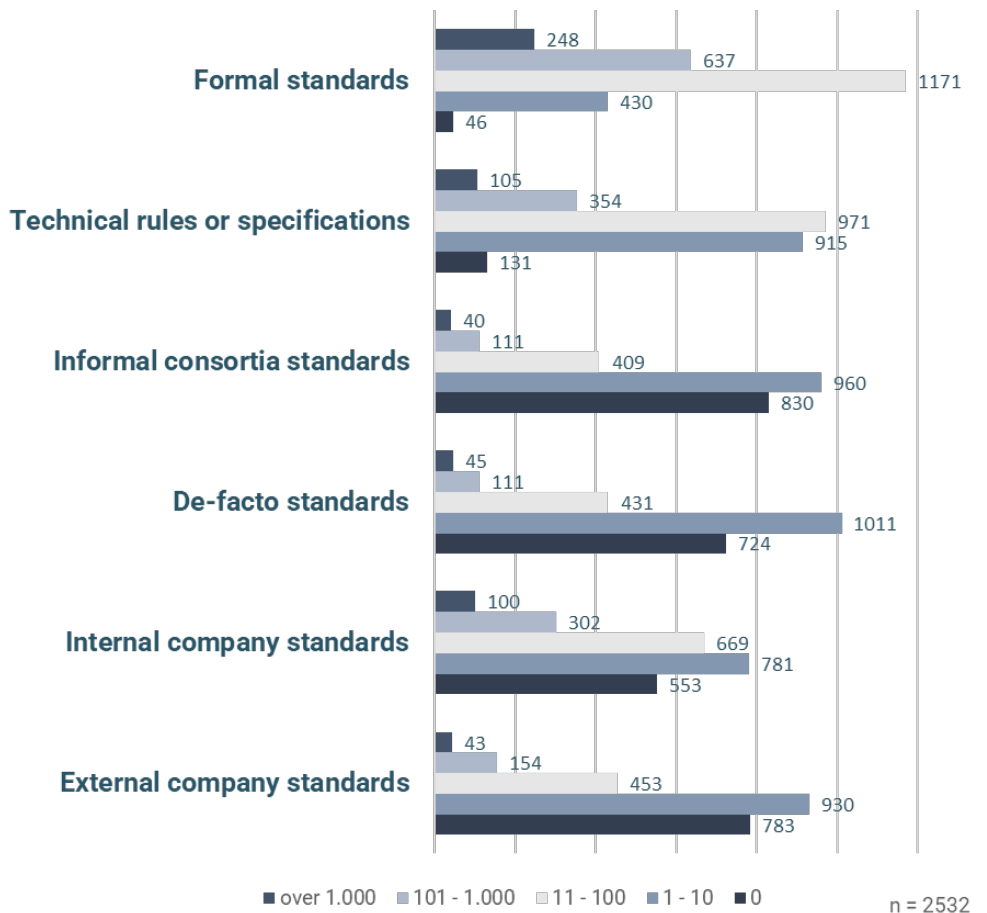


Figure 8. Number of standards implemented by type of standard.

Standards can have various impacts, which may differ between the different types. Consequently, formal standards and technical specifications released by formal SDOs have the most positive impact on legal security and market entry. Technical specifications are particularly relevant for technical interoperability, quality improvement and strengthening organisations' negotiating power with suppliers and customers. Important to note for the focus of the ESPS pilot study is the highest relevance of technical specifications for R & D. Consortium standards are most relevant for interoperability, reflecting the critical role of information and communications technology (ICT) standards released by the Institute of Electrical and Electronics Engineers, the World Wide Web Consortium and other organisations. In contrast, internal company standards are most important for improving organisations' productivity and quality. It has to be noted that this type of standard is also relevant for contributing to sustainability, assuring the resilience of the organisation and increasing its competitiveness. In summary, formal standards and technical specifications

are most relevant for all impact dimensions (Figure 9). Increasing productivity and quality and achieving new objectives, such as contributing to sustainability and achieving resilience, as well as supporting R & D, are essential aims of the portfolio of standards.

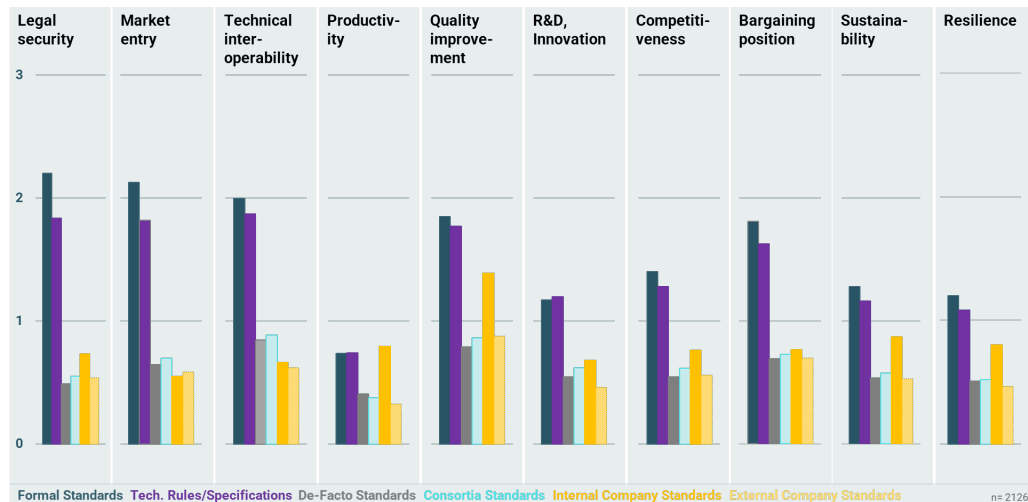


Figure 9. Impact of different types of standards by impact dimension.
NB. Scale from very negative (- 3) to very positive (+ 3).

4.3. Research and innovation activities

The participating sample is quite research active and, therefore, also innovative. More than 60 % of the organisations conduct internal research, and more than half perform external research. Similarly, more than 60 % claim to have introduced an innovative product in the market, and more than 50 % have implemented a process innovation ⁽¹¹⁾. These values are slightly higher than those for innovators surveyed in the context of the Community Innovation Survey, addressing the period between 2018 and 2020 ⁽¹²⁾.

Looking at the half of the respondents performing external R & D, knowing which collaboration partner they choose is an interesting first step. Most often, the respondents collaborate with universities, followed by customers and research institutes outside universities (Figure 10. R & D collaborations with suppliers are in fourth position, followed by alliances with business consultants and suppliers. This order of collaboration partners is similar to that of innovative companies surveyed in the German edition of the Community Innovation Survey covering the period between 2018 and 2020 ⁽¹³⁾.

⁽¹¹⁾ These shares are lower than in a sample of companies surveyed between 2013 and 2016 in the context of the GSPS (Blind and Müller, 2020).

⁽¹²⁾ https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Community_Innovation_Survey_2020_-_key_indicators.

⁽¹³⁾ http://ftp.zew.de/pub/zew-docs/Innovationserhebung/Dateien2022/ZEW_Innovationserhebung_Kooperationen_Ausgabe2022.xlsx.

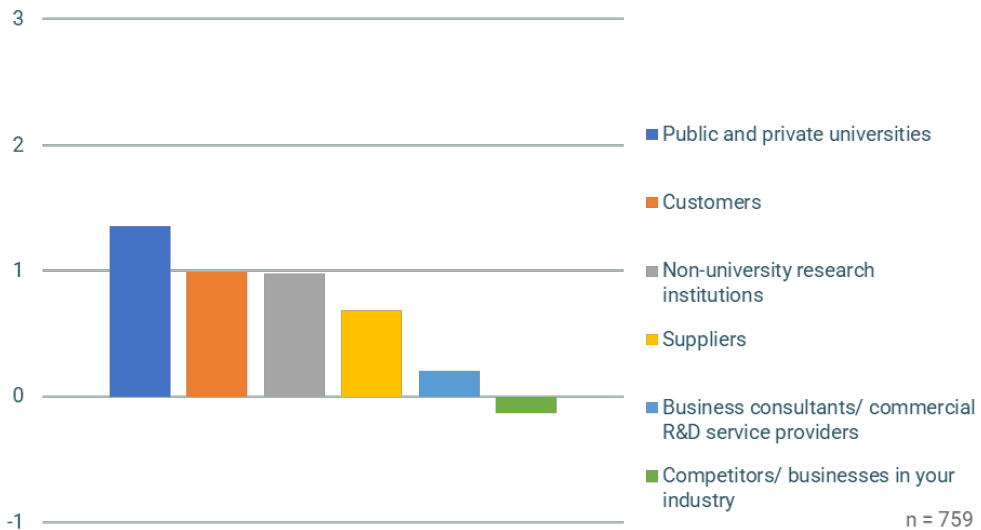


Figure 10. Relevance of collaboration in R&D by type of organisation.
NB. Scale from very low (- 3) to very high (+ 3)

The ranking of the relevance of R & D collaboration partners does not perfectly mirror the effectiveness of the collaboration. In particular, participants ranked collaboration with customers as most effective (Figure 11).

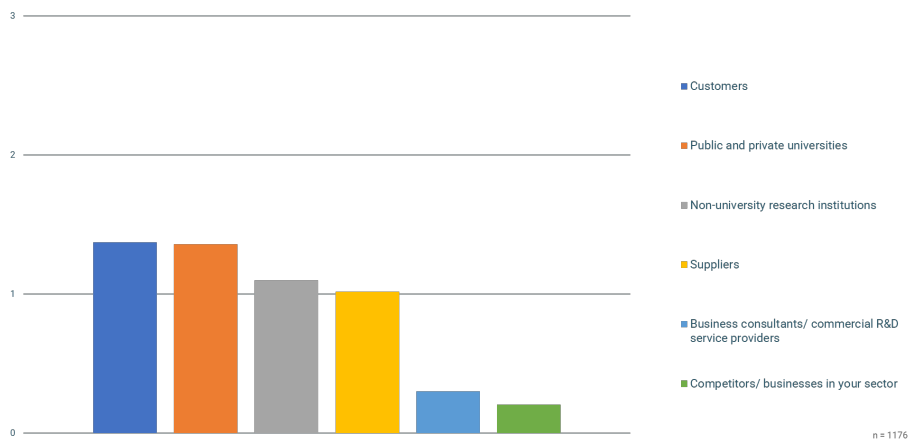


Figure 11. Effectiveness of cooperation in R&D by type of organisation.
NB. Scale from very low (- 3) to very high (+ 3).

There are different ways of realising knowledge transfer from scientific institutions. The most effective is further education and scientific training followed by informal contact. However, common standardisation activities are rated in third position. More interesting is the high degree of effectiveness of collaborative research funded at the national level compared with the lower effectiveness of collaborative research funded at the European level. Both licensing or buying technology from scientific institutions and temporary exchange of personnel are assessed as not very effective ways of knowledge transfer.

