

Towards a European Standard for an Operations & Supply Chain Management competence framework: evidence and learnings from the European ICT competence ecosystem

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Abstract: The rising complexity of Operations Management (OM) and Supply Chain Management (SCM) dynamics is dramatically impacting the organizational practices concerning the selection and procurement of resources, either tangible (e.g., raw materials) or intangible (e.g., competences). Major factors generating this effect are identifiable as the rapid operations and supply chain development, new technological advancements, and the current global pandemic, which are making the competition harder. In this landscape, identifying the right competences becomes one of the organizational critical success factors for operational excellence and is now a compelling need for most industries. Among those, during the last decades, the European Commission has been promoting the development of a European Information and Communication Technology (ICT) competence ecosystem, through the standardization activities performed by the “Comité Européen de Normalisation” (CEN) experts. This pioneering work carried out by the “CEN/TC 428” Technical Committee led to the definition of several standards, technical reports, and technical specifications. Among these, the EN 16234-1 (“e-CF”) is the most notable one and is shaping the European competence landscape, also by providing guidelines for the potential application of this framework to other industries. For this reason, this research paper aims to investigate the evidence and lessons learned from the CEN/TC 428 standardization process and the European ICT competence ecosystem and to propose a methodology and guidelines for the deployment of this approach in the OM and SCM field. This would provide a common European language for the OM and SCM professionals and improve European OM and SCM HR-related processes. To our knowledge, this research represents the first contribution advancing the proposal for a shared and harmonized European competence standard for Operations and Supply Chain Management, and lays the foundation for widening the competence ecosystem at EU and worldwide level.

Keywords: Operations & Supply Chain Management, Competence Framework, EN 16234-1, Human Factor, European Standard

I. INTRODUCTION

The promotion of standardization and interoperability of the European labour market, along with the implementation of education, lifelong learning and training policies, represents one of the key objectives of the European Union (EU) work, as recalled by several communications issued by the EU bodies (Council of the European Union, 2019; European Parliament, 2020). This EU goal has originated, especially during the last decades, a specific agenda and implementation programme in the Information and Communication Technology (ICT) industry, which plays a crucial role for Europe’s competitiveness in the global market (European Commission, 2020; European Commission, 2010).

Following the recommendations of the European e-Skills Forum (European e-Skills Forum, 2004) and of the European Commission (European Commission, 2007), the efforts of the European Union towards the creation of a comprehensive ICT competence ecosystem have been recently intensifying thanks to the “Comité Européen de Normalisation” (CEN) work, with the creation of the CEN/TC 428 Technical Committee, also

named as “Digital Competences and ICT professionalism”. CEN/TC 428 is responsible for the definition, development and maintenance, among the other standardization documents, of the well-known EN 16234-1 standard (“European e-Competence Framework” or simply labelled as “e-CF”), that was published for the first time in 2008 in a “CEN Workshop Agreement” (CWA) form. The standard, whose scope is to introduce a common language for the European ICT sector, provides reference for 41 ICT competences and their potential application to the labour market needs (CEN, 2019; Fernández-Sanz, et al., 2017). Moreover, consequently to the EN 16234-1 introduction, different standards, technical reports, and technical specifications have been published along the years, with the aim of creating a comprehensive European ICT competence ecosystem.

From the start of the pioneering work concerning the e-CF publication, the scientific landscape has been increasingly focusing the attention on the potential usages and implementations of the framework. For instance, several contributions adopt the e-CF model as the starting point for the development of training and

teaching programs, such as for cybersecurity (Blazic, 2021), for software engineering (Turkin, et al., 2017), for information technology infrastructure management (Bonders & Slihte, 2018), for entrepreneurship (Mets, et al., 2017) and for secondary education (Menichetti, 2017). However, the potential usages of the e-CF framework are not only limited to the definition of educational programs, but they span on a wide range of applications to stakeholders and organizations in both public and private sectors (CEN, 2019).

In this background, other industrial settings may take advantage of the well-established standardization work to introduce or expand the actual competence ecosystems of the European Union (CEN, 2021b). Among the potential competence ecosystems to be standardized, the Operations Management (OM) and Supply Chain Management (SCM) field seems to be the most prominent one, both in terms of published scientific contributions (D’Orazio, et al., 2019; Kotzab, et al., 2018) and organizational relevance (Miles & Snow, 2007). Indeed, organizational performances are dramatically impacted by OM and SCM outcomes, whose results are in turn shaped by the professionals’ knowledge, skills and attitudes (Di Luozzo, et al., 2021). This effect is even more significant considering the latest organizational trends (e.g., technological advancements) and current global situations (i.e., COVID19 pandemic), which are adding complexity to the management of day-to-day operations and identification of the optimal human resources practices for performance improvement (Aloini, et al., 2021).

