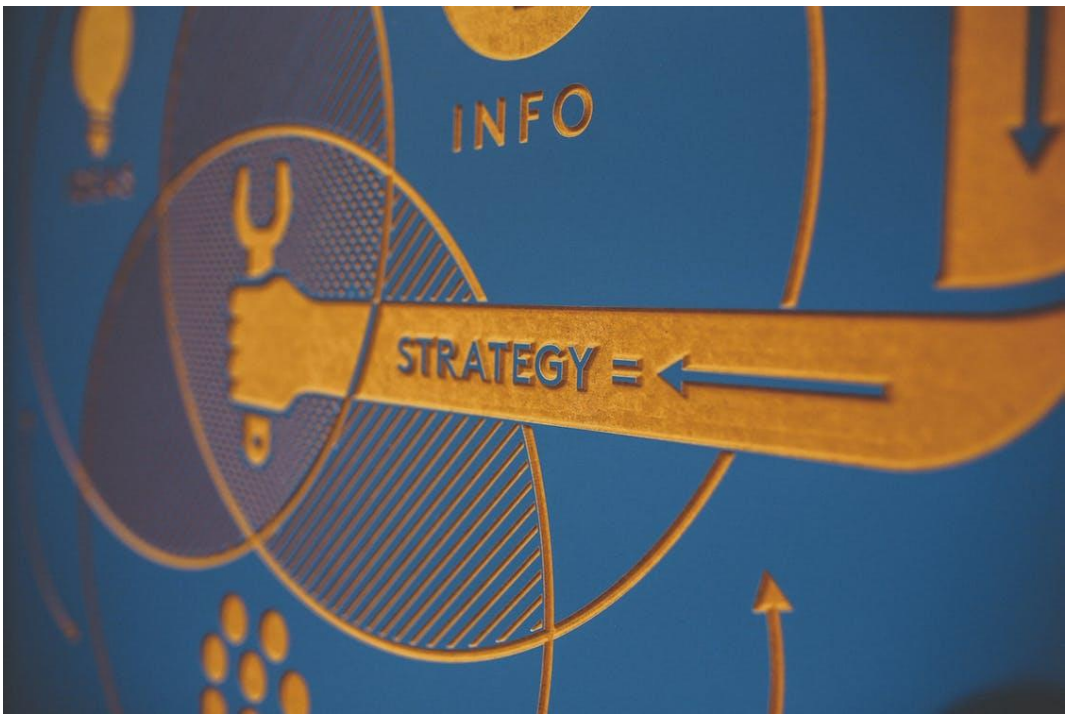
Digital Organisational Frameworks and IT Professionalism

EASME/COSME/2016/016

Interim Report

January 2018



Interim report, January 2018

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Service Contract: Digital Organisational Frameworks and IT Professionalism - EASME/COSME/2016/016

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Executive summary

The objective of this initiative is to promote IT organisational and management frameworks[1] together with IT professionalism in support of the digital transformation of enterprises in Europe. Digital transformation is the increasing adoption of information technologies (IT) to fundamentally alter its internal and external processes and functions, foster organisational change and adopt new IT-enabled business practices.

The digital transformation of enterprises is enabled by IT competences and professionalism at individual level and digital organisational capabilities at enterprise level. They are mutually reinforcing. This initiative aims to better understand how to increase the competences of individuals in tandem with the collective organisational capabilities of enterprises, with a particular focus on SMEs, to achieve digital capability excellence.

This interim report provides the insights collected during the research so far on three main topics:

- Part A - How organisations shape their digital transformation and the value of certifications;
- Part B - How organisations use and value IT organisational and management frameworks, and the possible conjunction with IT professionalism building blocks based on the e-Competence Framework;
- Part C - Latest statistics and forecasts on the evolution of the demand and supply of IT professionals and e-leaders in Europe.

IT professionalism is pivotal in digitally transforming organisations

Digital transformation has been a strong theme in both business and IT over the past five or so years – and often a much-maligned term used for almost any kind of new technology adoption. However, implementation of new digital technology does not necessarily mean it is digital transformation. There are two guiding principles for real digital transformation. One is that the technology adoption must be about transforming the business and not about the technology itself – so digital business transformation would be a much better term. The other guiding principle is that true digital business transformation is an ongoing process that requires organisational and cultural change. Because of the speed of technology change, treating digital transformation as a one-off project would mean that in a brief time, the organisation would once again be behind competitors and peers in the market. Enter the era of continuous digital innovation.

And with digital innovation comes an increasing demand for IT professionals who can deliver quality and value to organisations in such transformation process.

As numerous examples show, this does not always go well. Projects fail, up to three out of five according to US research[2]. Various studies attempted to quantify costs of software failures and generally indicate these costs run into double-digit billions[3], some even state trillions[4]. These failures affect citizens, as for instance travellers

[1] IT organisational and management frameworks represent an established norm and are a repository of specifications, procedures, guidelines in a certain domain. They are designed to ensure processes, methods, services and systems are safe, reliable and consistent. Frameworks provide a uniform language. They are based on industrial, scientific and consumer experience and are regularly reviewed to ensure they keep pace with new technologies. With 'IT organisational and management frameworks' we also include IT standards.

[2] The CHAOS Manifesto 2013. Publication. Boston, MA: Standish Group International, 2013. It reports that 61% of projects are challenged or failed

[3] Galorath, Dan, Software Project Failure Costs Billions. Better Estimation & Planning Can Help, Dan Galorath on Estimating blog article dated 7 June 2012, retrieved 20 June 2014 from http://www.galorath.com/wp/software-project-failure-costs-billions-better-estimation-planning-can-help.php

[4] For instance: http://www.computerweekly.com/feature/Calculating-the-cost-of-failed-software-projects, https://www.cloudcomputing-news.net/news/2017/oct/30/glitch-economy-counting-cost-software-failures/

with British Airways found out[5]. There have been different ransomware attacks, IT failures, data leakages and more which have affected organisations and customers around the world[6]. The challenge of the digital talent gap is no longer just an HR issue; it is an organization-wide phenomenon that affects all areas of the business[7]. It is pivotal to further mature the IT profession to avoid that the risks to society from IT will grow to unacceptable levels[8]. This starts with ensuring everyone working in IT followed, and continuous to follow, proper education to acquire relevant competences, knowledge and skills and keep up-to-date with developments, while behaving according to recognised ethical[9] norms. Software development and cybersecurity are essential areas in this respect.

Clear value propositions for IT expertise, professionalism, efficiency and certifications

Business leaders are working to transform their business, often employing digital technologies coupled with organisational, operational, and business model innovation to create new ways of operating and growing businesses. To be responsive to the need of the enterprise, IT organisations must accelerate the time to value of innovation all while optimizing spending on IT. Sometimes being responsive to the needs of the enterprise means upgrading hardware or implementing new software, but upgrading skills and certifying staff will deliver the most persistent performance improvement in IT operations. Certifications contribute to increase genuine knowledge and professionalism. The value propositions for leveraging IT certifications seems clear to each stakeholder:

- **Individual:** IT certifications improve on the job performance, career success and advancement, and salary potential. Individuals in IT or who intend to make IT a career choice should identify and actively consider if certifications would support their career aspirations.
- **Enterprise:** IT certifications improve organisational IT performance, IT-hiring costs and increase in quality hires. If high quality certifications are available for the significant components of the infrastructure, enterprises of all sizes and in any industry, should consider the potential impact of more thoroughly integrating IT certifications into the career development program and new hire selection criteria.
- **Technology vendors and consultants:** Successful client projects, increased quality engagements and increased revenue. While the evidence is less clear, technology vendors that support greater knowledge on the part of their partner consultants are likely to be rewarded with more satisfied clients, and more successful implementations of their technologies.

Certifications are often based on IT organisational and management frameworks. These represent an established *de facto* norm and are a repository of specifications, procedures, guidelines in a certain domain. They are designed to ensure processes, methods, services and systems are safe, reliable and consistent. Frameworks provide a uniform language. They also increase performance of the workforce and hence contribute to achieving the organisation's strategic goals.

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5 BA faces £80m cost for IT failure that stranded 75,000 passengers: https://www.ft.com/content/98367932-51c8-11e7-a1f2-db19572361bb

6 Top software failures - the worst software glitches in recent history: https://www.computerworlduk.com/galleries/infrastructure/top-software-failures-recent-history-3599618/

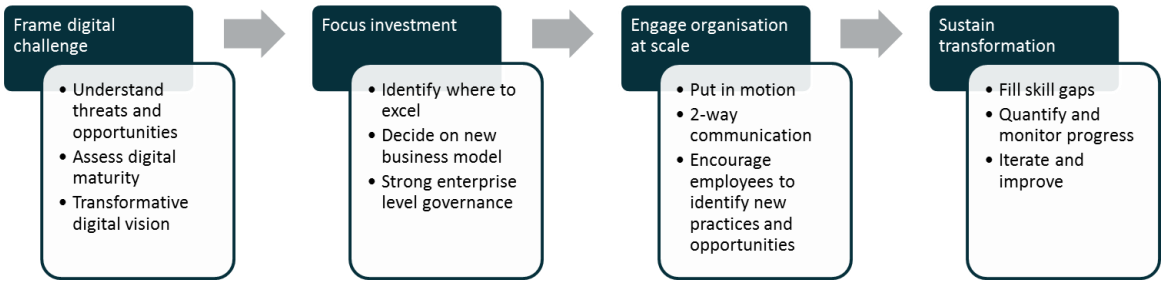
7 Capgemini and LinkedIn (2017), The Digital Talent Gap: are companies doing enough?, available on: https://www.capgemini.com/resources/digital-talent-gap/

8 IVI/CEPIS: "e-Skills and IT professionalism. Fostering the IT Profession in Europe", prepared for the European Commission, 2012.

9 Such as European Guidelines on Statements of Professional Ethics, developed in the context of the European IT Professionalism Framework with support of CEPIS, 2017

Improving organisational capability requires improving individual IT competences, skills and knowledge (and vice versa). This is essential for building digital management and governance capabilities, with relevant organisational structures and processes at enterprise level. A digital transformation process can be described in four steps (as captured in the figure below): frame the digital challenge, focus investment engage the organisation at scale, and sustain the transformation.

Figure 0-1 Four steps of driving digital transformation[10]



Understanding the connection between capabilities and competences in an organisation seems relevant in all steps of this process. If an organisation wants to invest in a certain capability for strategic reasons, it will have to understand:

- Which competences are relevant for developing that capability,
- Who in the organisation is carrying out a role associated with those competences, and:
- If the employee involved is matching the requirements for that role.

Based on the assessment of the latter, decisions can be taken as regards upskilling, recruiting or outsourcing.

This is where IT organisational and management frameworks can add value, as they provide the competences, knowledge and skills related to a certain area of expertise. Assessing current potential of the workforce can be input for understanding the organisation's digital maturity (frame), for deciding where to excel and invest in (focus), for identifying good or new practices (engage), or to understand which skill gaps need to be filled (sustain). Based on our research, the **digital capability reference framework** for enterprises consists of:

- An overview of digital capabilities building on the five core IT processes[11],
- Mapped to IT professional competences in the e-Competence Framework and consequently to
- Professional IT role profiles and further to
- Related IT organisational and management frameworks.

If structured efficiently, it would allow users to tap into the references (mapping) independent of the starting point. Business leaders and e-leaders likely start with capabilities and follow the thread to reach the frameworks, whereas IT might start the other way around. The following figure illustrates this view.

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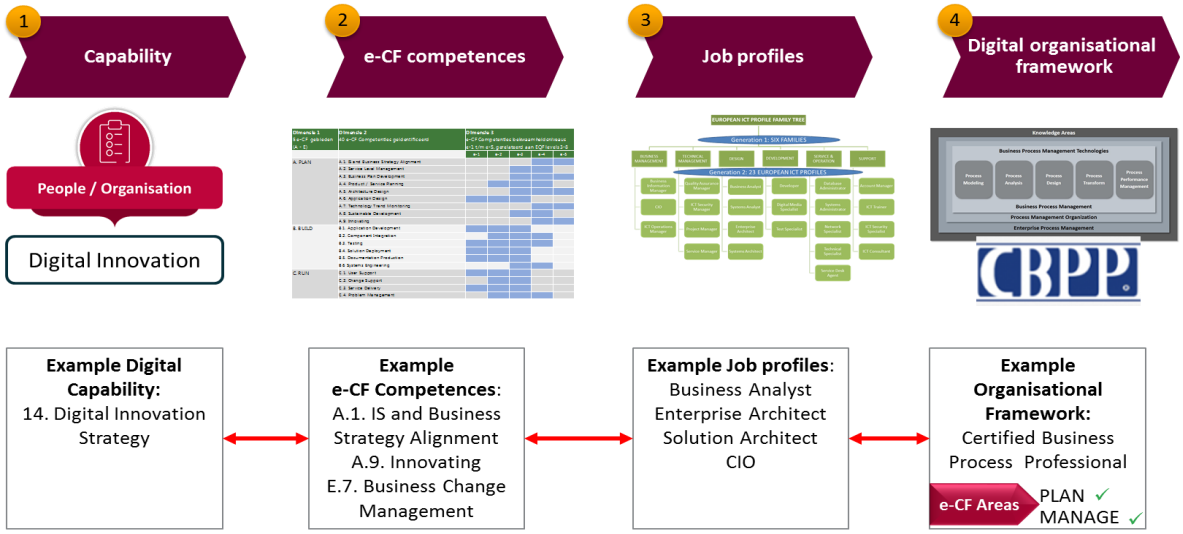
[10] Bonnet D. (2016), A Portfolio Strategy to Execute Your Digital Transformation, https://www.capgemini.com/consulting/resources/portfolio-strategy/