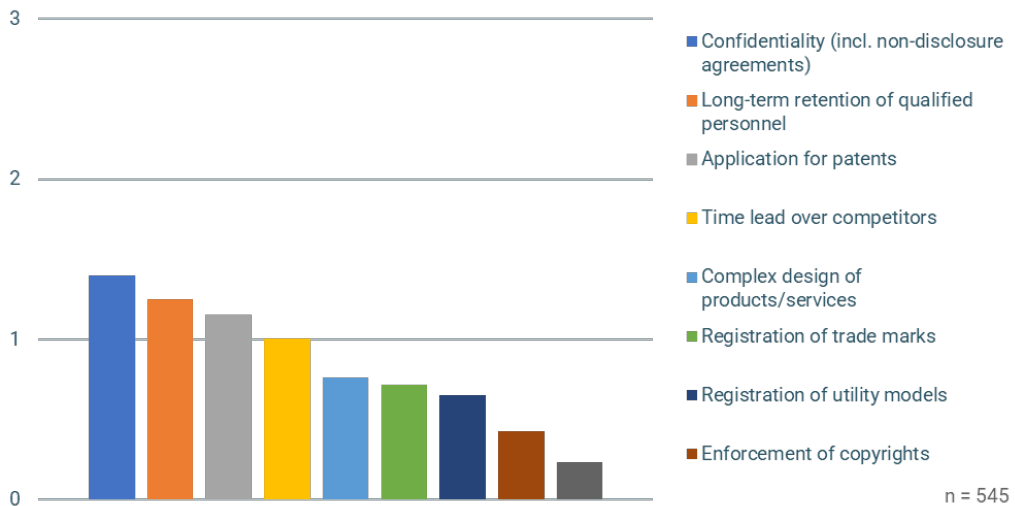


Figure 12 Effectiveness of forms of cooperation with scientific institutions for knowledge transfer.

NB. Scale from very low (-3) to very high (+3).

4.4. Role of research for standardisation

To assess the general role of research for standard development, the experts were asked about the relevance of numerous input sources identified from the literature, for example Featherston et al. (2016) or Moon and Lee (2022), but also validated via interviews with selected experts from industry.

The answers reveal that policy and regulation initiatives are the most relevant inputs for developing standards followed by customers' requirements and insights from organisations' own research and collaborative public research. One of the respondents added here that 'Technical Committee in SDOs could specify their future requirements from R & I activities as inputs into their standards development work to meet their needs, e.g. European Metrology Programme for Innovation and Research annual survey to CEN CENELEC Technical Committees and Technical Boards via CEN CENELEC WG STAIR'. Less critical are research results generated by other organisations. The requirements of suppliers and service providers, even the organisations' own business model, are of limited relevance as inputs for standardisation (Figure 13). Open-source software and hardware are positioned on the lowest level, which underlines their still difficult relationship with standardisation, because different communities drive them in accordance with different processes including a different IPR regime (Blind and Böhm, 2019). Overall, organisations' own, collaborative and even others' research results are essential input sources for developing standards. One of the respondents asked in this context 'what the actual source is' when 'the interdisciplinary input sources partly influence each other...'. Another evoked the importance of 'related standards [that] work, be they management... but also on a technical level'.

To put these assessments in the context of other studies, we refer to the insights from the German edition of the Community Innovation Survey about the relevance of knowledge

sources for the development of innovation⁽¹⁴⁾. The most important source for German innovators is their own company, which includes their research, followed by customers', competitors' and suppliers' research. Overall, the ranking of the sources is quite similar, which shows the reliability of the approach.

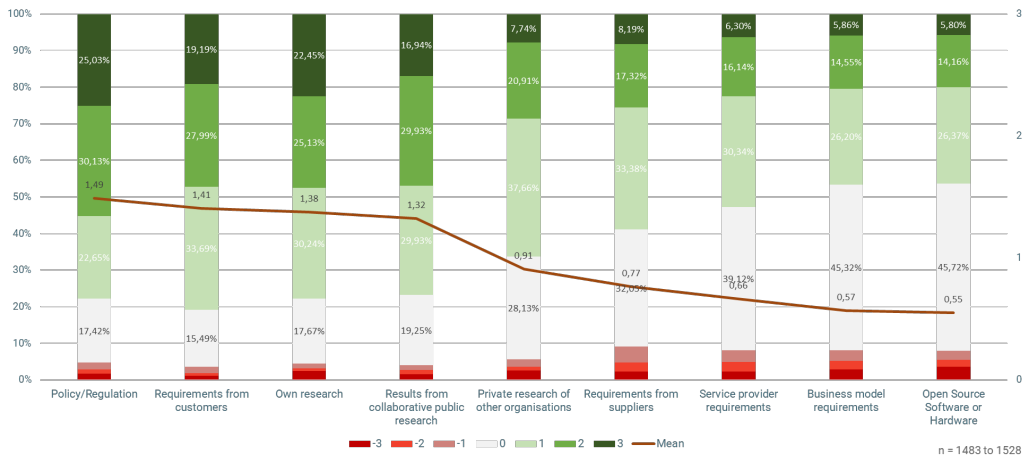


Figure 13. Relevance of input sources for standard development. NB. Scale from very low (- 3) to very high (+ 3).

Focusing on the answers of respondents from industry compared with those from the remaining participants, we observe that customers' requirements and policy or regulatory requirements are the most relevant inputs for developing standards (Figure 14)⁽¹⁵⁾. For SMEs, in particular, the needs of their customers are most relevant. In contrast, results from collaborative public research are more significant for the remaining sample, dominated by research-performing organisations. However, for research-performing companies, their own research inputs are most relevant. All other input factors receive quite similar assessments from both subsamples. For example, policy initiatives in general and regulation in particular are framework conditions ranked of similar importance for all stakeholders involved in standardisation. One of the respondents refers here to the '... requirements/interests of organisations from the areas of consumer or environmental protection'.

⁽¹⁴⁾ https://ftp.zew.de/pub/zew-docs/Innovationserhebung/Dateien2018/ZEW_Innovationserhebung_Informationquellen_Ausgabe2018.xlsx.

⁽¹⁵⁾ The non-industry subsample comprises almost 1 000 respondents from education, public health, human health, other services, extraterritorial and others. The remaining 2 300 respondents are attributed to industry. Industry is differentiated further between large enterprises and SMEs in accordance with the EU definition of having less than 250 employees if that information is provided.

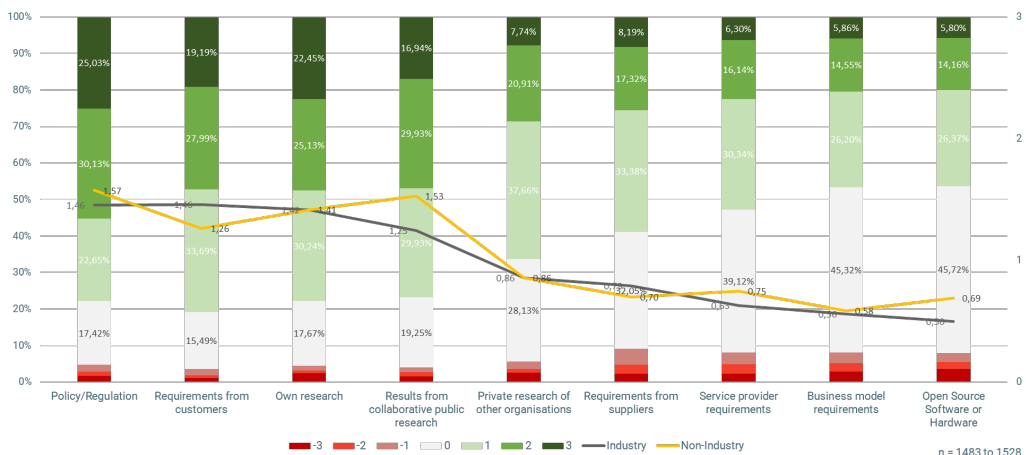


Figure 14. Relevance of input sources for standard development differentiated between respondents from industry and from the remaining sectors. NB. Scale from very low (- 3) to very high (+ 3).

In the next step, we asked about the role of research as an input for developing the various types of standards. Most relevant is research for the generation of measurement and testing standards, as evidenced by the high rating of research for measurement and testing (Figure 15). However, research is also somewhat relevant for quality standards, which is unexpected because quality improvement is not so close to R & D, but it is quite important for SMEs. In third position is environmental and sustainability standards, which can be explained by the increasing relevance of sustainability in both research and standardisation. Standards for safety and health issues and interoperability, compatibility and interfaces require significant input from research. Replying to the additional open question, most respondents referred to information technology (IT) and cybersecurity as a topic. One respondent specified this need in the following statement: ‘Data-sharing agreement is a significant aspect of cooperation between EU and [the Association of Southeast Asian Nations]. Thus, data security is an integral part relevant to research as input for different types of standards.’ Product and process standards do not require much research as input because they are generally more influenced by the requirements of markets and customers and companies’ production processes. Terminology and semantics are the least dependent on research input.

Overall, the assessment of the role of research in the development of different types of standards is generally rated slightly higher by respondents from other organisations, which are mainly conducting research, than by respondents from industry (Figure 16). This high level of agreement can be explained by the high research intensity of the responding firms, which have similar perceptions to those of the research-dominated remaining respondents. Interestingly, as for SMEs, research input not only for measurement and testing but also for quality standards is also important for large companies.

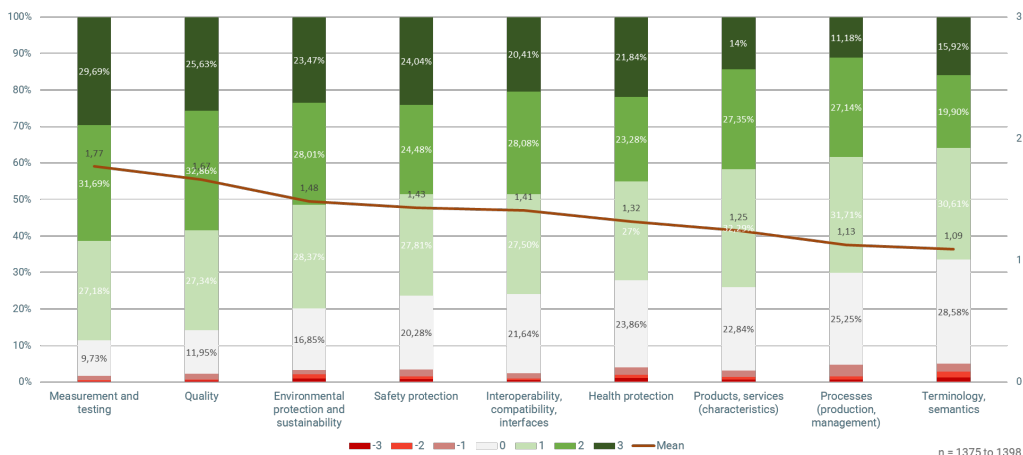


Figure 15. Relevance of research results as input for developing different types of standards. NB. Scale from very low (-3) to very high (+3).

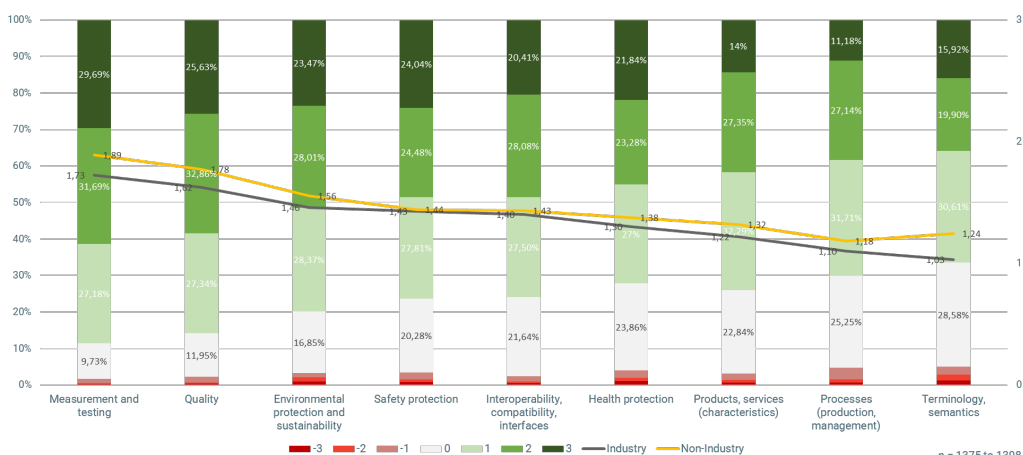


Figure 16. Relevance of research results as input for developing different types of standards differentiated between respondents from industry and from the remaining sectors. NB. Scale from very low (-3) to very high (+3).

