Summary: "Understanding ICT Standardisation: Principles and Practice" by Abdelkafi N., Bekkers R., Bolla R., Rodriguez-Ascaso A. & Wetterwald, M. (2021)[1]

[1]This document, prepared by Ellen Deuter, Eleftheria Stefanaki and Wayne Chinembiri, aims to summarize the study "Understanding ICT Standardization: Principles and Practice" by Abdelkafi N., Bekkers R., Bolla R., Rodriguez-Ascaso A. & Wetterwald, M. (2021), available at <https://www.etsi.org/images/files/Education/Textbook_Understanding_ICT_Standardization.pdf>. Neither the paper nor the summary necessarily represent the views of the authors, their employers, 4iP Council or any of 4iP Council supporters.

1. Introduction

A standard can be defined as a widely agreed upon way of doing something, designing a product, building a process, implementing a procedure, or delivering a service.[2] Therefore, a standard results from shared knowledge and dictates how to perform a technical solution. As a result, devices developed by different makers can interwork and communicate.

Much of the innovation, product-compatibility, and orderliness that we enjoy in our lives is attributed to standards. Standards can be seen in various facets of our existence such as the standardised way of telling the time, of measuring speed and distance and even the width of train tracks. Weight, length, and other basic aspects cannot be measured in the absence of a uniform reference system that is widely agreed upon by people and institutions (a standardised system). Standards have also been particularly important in ensuring compatibility of mobile devices when we want to communicate with users of different networks, or we are travelling abroad. Standards therefore help in making our lives easier and new technologies more convenient to adopt and use, as seen with the cellular standards (2G to 5G) for example.

2. Standardisation basics

2.1. Categories of Standards

2.1.1. De facto standards

Generally, there are two main categories of standards. The first category consists of standards that are created because a certain technology asserts itself on the market and becomes a natural choice for many manufacturers. This is referred to as a *de facto* standard. In other words, a *de facto* standard is a custom or convention that, due to wide public approval or market circumstances (e.g., first comer in the market) has gained popularity and has become dominant.[3] . *De facto* standards are appealing as they are often established through unrestricted competition in the market. [4]

The QWERTY keyboard is an example.[5] *De facto* standards could also be adopted by recognised Standards Development Organisations (SDOs), as was the case with HTML and PDF.[6]

2.1.2. Formal/SDO standardisation

The second category of standards concerns formal or SDO standards which are developed during a formal standardisation process with SDOs.[7] The term *de jure* standards is often used as a synonym, but it should be noted that de jure standards constitute a subcategory of formal standards used by legislation. The main characteristics of formal standards are the following:

1. the technical work for a standard's development in SDOs follows a fair development process and must be the result of consensus from a working group;
2. the adoption of standards is mostly voluntary unless mandated by governments regulations; and
3. standards define the minimum set of requirements for an item, thus are limited in scope.

2.2. The economic effects of standards

Patents and standards have a substantial impact on public interest issues, a fact that has been acknowledged by regulators and policy makers worldwide. Not only does standardisation influence how the market should operate – hence influencing the position of current and future stakeholders – , but it also ensures an environment that fosters

[2] Abdelkafi, N., Bekkers, R., Bolla, R., Rodriguez-Ascaso, A., & Wetterwald, M. (2021) "Understanding ICT Standardization: Principles and Practice" [hereinafter Abdelkafi et al.], p. 18. All abbreviations used in this text are compiled at the last page of this summary.
[3] Abdelkafi et al. p. 57.
[4] Ibid p. 57.
[5] Ibid p. 6-7.
6 Ibid p. 58.
[7] Ibid p. 56.

innovation and undisturbed competition in the market without any undue barriers or unnecessary friction.[8] Ultimately, formal standards are usually created to serve the public interest.

What follows is a summary of four types of standards and their impact from an economic perspective:

2.2.1. Compatibility/interface standards

Compatibility standards ensure that IT services/products can work effectively together and share a common environment and resources with other independent services/products without adverse side effects.[9]

In the field of information communication technology (ICT), the proliferation of compatibility/interface standards can be explained by two economic concepts: switchover costs and network effects. Switching costs can occur when customers decide to change from one technology or product to another. Due to the high investment in integrating an old interface standard, manufacturers may also be reluctant to switch to another standard.[10]

Oneadvantage of compatibility standards is that they help companies to decrease transaction costs.[11] Due to the compatibility between a particular software and a particular operating system, the user need not waste as much time and resources confirming whether the software will actually operate.[12]l. Generally accepted compatibility standards make market access easier for for small suppliers of "add-on" products.[13]

In the case of standards that are not developed in SDOs (e.g., de facto standards), the possibility of a lock-in is higher because the standard is fully controlled by one or few market participants.[14] For the market, lock-ins can also mean high barriers to entry for new participants due to the high royalties requested by the owner of the standard or patents. Moreover, switching to another environment may not be practicable, since a significant number of users have to “reverse” the lock-in.[15]

As formal standardisation is expected to follow the World Trade Organisation (WTO) Technical Barriers to Trade (TBT) principles (among which is openness), the standards created in accordance with these principles are open standards.[16] These standards protect consumers from the the risk of lock-in, because the standard is freely available, resulting in unrestricted or easier market access and reduced switching costs for consumers.[17]

2.2.2. Minimum quality/safety standards

These standards refer to the minimum acceptable level of requirements and may relate to the reliability, durability, side-effects or safety of products and services. A minimum quality standard may refer to the fuel consumption or carbon dioxide emissions generated using a motor vehicle.[18]

Minimum quality standards can have a positive impact on welfare, considering their application in the fields of health and natural environment.[19] They can also help overcome information asymmetries,[20] since said standards serve as a reference and describe the the minimum requirements that a product should fulfill. For this reason, consumers are informed about the product’s characteristics, which assists in their decision-making. [21] This is the case especially when a product receives a certification which functions as proof of compliance with a standard.