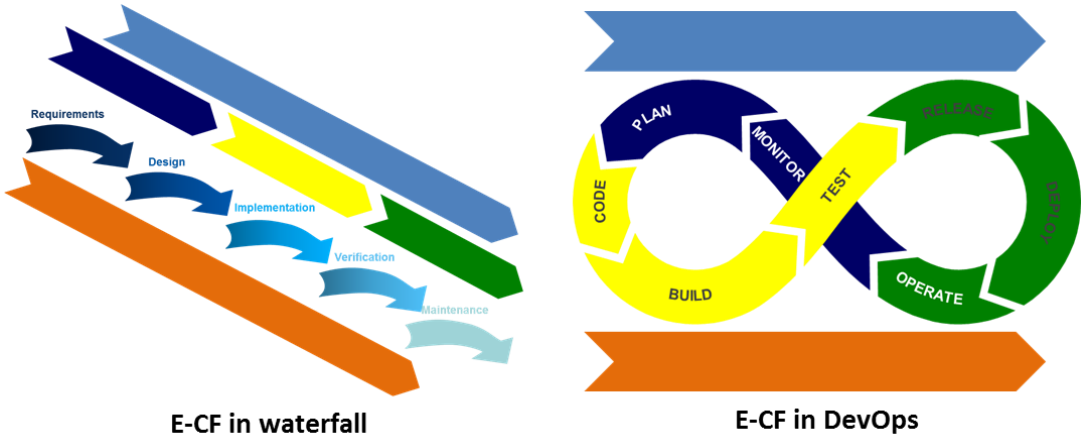
[11] As described in the e-Competence Framework (e-CF): These e-Competence areas reflect the ICT Business process and its main sub-processes, from a very general perspective. PLAN, BUILD and RUN are core areas whilst ENABLE and MANAGE are cross-cutting issues referred and related to the former. For more information see e-CF User Guide: http://www.ecompetences.eu/wp-content/uploads/2014/02/User-guide-for-the-application-of-the-e-CF-3.0_CEN_CWA_16234-2_2014.pdf

Figure 0-2 Example of how framework contribute to growing digital capabilities and competences in the organisation



Our research shows that the European e-Competence Framework (e-CF) is a great instrument for supporting a digital transformation journey. At this stage of our work, various mappings have been drafted to build the connection between capabilities and competences – such as a mapping of IT professional job profiles to IT organisational and management frameworks (in annex C), and a mapping of e-CF competences to the competences described in the most relevant frameworks (an overview of 16 frameworks in annex B). The description of IT Professional Profiles to e-CF competences is provided by the CEN (updated in May 2018[12]). This report also describes how the various frameworks can be categorised, in terms of both the five core IT processes (both in Waterfall as in DevOps environment) as well as the knowledge areas of the proposal for a European IT Foundational Body of Knowledge[13] (EU-BOK).

Figure 0-3 Application of e-CF in both traditional and agile environment



[12] See: www.ecompetences.eu/ict-profiles-update/

[13] Van der Linden, Siebes, Bonazzoli, European Foundational ICT Body of Knowledge, 2015. Online available: http://ictprofessionalism.eu/wp-content/uploads/EU-Foundational-ICT-Body-of-Knowledge_Brochure_final.pdf

Software as a major strategic capability

From our data collection, it also becomes apparent that software development and engineering is one of the most important capabilities for organisations at the moment. Between 2011 and 2016, the number of new jobs created (net) in software related professional jobs[14] amounted to 747,500 in Europe. This was an increase by 29% in five years, or 5.2% CAGR. In total, there were 3.4 million Software and applications developers and analysts in 2016, with the UK being the most important market (960,000 professionals). Software creation is important for European industry to remain competitive, and it appears as if Europe is failing in gaining true digital competitiveness in the Information Age. Policy makers should address this better, and take action as the shortage of professionals skilled in software design and engineering is huge, and growing.

If Europe wants to succeed, there is a need to change over from the 'use' of software and services to software 'creation' to become really innovative, globally competitive and successful in the market today and in the future. This would imply a radical change in our way of thinking and approaching software creation as an industry. On top of skilled IT-professionals and e-Leaders, Europe needs **creators** to realise software as a profit platform. It also calls upon structural innovations in higher and executive education and training landscape to support actual innovation. In the views of experts, Europe should work towards 'software universities' and foster programmes for research, education and training in software-based innovation.

Updated forecasts on the demand and supply of IT professionals and e-leaders (till 2020)

The IT labour market in Europe and globally has been very dynamic both in terms of new jobs created and in terms of pace of change with regards to occupational tasks and requirements. Digital skills and leadership are now a major policy concern in Europe in order to create employment as well as to drive innovation and growth. This has been a major topic in January 2018 at the World Economic Forum, at which the **SkillSET**[15] initiative (Sustainable Education and Training for the Digital Economy) has been launched.

Based on our previous analyses and forecasts, we have updated our "main forecast scenario" for the horizon of 2020. Previous forecasts had repeatedly warned of an imminent talent gap, with varying degrees of severity coming from the statistics and market information available at the time. A forecast in 2013, which was widely taken up as a wake-up call to policy makers and industry, came to the conclusion that there might be a structural gap of up to 900,000 in 2020 (the highest estimate from six possible scenarios). Forecasts in 2017 have subsequently lowered the potential talent gap down to 500,000, owing to the increasing mobilisation of stakeholders and policy makers resulting in a better supply situation and the repeated ability of the industry to find candidates for open posts outside of the still insufficient talent pool coming from ICT studies at higher and vocational education.

The lesson learned from past experience with our forecasts and their validation, or not, through the actual turnout of jobs statistics has led us to challenge some key assumptions about our model, namely especially the assumption that the new supply of ICT professionals in a year is strictly limited by the numbers of university and vocational school leavers in ICT. It has turned out that the market grew much faster than would have been possible if this restriction actually were as rigid as our model hitherto assumed.

Therefore, we propose two foresight scenarios:

- Firstly, a moderate growth scenario, where we stick to the methodology used in previous forecasts, and a high growth scenario, where we extrapolate using the previous average growth rate of the

[14] Containing the following job categories (ISCO-08 code): Systems analysts (2511); Software developers (2512); Web and multimedia developers (2513); Applications programmers (2514) and Software and applications developers and analysts n.e.c. (2519)

[15] See: www.theskillset.org

workforce as demand growth parameter and where we allow for more ICT outsiders (education wise) in those countries where we have seen previously a strong disconnection between workforce growth and graduate figures.

In this scenario, there is the current moderate demand growth of 1.8% until 2020 which results in a workforce growth of 558,000 jobs added and a structural gap (vacancy potential) of 526,000. The highest workforce growth in this model is expected in Poland[16] (+18% in 4 years), Spain (+12%) and the UK (+10%). This ranking reflects the model properties described above, namely that especially Poland and Spain are countries where the number of graduates is very high in comparison to their IT workforce.

- Secondly, a new **high growth foresight** exercise, where we assume an average growth of labour demand 3.6% throughout the years 2016-2020 and across countries. 3.6% was the average growth (CAGR) between 2002 and 2016 for the core category of ICT professionals[17]. On the supply side, we assume roughly 1 Million ICT graduate entries in four years (466,000 Higher Education and 542,000 vocational education). We assume entry of 959,000 "lateral entries", i.e. people without a (European) ICT degree. This additional inflow might represent in-migration or outsider recruitment from STEM or other disciplines. In four years, also 926,000 people leave the workforce and need to be replaced.

  As a result, we estimate that the IT workforce in Europe would grow from 8.5 million in 2016 to 9.5 million in 2020, of which 8.1 million would be IT practitioners and 1.4 million IT management and analysis level employees (the latter group growing slightly faster). The countries experiencing the fastest growth will be Poland, France and Portugal in this scenario. The excess demand or shortage (calculated as the number of open posts)[18] according to our research would amount to 434,000 in 2016 and 749,000 in 2020. Of these 474,000 there are 388,000 potential additional jobs in IT practitioner occupations and around 85,000 at IT management level.

These indications imply without a doubt that industry, government, research, education and training need to continuously prioritise initiatives that contribute to closing these shortages as they are generating very positive and encouraging results. It also underlines the importance of this initiative that will support the digital transformation of enterprises and SMEs.

e-Leaders, finally, are a highly selective group of business leaders who combine strategy, ICT and business skills and who enable innovation to be made in the first place, and then brought to bear in the market. The reason of monitoring and supporting the efficacy of e-leadership lies in their great contribution to industrial competitiveness, innovation and value and job generation. E-leadership demand is a less easily measured phenomenon and some proxy measurements have been done. Available evidence shows that there has been an increase recently for e-leadership by at least 3.0% annually. There are approximately 630,000 e-Leaders.

[16] Note that for the smaller countries (representing 6% of the workforce) we do not provide any country data on growth or individual forecasts.

[17] The average growth for the ICT specialist category is only available for the time bracket 2011 to 2016 and is 4.2%.

[18] This model simply adds up the national balances of supply and demand, but only where they reveal an excess demand. It should be noted that this is still a very conservative estimate, as within countries a perfect geographical match is assumed. Mismatches thus only occur between countries. Migration, which alleviates the geographical mismatch, is already built into the model, as described in the assumptions section. Apart from geographical mismatches, skills mismatches only exist between management and practitioner level skills, but the assumptions on management level recruitment out of the pool of practitioners are also conservatively estimated, rather overestimating the mobility between these categories.

1 Introducing this initiative

1.1 Rationale

The digitalisation of the economy leads to profound changes. Value chains shift, business models, organisations and workflows find new ways and the competitiveness of enterprises is newly defined. Digital transformation is the increasing adoption of digital tools and technologies by an organisation to fundamentally alter both its internal and external processes and functions. The digital transformation of enterprises is enabled by IT competences and professionalism at individual level and digital organisational capabilities at enterprise level. They are mutually reinforcing. There is a need to increase the competences of individuals in tandem with the collective organisational capabilities of the enterprise. This is what successful enterprises are doing but it remains a big challenge for many businesses.

The European Commission, Executive Agency for Small and Medium-sized Enterprises (EASME), started an initiative to develop an integrated **digital capability reference framework for enterprises** to strengthen capabilities to digitally transform businesses. This initiative is coordinated by Capgemini Consulting in partnership with IDC and Empirica, and runs until January 2019.

Recently, via interviews, desk research and an online survey, insights were gathered on how organisations shape their digital transformation and which digital capabilities, tools and competences are most important in that process. The growing importance of software in an increasingly digital economy and society was also addressed. This interim report present the insights gained so far in this initiative, and the outlines of the **digital capability reference framework**. This report also includes the latest statistics on the demand and supply gap for IT professionals in Europe.

1.2 Objectives

The aim of this service contract is to provide a key contribution to the development and the promotion of IT organisational and management frameworks and IT professionalism in support of the digital transformation of enterprises in Europe.

It will investigate how enterprises, especially SMEs, could benefit from a coordinated approach for the effective adoption of IT organisational and management frameworks[19] and IT professionalism to help them take advantage of the opportunities offered by digital technologies.

This initiative will run until January 2019, and aims to achieve four objectives:

1. Performing an in-depth analysis to provide a clear vision of the state-of-the-art in the EU based on the latest information, data, trends and development, regarding:
    - IT organisational and management frameworks;
    - The importance and the value of related certifications;
    - Best practices in the top ten EU countries (and sectors at EU level) where they are used;

    The results of this analysis will be complemented by:

        - An in-depth review of at least ten of the most relevant frameworks;

[19] We will refer to IT organisational and management frameworks as 'frameworks', and this includes IT standards or proven methods/practices. Since a framework is defined as 'a basic structure underlying a system, concept, or text' we feel this is the most appropriate abbreviation.

- An estimate of the potential benefits of their possible use in conjunction with the e-CF to strengthen the digital capability of enterprises;
- An overview of the situation at international level (North America and Japan) to draw meaningful conclusions and comparisons;
- Two annual updates of the evolution of the supply and demand of IT professionals and e-leaders in Europe at the end of 2017 and 2018.

2. Elaborating a proposal for an integrated digital organisational reference framework building on the conclusions of the interim report and recommendations of leading stakeholders (workshops, online surveys and interviews). Engaging a broad ecosystem of stakeholders will be crucial for generating useful recommendations and validating the proposal.
3. Creating general guidelines for the use of the digital organisational reference framework, to help enterprises and SMEs assess their digital capabilities. Concrete recommendations for implementation should be provided for at least three EU Member States (and sectors).
4. Promoting and widely disseminating the results of the work.

1.3 Approach, and where this interim report stands

This initiative started with the task of data collection to understand the state-of-the-art in Europe. This task was composed of:

- Desk research to compose an overview of the most relevant studies, experts and good practices (continuous);
- A series of in-depth interviews with experts in this field (conducted between March and June 2017);
- An online survey to collect views of a larger group of experts (conducted between September-November 2017)

The focus of the desk research was primarily focused on collecting evidence about the relevance of the use of organisational frameworks to digitally transform organisations. More specifically the focus of the desk research was on:

- Digital transformation for SMEs;
- Usefulness of different organisational frameworks;
- Connection of those aspects with the e-CF.

The interviews aimed to deepen preliminary insights and understand how IT organisational and management frameworks are used by organisations, and what needs exists depending on a stage/process an organisation is in. The interviews also collected input on usage, importance of these frameworks – and the connection to building capabilities on the one hand, and on developing competences on the other hand.

The survey was launched with great support from important stakeholders, such as EuroCIO, whose contribution provided excellent input from CIO's across Europe. The output of the survey is included in the annex E, and the insights are used in chapters three and four mostly.