To improve the interface between research and standardisation, we need to know more about the advantages and disadvantages of using research results to develop standards.

The most relevant advantage is free access to scientific publications and other materials on the internet and keeping track of scientific progress (Figure 17). One respondent proposed viewing standards as 'a broad knowledge transfer/dissemination channel for research results' beyond 'scientific publications or patents', because they are 'used by [a] far broader user base, and for both public and private good'. Furthermore, research provides a better evidence base for the development of standards⁽¹⁶⁾ and incentives for new standardisation initiatives. In second place is using scientific evidence for quality and environmental and

⁽¹⁶⁾ See Blind and Fenton (2022) on the increasing number of scientific references in ISO standards in general and Gottinger et al. (2023) on their role in standards for the bioeconomy.

sustainability-related standards. For standards supporting regulation (17), using research as input for their standardisation is also an advantage. Leveraging one’s own research results via standards for developing one’s own product and process innovation is rated as of similar importance to the role of scientific evidence in developing standards being relevant for follow-up research (18). In this context, one respondent highlighted that ‘being aware of the importance of data-sharing, intellectual property as rights (or joint ownership) of parties involved in the cooperation agreement should be given utmost importance during the course of development of standards beneficial to both parties.’ This assessment confirms the positive relationship between research, standardisation and, eventually, innovation (19). The least relevant advantage is the opportunity to prevent, via standardisation, competing research content from becoming market-dominant solutions. Overall, integrating research results into standard development is perceived as very positive.

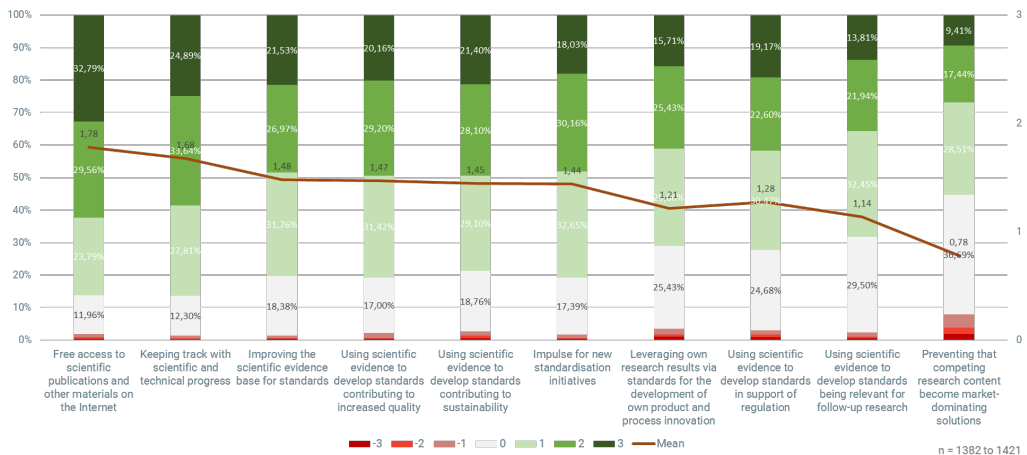


Figure 17. Relevance of advantages of research results as input for standard development. NB. Scale from very low (– 3) to very high (+ 3).

Respondents from industry assessed all advantages quite similarly but slightly less positively than the remaining respondents, which can again be explained by the high research intensity of the responding firms, which have similar perceptions to those of the research-dominated remaining respondents (Figure 18). However, the responses reveal that leveraging one’s own research results via standards for developing one’s own product and process innovation and preventing competing research content becoming market-dominant designs are more relevant for industry, particularly research-performing industry. The former motivation confirms the relevance of standardisation for innovation, which is an important driver for industry, but, due to the lack of pressure to commercialise organisations’ own innovative products, is less relevant for research organisations and other stakeholders. The latter motivation relevant to industry reveals the importance of the defensive character of standards in keeping markets open and preventing proprietary

(17) See Gottinger et al. (2023) for the first empirical analysis of the complex linkages between scientific publications, standards and regulation in the bioeconomy, whereas Blind (2023) describes their role in transformative innovation and Blind (2024) describes their role in socio-technical transformations.
(18) The virtuous long-term cycle between research and standardisation and standards postulated by Blind and Gauch (2009) is perceived by only a smaller share of respondents.
(19) See also the positive correlation revealed by Blind et al. (2022) for a representative sample of innovative companies in Germany.

standards from becoming dominant. Notably, using scientific evidence to develop standards relevant for follow-up research is more important for SMEs than for larger companies.

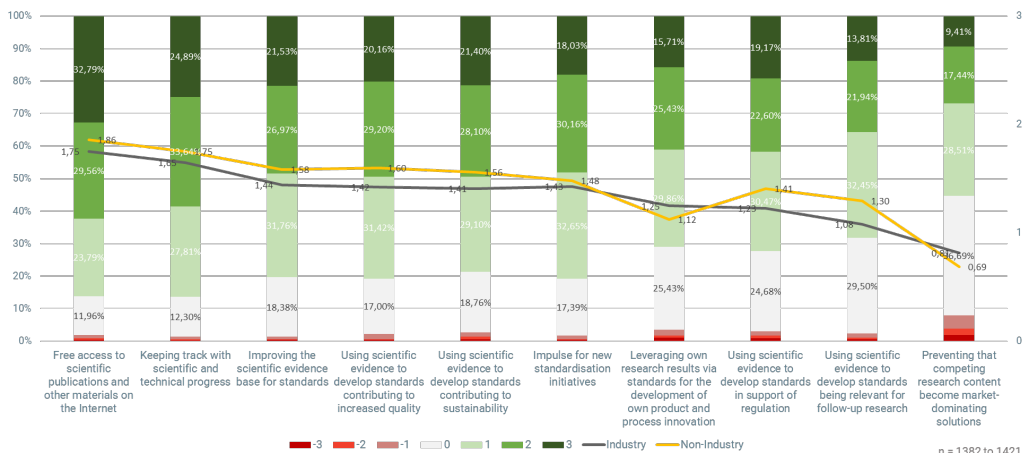


Figure 18. Relevance of advantages of research results as input for standard development differentiated between respondents from industry and from the remaining sectors.

NB. Scale from very low (- 3) to very high (+ 3).

While most respondents support all advantages of integrating research results into standards, the disadvantages are perceived as less relevant (Figure 19). The most serious problem is that the research results have not yet been validated in practice, are not ready as input for standardisation, and are too abstract, immature and ambitious⁽²⁰⁾. One respondent stated a ‘big lack of awareness of how to integrate research results into standards’. Furthermore, there is a lack of R & D staff available as experts in standardisation. Or, as one respondent explained: ‘Due to the constant expansion of knowledge and thus the expansion of specialised knowledge in standards, the resource requirements of the standard addressees are increasing. This leads to ethical problems and in some cases means a ban on production for some market participants (see the EU’s New Legislative Framework (NLF)).’ In addition, IPRs restrict standardisation activities if included. Furthermore, some respondents complained about the limited support from other companies, in particular, or stakeholders in general, which can be explained by their – probably contradictory – specific interests in influencing the content of standards⁽²¹⁾. If patented content is included in standards, licences for standard-essential patents are needed. Others complained of low rewards under royalty-free licensing regimes for standard-essential patents, which some standardisation organisations have implemented. However, the whole set of problems related to IPRs in standardisation is not perceived as a challenge by most respondents. Complementary to this, the proprietary use of one’s research results is not perceived as complicated. However, some respondents perceive integrating research results as tricky, since standardisation is often not considered in research processes.

⁽²⁰⁾ These disadvantages are a particular problem for smaller organisations. In particular, the challenge that research results might be too far away from the needs of their customers is in line with the high rating of the relevance of customers’ interests as input into standardisation, as explained above.

⁽²¹⁾ See Blind and Mangelsdorf (2016).

Looking at the differences between the answers from the industry respondents and the others, we cannot detect significant variance, nor can we detect differences between large companies and SMEs (Figure 20). Only respondents from companies not performing research rate the disadvantages slightly higher. In general, the various disadvantages of integrating research results into standardisation received only low ratings from respondents.

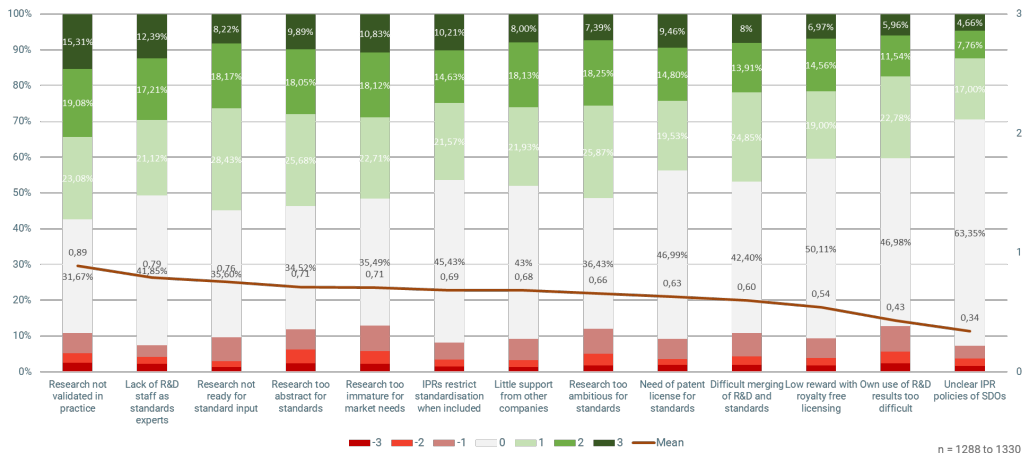


Figure 19. Relevance of disadvantages of research results as input for standard development. NB. Scale from very low (- 3) to very high (+ 3).

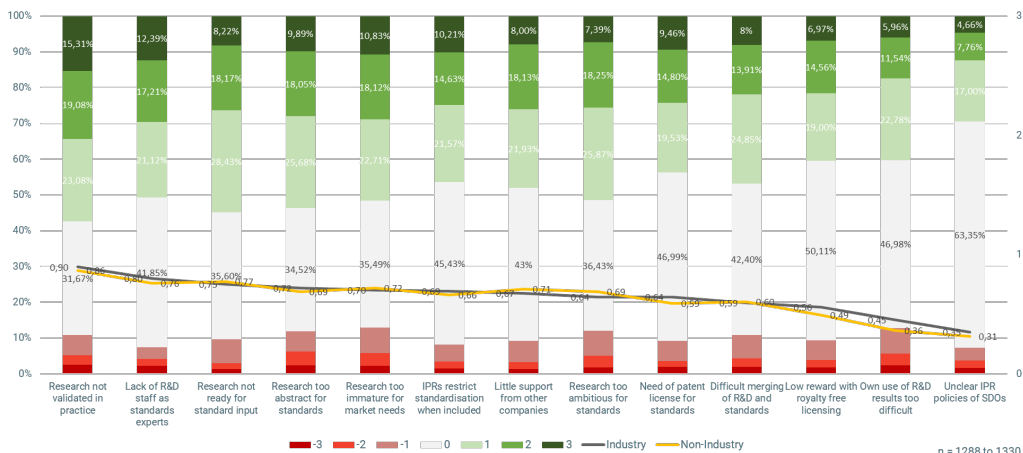


Figure 20. Relevance of disadvantages of research results as input for standard development differentiated between respondents from industry and from the remaining sectors. NB. Scale from very low (- 3) to very high (+ 3).