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[8] Ibid p. 206.
[9] Ibid p. 220.
[10] Ibid p.220.
[11] Ibid p 221.
[12] Ibid p.220.
[13] Ibid p.222.
[14] Ibid p.220.
[15] Ibid p.220.
[16] See WTO TBT principles inhttps://www.wto.org/english/tratop_e/tbt_e/principles_standards_tbt_e.htm; Also, Abdelkafi et al. p. 101, 4.2.2.]
[17] Ibid p 221.
[18] Abdelkafi et al. p. 222.
[19] Ibid p.222.
[20] Information asymmetry occurs when one party has more or better information (in this case, the seller) than the other (the buyer), which makes it hard for the one with less information to make an informed decision.
[21] Abdelkafi et al. p. 224.

Some companies even benefit from their good reputation and can obtain a price premium for their products whose quality is significantly higher than the minimum value defined in the respective standard.

Minimum quality standards increase trust between sellers and buyers. Sellers assure the existence of certain characteristics which, in turn, leads to reduced transaction and search costs. Additionally, it guarantees increased certainty for consumers, since it is easier to identify products.[22]

2.2.3. Variety-reducing standards

Standards that reduce variety have two main functions: (i) supporting the achievement of economies of scale and (ii) preventing market fragmentation, by minimising the proliferation of poorly differentiated products or models. Standards can play an important role in providing focus and cohesion for innovators and technology pioneers, especially in the early stages of a market.[23]

Standards can shape future technological developments and are therefore a tool for developing new markets. For suppliers, less fragmentation translates to less risk despite the growth of more competition in the same technology. By discouraging the spread of varieties, these standards can lower barriers to entry and encourage improvement of the existing versions of products and services. This becomes a trickle-down benefit for consumers.

2.2.4. Information and measurement standards

Information and measurement standards include codified knowledge and product descriptions. Such standards – being the result of years of knowledge and experience - are used as a tool for technology transfer. As such, they have a positive effect on markets by diffusing knowledge throughout practitioners, product developers and implementers of standardised technologies.[24]

Measurement standards ensure precise and high-quality product development and service provision which showcases their superiority.[25] Therefore, measurement standards lead to lower transaction costs and less risk between trading partners, as they can build on widely adopted and accepted standard methods used for assessing of the quality of raw materials, products, and services.

Due to their main function, information standards can spread state-of-the-art knowledge and promote capacity building .[26] When publicly available, they prevent information asymmetries between market players. This may lead to lower barriers to entry and can foster equal and competitive conditions in markets.[27]

Measurement and information standards are presented in the ETSI textnook as a separate category of standards; however, it should be noted that all standards contain the two types of codified knowledge in one way or another.[28]

2.3. Standards in public procurement

The public sector can use standards in public procurement[29] to promote demand-side effects for a certain standardised technology. In this way, governments can achieve the diffusion of innovations in the private sector, as companies and other organisations bidding for public tenders must comply with certain standards.[30]

In the context of public procurement, standards have many positive effects such as the improvement of the quality of public services and infrastructure, which leads to increased customer and citizen satisfaction. In addition, integrating

[22] Ibid p.224.
[23] Ibid p.225.
[24] Ibid p.226.
[25] Ibid p.226.
[26] Ibid p.226.
[27] Ibid p.227.
[28] Ibid p.226.
[29] Public procurement is the process by which government agencies acquire work, goods, or services from businesses, such as building a public school, purchasing furniture for a prosecutor's office, or contracting for cleaning services for a public university.
[30] Abdelkafi et al. p. 228.

innovation into the public sector can result in cost savings, such as reduced maintenance and repair costs or lower energy consumption.[31]

Standards referenced in public tenders lead to the development of innovative products that can lower production costs and reduce the price that public purchasers must pay. They also ensure the interoperability of purchased innovations with existing infrastructure and can boost competition by increasing the pressure to innovate among competitors for public tenders. They also reduce the risk of lock-in to a particular vendor and trigger direct innovation effects for companies implementing newly published standards. [32]

However, less positive effects can arise such as when new features or improved functionalities cause an increase in prices.[33]. Sometimes innovative technologies carry higher risks for the user, but also for the environment for example, and they may increase maintenance costs due to lower operational experience. In addition, competition may be very limited, as the innovation to be purchased by the public sector may be produced by only a small number of companies.[34]

2.4. Standardisation Development Organisations

SDOs are organisations engaging in formal standardisation, which develop, revise, and withdraw standards following clearly set rules and procedures.[35]

The ICT sector constitutes a vibrant example of fertile standardisation activity with many leading SDOs producing exemplary results. The ICT SDO landscape can be classified in the following main categories: (i) according to geographical coverage at international, regional, and national levels; (ii) according to the technical scope of activities; and (iii) whether they are recognised or not.

International SDOs such as the International Telecommunications Union (ITU) or the International Organization for Standardization (ISO) produce deliverables with international coverage. Regional SDOs such as the European Telecommunications Standards Institute (ETSI) or the Pacific Area Standards Congress (PASC) develop common norms and regulations for a set of countries. National SDOs such as the Association Française de Normalisation (AFNOR) focus on country-specific standards and usually participate in international or regional SDOs.[36]

Lastly, an SDO officially acknowledged by a regulatory system as a provider of standards is known as a 'recognized SDO'. Recognised SDOs often develop standards after a specific request by a governmental authority. In the European Union, Regulation (EU) No 1025/2012 of the European Parliament and of the Council recognizes three European Standards Organizations (ESOs): the European Committee for Standardization (CEN), the European Committee for Electrotechnology Standardization (CENELEC) and ETSI.