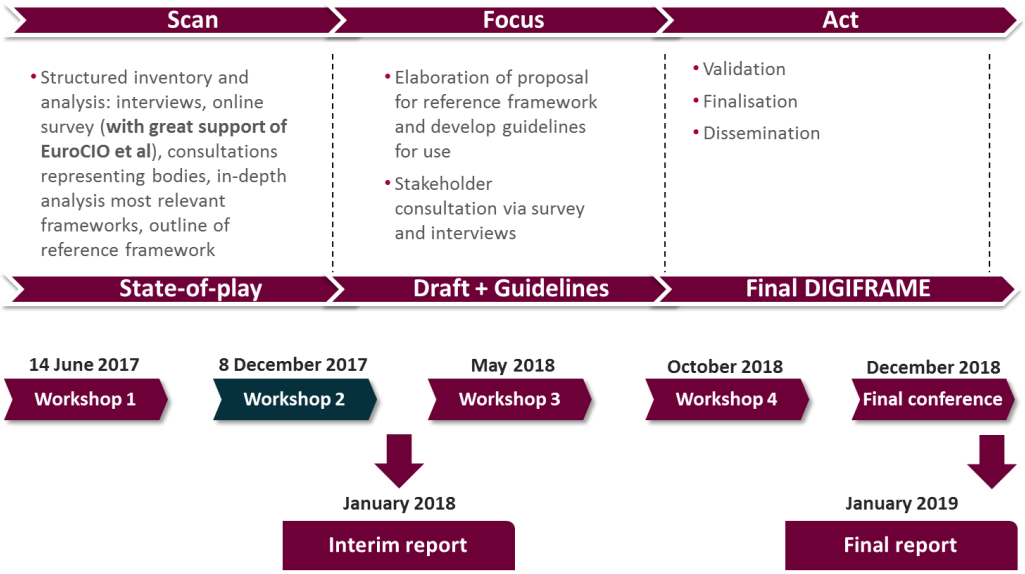
The findings of the data collection were shared with a selected group of experts during two workshops:

- On the 14th of June 2017, in Valetta (Malta), preceded by a conference on IT professionalism co-hosted with eSkills Malta association. Participants were partly from the Maltese industry, government and education sector, as well as from other countries. The objective was to contribute to the validation of the data collection activities, mainly to reach consensus on the frameworks inventoried

and agree on the 10 most relevant, for structured review and analysis based on a rigorous methodology and a template.

- On the 8th of December 2017, in Brussels (Belgium). This workshop focused on the validation of the in-depth analysis of the top 10 digital organisational frameworks and commonalities, the good practices selection and recommendations regarding how a digital organisational framework and the e-CF could complement and enrich each other. It also included a debate about the importance of software creation for European competitiveness – with input from TIVIA and the Hasso-Plattner Institute (HPI), and two excellent case studies: from Agfa-Gevaert and VIVAT insurances. The connection between capability and competence was further illustrated by a contribution from the Innovation Value Institute (IVI).

Figure 1-1 Schematic overview of the timelines of this initiative



Whereas the workshops in phase one of this initiative focused on the gathering of views, opinions and idea's and create the opportunity to give feedback and validate the progress of the project, the workshops that will be organised in the second phase will focus on the consolidation the results, and the preparation of the implementation of the Framework.

1.4 Reading guide

In this interim report, the description of the state-of-play is included:

- An overview of digital transformation trends, and an evaluation of the importance and the value of related certifications (chapter 2);
- A structured inventory of IT organisational and management frameworks, and in-depth review of the ten most relevant and popular (actually, sixteen were listed and analysed in the end) (chapter 3);
- Best practices of implementing these frameworks (chapter 3);
- An estimation of the potential benefits of their possible use in conjunction with the e-CF (chapter 3);

- An evolution of the supply and demand of IT professionals and e-leaders in Europe at the end of 2017 (chapter 5);

In advance of the final report, in chapter 4 of this interim report, the outline of a '**digital capability reference framework'** is sketched building on the connection between capabilities and competences.

PART A. How organisations shape their digital transformation and the value of certifications

2 State of play on Digital transformation

Digital transformation has been a strong theme in both business and IT over the past five or so years – and often a much-maligned term used for almost any kind of new technology adoption. However, implementation of new digital technology does not necessarily mean it is digital transformation. There are two guiding principles for real digital transformation. One is that the technology adoption must be about transforming the business and not about the technology itself – so digital **business** transformation would be a much better term. The other guiding principle is that true digital business transformation is an ongoing process that requires cultural change. Because of the speed of technology change, treating digital transformation as a one-off project would mean that in a brief time, the organisation would once again be behind competitors and peers in the market. Enter the era of continuous innovation.

2.1 Digital Transformation

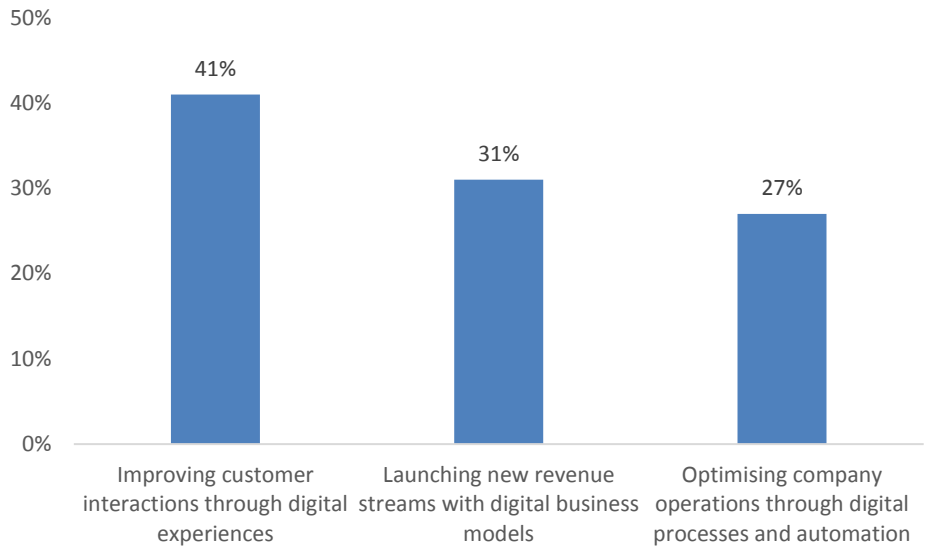
The past decade has seen a new wave of information and communications technology "coming of age" and being adopted widely in organisations in Europe (and worldwide). Technologies, such as cloud, big data and analytics, mobile devices and apps, and social media technologies are now fundamental to organisations' IT environments. More recently, there is a surge in interest in how to use emerging technologies such as cognitive computing, artificial intelligence (AI), robotics process automation (RPA), Internet of Things (IoT) and 3D printing to name a few. It could be argued that a spate of new IT coming to market is nothing new – but what is new is how organisations are looking at applying these technologies. They are no longer in the realm of the IT department only and neither are the skills needed for technology adoption. As stated by one of the consultancies interviewed for this project: *"Technology skills must move much closer to the core business. They cannot stay isolated just in the IT space. Many of the IT decisions will be taken outside of the IT department."*

According to IDC's Digital Transformation Leader Sentiment Survey in March 2017, 86% of more than 400 European organisations interviewed stated that digital transformation was part of the corporate strategy of the organisation. Another IDC survey (also of more than 400 European organisations) shows the key priorities for their digital transformation efforts (see Figure 2-1).

As can be seen, external considerations (improving customer interactions and developing new products and services) are driving the majority of digital transformation strategies with internal operational efficiencies in third place. However, this does not mean that organisations are downplaying the importance of digitising internal processes and operations. The past few years of experimentation has shown that without also addressing the underlying processes that, for example, underpin customer interactions (such as order, payment, fulfilment and return processes) even innovative digital customer experience interfaces will not be successful.

An example of this is a hotel chain, which hired a new Chief Digital Officer with the view to improve its customer experience. Through discussions with the front desk staff, they realized that they needed to take a holistic view of the customer journey from booking (which may not be directly with the hotel) through to the stay itself. The chain discovered that it had 200 silos of data that would need to be integrated – so it had to "shift investments from cool gadgets to a strong interoperable platform". So again, back to the fact that when talking digital transformation, the back-end processes need also to be in the picture. So, the basics have to be in order for successful digital transformation.

Figure 2-1 Key Priorities for Digital Transformation[20]



2.1.1 Cloud Underpins Digital

Cloud plays a strong enabling role in digital transformation. A key reason for this is that a major focus for organisations' digital transformation journeys is to seek out new business models and make the existing business much more agile and able to change at speed in response to new market conditions. One of the premises of cloud is that the technology enables rapid development, deployment and distribution of technology, compute power and applications. In addition, it frees organisations from making capital investments in IT equipment and software at a time where they may be in an experimental phase.

Consequently, many European enterprises have shifted to a "cloud first" strategy over the past several years as part of their IT strategy to deliver on digital transformation objectives. Although cloud service adoption in Europe is more weighted toward private cloud and hosted/managed cloud services, in the past couple of years there has been a surge in public cloud adoption according to IDC data. IDC estimates that by 2020 at least 35% of net-new IT spending in Europe will be cloud-based, while non-cloud enterprise applications spend will be flat.

2.1.2 AI, Cognitive and Automation

The interest in Artificial Intelligence (AI) and how it can be applied in businesses has exploded over the past 12 months. Although adoption is still nascent and on a very experimental stage, every day brings new examples on how organisations are trying to apply AI to different business issues from Enfield Council in the UK announcing in 2016 that it would use AI (a robot called Amelia) to deliver local authority services to Carlsberg announcing in January 2018 that it would use AI to develop beer.

Some of the AI technologies that are now already available are conjuring up images of robots from "Blade runner" such as the robot Sophia, which was "interviewed" on a range of TV channels in the summer of 2017 and have yet to be put to widespread use. However, intelligent personal assistants, such as Amazon's Alexa, is

[20] Source: IDC, European Digital Transformation Survey, March 2017 (n=423)

already being widely adopted by consumers. But underlying these manifestations of the technology are cognitive/AI systems and software platforms, which use deep natural language processing and understanding to answer questions, provide recommendations and direction, hypothesize and formulate possible answers based on available evidence. These can be trained through the ingestion of vast amounts of content, and can automatically adapt and learn from mistakes and failures. This is the technology that has the potential to automate processes with repetitive tasks and vast amounts of data, such as that resulting from the Internet of Things (IoT).

Cognitive technologies make possible new data-driven digital business models leveraging that data. However, the nascent stage of the market means that barriers to adoption include lack of understanding of the technology or how to make the business case a requirement to find the necessary skills. The rising emphasis on data privacy and transparency in processing personal data especially in Europe will also have a dampening effect on near-term demand.

2.1.3 Internet of Things (IoT)

IoT is a key element in many digital transformation projects and an essential part of business optimization and business process automation. Public and private organisations are embracing IoT to become more efficient and enhance their business models.

The number and variety of Internet-connected devices (including smartphones, wearables, and equipment sensors) is set to increase substantially over the coming five years. Currently at around 15 billion, the number of connected "things" already surpass the number of online PCs, tablets, and smartphones, and their growth will remain in double digits to bring the worldwide installed base of IoT endpoints beyond 36 billion by 2021.

As mentioned above, this will contribute to a rapid rise of IoT data that needs processing, managing, integrating, and analysing. Most organisations currently see IoT as a way to drive operational efficiencies, but it will increasingly be tied to digital transformation efforts and the need to drive value using advanced analytics and cognitive/AI technologies.

IoT is being adopted across most industries and will be one of the technologies central to retail transformation in 2017 and beyond, driving disruptive innovation opportunities. IDC predicts that by 2019, IoT will contribute to increase in-store, in-warehouse, and in-distribution centre productivity in a range between 1.5x and 3x. Some of the examples seen so far are on the experimental stage, such as Amazon Go, which has yet to reach Europe, and the BASF wine store in Germany. However, Ocado (the British online supermarket) has used IoT in its automated packaging service for two years.

According to IDC's European Vertical Markets Survey (November 2016), more than 50% of European manufacturers had already invested or were due to invest in an IoT application. The examples of initiatives are widely publicized, such as General Electric's GE Digital focusing on predictive maintenance amongst other issues and Bosch's implementation of IoT sensors in home appliances and development of an IoT platform for collaboration with partners.

2.1.4 The Value of Data

An organisation's ability to make efficient and fast data-driven decisions using both its own and external data is crucial for many digital transformation undertakings. This shift toward "the real-time enterprise" drives the adoption of technologies for streaming and analysing real-time data. Improving the speed of business as well as accuracy and precision of decision making driven by the digital economy continue to underscore the need for fast, relevant, and contextual insights. This has come at a time of explosive data growth from various sources including social media and mobile devices, all of which generate data that provides potential for

instant insight. These very large volumes of a wide variety of data combined with high-velocity capture, discovery, and/or analysis is termed Big Data.

In addition to using data for better and speedier decision making, organisations are also increasingly looking at how they can use data commercially. Data monetization (i.e., the process of trading or selling data, in whole or in part, to companies or data consumers) has received renewed attention in the past year. IDC finds many European organisations are attempting to uncover and understand the latest ways in which they can monetise or productise information and digital assets to customers with information needs while also adhering to regulations regarding data protection and use, especially with GDPR coming into effect in May 2018. Overall, the big data and analytics market growth is driven by the ongoing need to digitalize business and drive more value from the data captured and stored by organisations to better understand and serve their customers and move their businesses forward.

2.1.5 DevOps and Agility

To lead and excel in a digital economy requires faster response, better quality, and more secure products and services. Leading digital companies such as BBVA, Nordstrom, ING, Amazon, and Google are utilizing DevOps practices to deliver speed and quality advantages embedded in their product delivery systems. The bottom line is that digital transformation is a board level concern, and IT organisations need to figure out how best to support the business.

As a result, more and more organisations are embracing DevOps. Across Europe, there is a strong rise of the DevOps-driven enterprise; according to an IDC survey, close to three-quarters of large European organisations now claim to have adopted DevOps in some shape or form. While operational models and technology investment strategies to support DevOps are still evolving, there is a widening gap between enterprises in experimentation mode versus those that are well-versed in the benefits and rapidly deploying DevOps to accelerate business change.

It is important to understand that DevOps is neither a set of tools nor a technology. It is the intersection of people, processes, and technology that aligns with business leadership, culture and strategy. DevOps should be the goal and not the starting point — it is a transformation journey. There is no one-size-fits-all solution; organisations may choose different approaches. But it is part of an important cultural change necessary for creating a true digital enterprise.