We gave respondents the chance to assess the effectiveness of various approaches to promoting the stated advantages and reducing the disadvantages of integrating research results as input for standard development (Figure 21). The most appropriate is the primary objective of the code of practice on standardisation in the European Research Area (European Commission, 2023) for promoting standardisation as an instrument for knowledge valorisation within HEIs and PROs⁽²²⁾. Companies' involvement in public

⁽²²⁾ According to the European Commission, 'Knowledge valorisation is the process of creating social and economic value from knowledge by linking different areas and sectors and transforming data,

research is rated second, followed by the funding of standardisation as a means of exploiting knowledge valorisation by national ministries and research funding organisations and by funding of standardisation of Horizon Europe project results by the European Commission. Some respondents proposed encouraging the consideration of R & D results in standardisation requests from the European Commission. One of the responses to the open question was 'Awareness raising on benefits of integrating research results into standards for University & RTO research funding offices and Tech Transfer Offices and Start-up/Scale-up Incubators across Europe'. Interestingly, the more conceptual and long-term proposal of including standardisation in the definition of R & D was perceived to be effective by most respondents but was also considered completely ineffective by a few experts. The increased participation of HEIs and PROs in standardisation and its promotion within HEIs and PROs was supported by most respondents. Having dedicated work packages on standardisation in research projects was also rated as beneficial, as was the more generic claim of including standardisation in tax incentive regimes for R & D. Lastly, the involvement of SDOs in publicly funded research projects was supported only by a minority. Likewise, adjusting SDOs' service portfolios to align them with R & I activities was not perceived to be very effective by most respondents.

Looking at the responses from the industry and other stakeholders, we can observe some significant differences (Figure 22). First, companies, particularly SMEs, endorse approaches that promote their involvement in publicly funded research projects. Second, companies strongly prefer standardisation to be included in general tax incentive regimes for R & D because such an approach would reduce the costs of participating in standardisation. For other non-profit organisations, including HEIs and PROs, such tax schemes do, in general, not apply. Third, companies not performing research appreciate the involvement of SDOs in publicly funded research projects. However, industry support for measures focusing on other organisations, such as HEIs, PROs or SDOs, is lower than that for the other respondents. One of the respondents stated in this context that 'standardisation must be practicable'.

Overall, the focus of the code of practice on standardisation on encouraging its uptake by HEIs and PROs is perceived to be quite effective. Similarly, more funding of standardisation at the national and European levels to exploit research is seen to be most effective in encouraging the integration of research results into standard development. Lastly, the inclusion of standardisation in the definition of R & D is a discussion that deserves further consideration. Furthermore, SDO strategies and services would have to be changed significantly.

know-how and research results into sustainable products, services, solutions and knowledge-based policies that benefit society.' (https://research-and-innovation.ec.europa.eu/research-area/industrial-research-and-innovation/eu-valorisation-policy_en).

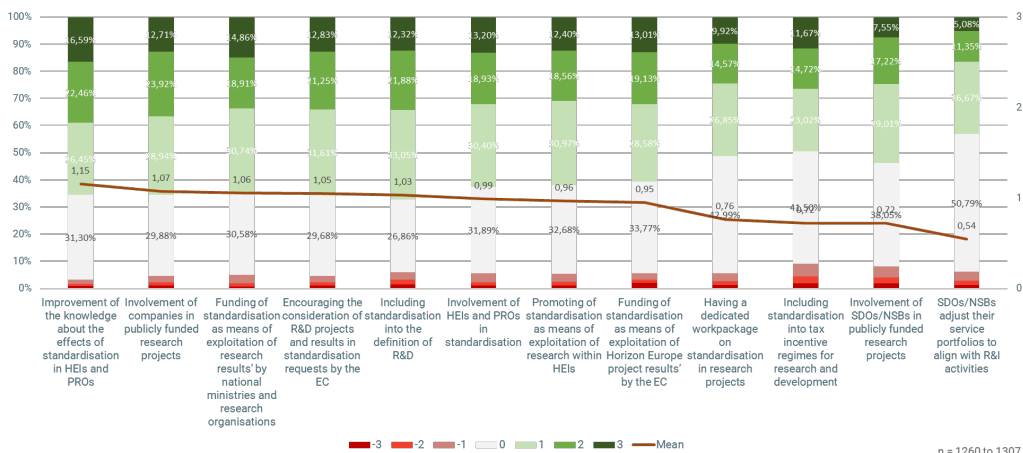


Figure 21. Assessment of the importance of various approaches to integrating research results as input for standard development.

NB. Scale from very low (-3) to very high (+3)

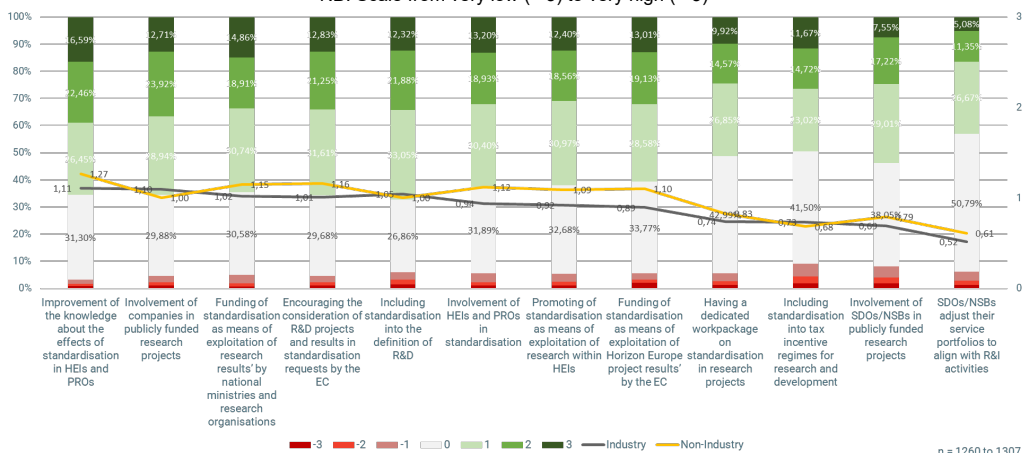


Figure 22. Assessment of the importance of various approaches to integrating research results as input for standard development differentiated between respondents from industry and from the remaining sectors.

NB. Scale from very low (-3) to very high (+3)

In the last section, the respondents were invited to assess the broader impacts of standards based on research results on innovation. Faster or easier market access (including European or international) can be achieved (Figure 23). In addition, the confidence level of consumers is improved, which is closely related to the wider use of recognised methods and processes and improved documentation of R & I results. The highest ratings of these impact dimensions are linked to the considerable influence of standards on market entry and legal security. This correlation shows the internal consistency and validity of the survey findings. However, it also reveals that further integration of research results into standards strengthens their impact in facilitating market access and legal certainty. One respondent stated in this context: 'The assessment specifications are too one-dimensional. The assessments depend, among other things, on the sector, the company's size and the employees' level of knowledges. Correlations can turn out diametrically different in the overall evaluation.' At the technical level, interoperability is improved. At the governance level, integrating research results into standardisation improves the capacity to respond to EU regulations/policies. In addition, it is perceived to improve the development and design

of products, services or processes. Furthermore, research results are disseminated faster via standards.

However, research integrated into standards does not necessarily signal the quality of a product or process, nor does it indicate that public procurement of innovation is expected ⁽²³⁾. More intensive collaboration with HEIs and PROs is also not anticipated. Lastly, larger economies of scale for products and services cannot be exploited by integrating research results into standards, which is a well-known tension.

Taking a last look at the differences between the answers from the industry and other stakeholders, we observe that the latter assessed most impact dimensions slightly more positively than the former (Figure 24). Larger companies in particular expect research-based standards and faster or easier access to European or international markets, which is crucial for their economic success. Other stakeholders, particularly those not performing research, expect an easier response to EU policies but not an improvement in public procurement and collaboration with PROs and HEIs.

Overall, integrating research into standards encourages faster and wider diffusion of knowledge and methodologies and strengthens standards' primary functions, such as market access, consumer confidence and interoperability. Complementary standards can better align with EU policy and regulation.



Figure 23. Assessment of the importance of impacts of standards based on research results on innovation. NB. Scale from very low (- 3) to very high (+ 3).

⁽²³⁾ See Blind (2008) for the role of standards in the public procurement of innovation, and see the first empirical evidence for their interrelationship in Blind et al. (2020).

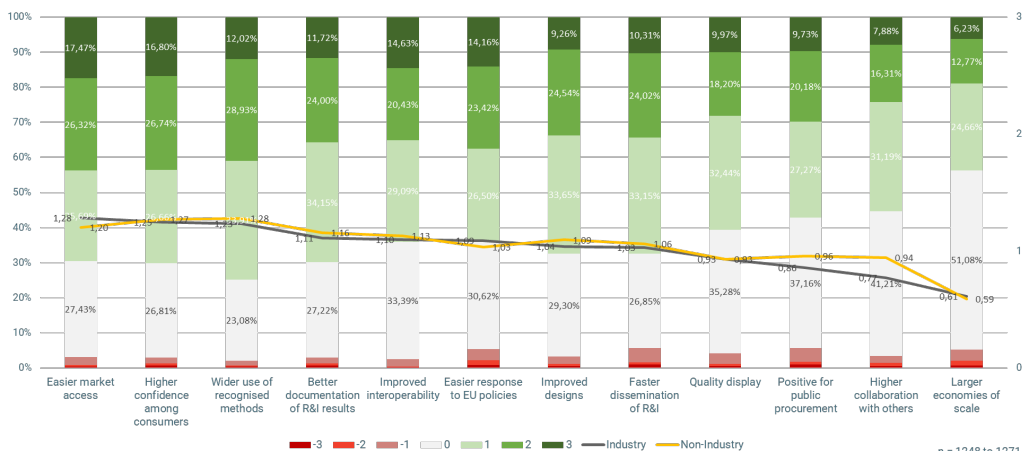


Figure 24. Assessment of the importance of impacts of standards based on research results on innovation differentiated between respondents from industry and from the remaining sectors. NB. Scale from very low (– 3) to very high (+ 3).

4.5. Organisations’ engagement in standardisation

Complementary to the closed questions related to using research results as input for standardisation, some generic open questions about organisations’ engagement in standardisation were asked (24). The answers were analysed by manual coding. Then, the frequency of mentioning the specific topics was calculated. The objective was to provide a comprehensive overview of the arguments made.

The first question aims to identify the needs most critical to increasing organisations’ engagement in standardisation activities. There are various ways to structure the needs of stakeholders (25). However, we rely on the frequency of the five most frequently mentioned topics. As there were five slots for participants to indicate their answers, the number of answers varies between 77 and 680 for each slot.

First, the benefits of standardisation and, more precisely, the financial returns were frequently mentioned by participants (n = 226) (Figure 25). The involvement in standardisation processes is time and resource consuming, but adequate resources and time commitment are necessary (26). For the participants, the advantages of engaging in standardisation must be clear in advance, for instance a high probability of entering the market with a new product or knowing that the administrative burden of entering a market will be reduced. More specifically, financial facilitations, such as tax reductions for companies active in standardisation or public funding for companies, are mentioned very often. This is particularly important for small companies, start-ups, HEIs and PROs because of their limited resources and lower incentives compared with large companies. One of the respondents even proposed ‘compensation for resources used’. Nonetheless, these

(24) We now expand the initially narrower focus on companies to organisations in general because all face challenges that are similar if not identical.