2.4.1. Code of good practice for the development of international standards

Formal standardisation is expected to follow international guidelines set out in, amongst others, the WTO TBT agreement.[37] More specifically, the TBT agreement includes six principles for the development of international standards: transparency, openness, impartiality and consensus, effectiveness and relevance, coherence, and development dimension.[38] The ETSI textbook includes balance as one of the main standardisation principles, even though it is not one of the WTO principles.

In this context, **transparency** means that all documents relevant to the standard are easily accessible to all interested parties from countries that are WTO members. In addition, they should have the time and opportunity to submit

[31] Ibid p.228.
[32] Ibid p.229.
[33] Ibid p.228.
[34] Ibid p.229.
[35] Ibid p.56.
[36] ITU and ETSI engage in similar technical activities, i.e., interoperable telecom specifications including architecture, services, protocols, the former on an international and the latter in a regional level.
[37] https://www.wto.org/english/docs_e/legal_e/17-tbt_e.htm and https://www.wto.org/english/tratop_e/tbt_e/tbt_info_e.htm
[38] Abdelkafi et al. p. 56 and 100 et seqq.

written comments. The publication of the relevant documents in a digital form has proven to be an effective way to disseminate information to all stakeholders.

In addition, according to the principles of **openness**, all stakeholders (at least coming from WTO Members) should have the opportunity to become members of international SDOs and participate in the standard development process on a non-discriminatory basis. Specifically, all interested parties should be provided with equal and meaningful opportunities to participate.

Impartiality is achieved when no privilege is given to any particular supplier/s, country/ies or region/s, nor are their interests favoured. Moreover, impartiality should be practiced during the whole a standard development process.

Consensus-building is the quintessential principle of formal standardisation. It requires all relevant stakeholders to seek general agreements and needs the absence of sustained opposition to substantial issues.

SDOs also need to ensure **balance** during the development, meaning that all stakeholders are guaranteed active participation by expressing their opinion. The development process must be neutral, and all opinions are to be considered.

In addition, the **development dimension** refers to the encouragement of participation of developing countries in SDOs and the adoption of non-discriminatory policies in favour of specific countries or regions.

Lastly, for the purpose of boosting international trade and avoiding barriers to trade, the principles of **effectiveness and relevance** ensure high-quality standards developed in SDOs is based on the best technology available. According to these principles, international standards are also expected to respond to existing or future market needs and to the current scientific and technological developments in various countries.

Lastly, SDOs are advised to avoid the duplication of standardisation efforts (overlapping or conflicting standards) in line with the **coherence** principle. This can only happen through effective cooperation and coordination of SDOs. It is at the discretion of each SDO to establish and formulate its internal procedures. However, recognised SDOs need to adhere to the above WTO TBT principles both in terms of their governance and standards development processes.

2.4.2. Stages of a standard's development process

The five stages of the formal standardisation process are the following:

1. **Inception**: Identification of a need for; 1) a concept or process to be standardised, or 2) the update of an existing standard .[39] The state of the maturity of the relevant technology must be verified.
2. **Conception**: Submission of a proposal for a new standardisation project to the best-suited technical body of an SDO. If the standard appears to be valuable, the proposal is endorsed as a work objective. Next, the SDO determines the best to pursue the work, particularly which sub-committee or project team will be in charge, and the proposal is added in the SDO work programme. If the proposal is not endorsed, it might be improved and presented once more, presented to a different group, or abolished altogether.
3. **Drafting**: Different contributors gather to prepare an initial outline which describes the structure and planned content of the standard's document. There are other activities that happen simultaneously during standard drafting such as test development, implementations, prototypes, and field tests .[40] A declaration of intellectual property rights (IPRs) is often sought by the SDO from its members prior to the finalisation of the standard document – even at an early stage, if possible - to ensure that the standardised technology is accessible to implementers of it on fair, reasonable and non-discriminatory (FRAND) terms.
4. **Approval and publication**: The final version of the draft – which has been agreed within the project team - is submitted for approval to the committee in charge. After reviewing the latest version of the document, the (sub-)committee members decide whether to approve, comment, oppose or abstain from the document. The

[39] Ibid p.110.
[40] Ibid p.111.

agreement within the committee needs to be at least with consensus and, if possible, with unanimity. Once the standard has been formally approved, the draft is sent for final editing and quality check procedure, and it is then sent for publication as a standard.

5. **Maintenance**: The continuous update of standards maintains their relevance in the context of changing market or regulatory needs, and new scientific and technological developments. If during the review process there is a need for corrections or maintenance of the standard or flaws are discovered, the above process is restarted.

2.4.3. SDO governance and participation

Governance

An SDO is often governed by a clear hierarchical structurewith clear responsibilities assigned to each group/member in order to ensure accountability within the system and[41] consistency of the different activities. Typically, the members of an SDO are its driving force, represented by a General Assembly, which is the body holding the power in terms of SDO governance. A Board of the SDO, on the other hand, is assigned with the day-to-day governance decisions for the sake of convenience and coherence. Another responsibility of the Board is to ovresee a standard's development within the SDO's technical bodies (e.g., committees, strategic groups or working groups (WG)).[42] The SDO's permanent staff provide assistance to the Board by coordinating the committees and arranging technical and operational cooperation with other SDOs.[43] The technical bodies are also supported by the staff in terms of administrative and logistical support.[44]

The committees within SDOs are usually quite autonomous, leading to the creation of sub-committees or WGs to address specific tasks. In the course of a standard's development, these groups are the ones to discuss the merits of the technical issues and come to a decision.[45] When the WG has fulfilled its tasks, it can cease its operations.