For this reason, the definition and selection of the right competences and resources in OM and SCM – intended as the combination of knowledge, skills, and attitudes (CEN, 2019) – becomes crucial for surviving the regional and global market competition. This relevance is demonstrated by the proliferation of scientific competence frameworks for OM and SCM professionals (Palsaitis, et al., 2017; Kovács & Pató, 2014) that, though expanding the field’s body of knowledge, is generating ambiguity given by the absence of a comprehensive reference model to be adopted for organizational and educational purposes. Thus, according to the previous considerations, our research work aims at filling this gap by proposing a methodology and guidelines for the definition of a standard European competence reference model for the OM and SCM field, through a deep analysis of the evidence and lessons learned coming from the from the CEN/TC 428 standardization process and the European ICT competence ecosystem. The research question is hence expressed as follows:

RQ: How could the lessons learned from the European ICT competence ecosystem standardization process be leveraged to construct an Operations and Supply Chain Management competence framework, to be potentially adopted as a European standard?

The rest of the paper is organized as follows. After the introductory section, a description of the OM and SCM

competence literature is provided, showing some of the most prominent scientific contributions. Successively, following a brief introduction of the European ICT competence ecosystem, the main evidence and lessons learned from the CEN/TC 428 standardization process are gathered. This hence allows the proposal for the structure of a European Operations and Supply Chain Management competence standard, along with potential benefits and implications arising from the standard definition. Lastly, we conclude the paper by providing indications for further research and advancements. These instructions are intended to provide the basic guidelines for preparing papers for the XXVII Summer School “Francesco Turco”. Please use this document as a template to compose your manuscript or as an instruction set.

II. COMPETENCES IN OM AND SCM: RESEARCH FIELD REVIEW

The quest for organizational improvement and competitive advantage through the achievement of performance excellence in Operations and Supply Chain Management has been pushing industry and academia towards rethinking the well-known Operational Excellence models (Found, et al., 2018) under a behavioural and cognitive perspective (Gino & Pisano, 2008), shifting hence to the novel concept of “Human Excellence” (Di Luozzo, et al., In press). Particular attention is given, in this area, to the definition, selection and development of professionals with the appropriate competences (Draganidis & Mentzas, 2006), which are found to be one of the most significant elements differentiating between average and superior operational performances (Dubois, 1993).

To this end, many authors have proposed different OM and SCM competence frameworks along the years, serving either similar or diverse purposes. For instance, Kotzab et al. (2018) adopt a lifelong learning perspective to specify the key competences for the logistics industry, along with a job posting analysis. A similar approach is described by Ciancarelli et al. (2020), that propose a competency framework for the OM and SCM field and performs an experimental analysis on a set of job descriptions. Additionally, further models can be found in APICS (2014), Cvetić et al. (2018) and Sinha et al. (2016).

Following a different methodological stream, Stek & Schiele (2021) identify a set of skills for achieving specific purchasing performance objectives, through a survey for the field’s professionals. The latter contribution is in line with Blas et al. (2019), which perform a wide literature review and integrates competence requirements for purchasing and supply professionals previously specified by Tassabehji & Moorhouse (2008). A similar background analysis is also carried out by D’Orazio et al. (2019), aiming at clarifying the competence concept, usage and the key characteristics of an OM and SCM professional.

However, though several efforts have been placed towards the definition of competence models and frameworks for OM and SCM, different gaps emerge from this analysis. Overall, the main literature missing elements are reported as follows:

- no holistic approach is adopted for the definition of the actual competence frameworks, which are typically based on opinions or self-reflections (Kotzab, et al., 2018; Stek & Schiele, 2021);
- the population covered by the actual research works is often limited to few countries (Stek & Schiele, 2021), thus missing to see the “big picture”;
- limited portions of the whole OM and SCM scientific and industrial setting are usually covered by the models (Derwik, et al., 2016), thus missing to see the “big picture”;
- there is a significant missing link between Human Resource Management (HRM) practices and the proposed models (D'Orazio, et al., 2019), hence failing to enable ad-hoc customizations for a proper HRM (Aloini, et al., 2021) and to achieve one of the key objectives of a reference competence framework (CEN, 2019).