(25) See, for example, the study by De Vries et al. (2009) focusing on SMEs.

(26) The burden of travel costs is still raised, despite common remote standardisation processes commonly being carried out remotely. See also Heß and Blind (2023).

organisations provide valuable input for generating standards that are often public goods ⁽²⁷⁾.

Second, the participants recognised the need to make companies more aware of the benefits that standardisation entails so that they will change their internal structures (n = 142). Therefore, it is essential to make managers aware of the benefits of standardisation. On the one hand, standardisation institutions must explain this to companies, but, on the other hand, companies themselves need to enable standardisation internally. Involvement in standardisation requires all organisations to take a strategic and long-term approach. Companies need to accept, foster and reward their employees' engagement in standardisation by providing them with time and money but also more substantial incentives, and the same applies to HEIs and PROs ⁽²⁸⁾. One respondent stated in this context: 'Increasing awareness about the importance of standardisation and its potential benefits is crucial. Companies must understand how adhering to standards can improve product quality, safety, interoperability, and marketability. Educational initiatives, seminars, and workshops can help disseminate this knowledge.' Some participants felt that they needed a stronger acknowledgement of their work in standardisation by the organisation's management board. Recognition of contributors to standardisation seems more important now than in the past ⁽²⁹⁾. Therefore, contributions should be publicly acknowledging. In some countries, the authors are listed on the title page of standards.

The third most frequently stated need concerns the public visibility of standardisation (n = 130). The participants stated that there is a need for a clearer, more realistic, understandable and accessible information on standardisation ⁽³⁰⁾. This refers to standardisation in general, as well as to the advantages of standardisation, and to the visibility of current standardisation activities. In addition, the impact of a standard is fully exploited only if it is rapidly and widely disseminated. One respondent proposed: 'More visibility for companies involved in standardisation, e.g. joint events, press releases. ...'. Another wrote: 'raising awareness and reducing the stigma attached to standardisation activities'.

Next, the participants indicated that there is also room for improvement in the work of the standardisation organisations (n = 121). In particular, the composition of the committee was often mentioned. Participants would like to see more diversity in the SDO committees, namely representatives from industry, research and politics and consumers, who would work with them on their drafts. Furthermore, the SDOs need to communicate with their members and increase the pace of delivering their services. Some participants wished for better support when working with committees, as well as the provision of funding for participants, that is, 'a simple and guided introduction to the world of standardisation is needed'. Moreover, the SDOs need to improve their public performance by clarifying why companies and experts should engage in standardisation ⁽³¹⁾. Complementary education and training in standardisation in HEIs and even schools could be part of a long-term strategy.

⁽²⁷⁾ See Kindleberger (1983).

⁽²⁸⁾ See the proposals in the code of practice on standardisation in the European Research Area (European Commission, 2023).

⁽²⁹⁾ See Blind and Gauch (2009).

⁽³⁰⁾ See also the proposals in Blind (2023) related to pushing the diffusion of standards to support transformative innovations.

⁽³¹⁾ Some respondents underlined that scientific evidence is needed to calculate the return on investment.

The fifth most frequently mentioned topic is the reduction in membership fees for organisations that participate in standardisation committees (n = 116). Access to standardisation activities and committees has to be facilitated, complemented by higher visibility and awareness of the benefits of standardisation and standards. Further incentives could be created to subsidise participation in standardisation, for example by reducing the costs of attending technical committees or waiving the costs of purchasing standards for contributors.

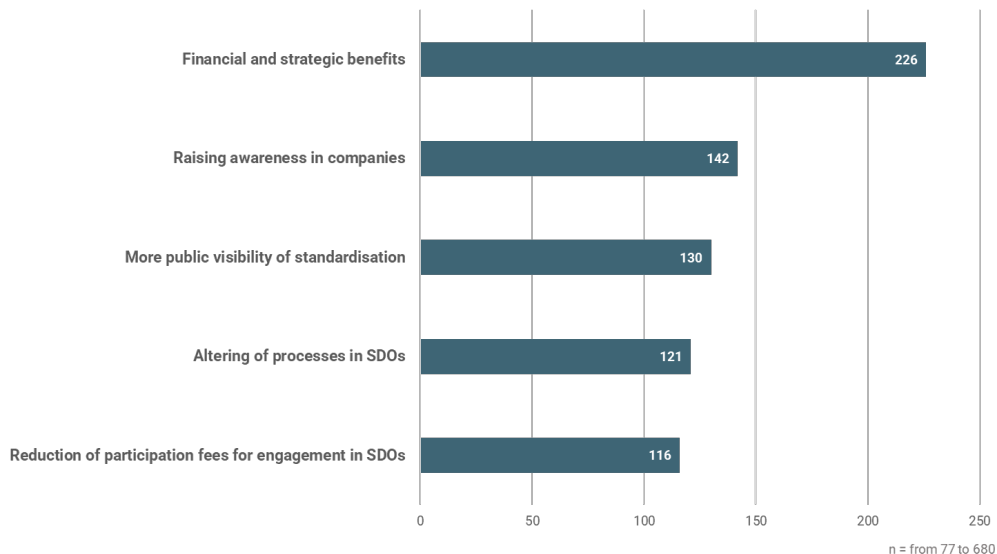


Figure 25. Most critical needs identified to increase organisations' engagement in standardisation activities.

However, even before standardisation processes start, respondents would appreciate a comprehensive overview of and easy access to existing standards, because this would increase the efficiency of standardisation processes and the incentive to participate. Generally, the generic functions of standards, such as having industry- or even economy-wide solutions instead of a fragmented landscape of specific and uncoordinated standards, and their financial impact, particularly when standardisation is lacking, must be communicated much more strongly and widely.

During the standardisation process, participants suggested increasing the efficiency of committees' work by focusing on the most relevant standardisation topics. Furthermore, the standardisation process should become faster and less bureaucratic. However, the acceptance and credibility of standards should not suffer⁽³²⁾. They should reflect the generally recognised state of knowledge and its relevance in practice. Participants' answers indicate that the various stakeholders' somewhat different interests and backgrounds require a carefully balanced consensus-finding process. Lastly, some respondents complained about the role of the harmonised standards consultants in delaying and complicating standardisation processes.

Following the open question on the needs of participants to get involved in standards, 475 participants responded to a request for proposals to help organisations in general and

⁽³²⁾ See Botzem and Dobusch (2012).

companies in particular to increase their competitiveness by strengthening their standard-setting capabilities (Figure 26).

For a number of participants, the most important requirements for getting involved in standardisation are (financial) benefits (n = 56), such as security of market entrance or the potential to become a market leader. The increase in consumer confidence or increased awareness of standardisation was also mentioned. One idea respondents proposed to achieve those goals was to grant 'free access to standards and tax advantages in their application'.

The next requirement is how participation in standardisation can be improved. Here, a reduction in the costs of participating in standardisation and the ability to use the outcomes of standardisation work was proposed. The proposition of one of the respondents was as follows: 'Promotion of standardisation work, at least partial refunding of the incurred costs for SMEs'. It was also stated that access to standardisation should be facilitated with the support of SDOs, for example by providing more low-threshold formats such as CEN workshop agreements. Another topic that was often mentioned in response to this question is the offer of training for standardisation personnel as well as the provision of consultancy by SDOs (n = 38). Participants should take a strategic approach towards their organisations' participation in standard-setting, including defining objectives such as shaping standards proactively, supported with appropriate resources.

Furthermore, respondents thought that the standardisation process should be fast and transparent to foster companies' competitiveness (n = 51). However, it was also highlighted that existing standards should be updated in a timely way. Some participants also mentioned a reduction in bureaucracy and a simplification of the whole process.

Since standards are often closely linked to the regulatory framework in the EU, participants thought that they should be well aligned with governmental regulations (n = 43)⁽³³⁾. Therefore, participation in setting standards should be perceived as an opportunity to influence regulations⁽³⁴⁾. However, it is not only alignment with certification and market surveillance that are required but also the international harmonisation of standards to avoid distorting competition and incurring additional certification costs. In this context, the role of certification, which can be a significant cost component, and market surveillance relying on standards, was mentioned in the context of reducing the share of defective products in the single market. Some respondents favour stricter regulations to comply with standards; one stated: 'Increasingly set framework conditions for legal requirements for market access through more accredited certifications (building trust in products and services through proof of compliance with standards)'.

⁽³³⁾ See Blind (2024).

⁽³⁴⁾ See also the survey results in Blind and Mangelsdorf (2016) from the machinery and electrotechnical industry, revealing that influencing standards is companies' most significant motive for standardising.

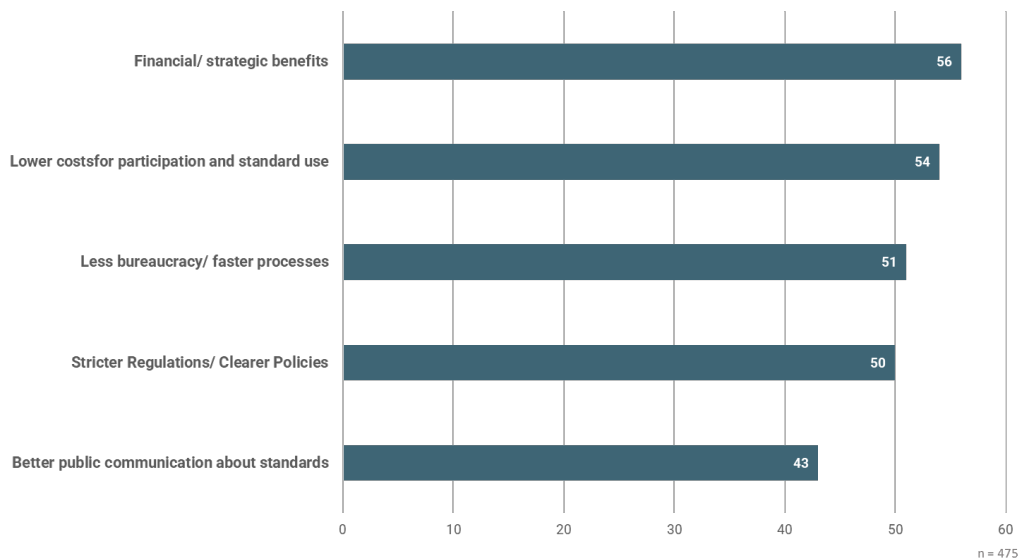


Figure 26. Measures to increase companies' competitiveness through strengthening their standard-setting capabilities.

Lastly, 434 participants answered the question about the needs of companies in relation to closer cooperation with research in standardisation.

In the most frequently answered topic, more participants answered in favour of closer cooperation with research in standardisation (n = 48) than stated that there is no need (n = 39) (Figure 27). To foster standardisation research and to deepen this tie, coordination between SDOs, research institutions and industry needs to be enhanced, and networks need to be created; 82 respondents supported that view.. The implementation of strategic coordination and communication tools could achieve this. HEIs and PROs with the knowledge, capacity and incentives should be more involved in standardisation processes, despite tensions with the interests of industry being likely. HEIs and PROs could play an essential role in consensus-finding because of their more technologically neutral position. Stronger relationships with SDOs could support their involvement. One respondent wrote in this context: 'Better information about the added value for themselves ... and the added value that science can bring to standardisation. Unfortunately, many scientific disciplines are not open to standardisation per se or see standardisation as something contradictory to science, sometimes even "at too low a level".'