2.1.6 Cultural Change and Continuous Innovation

As organisations are progressing on their digital transformation journeys, it is becoming clear that for true business transformation to happen, the changes need to transgress organisational siloes and traditional approaches. Although underpinned by digital technology, digital projects cannot be only in the realm of IT department – nor can they be solely driven by business operations.

Recurring themes in digital transformation are around speed, agility and responsiveness to market conditions and to changing client expectations. For most organisations, this will require a change in working practices, and in ways of collaborating as described above. Often this will mean that the organisation will have to change to give employees greater autonomy, to become more fluid and to create a flatter organisational structure in order to empower employees to make faster decisions. It does however also require different types of skill sets from employees with an emphasis on new and hybrid skill, such as technology and business understanding, analytical capabilities, teamwork and communication.

As stated previously, one of the guiding principles of digital transformation is that this is not a one-off project but a continuum with a focus on continuous innovation. This can only happen with the whole organisation embracing the change and with digital transformation "embedded" across the enterprise.

2.1.7 Where Are Organisations on the Digital Business Transformation Journey?

So where are organisations on their digital business transformation journeys?

Since 2015, IDC has been measuring the maturity of organisations worldwide in terms of digital transformation. There are five stages of maturity: ad hoc, opportunistic, repeatable, managed, and optimized. For each stage, the IDC MaturityScape Benchmark for digital transformation addresses how capabilities for a particular dimension need to develop to improve the business' ability to leverage digital technologies for competitive advantage. The key characteristics of the five maturity stages are:

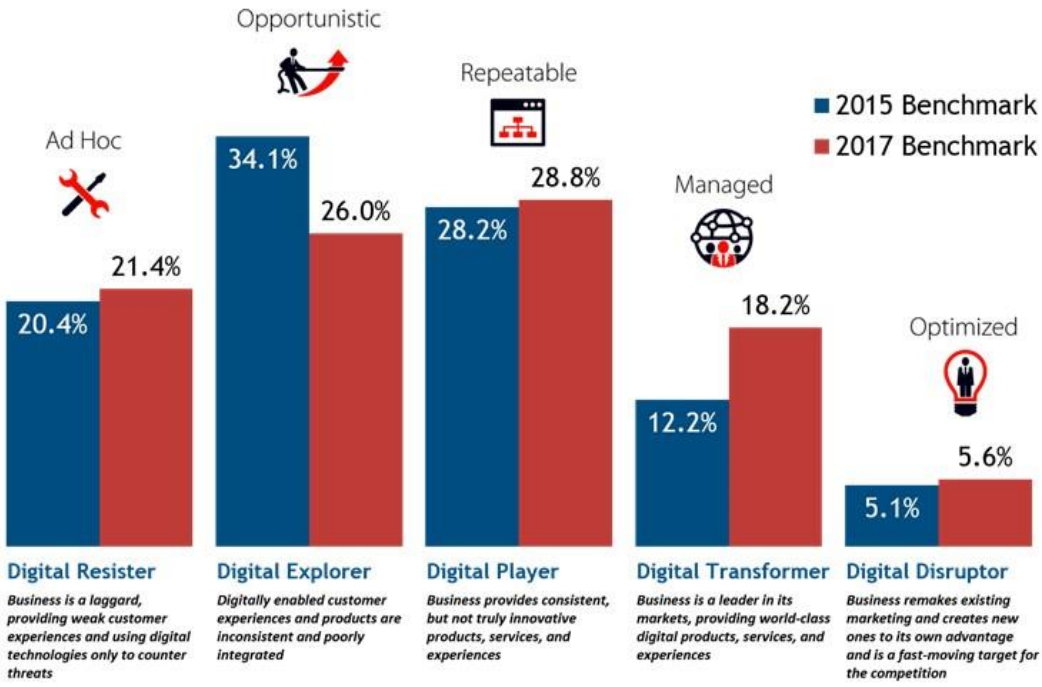
- **Ad hoc:** Management goals for digital transformation are poorly defined and occasionally chaotic. Success often depends on individual effort, and benefits are not widely shared within the business. Business and IT digital initiatives are disconnected and poorly aligned with enterprise strategy and not focused on customer experiences.
- **Opportunistic:** Basic capabilities are established. The necessary disciplines for digital transformation are in place to repeat earlier successes on similar initiatives. The business somewhat lags behind its best-performing peers. The business has identified a need to develop digitally enhanced customer business strategies, but execution is on an isolated project basis, and progress is neither predictable nor repeatable.
- **Repeatable:** Business-IT goals are aligned at the enterprise level to near-term strategy and include digital customer product and experience initiatives, but are not yet focused on disruptive potential of digital initiatives. Capabilities are documented, standardized, and integrated at the enterprise level. Digital transformation at the business level is a strategic business goal. The business maintains parity with its competitors and peers.
- **Managed:** Capabilities for digital transformation are embedded in the enterprise and tightly linked to an agile management vision. The business leads its peers and competitors. Integrated, synergistic business-IT management disciplines deliver digitally enabled product/service experiences on a continuous basis.
- **Optimized:** The enterprise is aggressively disruptive in the use of new digital technologies and business models to affect markets. Ecosystem awareness and feedback are constant inputs to business innovation. Continuous improvement is a core business management philosophy. Leadership embraces risk taking and experimentation to develop innovative, ground-breaking capabilities.

Figure 2-2 shows the results of the benchmark survey for Europe in 2017 compared with the 2015 results. As can be seen, many European organisations have evolved significantly since the assessment in 2015. However, most organisations (76%) continue to fall into the three lowest maturity stages.

There has been a significant reduction in organisations that are classified as digital explorers (maturity stage two) — which has gone down from 34% in 2015 to 26% in 2017. This change appears to be taking place because many organisations have advanced in their digital transformation journeys and are now reaching higher levels of maturity. Although the percentage of digital players (maturity stage three) has only gone up 1%, the number of digital transformers (maturity stage four) has gone up from 12% in 2015 to 18% of European organisation in 2017. It is also important to note that the number of organisations that are classified as digital resistors (maturity stage one) and digital disruptors (maturity stage five) has remained nearly identical.

The results imply that although many organisations are embracing and advancing their digital efforts, a large gap is forming between digital thrivers and digital survivors. Industry leaders that continue to ignore the threats and opportunity that IT-enabled processes, services, and business models introduce will risk becoming redundant soon. The data also shows that overcoming the last hurdles to become a digital disruptor is not a simple task. Early stages of digitalization are easier to implement (perhaps due to natural evolution of the business or limited to technology requirements) while the more mature stages (especially the last one) requires permanent and deeper changes to areas such as organisational culture and business models.

Figure 2-2 IDC[21] MaturityScape Benchmark:
Digital Transformation in Western Europe- Maturity Distribution Across the Stages



Looking at the results from the same study of US organisations, there is a higher degree of maturity. While there is only a slightly higher proportion of digital disruptors (stage five), the proportion of organisations that have reached stage four (managed) is around ten percentage points higher, while only 6% of organisations can be classified as digital resisters (stage one).

2.2 Value of IT Certification

In just a few short decades, information technology moved from the back office to the front office, and now has embedded itself into nearly every aspect of our business and personal lives. Fuelled by new, and innovative technologies like mobile, cloud, big data and analytics (BDA), artificial intelligence and robotics, the technologies and processes that businesses deploy are so tightly linked to their customers and markets that the boundary between the internal operations of the enterprise and its external ecosystem is disappearing.

Business leaders are working to transform their business, often employing digital technologies coupled with organisational, operational, and business model innovation to create new ways of operating and growing businesses.

[21] Source: IDC, March 2015 and March 2017

To be responsive to the need of the enterprise, IT organisations must accelerate the time to value of innovation all while optimizing spending on IT. Sometimes being responsive to the needs of the enterprise means upgrading hardware or implementing new software, but upgrading skills and certifying staff will deliver the most persistent performance improvement in IT operations.

When an individual IT professional gets certified, there are many types of benefits. The IT professional is often eligible for a higher salary – either at their current employer or when they seek a new position. The employer will likely see greater staff productivity from both individuals and teams of certified staff. Organisations looking to hire new staff find using certifications as a selection criterion speeds up identification of suitable candidates, and find that new employees reach full productivity sooner than non-certified employees. High performing IT service providers or consulting organisations also find that certified staff enhance credibility of consulting teams and can better perform their consulting roles.

IDC research and others have identified that certified IT professionals can help drive:

- **IT staff efficiencies**: Deeper knowledge and understanding of technologies enable time savings and higher productivity for certified staff members;
- **Improved IT operations**: Applications are delivered faster to users and customers, and users of these applications experience less unplanned downtime when certified staff are involved in their development and support;
- **New hire productivity:** New hires who have earned certification reach full productivity sooner and have longer tenures on average; and
- **Employee advancement:** Employees who are certified are often given more responsibility, have more opportunities for advancement, and have higher salaries on average.

Organisations that effectively leverage certifications can:

- More easily identify qualified candidates;
- Demonstrate/validate capabilities of consultants/SMEs and other technology vendors' staff.

2.2.1 IT Staff Efficiencies

IT organisations can realize substantial value by having IT staff members with certification. In 2015 research conducted by IDC (*The Business Value of IT Certification, #US40548315, November 2015*) organisations report certified staff members are more productive, can handle more complex issues efficiently, and are able to support and supervise the work of uncertified staff. This means that IT organisations require less staff time to support day-to-day operations for datacentre infrastructure, database operations, and application development efforts. IDC calculates that teams with certifications responsible for core IT activities are almost 20% more productive.

Organisations understand the advantages in having certified staff that generate efficiencies:

- **Better understanding of evolving technologies and priorities.** Certified staff have the knowledge and training to support complex and evolving technologies. An IT manager at a retailer said: *"It's about the knowledge and the confidence. Certified staff understand the concepts. Also, security technology is now in the forefront. In years past, it was in the background. From their certification experience – studying and testing – they are more aware of security issues and technology."*

- **Ability to handle more complex issues.** Certified IT staff members are often given responsibility for more challenging work critical to IT operations. An IT manager at a technology company explained: *"When it comes to server management, we have a tiered approach. The most important tasks are with the certified team members. They in fact spend less time on them than non-certified team members, but provide a higher level of support."*
- **Support work of non-certified staff members.** IT staff members with certification are able to support non-certified or junior employees, improving the quality of their work and providing them with valuable guidance. An IT manager at a multi-national company said: *"Less complex applications [are] developed by staff without IT certification. [Those] applications are tested and approved by someone with IT certification before being released."*

2.2.2 IT Operations

Risk Mitigation and Availability

Applications and systems perform better and experience less unplanned downtime with the support of certified IT staff members. According to interviewees, certified staff members reduce the frequency and duration of unplanned outages because of deeper knowledge and ability to apply their knowledge. An IT manager at a technology company explained: *"It is the in-depth knowledge that helps with any issues that might arise. We find it leads to a methodical approach to resolution by handling issues with confidence and capability."* As a result, their organisations experience fewer instances of unplanned downtime, resolve outages in less time, and reduce the impact on users. Certified staff members supporting servers and applications reduces the impact on users of unplanned downtime by 56% compared with non-certified IT staff.

Business Agility

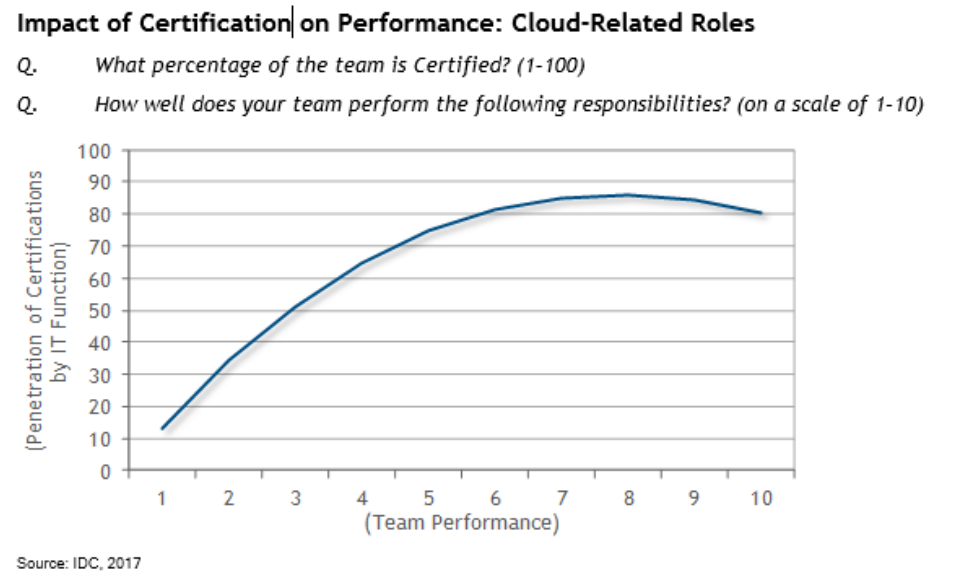
Certified IT staff members enable their IT organisations to be more agile and better meet demands from the businesses they support. This positive impact is particularly evident in terms of their ability to support users and customers with business applications. According to IDC research, certified application developers are almost 90% more productive and more nearly 60% more efficient. An IT manager at a transportation company explained the outsized role of his organisation's one certified application developer: *"We have one certified developer who reviews and finalizes the applications developed by our five uncertified developers. He also develops a number of applications completely on his own."* This means that IT organisations with certified application developers reduce the time to market for new applications and features, putting the tools that employees need to better do their jobs earlier, and delivering faster the services needed to generate and drive business from customers.