According to the previous considerations, no proposed OM and SCM competence framework could serve as a reference for the whole scientific and industrial settings, leaving hence ambiguity for researchers and practitioners. For this reason, our paper aims at proposing a methodology to integrate and unify this research area into a comprehensive reference model, ensuring a basic standard structure for the organizations, policy makers and labour market. Note that this proposal could potentially be adopted for the definition of a comprehensive standard enabling the development of a European Operations and Supply Chain Management competence ecosystem.

III. THE EUROPEAN INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) PROFESSIONALISM ECOSYSTEM

Since the EU's 2020 strategy definition, EU has put forward “smart growth” as one of the three main priorities for the development of the economy (European Commission, 2010), with the aim of putting knowledge and innovation at the heart of the community's progress (Stec & Grzebyk, 2018). Key pillars of the abovementioned growth are given by the Europe's Digital Agenda (European Parliament, 2020) and by the European e-Skills Forum (European e-Skills Forum, 2004), defining the guidelines and strategy for the development of a European ICT competence ecosystem. The main objective underpinning the creation of the ecosystem was to foster EU's economy through the identification and deployment of key competences for the development of capable ICT professionals, thus enabling the digital transformation and growth of the whole community (CEN, 2019).

From these considerations, the EN 16234-1 standard originated. First published as a CWA (version 1.0 –

2008), the e-CF became an official European standard in 2016, with a further revision released in 2019. The e-CF has been considered along the years as the center of the European ICT competence ecosystem, as demonstrated by the wide and consensual adoption in the different European countries. Exemplary of the e-CF deployment is the Italian case, where “Agenzia per l'Italia Digitale” (AgID) – namely the designated body for Italy's digital innovation and advancement – recognized EN 16234-1 as the reference model and tool for the country's digital agenda (Agenzia per l'Italia Digitale, 2020).

Successively to the e-CF publication, several other standardization documents have been published along the years, building upon the 41 ICT competences introduced by the standard. This allowed to create the so-called European ICT competence ecosystem, that comprises four different blocks as depicted by Figure 1 (some of the documents are still under development and/or approval):

- **Competences:** includes the series of documents specifying the main competences and set of ICT professional role profiles, covering the main business processes;
- **Bodies of Knowledge:** includes the series of documents providing a specification of knowledge required by ICT professionals;
- **Education and Training:** includes the series of documents providing guidelines for the development of ad-hoc educational and training programs, along with metrics for the competence assessment;
- **Professional Ethics:** includes the series of documents introducing directions for the ICT professional ethics consideration and improvement within organizations.

Hence, given the pioneering work carried out during the last decades by the CEN/TC 428 Technical Committee and experts, it is possible to draw up some evidence, lessons learned and guidelines to ensure the replicability of this approach to also other research fields, such as the Operations and Supply Chain Management setting.

A. The ICT competence framework (EN 16234-1)

A description of the e-CF competence framework structure is outlined as in Figure 2 (CEN, 2021b), showing the model from both an internal and external view. The internal view is represented as a temple, and defines the core structure of the competence framework, while the external view simply indicates its relationships with other relevant models in the scientific and organizational background.

Specifically, considering the internal view of the framework, the structure of the competence model is composed as follows (CEN, 2021b; CEN, 2019). The cornerstone of the framework is represented by a shared and comprehensive definition of the “competence”, “knowledge”, “skills”, “attitudes” concepts, which enable for a coherent development of the whole ecosystem. Successively, the model is built upon 4

different dimensions, which characterize the competence definition (CEN, 2019):

Dimension 1. Represents the 5 main ICT business processes, allowing for a categorization of the competences. These processes are drawn upon relevant frameworks in the literature;

Dimension 2. Identifies the 41 ICT competences (“e-Competence”) for each competence area, specified by a title and a description;

Dimension 3. Assigns potential proficiency levels to each e-Competence of the framework, on a 5-levels scale (from “e-1” to “e-5”). Note that these levels are defined according to the European Qualification Framework (EQF);

Dimension 4. Describes a set of exemplary knowledge and skills for each e-Competence, aiming at providing guidance for the identification of sector-specific knowledge and skills.

Lastly, the framework incorporates the concept of “transversal aspects”, namely cross-cutting elements specific to the ICT workplace and applicable to many different e-Competence. Differently, the “attitude” concept is not explicitly defined; however, according to the standard (CEN, 2019; CEN, 2021b), transversal aspects and dimensions 2,3,4 implicitly embed the human attitudes. On the other perspective, considering the external view, the standard provides several analysis of the relationship between the competence framework and other relevant models. This is the case, for instance, of the ESCO database, whose relationship with the e-CF is also described in the scientific background (Fernández-Sanz, et al., 2017).