SDO funding is generated from different sources, such as membership fees, state or government funding, income from the selling of standards, and income from certification activities and their operations.[46]

Participation

Following the WTO TBT principle of openness, all interested stakeholders are welcome to participate in the development of standards in SDOs. Depending on the SDO, becoming a member may be achieved via national representation (national delegation, e.g., ISO, CEN and CENELEC) or through business interest (industry and private entities, e.g., ETSI).

In ICT standardisation, SDO members are usually industry companies, small and medium enterprises (SME), hardware manufacturers, network operators, as well as research institutes and universities. In addition, several administrations and public authorities, national organisations and government agencies are often members of SDOs and closely follow standardisation activities. End users are rarely members of SDOs due to lack of expertise.

2.4.4. Standardisation professionals

Standardisation professionals consist of all contributors to the standardisation process (e.g., representatives of industry, research organizations etc.), including those involved in the management and organisation of the standardisation process. These professionals can act as chair (or vice-chair) of a committee, a standards proposer, a rapporteur, or a liaison representative and ensure that the work programme is completed in due time, milestones are achieved, and the strategy of the SDO is followed within the committee.[47]

[41] Ibid p.116.
[42] Ibid p.117.
[43] Ibid p.117.
[44] Ibid p.117.
[45] Ibid p. 122.
[46] Ibid p. 117.
[47] Ibid p. 125.

Standardisation experts, a subcategory of standardisation professionals, are those who make contributions with their specific technical knowledge to the written standard. During standardisation meetings, these experts discuss the content of the drafts and contributions and make technical decisions. They work for the production of standards not only during committee meetings, but also during breaks and between meetings when they are back in their organisations.[48] They also closely collaborate with their colleagues from development, marketing and management teams within their own organisations.

The rapporteur is the individual responsible for a standard's development.[49] During the drafting phase, the rapporteur is the leader/ editor of the standardisation document. The rapporteur follows the guidance of the project team and collect contributions from other standardisation experts and organisations involved in the committee.

The liaison representatives/delegates constitute the link between two committees or WGs. Their main responsibilities are to attend the meetings as observers and report back to their group on the activities of other groups.[50]

Lastly, permanent SDO staff participate in different committees to facilitate the work of standardisation professionals. They monitor the standardisation work from beginning to end, coordinate the standardisation process and publish the standard after its approval and final editing.

2.4.5. Consortia

Companies in the same sector often form alliances that get together for a set period in order to prepare specifications for products which will be introduced to the market expeditiously through faster procedures; these are called industrial consortia.[51] Such alliances often enjoy advantages such as a lighter process and a lower level of consensus required for document approval than the processes that formal standards go through. In response to the rapid development of ICT systems, many consortia have been created in this sector.[52]

Due to their flexible nature, major industry players often consider consortia to be more efficient and more oriented towards the needs of the industry. Their specifications "hit the market" in a shorter time than those from formal standardisation bodies.[53] However, in the pursuit of swift standard setting, industry consortia might forgo the principle of openness in their operations. For example, they might only allow the participation of certain companies with specific industry interests or allow only paying members to access their standards.[54]

Since formal standardisation provides more legitimacy and guarantees broader adoption of a specification, it is often the case that a consortium may request that its specifications become formal standards.[55] It may bring a whole set of benefits to the developed technology, because it ensures that the specifications comply with quality rules, which are often tighter than what a private group may deliver.[56]

2.5. Standards and regulation: Standardisation requests and harmonised standards

Governments often identify standardisation needs, and, for the purpose of supporting specific policies or legislation, SDOs might be requested to develop certain standards .[57] As mentioned above, ETSI, CEN and CENELEC are ESOs that develop standards following standardisation requests by the European Commission. These requests are a result of a consultation process between the Commission and several stakeholders such as consumers, SMEs, EU Member States and the ESOs themselves.

[48] Ibid p.139.
[49] Ibid p.127.
[50] Ibid p.128.
[51] Ibid p. 58.
[52] Ibid p. 58.
[53] Ibid p. 58.
[54] Ibid p.101
[55] Ibid p. 58.
[56] Ibid p.58.
[57] Ibid p. 78.

Such requests aim to harmonise the requirements on products, goods and services throughout the EU via the development and adoption of harmonised European standards.[58] Compliance with a harmonised standard confers a presumption of conformity with the corresponding essential requirements set out in EU harmonisation legislation. However, in principle, the adoption and implementation of standards is voluntary; thus, a manufacturer might find alternatives to the harmonised standard that allows compliance with the regulation principles.[59]

3. Standardisation and innovation

3.1. The basics of the interplay between standards and innovation

Innovation is considered the output of a creative process as well as the process itself, while standards are the result of many years of knowledge-gathering and -structuring, representing an important source of codified knowledge and stability.[60] There is, however, a synergy or interdependence between the seemingly controversial notions of standards and innovation.