Illustration: The Importance of Certification to Performance: Cloud-Related Roles

(Source: Cloud Skills and the Impact of Training on Successful Cloud Implementations, August 2017, IDC #US42965317)

The concentration of certifications within a team is strongly correlated to "success" for the team. This is particularly important for newer technology areas. For example, cloud deployments are becoming an essential ingredient to a successful IT infrastructure. The growth of cloud as a computing platform has magnified the importance of cloud skills to the success of the enterprise. And, it is becoming clear that IT professionals with cloud skills strongly influence both the type of cloud infrastructure and the ultimate pace of adoption of cloud. This puts IT professionals with cloud skills in the driver's seat of their own career. In fact, IT professionals with certifications related to cloud development and operations, have dramatically more influence over their organisations' adoption and expansion of cloud services than otherwise similar IT professionals have over the adoption of other types of technical solution. Cloud skills accelerate the success and career path of IT professionals.

While the impactful cloud roles are diverse, and include multi-cloud or hybrid-cloud management, workload-centric management, and DevOps, IT professionals who work with Cloud who were described as more successful by their managers had greater competencies in areas relevant to their role, and had more, relevant certifications, on average. Of course, the proficiency of various IT skills required for each role was different, but consistently, greater skill in key areas leads to a higher level of performance. Consequently, there is a strong correlation between team performance with the percentage of the team that is certified. In fact, normalizing performance of almost 400 teams across all cloud related functions, we found that teams performing over the 75th percentile typically had more than 85% of the team certified in a relevant domain. Cloud teams that performed in the bottom quartile typically had 30% or less of the team certified.



2.2.3 New Hire Productivity

Beyond the impact of certification on IT staff performance and IT operations, organisations consistently describe how hiring applicants with certification can result in cost reductions, staff time savings, and higher productivity. (*The Business Value of IT Certification, #US40548315, November 2015*) Benefits include:

- **Higher productivity.** New hires with certification reach full productivity levels substantially faster – a full month earlier - than non-certified hires. According to the IT manager at a transportation company: *"Certification improves productivity right out of the chute. It also, I think, strengthen their commitment to the job."*
- **Longer average tenure.** While several organisations noted that certified staff members are attractive potential hires for other organisations, they reported that the average tenure for certified staff members is about 15% longer. As the IT manager at a multi-national company explained: *"I believe that employees with certification generally stay longer. They perform better, have more subject matter expertise, and are more satisfied employees."*

2.2.4 Employee Advancement

In addition to the ways employers derive value from having certified IT staff members, certification can benefit individual employees both financially and in terms of career prospects *(The Business Value of IT Certification, #US40548315, November 2015)*, including:

- **More responsibility.** Organisations consistently report that certified IT staff members are given more responsibility than non-certified staff members, and are more often given responsibility for managing and supervising non-certified staff members
- **More opportunities for advancement.** These additional responsibilities create more opportunities for advancement within organisations. In addition, IT managers generally express a sense that earning certification reflects an employee's interest in career advancement. An IT manager at a hospital said: "*Certification is a motivation tool to build confidence and competence. Staff knows it is required for advancement, including pay increase or title increase."*
- **Higher salary.** Perhaps the most fundamental benefit for employees of certification is that they earn more; organisations reported that certified staff members earn up to 15% more on average than staff without certification. Higher salaries reflect their skills and knowledge, increased likelihood of taking on supervisory responsibilities.
- **Professional influence.** Career advancement is often based on professional influence, and professional influence is strongly related to competence and performance.

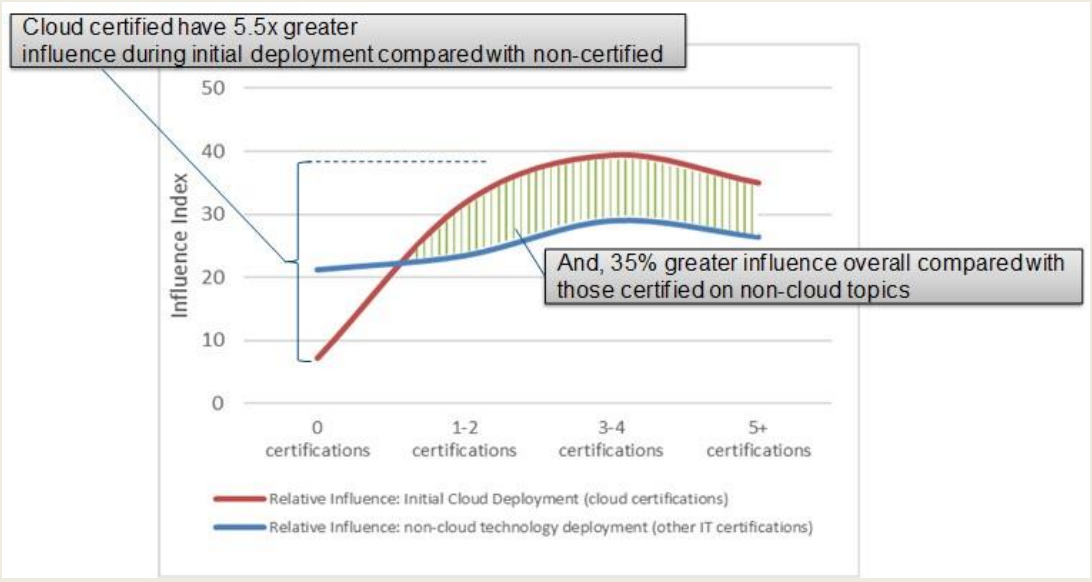
Illustration: The Importance of Certification to Professional Influence: Cloud-Related Roles

(Source: Cloud Skills and Organisational Influence: How Cloud Skills Are Accelerating the Careers of IT Professionals, May 2017, IDC #US42515917)

With the rapid adoption of cloud, and the scarcity of talent, enterprises in all industries are leveraging training and certifications to help their IT professionals develop the skills they need. But being certified also helps the professional's career. Competence, recognition and influence all contribute to the professional advancement of IT professionals, As IT professionals increase in competence, their participation and influence in IT decisions, planning and even strategic direction all increase. Playing more important roles in increasingly important activities results in greater professional relevance and influence.

Because certified IT professionals are more proficient, and have a greater competence, it follows that certified IT professionals have a professional advantage over their non-certified colleagues. IT professionals with at least one cloud-related certification are far more "relevant" to cloud initiatives than IT professionals with no certifications or who are certified in non-cloud topics. Comparing how often IT professionals participated in cloud-related projects and what role(s) they played shows that for projects described as "initial deployment" of cloud services, IT professionals with cloud related certifications have up to 5.5 times more influence than IT professionals who were not certified, and had about 35% more influence than IT professionals who are certified in non-cloud topics.

As IT organisations leverage cloud technologies more broadly and continue to expect a wide range of benefits from adopting cloud, the need for defined, relevant skills in IT professionals will continue to increase.



2.2.5 Easier Identification of Qualified Candidates

When enterprises of any size are looking for IT talent, certifications can help speed identification and increase confidence in selection of qualified candidates. According to the technology industry association CompTIA[22], while quality of experience and experience in specific areas often matters more, 86% of IT hiring managers place a medium or high value on IT certification when selecting a candidate.

Other research by CompTIA illustrates how widely IT certifications are used to help organisations screen candidates of IT positions. CompTIA found that[23]:

- 72% of employers require successful candidates hold IT certifications for certain job openings.
- 60% of employers have used IT certifications to confirm subject matter expertise of candidates

HR organisations that leverage relevant IT certifications as an initial screening criteria show benefits, too. In fact, research[24] shows that organisations that leverage IT certifications during the hiring process, have a:

- **Reduced cost of hiring.** Organisations consistently report that each new hire incurs substantial costs in terms of hard costs (advertising, recruiters, etc.) and employee time (HR, Line of Business) and that IT certifications that align with job roles helps more quickly identify potential candidates. According to CompTIA, 92% of organisations think IT certifications save time and resources when evaluating a potential IT candidate.
- **Reduced time to hire.** Some organisations report that they can make certified hires faster. The IT Director at a software company explained: *"Hiring is faster because the screening process is simplified with certification as a criterion, and the weeding out of candidates happens more quickly."* Intuitively, that makes sense: reducing effort and cost would also reduce the time to hire. However, generally, opinions are mixed about whether it takes less time to hire individuals who have relevant certifications. On average, they reported that making certified hires takes 8% longer. This may be due to more significant responsibilities associated with certified roles.

2.2.6 Demonstrate/Validate Capabilities of Consultants/SMEs and Other Vendors' Staff

Regardless of size, enterprise customers of technology vendors believe certified consultants, partners and vendor employees help the enterprise get the most value from their purchases. And the technology vendor and the partner organisations benefit, too. In a survey of 200 enterprise IT and line of business managers, respondents consistently agreed that certified consultants provided better service and solutions than non-certified consultants. (*Source: For High-end Consultants – Certified Knowledge and Skills Matter, IDC#: US42491017, April 2017).*

Most organisations also believe certified consultants increase the value of a technology being deployed and certified consultants are more likely to produce an effective solution design. Ultimately, enterprises IT and business leaders consistently believe that certified consultants increase likelihood a project will meet its business objectives. For instance,

- 55% said certifications increase the credibility of technology consultants.
- 50% said certifications improve implementation of technology.

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22 Source: Employer Perceptions of IT Education and Certification, CompTIA, January 2011

23 Source: CompTIA HR Perception of IT Training and Certification Study: 2015

24 Source: The Business Value of IT Certification, IDC#US40548315, November 2015

- 52% said certifications validate product knowledge of technology consultants

IDC has found that well-trained IT services consultants and system engineers are better able to sell and implement their vendor partners' solutions. Some partners are responsible for understanding client requirements and effectively positioning a range of technologies to address client needs. Technology firms provide a wide range of training and in some cases certification for these pre-sales consultants to help convert business opportunities to sales. And certification of these partners can have a significant impact. When performed by certified partners:

- Proof-of-concept (POC) demonstrations result in customer purchases 15% more often
- Client requirements are solved with partner technologies 15% more often
- Sales meetings with the client result in sales for partner 10% more often

Other partners are responsible for designing and implementing technology solutions with equipment or software provided by the technology vendor. Training and certification are expected to improve the business value of the resulting system and begins with efficiently implementing new technologies. When performed by certified partners:

- System migrations meet testing specifications at "go live" 20% more often
- Deployed technologies are correctly implemented the first time 10% more often
- On the other hand, the consequences of failing to train partner consultants sufficiently can be severe:
- Consultants who are unprepared for their responsibilities are more likely to change jobs and more likely to leave the profession, increasing cost of sale and decreasing project success.
- The clients of less-prepared consultants are less likely to request additional work, and are significantly less likely to refer prospects or offer recommendations when asked.

All this leads to a significant impact on the business success of the client, and the current and future growth for the partner and the technology vendor[25].

2.2.7 Conclusion: Certifications Matter

The value propositions for leveraging IT certifications seems clear to each stakeholder:

- **Individual:** IT certifications improve on the job performance, career success and advancement, and salary potential. Individuals in IT or who intend to make IT a career choice should identify and actively consider if certifications would support their career aspirations.
- **Enterprise:** IT certifications improve organisational IT performance, IT hiring costs and increase in quality hires. If high quality certifications are available for the significant components of the infrastructure, enterprises of all sizes and in any industry should consider the potential impact of more thoroughly integrating IT certifications into the career development program and new hire selection criteria.
- **Technology vendors & consultants:** Successful client projects, increased quality engagements and increased revenue. While the evidence is less clear, technology vendors that support greater knowledge on the part of their partner consultants are likely to be rewarded with more satisfied clients, and more successful implementations of their technologies.

[25] Source: Impact of Juniper Training and Certification on Professional Network Services Consultants and Presales Network System Engineers, March 2014, IDC #247572.

PART B. How organisations use and value IT organisational and management frameworks, and the possible conjunction with IT professionalism building blocks based on the e-Competence Framework.

3 State-of-play on IT organisational and management frameworks

The skills required to benefit from the advantages modern technology offers are changing. Part of the solution is to understand what kind of skills are required to enable digital capabilities and how to facilitate this process.

The objective of this initiative[26] is 'to provide a key contribution to the development and the promotion of digital organisational frameworks and IT professionalism in support of the digital transformation of enterprises in Europe' and to 'investigate how enterprises, especially SMEs, could benefit from a coordinated approach for the effective adoption of digital organisational frameworks and IT professionalism to help them take advantage of the opportunities offered by digital technologies'. 'The digital transformation of enterprises is enabled by IT competences and professionalism at individual level and digital organisational capabilities at enterprise level. They are mutually reinforcing. There is a need to increase the competences of individuals in tandem with the collective organisational capabilities of the enterprise'.

The previous chapters illustrated important 'digital transformation' trends. This chapter will deepen the insights as regards what IT organisational and management frameworks are, their value for organisations (especially in processes of digital transformation), and how these frameworks[27] can be used to further build capabilities and competences. The next chapter will then propose an outline for a reference framework that connects capabilities, frameworks and (e-CF) competences.

3.1 Definition and purpose of IT organisational and management frameworks

This chapter sets out to investigate how businesses could benefit from a coordinated approach for the effective adoption of IT organisational and management frameworks and IT professionalism to help them take advantage of the opportunities offered by digital technologies.

What is exactly meant by 'IT organisational and management frameworks'? In essence, these frameworks represent an established norm and are a repository of specifications, procedures, guidelines in a certain domain. They are designed to ensure processes, methods, services and systems are safe, reliable and consistent. Frameworks provide a uniform language. They are based on industrial, scientific and consumer experience and are regularly reviewed to ensure they keep pace with new technologies. With 'IT organisational and management frameworks' we also include IT standards.

As Van Haren[28] puts it: 'The use of standards and frameworks gives everyone the same language thus minimalizing the chance of errors due to unclear communication. Best Practices regarding these standards and frameworks provide you with information summarizing years of experience by the best in the industry'.

Key characteristics of frameworks are:

- Servicing multiple areas of expertise

[26] Source: specifications request for services. Available online: https://etendering.ted.europa.eu/cft/cft-display.html?cftId=1596

[27] With 'frameworks' we refer to IT organisational and management frameworks, including IT standards or proven methods/practices. Since a framework is defined as 'a basic structure underlying a system, concept, or text' we feel this is the most appropriate abbreviation.

[28] Van Haren Publishers, Global Standards and Publications, edition 2016/2017.