B. A procedure for the construction of a competence framework

Besides the fundamental structure of the e-CF competence framework, it is also possible to consider the EN 16234-1 standard rationale to derive a general procedure for transferring the methodology and lessons learned for the construction of competence models for other industries, as shown by CEN (2021b). The procedure is described as in Table I, and adopts the basic assumption that a right group/audience of stakeholders and experts should be selected for the framework design and definition. Indeed, before constructing the competence framework, it is essential to select the appropriate experts, observers, and stakeholders to ensure the widest possible representativeness of the standard – in terms of organizations, policy makers and labour market – which has been identified as one of the major gaps of the scientific background as described in Section 2.

It is possible to observe that these steps shall be tailored to the specific industry taken under consideration, with the aim of reaching the maximum consensus among the market for the competence framework adoption and integration with other management systems (Granja, et al., 2021). Moreover, as per the e-CF’s experience, once the model has been designed and effectively deployed, the next step would be to build upon the competence

framework for the specific sector to shape the related professionalism and competence ecosystem.

TABLE I
PROCEDURE FOR THE CONSTRUCTION OF A COMPETENCE FRAMEWORK, ADAPTED FROM CEN (2021B)

Step	Description
1	Establish a common and shared taxonomy for the "competence" concept and related vocabulary (e.g., "knowledge", "skills", "attitudes", etc.)
2	Determine the objective of the specific framework and its basic structure in terms of relevant business processes, which will represent the starting point for the competences definition
3	Create competences specifications with a chosen granularity level, and establish possible proficiency levels for each competence
4	Evaluate and assess the relationships of the framework with other models and business structures, also ensuring the compatibility with relevant frameworks in the literature

IV. PROPOSAL FOR A EUROPEAN OM AND SCM COMPETENCE FRAMEWORK

It is now possible to review and analyze those learnings in light of the potential definition of a European Operations and Supply Chain Management competence framework. For this reason, we decided to adopt the procedure described as in subsection 3.2., and to analyze the most prominent scientific contributions for the construction of an OM and SCM competence framework, hence providing guidelines and insights for its design. Indeed, for each step for the construction of a competence framework, possible relevant works are reported along with an analysis of the main insights of the contribution. The analysis allows to identify guidelines for the OM and SCM competence framework development and is reported in Table II.

According to the previous table, it is hence possible to derive some insights and guidelines for the construction of an OM and SCM competency framework, reported as follows considering the procedure of subsection 3.2.

Step 1. The definition of competence-related concepts introduced by CEN (2019) could be adopted as the basis for the competence framework development, in order to ensure coherence with the European professionalism ecosystem, and successively integrated according to the common definitions of the scientific and industrial background;

Step 2. The well-established and largely accepted SCOR model (APICS, 2017) could represent the starting point for the modelling of OM and SCM main business processes (Plan, Source, Make, Deliver, Return, Enable), to be complemented with other relevant frameworks and structures (e.g., GSCF, PCF);

Step 3. Once the main business processes have been defined (Step 2), a large scale review of the scientific and industrial background concerning OM and SCM competence frameworks is required before proceeding with the model construction. The contributions reported as in Table II represent valuable research and examples for achieving this objective, though a broader analysis is needed to collect and

identify the main OM and SCM competences. During this phase, it will also be crucial to reach a consensus amongst all the stakeholders, to ensure the representation of the widest possible European professional population. Additionally, after the competences definition, it is required to determine the potential associated proficiency levels. The European Qualification Framework (European Council, 2017) and e-CF (CEN, 2019) will serve for this purpose.

Step 4. The last step requires to analyze the relationship of the OM and SCM competence framework with relevant models in the literature. The starting point of this assessment could be the relationship between the framework and the ESCO database, as per the contribution of Fernández-Sanz, et al. (2017). Successively, other models should be identified and analyzed, to ensure the potential integration of the European OM and SCM competence framework with different management systems.

Successively to the framework construction, besides the possibility to adopt the model as the basis for the potential definition of a shared European standard for the OM and SCM competence ecosystem, the next step is represented by the development of a wide consensus concerning its adoption and scientific-industrial implementation, which would allow the community to reap the benefits of a greater market interoperability. Successively, in order to be developed as an international norm, the competence framework should follow the standard procedure described as in (ISO, 2022).