Standards encourage innovation and the development of new products and services and can often act as the basis from which new markets can grow.[61] As innovation fuelstechnological progress, standardisation nurtures this progress by preventing inefficient technology development.[62] Without standards, resources could be allocated to multiple innovation streams, leading to resource waste and duplication which could inhibit progress and growth.[63]

Furthermore, standards and the standardization process are intrinsically linked to the four phases of the technology lifecycle: introduction, growth, maturity, and decline.[64] There are three categories of standards linked with the technology life-cycle:[65]

- **Anticipatory standards** are future-oriented and aim to provide solutions to expected interoperability problems. As such, standards of this type support the introductory or early-stages of a technology (e.g., Bluetooth and Universal Mobile Telecommunications System (UMTS)).[66]
- **Enabling standards** are developed throughout the growth phase and improvement of a technology or product and seek to improve the robustness and scale of a pre-determined or dominant design.[67] Enabling standards facilitate the distribution of technical information and prevent market fragmentation.[68]
- **Responsive standards** are established towards the the end of technology development, during the maturity and decline phase.[69] The aim of responsive standards is to pick up on and document the best practices and winning solutions that have been implemented successfully in the field.[70]

3.2. Research and standardisation

Research is intrinsically linked with innovation, the prerequisite of technological progress. Therefore, the successful distribution of research correlates with the development of innovative products and processes and is essential for the economy.[71]

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[58] Article 2 of Regulation 1025/2012 of the European Parliament and of the Council on European Standardisation.
[59] The European CE marking regulation is an example of a regulation referencing standards. "CE" is the abbreviation of "Conformité Européenne", or "European Conformity". The official term now used for labelling is "CE Marking" and is an indicator of a product's compliance with EU legislation, enabling the free movement of products within the European market. Page 83.
[60] Abdelkafi et al. p.148.
[61] Ibid p.152.
[62] Ibid p.152-153.
[63] Ibid p.168.
[64] Ibid p.168.
[65] Abdelkafi et al. p.155.
[66] Ibid p.155.
[67] Ibid p.168.
[68] Ibid p.156.
[69] Ibid p.156.
[70] Ibid p.156.
[71] Ibid p.157.

Standardisation can be supportive towards research and vice versa, in the sense that research produces knowledge used as an input into standards, while standards can serve as a knowledge source and basis for additional or new R&D projects.[72] This represents a recursive knowledge flow from standardisation to research. In addition, the collaborative nature of the standardisation process enables a diverse group of stakeholders to work together and share their perspectives and knowledge in the technical committees, enriching and fostering any relevant research activities of the participants.

The research and innovation process has been shown to have five different phases: pure basic research, oriented basic research, applied research, experimental development, and diffusion. [73] These phases are supported by different types of standards. **Terminology standards** enable efficient communication are necessary for the exchange of information which influences the direction of research and innovation.[74] **Measurement and testing standards** are utilised to examine if certain factors such as performance criteria have been achieved and can ensure the comparability of any results.[75] **Interface standards** facilitate interconnection and interoperability of components, whereas **compatibility, quality and variety-reducing standards** support diffusion.[76]

3.3. Formal standards as enablers of innovation

The activities within SDOs can support innovation in the following ways:[77]

i) **EFFICIENT AND TARGET-ORIENTED INNOVATION:** Standards can promote efficient and target-oriented innovation, as products developed in compliance with available standards are more likely to be accepted by the market and have an increased likelihood of success.
ii) **INNOVATION COMMUNICATION:** By participating in standardisation committees, companies can actively promote their involvement which can enhance their reputation and indicate to investors, competitors, and consumers that they are innovative.[78]
iii) **INNOVATION IMPULSES:** Updating standards can create impulses for innovation, with companies being more receptive to switching products and further innovation.[79]
iv) **DIFFERENTIATION:** Throughout the development of a standard's development, participating companies may obtain invaluable knowledge which can be used to distinguish their products or services. uring the standardisation process, companies may gain valuable knowledge that they can use to differentiate their products.[80]
v) **EXCEEDING THE REQUIREMENTS OF STANDARDS:** A standard can be used as a minimum requirement, and companies may proactively choose to exceed the the standard's requirements and generate further innovation.[81]
vi) **BUSINESS MODEL INNOVATION:** Some companies may develop their business models upon standards e.g., consulting companies or certification organisations.[82]
vii) **ABSORPTION OF INNOVATION:** Finally, by participating in standardisation processes, companies can obtain new knowledge, which can be utilised to further innovationor to identify new market

[72] Ibid p.157.
[73] Ibid p.159.
[74] Ibid p.168.
[75] Ibid p.168.
[76] Ibid p.168.
[77] Ibid p.169.
[78] Ibid p.168.
[79] Ibid p.169.
[80] Ibid p.169.
[81] Ibid p.169.
[82] Ibid p.169.

oppertunities.[83] Being aware of these advantages enables companiesto leverage standards and standardisation to amplify their innovation and research capabilities.[84]

Standards and standardisation can provide significant contributions to research as both a process and an output, however they are more effective in facilitating incremental and evolutionary, rather than radical and disruptive innovations.[85]

4. Strategic perspective on standardisation

4.1. The strategic value of standardisation

The strategic value of standardisation is based on three key pillars which are business, technological leadership and political/legal leadership.

From a **business perspective**, standardisation environments promote co-operation between rival companies that share different perspectives to create innovative solutions, fostering global collaboration. Standards are also responsible for making technology accessible to all worldwide. In addition, standards can also lower production costs by creating economies of scale, and lower investment risks by sharing the risk of inventing new technologies.[86]

In the **technological sense**, standards are useful for promoting creativity and innovation as each standard release is a step up the ladder of innovation. Standards also encourage adoption and implementation of R&D findings and new scientific evidence. Standards can ensure interoperability and avoid fragmentation of technical solutions. Standards also guarantee greater availability of expertise in all areas of the new technology and prevent wastage of resources through unnecessary fragmentation.[87]

Lastly, standardisation can be supportive of **policies and legal issues**, first and foremost, by ensuring compliance with the law (e.g., harmonised standards in EU) and the policy objectives of governments. Standards also make innovative technologies available and accessible to all, while making sure that they are safe and secure. In addition, standards make it easier to gain access to regulated markets. Lastly, standards also allow governments to participate in technology development.[88]

4.2. Participation in standardisation

Technology developers naturally make the decision of participating in standards development by weighing the benefits as well as any relevant concerns e.g., organisation of the SDO, or the geographic location.