For 49 of the respondents, the topic of financial incentives was the second most important need. As one respondent put it, 'The purpose of a company is to generate (sustainable) turnover. Anything outside that scope is perceived as "useless". For now, the processes take too long; they require the support of expensive external consultants, the outcomes are uncertain, etc. ... in other words, there is no clear or sufficiently rapid return on investment. So, either increase the Return on Investment (difficult), speed up the process (difficult), or decrease the costs involved ... I suppose the latter is the only one that can be acted upon.'

The third most frequently mentioned topic in this context was project-based funding for collaborative research (n = 44). Along with access to national research facilities, this is identified as a critical need because networking and active collaboration between industry and academia are crucial. Including standardisation as a work package in research projects was the fifth most frequently mentioned topic (n = 40) and could be essential to project-

based funding. Here, respondents declared that a clear definition of the goal and instructions, testing phases and consideration of the topic in public procurement are important.

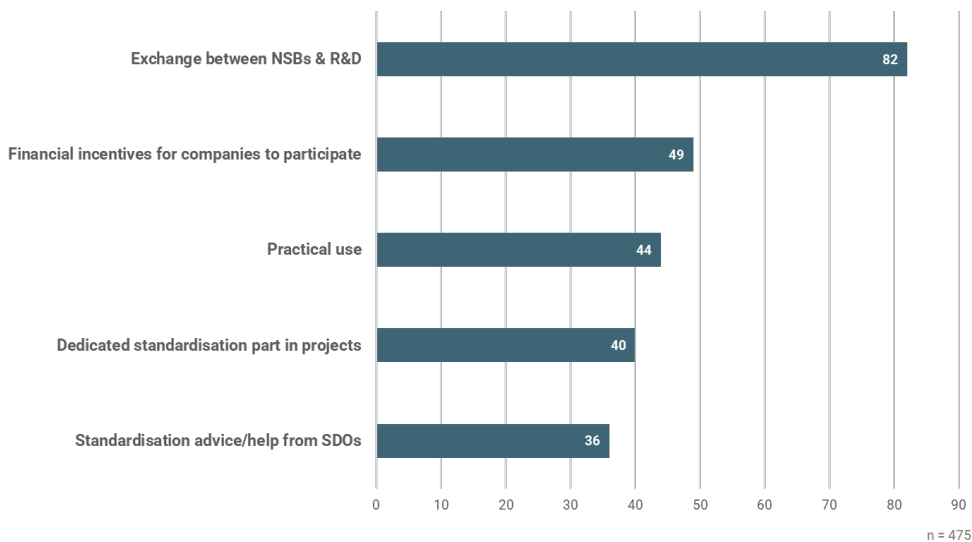


Figure 27. Companies' requirements for better implementation of standardisation through cooperation between industry and science.

The practical applicability of scientific results and more market-oriented science was mentioned by 44 participants and is the third most important need. Here, the consideration of cost-effectiveness and the need for SMEs to improve collaboration in standardisation, which eventually contributes to technical progress and innovation, plays an important role. In particular, pre-normative research needs to be undertaken before standardisation, for example extensive testing of the product and the methods, as well as a clear picture of the current market situation being drawn. For efficient collaboration on standardisation, the sharing of data and research findings between industry and scientific communities is needed, and this can be supported by open science and open access. Mechanisms should also be established for continuous monitoring and feedback from scientific partners to ensure that standards are at the cutting edge of technology. According to respondents, this is important because 'the implementation of standardisation projects must first and foremost be practice-oriented. It is of no use to anyone to develop standards that are scientifically detached and far removed from everyday practice. A further distinction must be made between product and process standards. The standardisation committees should at least have an equal number of stakeholders from all areas.'

The importance of knowledge, education, continuous internal training for effective cooperation with research organisations, and training about standardisation was also stressed in the context of this question. In addition, opportunities for interdisciplinary collaboration are considered essential for developing comprehensive and implementable standards.

4.6. Summary of the survey results

Based on the answers of more than 3 700 respondents (with slight over-representation from Germany), we can reveal several insights arising from answers to the main questions in the ESPS and derive recommendations.

Sample characteristics

The majority of the respondents work for industry, mainly mechanical and electrical engineering companies. However, other stakeholders, such as experts from non-governmental organisations, HEIs, PROs and the public sector, also answered the questionnaire. Overall, we achieved a balance between large organisations with over 250 employees and small organisations, particularly SMEs. More than 80 % of the experts are male, and more than 60 % are aged over 50.

General relevance of standards

Formal European standards followed by international standards were rated the most important. However, European technical specifications, such as CEN workshop agreements and national standards, have almost the same relevance. Over one third of the organisations surveyed have implemented more than 100 formal standards. More than half are certified to at least ISO 9001 for quality and ISO 14001 for environmental management. Respondents considered formal standards most relevant for legal security but that they also facilitate market access or achieve technical interoperability, for which technical specifications are almost equally relevant. Company internal standards are essential for firms to improve quality, but other types of standards are of limited relevance.

Research and development collaboration partners

More than half of the responding organisations perform R & D and have introduced product or process innovations. Collaborations with PROs and universities are relevant. After further education and informal contacts, common standardisation activities were rated the most effective forms of cooperation with scientific institutions for knowledge transfer.

Research as input into standardisation

Policy initiatives, including regulations and customers' requirements, particularly for industry, as well as organisations' own and collaborative research, are the most relevant sources for standard development. Research input is most important for measurement and testing standards, followed by quality and environmental standards. The most significant advantage of research as input for standardisation is free access to scientific content and the ability to keep track of scientific progress. The challenges are the lack of validation of research results, but the lack of R & D staff as standards experts as input for standards is also a problem. However, overall the advantages of integrating research results into standardisation are rated much higher than the disadvantages.

Approaches for the integration of research in standardisation

There are various approaches to improving the integration of research results as input for standard development. Increasing the knowledge of HEIs and PROs was found to be most effective, followed by more companies' involvement in publicly funded research projects, particularly SMEs. However, funding standardisation as a means of exploitation of research

results seems also to work. Lastly, including research into standards, which are the basis of innovation, fosters the primary function of standards, such as facilitating market access, strengthening consumer confidence in innovative products, wider use of recognised methods and better documentation of R & D results.

Organisations' engagement in standardisation

Three open questions were posed and the answers analysed qualitatively. The most critical needs to increase organisations' engagement in standardisation are related to a lack of awareness of the benefits of standardisation, particularly the financial returns. Involvement in standardisation processes requires adequate resources and a time commitment. More specifically, financial facilitation, such as tax reductions for companies active in standardisation or public funding for companies' projects, were mentioned very often. In addition, there is a need – also supported by SDOs)– to make companies more aware of the benefits that standardisation brings so that they change their internal structures to foster employee engagement in standardisation, which is also required for HEIs and PROs.

Furthermore, there is a need for clearer, actual, more understandable and more accessible information on standardisation. In addition, there is room for improvement in the work of SDOs, particularly the diversity of committee composition and the speed of processes. Lastly, the reduction of participation fees in standardisation committees is mentioned.

Companies' competitiveness can be strengthened if their participation in standardisation brings benefits, for example by lowering costs, but also facilitates market entry or increases consumer confidence. Furthermore, training for personnel developing standards and the provision of consultancy by SDOs are helpful. Since standards are often closely linked to the regulatory framework in the EU, they should be well aligned with governmental regulations to foster companies' competitiveness.

Related to the need for companies to foster closer cooperation with research in standardisation, better coordination between SDOs, research institutions and industry is required, which can be enhanced by networks that need to be created. HEIs and PROs need to increase their standardisation-related knowledge, capacity and incentives. However, the capability to get effectively involved in standardisation must also be strengthened within companies. Furthermore, communication capacity is needed to support census-finding processes and exploit opportunities for interdisciplinary collaboration to develop comprehensive and easily implementable standards. Here, project-based funding for collaborative research related to standardisation and the inclusion of standardisation as a work package in research projects are suggested. These approaches would also improve the practical applicability and the market orientation of research results. Lastly, education and continuous internal training are needed to cooperate with research organisations effectively.

5. RECOMMENDATIONS

A survey was developed based on the literature review and then assessed by selected experts from industry. The answers to the survey, supported by insights from research, but also considering the general aim of promoting cutting-edge innovation that fosters timely development of standards in accordance with the European standardisation strategy (European Commission, 2022), are used to derive recommendations addressing different target groups, as in the code of practice on standardisation (European Commission, 2023). Preliminary recommendations were presented and discussed at the online workshop on

8 December 2023. The following list of final recommendations addressing different stakeholders is the outcome of the discussions at that workshop.

5.1. Recommendations addressing industry

As a significant player in developing standards and a beneficiary from their implementation, industry has to increase awareness within companies of the benefits of participating in standardisation in general and of collaborating with research (see Sections 4.4 and 4.5). The latter is an essential driver for initiating standardisation processes, which can benefit from the freely accessible and timely insights from research (see Figure 19). Since standardisation is often a new topic for researchers in industry, the effectiveness of company internal communications and awareness campaigns related to standardisation has to be improved. Furthermore, companies' involvement in standardisation will require the promotion of positive business cases. These recommendations have been derived from the discussions at the online workshop.

Setting research-based standards is an option for shaping the regulatory framework (see Figure 19) and is relevant for companies' markets despite the even greater challenge of constructing a positive business case. Therefore, we recommend providing adequate resources for standardisation activities to exploit the opportunities of research but also to direct future regulatory developments. However, the challenge of integrating as yet unvalidated, premature, too abstract and ambitious research results into standardisation (see Figure 20) needs to be tackled by providing funding for the further validation of research results for standardisation.

Industry in general and SMEs in particular benefit from research-driven standardisation, for example by keeping track of scientific and technical progress⁽³⁵⁾ but also from the opportunity to use their own research results for the development of their own innovative products (see Figure 19). Furthermore, standards can prevent proprietary dominant designs from making market entry and achieving competitiveness, particularly for SMEs, more difficult. Lastly, SMEs in particular benefit from the quality-enhancing impact of research-based standards (Figure 25). Therefore, it is recommended that – despite significant challenges – research-active SMEs are supported to adopt standardisation.

5.2. Recommendations addressing higher education institutes and public research organisations

Similar to industry, HEIs and PROs can also benefit from research-driven standardisation, for example by using scientific evidence to develop standards that are relevant for their follow-up research (Figure 19). Therefore, their representatives, and also stakeholders from industry, suggest increasing awareness of the relevance of standardisation and funding opportunities (Figure 23).

⁽³⁵⁾ See the critical role of participation in standardisation for knowledge acquisition by SMEs in Blind and Mangelsdorf (2016).

Since the involvement of researchers in standardisation is not adequately rewarded, appropriate incentives should be provided (see Blind and Gauch, 2009), which will need effective performance indicators ⁽³⁶⁾.

Since the survey revealed for the first time the age distribution of experts involved in standardisation and the need to replace several thousand of them in the next few years (Figure 5), educating and training future experts is a crucial challenge. Therefore, the recommendation addressing HEIs to provide education and training on standardisation already underlined in the code of practice on standardisation and in the study about the functions and effects of European standards (European Commission, 2022b) was affirmed by the discussions at the workshop ⁽³⁷⁾. Because of the still small share of female standardisation experts, the forthcoming shortage of experts should also be addressed by recruiting women, which might be supported by considering gender aspects in future education and training activities.

At the workshop, it was pointed out that standardisation is not very prevalent in HEIs. However, the differences between technical universities, business schools and other faculties, as well as between scientific disciplines, should be considered. It is recommended that HEIs follow the new Horizon Europe project EDU4Standards ⁽³⁸⁾, started in January 2024, to tackle the challenges mentioned by expanding, improving and diversifying their teaching and education portfolios related to standardisation.