- Based on knowledge items, capabilities, competences
- Proficiency levels describing foundational to advanced levels, usually related to certification tracks
- Relationship with other frameworks
- Identifiable target group for use
- Value in the market

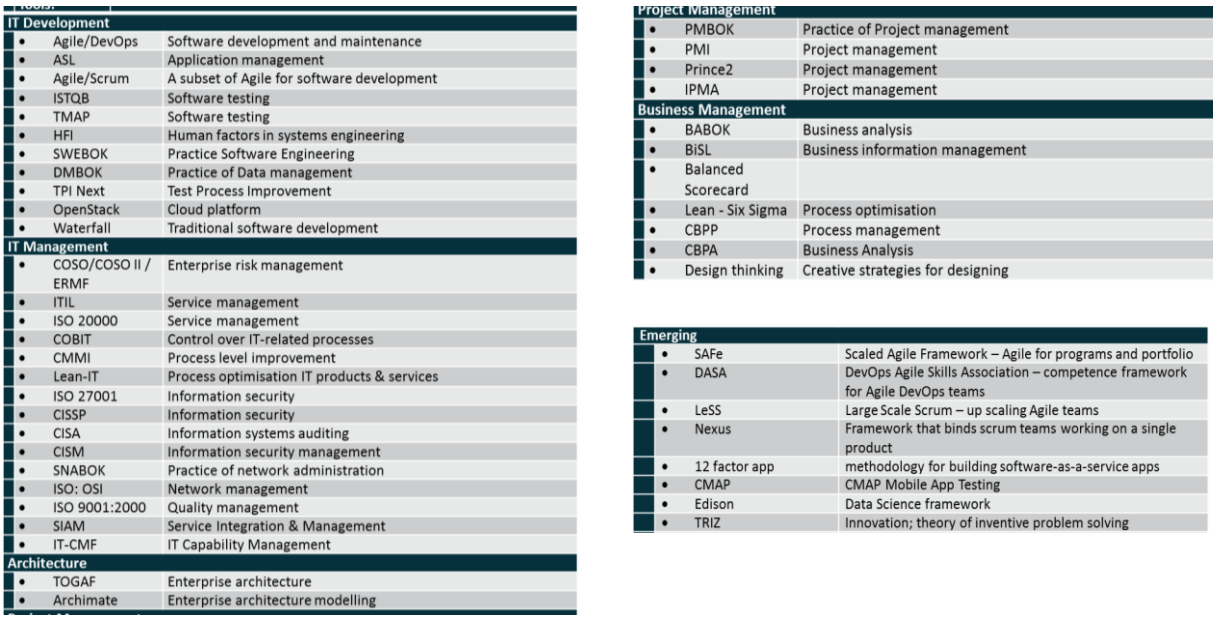
Different roles/functions and organisations benefit from these frameworks:

- Education providers can develop training courses based on frameworks
- HR can design career paths
- HR can setup job profiles
- User groups can structure their profession and advance their individual careers
- Certifying bodies can develop certification based frameworks
- Enterprise Architects can select standards for their organisation
- Product/Service development between organisations (industry accepted)

3.2 An inventory of IT organisational and management frameworks

With the purpose of selecting which 10 frameworks are most relevant for organisations, and to produce an in-depth analysis of these frameworks, the first step was to collect a longlist of frameworks. The list was constructed following desk research on existing publications, consultation of IT professionals in various areas of expertise, and finalised after the interviews with experts. The list includes recognised frameworks as well as emerging frameworks. Please revert to Annex A for an overview and short descriptions.

Figure 3-1 Longlist of IT organisational and management frameworks



IT Development	
Agile/DevOps	Software development and maintenance
ASL	Application management
Agile/Scrum	A subset of Agile for software development
ISTQB	Software testing
TMAP	Software testing
HFI	Human factors in systems engineering
SWEBOK	Practice Software Engineering
DMBOK	Practice of Data management
TPI Next	Test Process Improvement
OpenStack	Cloud platform
Waterfall	Traditional software development
IT Management	
COSO/COSO II / ERMF	Enterprise risk management
ITIL	Service management
ISO 20000	Service management
COBIT	Control over IT-related processes
CMMI	Process level improvement
Lean-IT	Process optimisation IT products & services
ISO 27001	Information security
CISSP	Information security
CISA	Information systems auditing
CISM	Information security management
SNABOK	Practice of network administration
ISO: OSI	Network management
ISO 9001:2000	Quality management
SIAM	Service Integration & Management
IT-CMF	IT Capability Management
Architecture	
TOGAF	Enterprise architecture
Archimate	Enterprise architecture modelling

Project Management	
PMBOK	Practice of Project management
PMI	Project management
Prince2	Project management
IPMA	Project management
Business Management	
BABOK	Business analysis
BiSL	Business information management
Balanced Scorecard	
Lean - Six Sigma	Process optimisation
CBPP	Process management
CBPA	Business Analysis
Design thinking	Creative strategies for designing

Emerging	
SAFe	Scaled Agile Framework – Agile for programs and portfolio
DASA	DevOps Agile Skills Association – competence framework for Agile DevOps teams
LeSS	Large Scale Scrum – up scaling Agile teams
Nexus	Framework that binds scrum teams working on a single product
12 factor app	methodology for building software-as-a-service apps
CMAP	CMAP Mobile App Testing
Edison	Data Science framework
TRIZ	Innovation; theory of inventive problem solving

3.3 Key perceptions on IT organisational and management frameworks

The research included two main sources for capturing key perceptions on added-value and use of these frameworks:

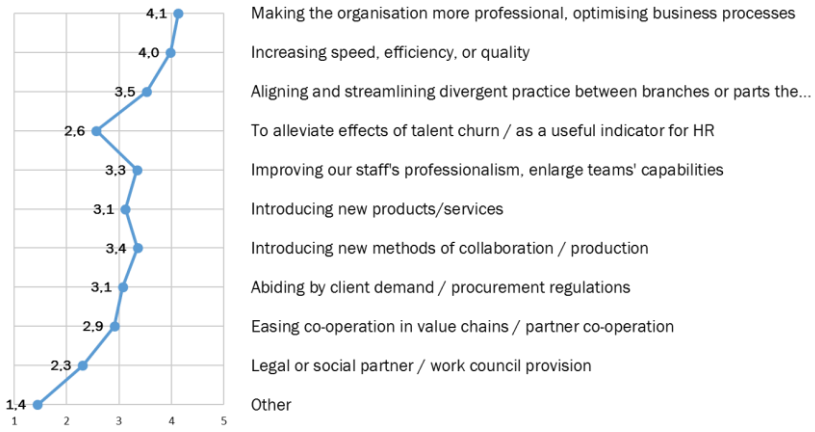
- A series of in-depth interviews with experts from industry, certification organisations, education;
- An online survey targeting stakeholders across Europe – mainly leadership who are in a position to value these frameworks and provide insight into key considerations for selecting;

3.3.1 Value of frameworks

Let's first observe why organisations implement frameworks. There are three main objectives:

- Making the organisation more professional and optimising processes;
- Improving output of the organisational processes;
- Valuable for (internal and external) collaboration, as they define the space of appropriate and expectable action;

Figure 3-2 Reasons to implement frameworks (5=very important)



When implementing such frameworks, experts indicate that it is most important that implementation is accompanied by training of key staff, using various forms of training, and that communities play an important role too.

3.3.2 Perceptions on using frameworks

Over the years, numerous IT organisational and management frameworks have been developed in the world. There is a large number of existing IT organisational and management frameworks – even the longlist that is provided in section 4.1 is not exhaustive. Large enterprises have implemented various combinations of them and it is important to learn from their experiences.

From the interviews, workshops and survey the following insights appeared concerning use of these frameworks:

- **Existing frameworks are increasingly outdated and conflict with 'digital ways of working'**. With the latter, most respondents referred to agile ways of working that contrast with the traditional waterfall approach that is still characteristic for many of the traditional frameworks. For instance, Prince2 and Scrum do not really complement each other. Some respondents indicated they are making their own

work-arounds to make these frameworks better match the daily practice. This illustrates a dilemma between a robust framework on the one hand, and the need to explore new digital ways of working on the other hand. Technology moves fast and it is difficult for frameworks to keep up with required digital competences. Frameworks are sometimes too much focused on the technology, and business and organisational competences are missing. On the positive side, a trend amongst these frameworks seems to gain foothold to adapt to these new ways of working and many of the well-known frameworks are now offering 'agile- versions' (for instance IPMA Agile Leadership, Prince2 Agile etc.).

- **Organisations are missing commonly accepted frameworks that support new technologies** (e.g. cloud, mobile, Internet of Things, Big Data a.o.). Even though new frameworks are emerging, organisations are sometimes hesitant to be amongst the first to try them.
- **Some frameworks are conflicting**: this is especially the case in organisations that on the one hand maintain a traditional backbone and on the other hand encourage an innovative front-end. It can be difficult to develop the existing a traditional IT workforce with new 'digital' capabilities. Some organisations cannot yet build the business case to change, other are forced to turn around (see the good practice of VIVAT in textbox below). The sense of urgency depends on the market and competition. At least for those organisations that have not yet transformed, the governance remains a challenge. At the same time, it also occurs that frameworks that at first sight look challenging to work together, in practice actually come together fine (see also the VIVAT case).
- **Selection of frameworks is often based on personal preferences and is commercially driven** (especially if e.g. a market is only accessible for a company if it can proof a certain ISO certification of their products). Sometimes organisations do not use frameworks, especially SME's that only focus on their core and outsource other activities. Certification increased market value and this is often a driver.
- **SME's have different needs**. First, there is a distinction between product and serviced selling SME's. Product-based increases the urgency to acquire certification of the organisation itself, whereas service-based SME's will more focus on certification of employees. The latter comes at a risk SME's indicate, because they fear that investing in their employees increases the chance these employees job-hop to another company. Second, SME's seem to be careful in deciding what to do in-house and what to outsource. Third, certain frameworks can be too complex to use for SME's and business competences are preferred as they seem to have more impact on sales/revenue. From this it becomes at least apparent that a transparent overview of existing frameworks and what capabilities they contribute to, could help organisations to determine relevant competences when recruiting professionals.
- Existing frameworks move towards more granular structure & badging. This builds on the trend that traditional frameworks are increasingly offering agile-versions of their programmes. Whereas professional certification programs often follow a quite long path to obtain a certification, users are now demanding to be recognised not only at the end of the programme but also intermediary. A more granular structure, and badging as a way to express and share that recognition in (online) communities. This is what is motivating users to follow such programmes. It also becomes clear there is an increasing need for short learning programs that recognise skills of the professional (e.g. informal training, MOOC's etc.).

These findings feed into requirements or design principles for the '**digital capability reference framework'.** The implications are further described in section 3.3.5. after which this chapter continues with describing how the most relevant and popular frameworks were selected, and the potential benefits of using these frameworks in conjunction with the e-CF.

Case Study VIVAT: implementing e-CF together with IT organisational and management frameworks

VIVAT is an insurance company in the Netherlands. The process of digital transformation at VIVAT illustrates the added value of using a uniform language when it comes to competences. A very urgent shift in business model forced VIVAT to re-think their approach towards high-performing teams. Building from their view on the IT specialists for the future, they started to design the organisation and describe jobs for the next level of Agile maturity. This implied a shift from segregated teams to high performing teams.

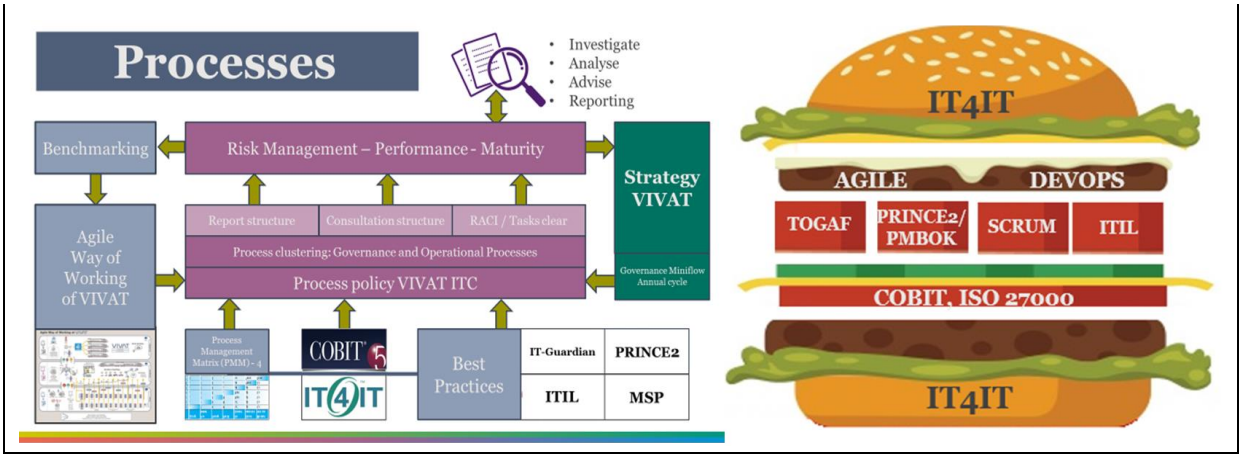
Building digital capabilities around customer experience and insight was one of the priorities. The motives of consumers taking insurances is more and more one of convenience and added value. Convenience means the ease of doing research and making purchases, avoiding problems, and services like claims handling. Added value refers to a balance between price, product and service. Digital journeys were made to understand the customer life events and to retain customers. The ultimate goal of VIVAT is offering customer centric solutions by high performing teams using advanced automation at flexible and secure platforms.