Organisations can be classified on the basis of their participation in standardisation activities as follows:

Leader	**Contributor**	**Follower**	**Spectator**
Participating in standard-setting and -development is a core part of the business model	• Active participation in standardisation • Less interested in the strategic direction adopted by an SDO.	• Full membership privileges in SDO. • Not interested in shaping SDO's direction.	• Gathers information during SDO meetings. • No participation or submission of technical contributions.

[83] Ibid p.169.
[84] Ibid p.169.
[85] Ibid p.168.
[86] Ibid p. 178.
[87] Ibid p.178.
[88] Ibid p.178.

Participation in standardisation activities can assist a company in anticipating disruptive changes in technology or in market choices of consumers. Sometimes companies participate in standardisation to ensure that their intellectual property is protected. This means that a company can hold multiple viewpoints, depending on whether the SDO's activities fit into its business model.[89]

Some companies may choose to participate in SDOs based on the SDO's status and relationship with other standardisation bodies and with regional and international organisations. For example, many of ETSI's members choose to join and participate, because ETSI is a recognised European Standards Organisation (ESO).[90] In addition, ETSI has strong relations with other important bodies such as the ITU and CEN/CENELEC, CEPT and the IEEE.

4.3. Choosing a standard – how?

Characteristic examples of successful standardisation are the sets of standards for 2G, 3G, 4G and 5G mobile networks which have achieved wide acceptance in global markets.[91] Widespread dissemination is indeed the desirable outcome of standards development. For this reason, the choice of standards and standards evaluation is significant for a flourishing standardisation ecosystem. The following criteria may be considered in this context:

- **Completeness**: Are additional standards required to assist or complement the existing/proposed standard(s) or is it sufficnent on its own?[92]
- **Stability**: is the standard new and still in development; is it mature. widely establised and thoroughly tested; is it aging and in need of updating (legacy components, coexistence, and interoperability with more recent systems); is there an installed user base, and what is its influence (stability, but also innovation inertia)?[93]
- **Maintenance**: is the standard(s) maintenance ensured; are there alternative measures which could be used to to learn about issues, workarounds, and de-facto reference implementations?[94]
- **Interoperability and conformance**: are quality conformance tests and test facilities available; whatdegree of interoperability is required, must interoperability and conformance be demonstrated, is it a condition sine qua non; how broad is the scope of the required interoperability: some functions, a subset, all functions; is interoperability required with the standard or with a dominant implementation (that itself may be only partially compliant with the standard or specification); what degree of interoperability do products on the market demonstrate?[95]

5. Standardisation and Intellectual Property Rights

Standards often relate to new technologies and innovative solutions to technical challenges in products, with various participants contributing innovative ideas. At the same time, innovative ideas are often the result of significant R&D investments and are typically protected by intellectual property rights (IPRs).[96]

IPRs allow the right-owner to exclude other parties from using the creation or invention. To provide surety against exclusion a third party can seek a licence from the IPR owner, commonly in exchange for financial compensation.

[89] Ibid p.179.
[90] Ibid p.181.
[91] Ibid p.187.
[92] Ibid p.188.
[93] Ibid p.188.
[94] Ibid p.188.
[95] Ibid p.188.
[96] Ibid p.195.

5.1. Standards and copyright / trademark

Copyrights are affected by standards. As previously mentioned, standards are documents that naturally enjoy copyright protection; thus, most SDOs require standardisation participants to transfer or license any possible copyrights relating to their contributions to the SDO which becomes the copyright owner.[97]

Standards are primarily identified by **trademarks** and are associated with certain logos, symbols or emblems (e.g., GSM, Wi-Fi, Bluetooth and CD). These marks indicate that a particular device is compatible with that standard. Such an example can also be seen in the IEEE 802.11 series of standards for Wireless Local Area Networks, known as 'Wi-Fi'. This trade name and associated well-known logo are owned by the Wi-Fi Alliance, a not-for-profit organisation that provides certification of devices based on the IEEE standards, and which allows the use of the Wi-Fi name and logo on products that successfully complete interoperability certification testing.[98]

5.2. Standards and standard essential IPR

The implementation of a standard may require the use of standard essential patents (SEPs) and standard essential copyrights. A standard essential copyright protects the use of copyrighted software code, insofar as the standard requires the implementer to use exactly that specific code to implement the standard.[99] SEPs are those patents claiming rights to a technical solution without which the implementation of a standard would not be possible. In other words, it is not possible to produce a standard-compliant device or implement a service without obtaining a license for the respective SEPs .