5.3. Recommendations addressing standard development organisations

SDOs provide the platform for successfully integrating research results into standards, as confirmed by the workshop discussions. Therefore, it is recommended that they improve the agility of their processes to allow the timely release of standards (see Section 4.5). In particular, it is suggested that they further develop their service portfolios for R & I actors and examine new ways to align their activities with R & I, which is particularly appreciated by research-active SMEs (Figure 23) ⁽³⁹⁾. Some of their products, such as CEN workshop agreements, whose impact is judged to be similar to that of standards, are not well known by most experts. However, several workshop participants considered them effective instruments for rapid innovation and an important step in the run-up to regular standardisation and lowering the entrance barriers for research-based newcomers to standardisation.

Furthermore, open-source software and hardware are still irrelevant inputs for standardisation processes (Figure 14). Therefore, SDOs should consider addressing them explicitly within their IPR policies but also consider closer collaboration with open-source communities, because they might support SDOs in their efforts to speed up the processes

⁽³⁶⁾ See examples in the annex to the code of practice on standardisation (European Commission, 2023). In Germany, the new transfer initiative within the framework of Germany's federal government's high-tech strategy and in GWK's new taxonomy of transfer indicators includes standardisation activities as a seventh pillar (GWK, 2020), which requires the research organisation to report its involvement in technical committees. In addition, Germany is currently discussing whether to disclose voluntarily the names of the experts contributing to a standard, as is already the case in France.

⁽³⁸⁾ <https://edu4standards.eu>.

⁽³⁹⁾ In some countries, such as France, SMEs can participate without paying any fees for standardisation.

and to improve the agility of standard development, and also might support the inclusion of research-performing SMEs active in open source ⁽⁴⁰⁾.

Lastly, SDOs should also monitor the implementation of standards-based certification to collect feedback, which will eventually be integrated into the revision or withdrawal of existing standards to maintain a timely stock of standards promoting firms' competitiveness (see Section 4.5).

5.4. Recommendations addressing research funding organisations

The participants highlighted the need for and the effectiveness of funding standardisation as a means of exploiting research results at the European and national levels and an option for knowledge valorisation (Figure 22). Therefore, it is recommended that new funding schemes are established or the financial support already available under the European standardisation strategy (European Commission, 2022) is continued and expanded. Meanwhile existing opportunities, such as the support services offered within the Horizon Europe project HSBooster ⁽⁴¹⁾ or the funding opportunities for European experts offered by StandICT ⁽⁴²⁾ for ICT-related standardisation activities, by Seeblocks ⁽⁴³⁾ and by Blockstand ⁽⁴⁴⁾ for blockchain-related standardisation activities at the international level, should be utilised. At the national level, Germany has established a programme of knowledge transfer via patenting and standardisation (Wipano ⁽⁴⁵⁾). It is recommended that this initiative should be continued in Germany and that other Member States establish similar funding programmes.

Complementary to these funding schemes, workshop participants recommended that standardisation should be considered at the beginning and not only at the end of R & D projects because researchers are confronted with standardisation at an early stage, and the results can be better integrated into standardisation processes. Since some players focus more on research and others more on standardisation, it is suggested that in coordination and support actions involving these different actors, research and standardisation can also be more effectively and efficiently integrated.

In addition, SME-specific needs for less bureaucratic procedures in standardisation-related research funding should be considered, as should the option to promote their international visibility via standardisation. In this context, the workshop participants demanded more and accurate supplementary information on standardisation in research calls, additional support during the implementation of research projects and more examples of best practices.

Since HEIs and PROs are – according to the responses to the survey – lacking in knowledge about standardisation and are therefore insufficiently represented in standardisation activities, they should also be considered for public funding schemes (Figure 22), as also suggested in the code of practice on standardisation (European Commission, 2023).

⁽⁴⁰⁾ See the recommendations by Blind and Böhm (2019).

⁽⁴¹⁾ <https://www.hsbooster.eu/>.

⁽⁴²⁾ <https://standict.eu/>.

⁽⁴³⁾ <https://seeblocks.eu/>.

⁽⁴⁴⁾ <https://blockstand.eu/>.

⁽⁴⁵⁾ <https://www.innovation-beratung-foerderung.de/INNO/Navigation/DE/WIPANO/wipano.html>.

Since SMEs express a greater need for support from SDOs in integrating research results into standardisation, they should also be considered for the support programmes on standardisation that support knowledge valorisation in order to offer appropriate services (Figure 22).

5.5. Recommendations for other areas of innovation policy

We must reconsider basic definitions if we are to change the general understanding of standardisation as being wholly separate from or contradicting R & D. Standardisation is not considered in the Organisation for Economic Co-operation and Development (OECD) definition of research and experimental development in the Frascati manual (OECD, 2015) and only as a knowledge source for innovation in the Oslo manual (OECD and Eurostat, 2018). Therefore, it is recommended (Figure 22) that the comprehensive integration of standardisation is discussed in the upcoming revisions of both manuals because most respondents to our EU-focused survey would endorse that.

Following a revision of the terminology, indicators and evaluation systems have to be developed, as already suggested in the code of practice on standardisation, to help standardisation experts demonstrate their contributions to the performance of their organisation, since several respondents expressed this as a significant need.

Specifying the general recommendation in the code of practice on standardisation (European Commission, 2023) that Member States should use national support structures concerning the role of standardisation for knowledge valorisation, we address the following areas based on the responses to the survey.

Complementary to providing explicit funding to promote the integration of research results into standardisation, there is an opportunity for Member States to treat R & D expenditure differently from other types of expenditure (Figure 22). In 2022, more than three quarters of OECD countries gave preferential tax treatment to business R & D expenditure⁽⁴⁶⁾. The French research tax credit approach has allowed the declaration of the cost of participating in standardisation since 2009⁽⁴⁷⁾. Therefore, it is recommended that Member States with a research tax credit system expand the tax base to expenditure incurred by participation in standardisation, because smaller organisations confirmed the effectiveness of this approach in the survey. Furthermore, SMEs do not benefit in the same way as large organisations from public research funding programmes⁽⁴⁸⁾.

In addition to this specific recommendation, it is suggested that standardisation is considered in further R & I-related support programmes targeting SMEs.

While in the mobile communication area, patents and other IPRs, particularly standard-essential patents, play a major role, which impacts research and standardisation, the ESPS did not reveal significant problems in the organisations surveyed (Figure 19)⁽⁴⁹⁾. Therefore, no specific recommendations on this can be derived.

⁽⁴⁶⁾ <https://www.oecd.org/innovation/tax-incentives-rd-innovation/>.

⁽⁴⁷⁾ See the recommendation in De Vries et al. (2009) to support SMEs.

⁽⁴⁸⁾ Dinges et al. (2013) reveal that all SMEs, accounting for more than 90 % of enterprises in the EU, received only a similar amount of funding under Horizon 2020 as some large companies.

⁽⁴⁹⁾ See Blind and Gauch (2009).

A closer alignment is needed between standards and regulations to promote innovation ⁽⁵⁰⁾, particularly in the EU, as more than 3 000 European standards are referenced in EU directives and regulations. The increasing relevance of a robust science base for standards (Figure 17) ⁽⁵¹⁾ can also be leveraged in the regulatory framework of the EU, particularly in emerging fields of science and technology often addressed in standardisation requests adopted by the European Commission ⁽⁵²⁾. Therefore, it is recommended that *ex ante* regulatory impact assessments should screen the existing standards landscape to use the already existing scientific evidence base and avoid contradictions.

Lastly, public procurement can benefit from research-based standards, particularly to promote innovation ⁽⁵³⁾. In pre-commercial procurement, not only research but also new standards can be developed, which the whole EU single market will eventually have access to. Therefore, it is recommended that the role of research-based standards is considered in updating the public procurement directive (Directive 2014/24/EU) and also in the EU funding programmes supporting innovation procurement, such as Horizon Europe, Innovation Fund, new defence programme and Digital Europe.

In summary, the challenges of effectively implementing the recommendations in practice are that numerous stakeholders, different governance levels and various strategy and policy areas are addressed. Therefore, close coordination of stakeholders and instruments across multiple levels is needed.

⁽⁵⁰⁾ See Blind (2023) on the coordination of standardisation and regulation to promote transformative innovation.

⁽⁵¹⁾ See the increasing amount of scientific references in ISO standards revealed by Blind and Fenton (2022).

⁽⁵²⁾ Here, standards are perceived as lower barriers to innovation than regulations (Blind et al., 2017).

⁽⁵³⁾ See Blind (2008).

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ANNEX 1: QUESTIONNAIRE FOR THE EUROPEAN STANDARDISATION PANEL SURVEY

Structure of the questionnaire

The questionnaire is structured along the following major themes:

- importance of standards: questions on the importance, use and implementation of standards, as well as on other aspects of technical rules;
- standardisation activities: questions about the use of resources for standards and standardisation activities;
- general information: questions about the general characteristics of your organisation, including, but not limited to, information that can be found in your annual report;
- influence of research on standardisation: questions about the role of research for standards development;
- importance of European standardisation.

General questions

Section A: Information about the participating organisation and the person completing the questionnaire

A1. From which point of view will you be answering the following question? (one answer)

- The view of the organisation
- The view of the business group
- My expertise as an individual

A2. What type of organisation do you belong to? (one answer)

- Private for profit organisation (company)
- Public organisation
- Non-governmental organisation
- Governmental organisation
- Higher education institution (HEI)
- (Public) research organisation (PRO)

- Foundation
- Other

A3. Does your organisation/company belong to a group of organisations/companies or an association of several organisations/companies?

- Yes, a national business group with headquarters in your country
- Yes, an international business group with headquarters in country
- Yes, an international business group with headquarters abroad
- No, an individual company with headquarters in your country
- No, an individual company with headquarters abroad

A4. In which country are you located?

A5. In which country are your headquarters located?

A6. Please state the main sector of your organisation in 2022. If you answer as private person please indicate the sector of your main occupation, that is, for which sector your answers are representative.

A7. Please state the full name of your organisation.

A8. Please state your function within your organisation (one answer):

- Education, training
- Procurement, materials management
- Export
- Finance, accounting
- Research, development
- Executive management, plant manager
- IT, data processing
- Infrastructure construction
- Logistics, storage, transportation
- Marketing
- Standardisation

- Human resources, social affairs
- Production, manufacturing
- Quality management
- Services, technical support
- Miscellaneous
- Distribution, sales
- Administration
- Other

A9. If you checked 'Other', describe your function in this field.

A10. Did you receive a formal training in standardisation before you entered your organisation or within your organisation? (one answer)

- Yes
- No

A11. Please indicate to which age group you belong (one answer):

- Below 30
- Between 30 and 39
- Between 40 and 49
- Between 50 and 59
- Between 60 and 69
- Between 70 and 79
- Above 80

A12. To which gender identity do you most identify? (one answer)

- Female
- Male
- Diverse

Section B: General significance of standards and specifications

The following section contains questions about the relevance, the use and the implementation of norms and standards, as well as other aspects of technical rules.

A distinction is made between formal standards, technical rules or specifications, consortia standards, de facto standards and company standards.

Formal standards are developed in the committees of your national, European or international standardisation organisations (SDOs) with full consensus of all interested parties.

Specifications are developed by experts in formal SDOs, but, like technical rules, are not adopted in full consensus decisions.

Informal consortia standards are developed by a select group of companies in consortia (and thus outside the formal SDOs).

De facto standards are not developed by consortia, but result from the market.

Internal company standards are developed within a company and are used company-specifically by the company itself or by cooperating companies (e.g. suppliers). External company standards are company standards originally developed by other companies (e.g. purchasers /buyers) and then introduced internally.