This meant that the employees of the VIVAT IT & Change organisation had to work in teams, using new technologies and frameworks like Agile and DevOps. A new organisation was designed, and new job roles were introduced which had to match with some traditional job roles. In these teams, employees need to be 'T-shaped professionals'. The new job descriptions and classifications are based on the e-CF, and all job descriptions together cover all competences in the e-CF. This works perfectly fine, also in an Agile/DevOps context. Some new job roles, like DevOps Engineer, are also based on the e-CF competences. These profiles then made it possible to select employees, to identify the skills and competences needed for digital transformation and to focus on the most suitable qualifications/certifications to further grow their professionals. In the words of Ms. de Groot-Grosman: '***e-CF helps you to understand what you do, why and how you need to do it'***. VIVAT also indicated that on top of the e-CF profiles it is necessary to add certain competences around agility for instance, and to combine with business knowledge and soft skills to complete the profiles.

Another interesting point is that VIVAT works together with start-ups, and through this collaboration also the ecosystem of VIVAT is introduced with the e-CF standard.

Key challenge in the transformation process is to monitor progress – outcomes rather than outputs. This is also important as they consider 'change' as a constant; it is continuous, ongoing and organisations need to be prepared for that. In this context, VIVAT also underlined the absolute need to increase supply of T-shaped IT professionals.

To support the digital transformation VIVAT chose for specific frameworks like IT4IT as the foundation of managing the digital enterprise. Agile and DevOps for self-managing and controlling teams. Prince2 Agile for project management. Agile and Scrum for developing new apps. Some traditional frameworks are also still used like TOGAF and ITIL. This is visualised below.



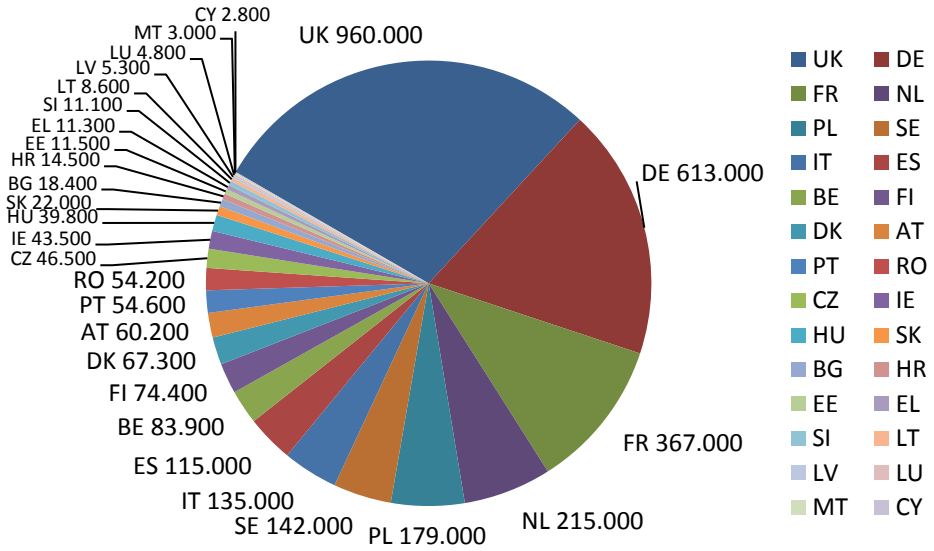
3.3.3 The importance of software creation for European competitiveness

Software and applications developers and analysts

Between 2011 and 2016, the number of new jobs created (net) in software related professional jobs[29] amounted to 747,500 in Europe. This was an increase by 29% in five years, or 5.2% CAGR.

In total, there were 3.4 million Software and applications developers and analysts in 2016, with the UK being the most important market (960,000 professionals).

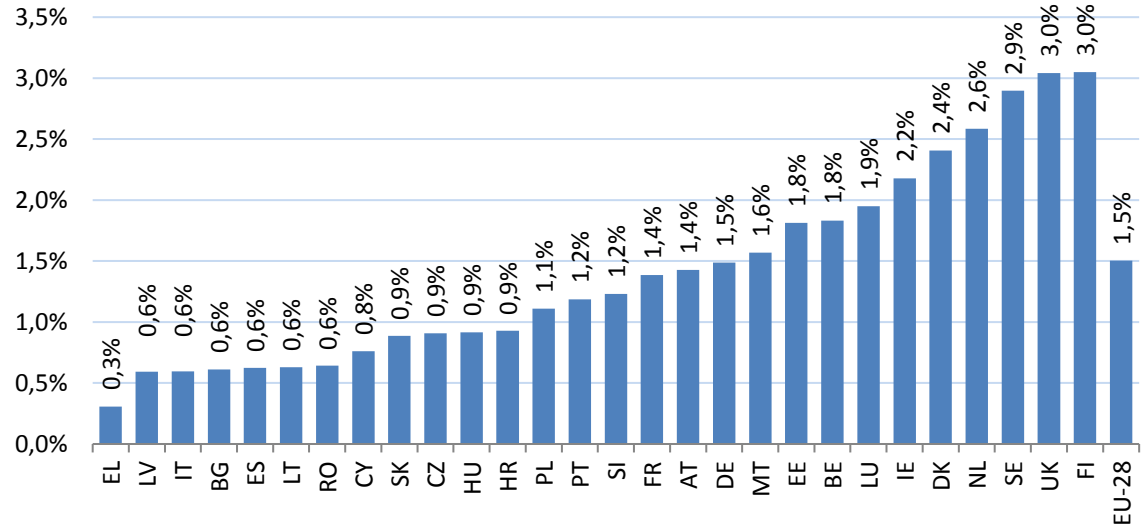
Figure 3-3 Number of software and applications developers and analysts (ISCO-08 minor group 251) in the EU in 2016



Countries with the largest relative share of software professionals are the three Nordic countries, the UK, Netherlands and Ireland.

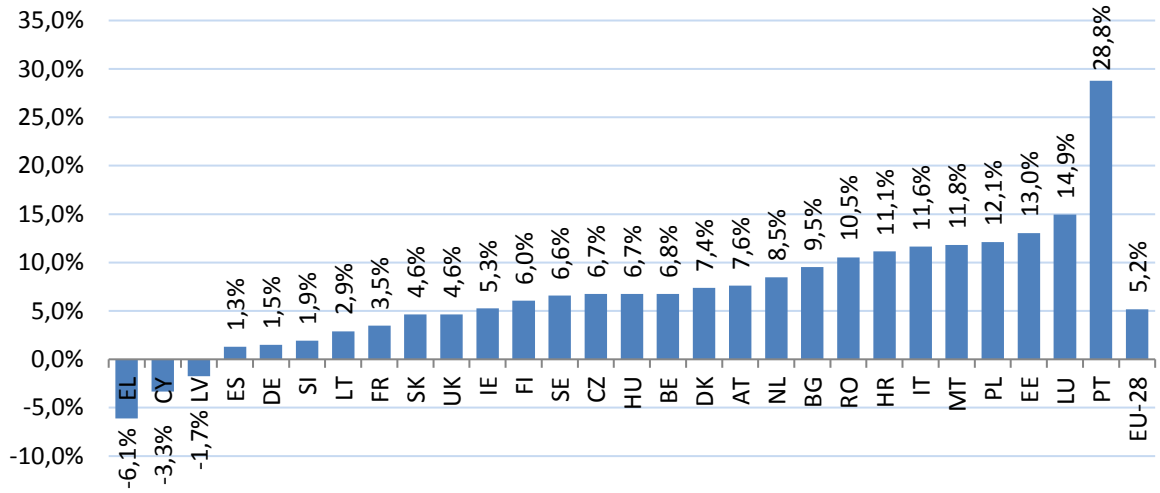
[29] Containing the following job categories (ISCO-08 code): Systems analysts (2511); Software developers (2512); Web and multimedia developers (2513); Applications programmers (2514) and Software and applications developers and analysts n.e.c. (2519).

Figure 3-4 Share of software and applications developers and analysts (ISCO-08 minor group 251) in total workforce, EU in 2016



The most dynamic countries in terms of relative growth are Portugal, Luxemburg and Estonia.

Figure 3-5 Annual growth (CAGR) in the number of software and applications developers and analysts (ISCO-08 minor group 251) in the EU-28 between 2011 and 2016



From the data collection, it also becomes apparent that software development and engineering is one of the most important capabilities for organisations at the moment. Software creation is important for European industry to remain competitive, a strategic weapon in the words of Mika Helenius[30]. and it appears as if Europe is failing in gaining true digital competitiveness in the Information Age. Policy makers should address this better, and take action as the shortage of professionals skilled in software design and engineering is huge, and growing. If Europe wants to succeed, there is a need to change over from the 'use' of software and services to software 'creation' to become really innovative, globally competitive and successful in the market today and in the future. This would imply a radical change in our way of thinking and approaching software creation as an industry. On top of skilled IT-professionals and e-Leaders, Europe needs **creators** to realise software as a profit platform. It also calls upon structural innovations in higher and executive education and training landscape to support actual innovation. In the views of experts, Europe should work towards 'software universities' and foster programmes for research, education and training in software-based innovation. One excellent example

[30] Based on presentation given by Mika Helenius, the general secretary and chief executive of TIVIA Finland (est. 1953), Infuture think tank, and Computer Science Foundation since 2016.

of such innovation in education is for instance the Hasso-Plattner Institute (HPI) in Potsdam, as further illustrated in the text box below.

Innovation in software education: the approach and success of the Hasso-Plattner Institute (HPI) in Potsdam[31].

The HPI brings structural academic innovation through its Digital Engineering Faculty. It saw the shortcomings in university-level computer science programs, especially as regards the lack of engineering education and spirit and missing industry cooperation in teaching.

The success is based on HPI's approach to user-centric education: a great focus on people and development of their skills. This concerns soft skills such as communication skills and teamwork, as well as design thinking and entrepreneurship.

Besides the people aspect, HPI focusses on solutions by including large proportion of software engineering qualifications in the mandatory curriculum, and via a hands-on approach where students get ample opportunity to apply knowledge in practice (and thus build competences rather than knowledge alone). Students are prepared for Agile and DevOps environments, quite in line with current market demands.

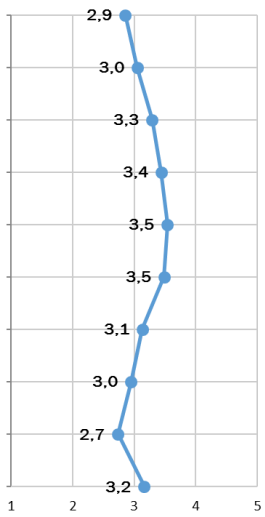
Via their successful collaboration with SAP in openHPI platform, the HPI also reaches many IT professionals around the world. Via this modern form of digital education, organisations have the opportunity to develop their staff in the context of their digital transformation.

3.3.4 The importance and the value of related certifications

Following the section 2.2 on the importance of certifications, this paragraph shortly lists the benefits that respondents in the survey indicated to most important. This is visualised in the figure below. It also comes with the remark that we observe different responses depending on whether the organisation is large or smaller, and is sometimes conflicting with the perception of the professional. As one respondent from an SME indicated: '*Investing in certification is a risk in terms of retention. We rather facilitate online learning*'. This can obviously conflict with the opinion of the professional him/herself, who has interest in life-long learning and continuous development in order to bring value to the organisation and develop a career.

[31] With generous input as provided by Mr Christian Willems, research assistant at the Chair of Internet Technologies and Systems at HPI.

Figure 3-6 The importance of benefits of individual/employee certification



Increase the authority and image of the organisation vis-a-vis clients and partners

Proof of skills in selecting professionals for projects

Proof of skills in recruiting professionals

Proof of skills in selecting contractors

Important for employee career development on the job / advancing their career

Encourage life long learning

Giving staff the opportunity to showcase achievement

Comply with staff request

Project contractual / procurement requirements

Especially important for companies providing services rather than products

In terms of next steps, there will be a concise survey amongst certification providers in order to collect data on issued certifications and hence the corresponding frameworks. The ambition is to also understand differences between Europe and other regions in the world.

3.3.5 Implications of state-of-play data collection for design of a digital capability reference framework

From the data collection activities, the following implications and requirements are derived for the **digital capability reference framework**:

- Establish a link from the frameworks to IT professionalism Framework by e.g. mapping competences of these frameworks to e-CF competences, and categorising frameworks to the knowledge areas of the EU-BOK.
- Include both reference to commonly accepted frameworks as well as emerging frameworks.
- Distinguish between frameworks that are relevant for the professional and those that target the organisation as a whole.
- Show the relationship between the various frameworks and show the different paths of their lifecycle.
- Illustrate how frameworks correspond to professional role profiles.

Besides the 'technical' requirements, there is also a governance element of course. It also becomes apparent that with a rapidly changing IT domain, the content of existing frameworks will continuously develop, and there will be new frameworks entering the market (and possibly others will be in decline). This brings the challenge of keeping a **digital capability reference framework** up to date over time. It will require it to be adopted by a technical committee or community of stakeholders that can keep it up to date.

The following paragraphs will elaborate on the requirements listed above. First, by in-depth analysing the most relevant frameworks, and second, by analysing the benefit of using frameworks in conjunction with the e-CF.