5.2.1. Standards and SEPs

Both patents and standards serve the public interest and promote innovation, but in different ways. Patents promote innovation by granting temporary rights to patent owners to exclude others from using technological innovations, whereas standards aim to promote innovation by making technical solutions available to all interested parties without unnecessary barriers.[100]

The difficult relationship between the above concepts is compounded by the nature of SEPs. Without the use of the technology protected by an SEP, a product will not comply with the standard. It is not possible for an implementer to create a standard-compliant device by 'inventing around' or choosing not to implement the standard feature. For this reason, an implementer cannot make or sell a product compliant with the standard without infringing the SEPs.[101]

5.2.2. Standards and patent essentiality

In the telecommunications and consumer electronics industries, it is common that standards are covered by multiple patents. [102]

Determining the essentiality of a patent to a standard requires a comparison between the text of the standard to the text of the patent. This, in turn, necesitates specific expertise and substantial effort. Usually, a large number of patents are needed to check for essentiality.[103] In the course of standardisation, SEP owners may disclose to the SDO patents (and sometimes patent applications) they believe to be *potentially essential* to a standard. At the time of disclosure, the precise content of the final standard may not yet be known. This means that the technology in the disclosed patent may eventually not be included in the standard at all. In addition, in case of disclosure of patent applications, the full scope of a patent only becomes known at the moment when that patent is actually granted, if at all.[104]

[97] Ibid p.196
[98] Ibid p.196.
[99] Ibid p.196.
[100] Ibid p.197.
[101] Ibid p.197.
[102] Ibid p.198.
[103] Ibid p.198.
[104] Ibid p.198.

Another reason why essentiality assessments are challenging is that, without extensive expertise, it is difficult to ascertain the exact boundaries of a patent and to determine whether the protected subject-matter is the only way to satisfy the requirements contained in the standard.[105]

5.3. IPR policies in SDOs

In order to regulate this relationship between essential IPR and standards, SDOs started to create their own rulemaking mechanisms around IP based on their own objectives and technical context. Still, these policies can be broadly categorised into two main categories: commitment-based and participation-based policies.[106]

5.3.1. Commitment-based policies

Commitment-based policies (for example, at ISO, IEC, ITU, ETSI, and IEEE) consist of two main elements: disclosure and commitment. Under these policies, members are required to disclose to the SDO any patents (and sometimes patent applications) that they believe are or may become essential to a standard.[107]

This may occur, for example, when a patent owner submits a proposal (technical contribution) to a standard that covers its patent(s), or when solutions covering its patent(s) are proposed by others.[108] The disclosure triggers the second element, the commitment. Following disclosure, the patent owner is requested to commit to providing licenses for those patents on fair, reasonable and non-discriminatory (FRAND) terms to implementers that produce products that are compliant with the standard, should the patent(s) indeed become essential.[109] FRAND can include both, royalty-free (RF) as well as monetary compensation.

Most SDOs (including ISO, IEC, ITU, and IEEE) give contributors the opportunity to select between a FRAND and an RF obligation. However, once the patent owner has chosen RF licensing, it cannot later reverse this choice and require financial compensation.[110] Other SDOs (such as the IETF in the case of its security standards) require an RF obligation, meaning that the patent owner cannot obtain any financial compensation from its SEPs.

In case an SEP owner refuses to commit to any of the above requirements, SDOs will typically seek to work around this particular technology and avoid including it in the standard.

5.3.2. Participation-based policies

Participation-based policies (such as those used by the W3C and HDMI Forum) require that members of the SDO or participants to a work group in the SDO agree to license all their essential patents on certain terms, e.g., FRAND or RF, therefore membership in the SDO is conditional upon this commitment.[111]

While it is not usual, some SDOs with participation-based policies have additional or more limited disclosure rules. Participation-based patent policies are most typical in smaller SDOs that focus on relatively niche technology areas.[112] In such 'smaller' environments (e.g., W3C), participants are more willing to accept such policies than in 'broad' environments (e.g., ISO), where work begins in multiple technology areas, which is difficult to track.[113]

Regardless of the policy chosen by an SDO, obtaining a FRAND or an RF commitment from all (known) owners of potentially essential patents is the most effective system for addressing the four potential issues mentioned above under 5.[114]

[105] Ibid p.199.
[106] Ibid p.201.
[107] Ibid p.202.
[108] Ibid p.202.
[109] Ibid p.202.
[110] Ibid p.202.
[111] Ibid p.202.
[112] Ibid p.202.
[113] Ibid p.202.
[114] Ibid p.202.

5.4. The legal basis for the enforcement of the FRAND commitment

Patent law, private law, and competition/antitrust law are relevant to the discussion of how FRAND commitments can be enforced. Patent law allows a patent owner to restrict others from making, using, selling, or importing the patented invention without permission.[115] Private law regulates contractual and other relationships between businesses and other parties.[116] Competition/antitrust law governs the conduct of parties that have a dominant market position.[117]

SDOs do not resolve licensing disputes but recognise that national courts have jurisdiction to resolve such IPR disputes if the parties themselves are unable to enter into successful licensing agreements. The legal rationale behind how SEPs and FRAND disputes should be resolved depends on the jurisdiction in which the underlying SEP rights are enforced. In the US and UK, private law often plays a central role in resolving SEP disputes,[118] while in the EU competition law appears to be more important. The landmark case for EU countries is the 2015 case of *Huawei v. ZTE*,[119] in which the Court of Justice of the European Union (CJEU) was requested to interpret the relevant EU law.

5.5. Patent pools

The fragmentation of ownership of essential patents related to standards and the associated costs for implementers to negotiate numerous licences has led to the creation of patent pools. In the 1980s, patent owners started setting up joint licensing programmes for technical standards and these platforms later became patent pools. On these platforms, a central body, called the pool administrator, can license out a bundle of patents, on behalf of the participating patent owners.[120]

Patent pools have been targeted by competition/antitrust authorities to ensure they are compliant with competition/antitrust laws. It is generally accepted that the pro-competitive aspects of patent pools are typically stronger than the anti-competitive ones, provided that pools only include complementary, not substitute, patents. SEPs are by definition complementary. Moreover, patent pools have adopted mechanisms to examine essentiality, including only SEPs in the pool.[121]

Patent pools are voluntary for SEP owners who can decide to join or to license their patents bilaterally – or both.[122]

5.5.1. Benefits for SEP owners and implementers

For implementers, patent pools provide a one-stop shop for access to a number of patent licences, reduce transaction costs and allow for a decreased licence fee compared to multiple individual licences.[123] In addition, patent pools can level the playing field by reducing the number of competitors who do not pay royalties. Lastly, they help to reduce uncertainty and increase transparency in licensing.