B1. How important are the following types of national level standards established for your organisation? (very low to very high)

- Formal standards
- Technical rules or specifications
- Informal consortia standards
- De facto standards

B2. How important are the following types of standards established at European level for your organisation? (very low to very high)

- Formal standards
- Technical rules or specification
- Informal consortia standards
- De facto standards

B3. How important are the following types of standards established on international level for your organisation? (very low to very high)

- Formal standards

- Technical rules and specifications
- Informal consortia standards
- De facto standards

B4. How important are internal and external company standards for your organisation? (very low to very high)

- Internal company standards
- External company standards

B5. Please indicate the number of standards implemented by your organisation in 2022:

- Formal standards (e.g. national, EN, ISO, IEC, ETSI, ITU standards)
- Technical rules or specifications (e.g. guidelines issued or specifications)
- Informal consortia standards (e.g. like W3C, OASIS, IEEE, ASTM, OECD, Codex Alimentarius, UNECE, EFSA, OGC, CIPM, IFCC, ICRM, IAEA)
- De facto standards
- Internal company standards
- External company standards

B6. Please indicate whether or not your organisation was certified according to the following ISO standards in 2022:

- ISO 9001 (Quality management system standard)
- ISO 14001 (Environmental management system standard)
- ISO/IEC 27001 (Information security management system standard)
- ISO 50001 (Energy management system standard)
- Other

Section C: Specific significance of standards and specifications

C1. Please assess the impact of various types of standards on legal security (very negative to very positive)

- Formal standards
- Technical rules or specifications

- Informal consortia standards
- De facto standards
- Internal company standards
- External company standards

C2. Please assess the impact of various standards on the fulfilment of formal and informal market entry conditions (very negative to very positive):

- Formal standards
- Technical rules or specifications
- Informal consortia standards
- De facto standards
- Internal company standards
- External company standards

C3. Please assess the impact of various standards on the realisation of technical interoperability (very negative to very positive):

- Formal standards
- Technical rules or specifications
- Informal consortia standards
- De facto standards
- Internal company standards
- External company standards

C4. Please assess the impact of various standards on the increase in productivity (including cost reduction) (very negative to very positive):

- Formal standards
- Technical rules or specifications
- Informal consortia standards
- De facto standards
- Internal company standards

- External company standards

C5. Please assess the impact of various standards on the improvement of quality (very negative to very positive):

- Formal standards
- Technical rules or specifications
- Informal consortia standards
- De facto standards
- Internal company standards
- External company standards

C6. Please assess the impact of various standards on the competitiveness regarding direct business rivals (very negative to very positive):

- Formal standards
- Technical rules or specifications
- Informal consortia standards
- De facto standards
- Internal company standards
- External company standards

C7. Please assess the impact of various standards on the effectiveness of research, development, and innovation activities (very negative to very positive):

- Formal standards
- Technical rules or specifications
- Informal consortia standards
- De facto standards
- Internal company standards
- External company standards

C8. Please assess the impact of various standards on the bargaining position regarding suppliers and customers (very negative to very positive):

- Formal standards

- Technical rules or specifications
- Informal consortia standards
- De facto standards
- Internal company standards
- External company standards

C9. Please assess the impact of various types of standards on your organisation's sustainability (very negative to very positive):

- Formal standards
- Technical rules or specifications
- Informal consortia standards
- De facto standards
- Internal company standards
- External company standards

C10. Please assess the impact of various types of standards on the organisation's resilience (very negative to very positive):

- Formal standards
- Technical rules or specifications
- Informal consortia standards
- De facto standards
- Internal company standards
- External company standards

Section D: Standardisation activities

D1. In which standardisation organisations was your organisation represented in 2022?

- National standardisation body
- CEN (European Committee for Standardization)
- Cenelec (European Committee for Electrotechnical Standardization)

- ETSI (European Telecommunications Standards Institute)
- ISO (International Organization for Standardisation)
- IEC (International Electrotechnical Commission)
- ITU (International Telecommunication Union)

D2. Please specify your national standardisation body.

D3. Did your organisation participate in standardisation consortia in 2022?

- National consortia
- European consortia
- International consortia

D4. In which specific standardisation consortia did your organisation participate in 2022?

D5. Did your organisation maintain a standardisation department in 2022?

D6. Please define the tasks and authority of this department.

D7. Please state the number of employees in the standardisation department in your organisation in 2022.

D8. Please estimate the approximate total expenditures on all standardisation activities of your organisation in 2022.

Section E: General and research and innovation (R & I)-related information about the organisation

E1. How many employees worked in your organisation in total in 2022?

E2. Please estimate your organisation's total turnover, costs and profit in 2022:

- Total turnover
- Total costs
- Total profit

E3. What percentage of your organisation's turnover was generated by exports in 2022?

E4. Please divide the export share by region of destination:

- Share within Europe
- Share to Asia

- Share to the United States
- Share to rest of the world

E5. Has your organisation introduced new or significantly improved products or services (product innovations) to the market or introduced new or significantly improved processes (process innovations) between 2020 and 2022? Did the research and development (R & D) activities in your organisation take place internally and/or in cooperation with external partners?

- Product innovation
- Process innovation
- Internal R & D

External R & D

E6. How often did your organisation cooperate in research and development activities with the following organisations in 2022?

- Public and private universities
- Non-university research institutions
- Suppliers
- Competitors/businesses in your industry
- Business consultants / commercial R & D service providers
- Customers

E6. Which of the following measures for the protection of intellectual property did your organisation use in 2020–2022 and what was the importance of these measures in protecting your intellectual property? (very negative to very positive)

- Application for patents
- Registration of utility models
- Registration of designs
- Registration of trade marks
- Enforcement of copyrights
- Confidentiality (incl. non-disclosure agreements)
- Complex design of products/services

- Time lead over competitors
- Long-term retention of qualified personnel

E7. How relevant is it for your organisation to cooperate in research and development activities with the following institutions in 2022? (very low to very high)

- Public and private universities
- Non-university research institutions
- Suppliers
- Customers
- Competitors/businesses in your industry
- Business consultants / commercial R & D service providers
- Customers

E8. Which forms of cooperation with scientific institutions did your organisation use and how effective were they in obtaining know-how from scientific institutions? (low to high)

- Collaborative research funded at national level
- Collaborative research funded at European level (Horizon 2020, Horizon Europe)
- Contract research
- Student theses/dissertations in the organisation
- Licensing/purchase of technology
- Temporary exchange of personnel
- Further education / training of own staff
- Scientific/technical consulting
- Informal contacts / informal exchange
- Common standardisation processes

Special section questions: influence of research on standardisation

The following special section contains questions on the importance of research for the standardisation process in general and for certain types of standards in particular. In addition, questions are asked about the advantages and disadvantages as well as the possible effects, of using research results as input for standardisation. Finally, the effectiveness of the European research policy approaches will be assessed. The background is that Horizon Europe, the R & I funding framework programme of the EU, represents an important funding opportunity for universities, research institutions and companies. However, the research results should not only result in scientific publications or patents but also flow into standardisation processes. In this year's special section of the European Standardisation Panel Survey, we would like to understand how you, as standardisation experts, assess the contributions of research to the development of standards and where you locate problems and potentials.

F1. Please assess the relevance of the following input sources for standard development (very low to very high):

- Own research
- Private research of other organisations
- Results from collaborative public research
- Open-source software or hardware
- Requirements from customers
- Requirements from suppliers
- Services
- Business model
- Policy/regulation
- Other

F2. Please assess the relevance of research as input for different types of standards (very low to very high, I do not know):

- Terminology/semantics/ontology
- Measurement/testing
- Interoperability/compatibility/interfaces
- Quality
- Products/services (characteristics)

- Processes (production/management)
- Health protection
- Environmental protection and sustainability
- Safety protection
- Other

F3. Please assess the relevance of advantages of research results as input for standard development (very low to very high):

- Free access to scientific publications and other materials on the internet
- Impulse for new standardisation initiatives
- Improving the scientific evidence base for standards
- Keeping track with scientific and technical progress
- Leveraging own research results via standards for the development of own product and process innovation
- Preventing competing research content becoming dominant designs including standards
- Using scientific evidence to develop standards contributing to increased quality
- Using scientific evidence to develop standards contributing to the protection of the environment and sustainability
- Using scientific evidence to develop standards relevant for follow-up research
- Using scientific evidence to develop standards in support of regulation
- Other

F4. Please assess the relevance of disadvantages of research results as input for standard development (very low to very high):

- Proprietary use of own research results becomes difficult
- Research results not yet ready for standard relevant inputs
- Research results too ambitious for implementation in standards
- Research results too abstract for implementation of standards
- Research results too immature for market/customer needs

- Research results not validated in practice
- Little support from other companies/stakeholders
- Since standardisation not considered in research process, integration difficult
- IPRs, in particular patents, restrict implementation of standards when included in a standard
- Requirement to provide a licence to patents when included in a standard
- Lack of reward for patented technologies when included in a standard because of royalty-free licensing
- Lack of clarity or absence of IPR policy of an SDO
- Lack of R & D staff as experts in standardisation
- Other

F5. Please assess the importance of the following approaches to integrate research results as input for standard development (very low to very high):

- Including standardisation in the definition of R&D
- Funding of standardisation as means of exploitation (knowledge valorisation) of Horizon Europe project results by the European Commission
- Encouraging the consideration of R & D results in standardisation requests by the European Commission
- Funding of standardisation as a means of exploitation (knowledge valorisation) of research results by national ministries and research funding organisations
- Promoting of standardisation as means of exploitation (knowledge valorisation) of research within HEIs and PROs
- Including standardisation in tax incentive regimes for R & D
- SDOs adjust their service portfolios to align with R & I activities (better integration)
- Involvement of SDOs in publicly funded research projects
- Involvement of companies in publicly funded research projects
- Having a dedicated work package on standardisation in research projects
- Involvement of HEIs and PROs in standardisation
- Improve the knowledge about the effects of standardisation in HEIs and PROs

- Other

F6. Please assess the following impacts of standards based on research results as input for innovation (very low to very high):

- Better documentation of R & I results
- Faster dissemination of R & I results
- Wider use of recognised methodologies, processes
- Improved (development and) design of products, services or processes
- Larger economies of scale for products and services
- Enabling the display of a mark of product or process quality
- Higher confidence in innovative products and processes among consumers
- Faster or easier market access (incl. European or international)
- Improved capacity to respond to EU regulation/policies
- Improved interoperability of products, services or processes
- Positive impact on public procurement (referencing standards) promoting innovation
- Disclosure of knowledge negative for own competitiveness
- Intensified collaboration with other companies, PROs and HEIs
- Other (please specify)

F7. Please identify the most important needs in order to increase companies' engagement in standardisation activities.

F8. What do you think could most help companies to increase their competitiveness through strengthening their standard-setting capabilities?

F9. What are companies' needs for a better implementation of standardisation through cooperation between industry and science?

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The survey aims to identify the demand from industry and other stakeholders for standards as potential results of research and innovation (R & I) projects, to assess how EU R & I framework programmes could tackle them, and generally to raise awareness of the importance of standardisation as a knowledge valorisation channel. A Europe-wide survey revealed that policy initiatives, including regulations and customers' requirements, particularly for industry, as well as organisations' own and collaborative research, are the most relevant sources for standard development. Research input is most important for measurement and testing standards, followed by quality and environmental standards. The most significant advantage of research as input for standardisation is free access to scientific content and the ability to keep track of scientific progress. Recommendations are derived for industry, higher education institutes and public research organisations, standard development organisations, research funding organisations and other innovation policy areas.

Studies and reports