TABLE II
RELEVANT CONTRIBUTIONS FOR THE CONSTRUCTION OF A EUROPEAN OPERATIONS AND SUPPLY CHAIN MANAGEMENT COMPETENCE FRAMEWORK

Step	Reference	Insights
1	(APICS, 2014)	Reports a categorization of competences for the OM and SCM field along with their definitions
	(Battelle for Kids, 2019)	Introduces generic definitions for behavioural/interpersonal knowledge and skills
	(CEN, 2019)	Presents the basic concepts of competences, knowledge, skills, attitudes for the ICT sector
	(D’Orazio, et al., 2019; Kotzab, et al., 2018)	Perform the scientific background review concerning the definition of the competence concept for OM and SCM
2	(APICS, 2017)	Introduces the well-known “SCOR model” with reference processes, metrics, practices for OM and SCM
	(The University of Auckland Business School, 2008; Cooper, et al., 1997)	Describe the “Global Supply Chain Management” (GSCF) model to map the SCM processes
	(APQC, 2019)	Shows the “Cross Industry Process Classification Framework” (PCF) for generic business processes
	(Lambert, et al., 2005; Tan, 2001)	Perform the scientific background review concerning the OM and SCM process management frameworks
3	(Ciancarelli, et al., 2020; Derwik, et al., 2016; Kovács & Pató, 2014)	Introduce general OM and SCM competence frameworks, based on the scientific background and experiences
	(Stek & Schiele, 2021; Bals, et al., 2019)	Introduce role-specific competence models, based on the knowledge of a

Step	Reference	Insights
4	(2019)	precise area in SCM (i.e., purchasing)
	(European Council, 2017; CEN, 2019)	Illustrate the potential proficiency levels to be adopted for the competence assessment (e.g., EQF)
	(CEN, 2021b)	Shows how to analyze the relationships between a competence framework and other models (e.g., e-CF and ESCO)
	(Fernández-Sanz, et al., 2017)	Proposes a methodology for mapping and integrating the e-CF, ESCO BOKs, Axelos frameworks

Please note that the abovedescribed procedure is an adaptation to the OM and SCM fields of the process reported as in Table I, which represents the first example of a methodology proposal for the competence framework definition. Moreover, it is possible to observe that such method can be potentially reused and reapplied for the ideation and implementation of a competence framework in different industrial settings and backgrounds.

V. CONCLUSIONS AND FURTHER DEVELOPMENTS

This research work investigates the importance of designing and developing a comprehensive Operations and Supply Chain Management competence framework, and discusses a procedure and practical guidelines for the framework construction. The contribution leverages the learnings coming from the development of the European ICT professionalism and competence ecosystem, through a deep analysis of the EN 16234 (e-CF) standardization process, which could be replicated and adopted for the creation of a European standard for a competence framework in the Operations and Supply Chain Management field.

The main insights of this research work are twofold. First, it clearly and practically introduces a procedure to construct a competence framework, and reports insights for the development of a model in the Operations and Supply Chain Management setting. Second, it shows that the learnings stemming from the ICT professionalism and competence ecosystem construction are valuable for the development of a comprehensive competence framework, hence highlighting the pioneering work of the EU and of the CEN/TC 428 Technical Committee. However, it should be highlighted that the proposed guidelines and contributions are to be intended as a reference for the model development, without having the ambition of being necessarily exhaustive and far-reaching. Therefore, further developments may adopt this contribution as the founding stone for deepening this research stream.