For SEP owners, patent pools provide the advantage of decreased transaction costs by reducing the number of negotiation meetings. Additionally, pools can promote the general acceptance and success of the technology and are expected to lead to higher profits due to more efficient licensing and royalty collection.[124]

5.5.2. Royalty determination and distribution

The questions of the appropriate scope of licensing, the determination of the total pool royalty and the distribution of the total licensing income among the patent pool licensors can often be a source of debate. The reason for this is the

[115] Ibid p.203.
[116] Ibid p.203.
[117] Ibid p.203.
[118] Ibid p.204. More specifically, *see* Microsoft Corp. v. Motorola, Inc., No. C10-1823, 2013 WL 2111217 (W.D. Wash. Apr. 25, 2013); In re Innovatio IP Ventures, LLC Patent Litigation, No. C11-9308 2013 WL 5593609 (N.D. Ill. Sept. 27, 2013); TCL v Ericsson 8:14-CV-00341 JVS-DFMx (US District Court, Central District of California Dec. 22, 2017).
[119] Huawei Technologies Co. Ltd v ZTE Corp. and ZTE Deutschland GmbH (2015) CJEU. Case C-170/13.
[120] Abdelkafi et al. p.204.
[121] Ibid p.204.
[122] Ibid p.204.
[123] Ibid p.204.
[124] Ibid p.204.

different views may be held by patent owners on the expected revenue, considering the different types of patents being licensed at once. In addition, the value or technical merit of the patents themselves can vary widely.[125]

Mutually determining the royalty rate and how those royalties should be distributed amongst the pool membersis a delicate process when establishing a pool.[126] Both the royalty rate and its method of distribution should be as attractive as possible to as many potential pool members.[127] Some pools base the allocation only on the number of national patents, while other pools distinguish between higher and lower value patents.

5.5.3. Difficulties in setting up a pool

What limits the popularity of patent pools is the difficulty and high cost of setting them up. Pools need to be set up at an early stage before bilateral licences become the norm. At this stage, however, there is no certainty about the standard or the market value of it, and the number of members on the patent owner's side may be insufficient. Furthermore the interests and views of the (potential) pool licensors are often diverse, meaning a mutually agreeable set of procedures and rules can be difficult to establish.[128] The freedom and flexibility offered by bilateral licensing might also outweigh the many advantages of pools. [129]

In the era of the Internet of Things (IoT) and Industry 4.0, SEP owners are expected to negotiate with a significantly long list of implementers and at various levels of the value chain. In light of this, patent pools appear to be an appealing solution.[130] The creation of the Avanci patent pool - which licenses 2G, 3G and 4G SEPs for connected cars - is a positive advancement on the road to increased and easier access to standardised technologies.[131] Avanci has announced plans to use a similar approach for licenses for the IoT market.[132] This may promote the future of IoT as Avanci incorporates many patent owners into its membership.[133]

6. Conclusion

In conclusion, standardisation is an important process that fosters innovation and promotes development of new and high-quality products and services. When the process of standardisation is mismanaged, non-consensual or untransparent, it can stifle innovation and cause lock-ins. However, when the process complies with the WTO TBT guidelines on standards development, it brings more advantages than disadvantages for all stakeholders.

Standards enable interconnection and interoperability of products and services from different vendors. Consumers benefit from the freedom to choose the best equipment and services without fear of incompatibility. Standards are important for ensuring safety, reliability, and environmental sustainability. They can protect consumers and business interests, and when referenced in laws and regulations, standards can support government policies.

Standards depend on technical contributions from various stakeholders such as universities, research institutes and technology companies. Sometimes these contributions read on patented technologies (SEPs), which are typically available on FRAND terms and conditions.

[125] Ibid p.205.
[126] Ibid p.205.
[127] Ibid p.205.
[128] Ibid p.205.
[129] Uijl, S. d., Bekkers, R., & de Vries, H. J. d. (2013). Managing Intellectual Property Using Patent Pools: Lessons from Three Generations of Pools in the Optical Disc Industry. California Management Review, 55(4), 31-50. DOI: 10.1525/cmr.2013.55.4.31
[130] Abdelkafi et al. p.205.
[131] Ibid p.205.
[132] Ibid p.205.
[133] Ibid p.205.

Abbreviations

API: Application Programming Interface

CEN: European Committee for Standardization

CENELEC: European Committee for Electrotechnical Standardization

ETSI: European Telecommunications Standards Institute

GSMA: Global System for Mobile Communications (GSM) Association

ICT: Information and Communication Technology

IEC: International Electrotechnical Commission

IETF: Internet Engineering Task Force

ISDN: Integrated Services Digital Network

ISO: International Standardization Organization

ITU: International Telecommunication Union

SDO: Standard Development Organization

SME: Small and Medium-sized Enterprises

3GPP: 3rd Generation Partnership Project

GDP: Gross Domestic Product

TSL: Transport Layer Security

SSL: Secure Sockets Layer

UMTS: Universal Mobile Telecommunications System

W3C: World Wide Web Consortium

WLAN: Wireless Local Area Network

WTO TBT: World Trade Organization Technical Barriers to Trade