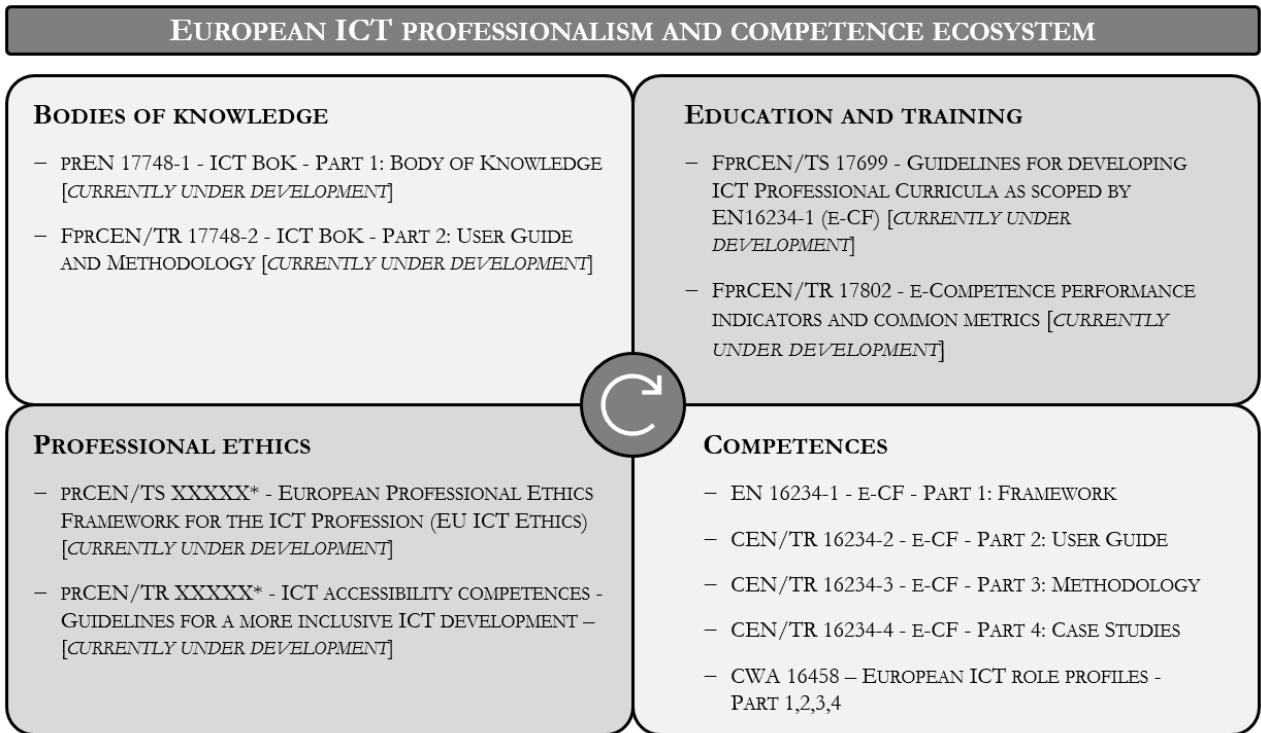
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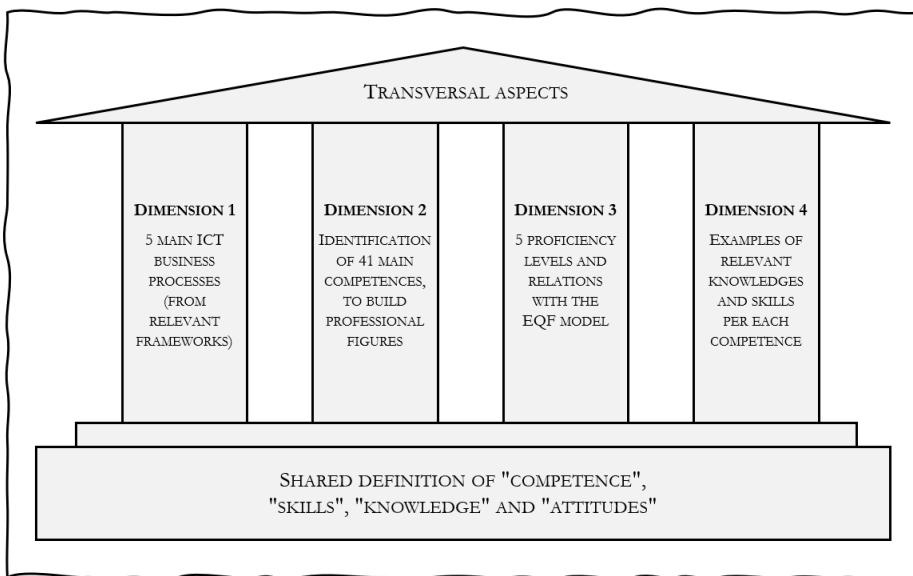
Appendix A. FIRST APPENDIX



* The wording "XXXXX" indicates that no code has been yet assigned to the document

Fig. 1. Standardization documents composing the European ICT professionalism and competence ecosystem.

INTERNAL VIEW



EXTERNAL VIEW

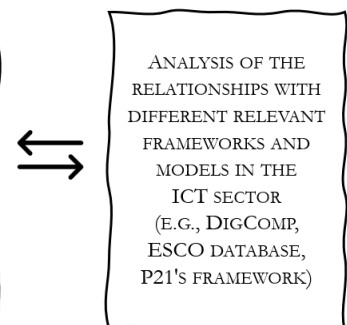


Fig. 2. EN 16234-1 (“e-Competence Framework”) competence framework structure.