3.4 An in-depth review of the most relevant and popular frameworks

3.4.1 Selection of most relevant frameworks

The selection of 'ten most relevant' frameworks was done taking into account the following criteria:

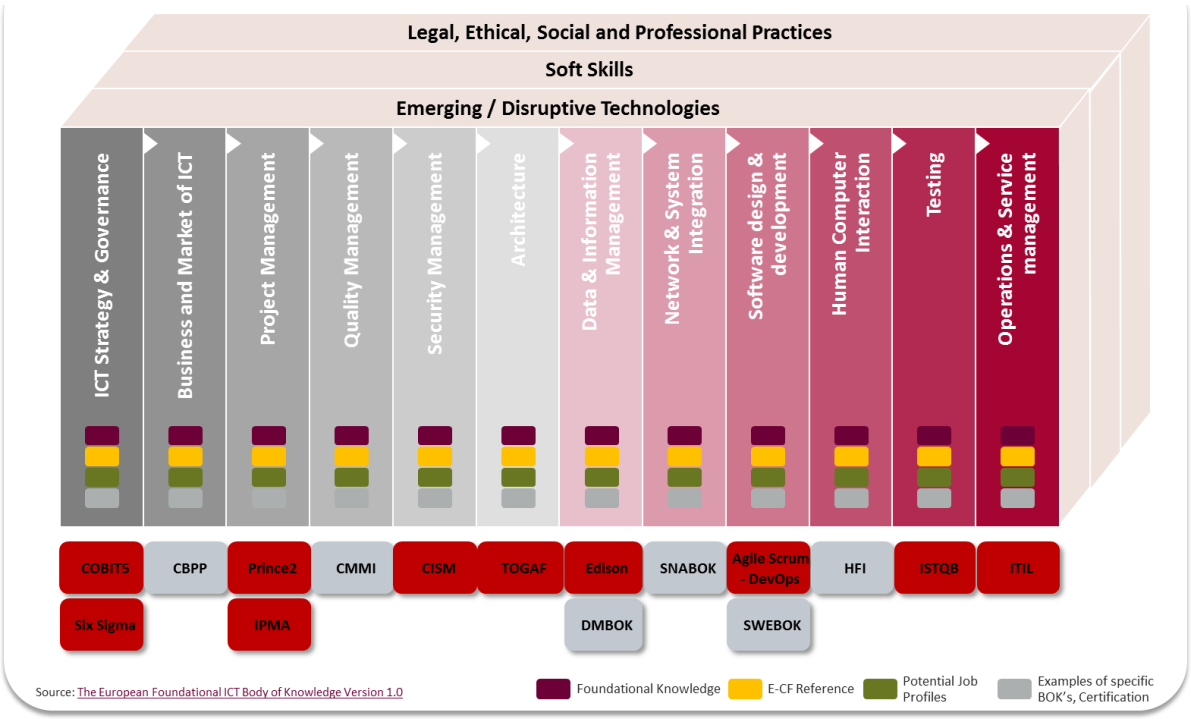
- **Popularity (use).** This criterion refers to the volume of professionals applying a framework in practice and/or following courses to advance skills. Data for this criterion builds on the evidence from expert interviews and survey (where respondents were asked to mark the frameworks they use), as well as on numbers on training courses followed at the Capgemini Academy by a variety of private and public organisations.
- **Impact on digital transformation**. 'Most relevant' is not always the same as 'most popular'. There are many more project managers in IT applying PRINCE2 than there are service managers using COBIT. However, the impact of COBIT on digital transformation of an organisation is likely higher than project managers using PRINCE2 principles. It is hence important to take into account impact on digital transformation of an organisation. COBIT is an IT governance framework and supporting toolset that allows managers to bridge the gap between control requirements, technical issues and business risks. COBIT emphasizes regulatory compliance, helps organisations to increase the value attained from IT, enables alignment and simplifies implementation of the enterprises' IT governance and control framework. As governance of IT one of the major topics at the moment, it should therefore be part of the assessment. In similar fashion security frameworks are important.
- **Balanced representation of the core of the IT profession**. Frameworks cover a variety of business areas / areas of expertise. A top-10 should consist of a balanced representation of these business processes and related knowledge areas – that compose the core of the IT profession - to avoid tunnel vision. For this criterion, the knowledge areas of the European Foundational IT Body of Knowledge[32] and the business process of the e-CF serve as structure. An IT professional is working in a specific area of expertise. These areas of expertise are characterized to have a specific skill set (IT, personal and business competences) and standards (frameworks). The areas of expertise can be linked to the European IT professional profiles (CWA 16458:20112).
- **Balancing established and emerging frameworks.** This criterion was added to ensure that the list of most relevant frameworks also includes frameworks that might not be very well-known at the moment, but seem to be upcoming in terms of popularity (use) and proven impact. Good practices as well as expert views (e.g. trainers and experienced IT professionals) served to provide input on this point.

Of course, such a selection is always a bit arbitrary but the data collection and the iterations with experts during the workshops provides a solid analysis.

Following the criterion to adhere to the knowledge areas of the first version of the European Foundational IT Body of Knowledge (EU BoK), it was decided that it is needed to increase the number of frameworks to be selected. In order to cover all the domains of the EU BoK, six more frameworks were added to the list. The figure below illustrates how each of these sixteen frameworks relate to the knowledge areas of the EU BoK. The frameworks in grey colour are the six that were added.

[32] Online available: http://ictprofessionalism.eu/wp-content/uploads/EU-Foundational-ICT-Body-of-Knowledge_Brochure_final.pdf

Figure 3-7 Mapping of frameworks to the knowledge areas of the European Foundational IT Body of Knowledge (EU BoK)[33]



3.4.2 In-depth analysis

The table below lists the frameworks that were selected for in-depth analysis. Each of these is described in the Annex B in terms of their main characteristics: origin, specialty, focus areas and structure, taxonomies, governance, intellectual property rights, terms and conditions of usage, utility, maintenance, popularity.

Figure 3-8 Overview of frameworks selected for in-depth analysis

Most relevant individual IT organisational and management frameworks

IT Development:
- Agile/DevOps (DASA)
- Agile/Scrum
- Waterfall
- ISTQB

IT Management:
- ITIL
- Security Frameworks (CISM a.o.)
- COBIT

Architecture:
- Togaf 9

Project management:
- Prince2
- IPMA

Business management:
- Six Sigma/ Lean IT

Most promising – emerging frameworks
- SAFe
- Edison Data Science Framework

Frameworks added to cover each domain EU ICT Body of Knowledge
- CMMI
- SNABOK
- HFI
- SWEBOK
- DMBOK
- CBPP

Short descriptions

The objective of these frameworks is to provide a structure for organising professional processes, a common language, a blue print, a reference model or a way of working. In more detail:

[33] The mapping of frameworks to one knowledge area does not mean they are only relevant for that area. On the contrary, many of them are relevant for multiple areas. The mapping represents most common application.

- DevOps Agile Skills Association (DASA) is an open global community for DevOps and Agile Skills development. It is organized as a community-driven organisation open for participating member organisations to help define role-based competencies and learning curricula. DASA aims to a.o. promote a knowledge and skills framework for DevOps, based on a defined set of principles, and develop and evangelize a vendor neutral DevOps qualification program for professionals
- With four certification levels, Scrum organizes the product development team into specific roles, allowing organisations to meet complex requirements and aggressive deadlines. Product owner, the developer team and the scrum master work together under the Scrum software development process to achieve continuous product improvement.
- ISTQB offers a higher level of reliability of the applications being developed due to efficient and cost effective testing practices derived from the ISTQB competencies ISTQB offers a higher level of reliability of the applications being developed due to efficient and cost effective testing practices derived from the ISTQB competencies. ISTQB emphasis on static and dynamic testing techniques in their certification to ensure the desired output in quality assurance.
- ITIL offers five certification levels while specializing on service strategy, service design, service transition, service operation, and continual service improvement. ITIL Service Management supports business transformation through the use of the 5 stage Service Lifecycle, where each stage is dependent on processes and the other lifecycle stages. With a comprehensive, consistent and coherent set of best practices focused on the management of IT service processes, ITIL provides means for managing the IT projects.
- CISM certification enhances the capabilities of information security managers by providing with the knowledge of risk, governance, incident response and the IS program. CISM demonstrates a deep understanding of the relationship between information security programs and broader business goals and objectives.
- ISACA's COBIT5 offers five certification levels to improve performance with a balanced framework for IT governance, risk management, security and auditing. The COBIT 5 process reference model defines and describes in detail the governance and management processes within an enterprise relating to IT activities
- With two certification levels, TOGAF provides an approach for designing, planning, implementing, and governing an enterprise information technology architecture. TOGAF Architecture Development Method (ADM) describes a way of developing and managing the lifecycle of an enterprise architecture and forms the core of TOGAF.
- PRINCE 2, a project management methodology, offers four levels of certification to cover planning, management, control and organisation of a project. PRINCE2 is a process-based approach for project management where each process is defined with its key inputs and outputs together with the specific objectives
- With PMBOK guide and 8 certifications, PMI offers a collection of knowledge areas and processes, accepted as best practices for project management, to organisations. PMBOK Guide divides a project's lifecycle into 5 major process groups; with execution of each group along with the help of areas of knowledge and tools, desired output is achieved.
- With two widely accepted methodologies, DMAIC and DMADV, Six Sigma offers organisations to reduce defects. The Six Sigma DMAIC approach can be utilized for the customer experience transformation to cover the quality standards with the aim to achieve 99.9997% process efficiency.
- SAFe is an online freely revealed knowledge base of proven, integrated patterns for implementing Lean-Agile development. It provides comprehensive guidance for work at the Portfolio, Large Solution, Program, and Team Levels.
- The EDISON Data Science Framework (EDSF) is a comprehensive collection of interrelated documents that can be used by a range of stakeholders to construct their own structured solutions for educating, training,

certifying, recruiting, managing, and otherwise supporting data scientists and other data-dependent professionals. It has been developed to support, guide and ultimately accelerate the education process of Data Science Professionals.

- CMMI offers multiple models focusing on development, services, acquisition, people, and data management while it also comes in two flavours – staged and continuous. 5 CMMI maturity levels are a well-defined evolutionary plateau toward achieving a mature software process for continuous process improvement.
- SNABOK stands for a system and network administration body of knowledge. The focus is on making existing software plus hardware artefacts available for use to other users. This also involves the selection, configuration or composition, installation, the provision of instructions for appropriate use, and the operational integration of relevant artefacts given the tasks that a user or user group intends to perform.
- HFI designed projects ensure an unbroken golden thread, from executive intent, through digital strategy and innovation, to structural and detailed design and validation The HFI Framework is a complete User Centric Design process assembled from best practices for optimizing user experience. HFI customizes this process to fit the organisational needs.
- The SWEBOK guide defines 15 knowledge areas which are focused upon software requirement identification, validation & development throughout software life cycle. SWEBOK provides a characterization of the bounds of the software engineering discipline as well as a topical access to the body of knowledge supporting software engineering.
- DMBOK provides a definitive introduction to data management with presenting a standard industry view of data management functions, terminology and best practices. DMBOK defines standard terms and definitions for data management processes cited consistently with the help of 10 data management functions & 7 environmental elements.
- Certified Business Process Professional (CBPP) certification enables project management professionals with capabilities to ensure business process management.

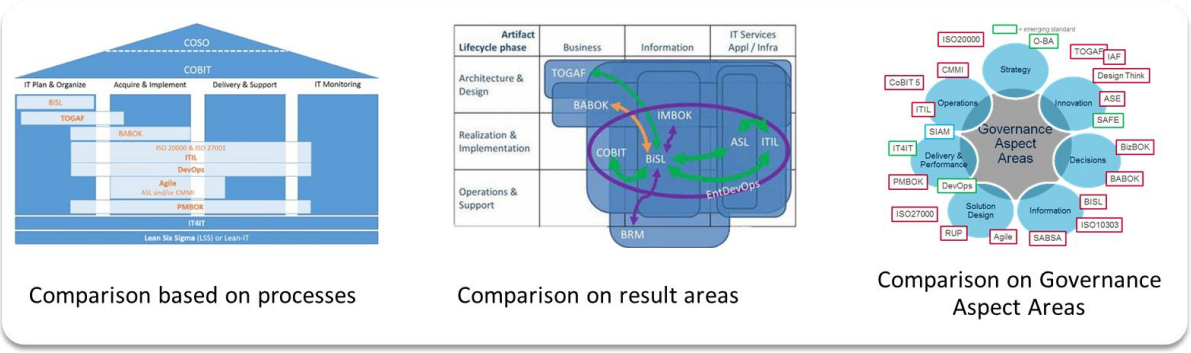
Categorisation

There are different ways of categorising these frameworks, as the below figure shows:

- Comparison based on **processes** follows the underlying COBIT structure. The purpose of this structure is an approach to communicate with business stakeholders so that they “get on-board” with their support.
- Comparison based on **result areas** is based on the strategic alignment model and was developed to discuss sourcing. It helps to determine what standards should be used by outsourcing and insourcing partners to talk the same ‘language’.
- Comparison on **governance** areas is made keeping up with the ebb and flow within the digital economy and involves multiple type of transformation activities. Successful transformation activities require rigorous governance activities. When a change is needed in a governance area, frameworks can help supporting the change.

There is not one best way, as it will depend on which frameworks are relevant for your organisation and what the objective of the categorisation is for your organisation. However, since the objective of this initiative is to better understand the benefits of using frameworks in conjunction with the e-CF, the following section will present a categorisation of frameworks based on the structure of the e-CF.

Figure 3-9 Various approaches of categorising IT organisational and management frameworks



Comparison based on processes

Comparison on result areas

Comparison on Governance Aspect Areas

3.4.3 The IT Capability Maturity Framework (IT-CMF)

The IT-CMF is developed by the Innovation Value Institute (IVI) and aims to align IT with business strategy. It is an IT Framework which allows organisations to baseline their current capabilities while enabling targeted improvement of capabilities in a systemic way. The IT-CMF enables decision-makers to identify and develop the IT capabilities they need in the organization to deliver agility, innovation and value for the organisation. IT-CMF is a high-level management framework covering IT Management, but not a process framework comparable to the long-list included in previous sections. It does cover breadth of IT from technical infrastructure to strategic management. In that sense, it is particularly useful to understand how IT-CMF works, and why it is successful, in order to derive lessons-learned that can be feed into the design of the digital capability reference framework in this initiative.

The IT-CMF is structured in:

- Four (4) macro-capabilities:
    - Managing IT like a business: adopting business practices to run the IT operation with the goal of maximising the overall business value that IT contributes to an organisation
    - Managing the IT budget: a proactive and explicit strategy for finding a sustainable economic model for IT products and services
    - Managing IT for business value: includes the knowledge, skills, tools, processes, abilities, and motivation available in the IT department to support or perform enterprise business activities
    - Managing the IT capability: an integrated process of selecting and implementing investments in IT that will likely bring the highest value to the organisation
- Thirty-five (35) IT management capabilities, or 'Critical capabilities': these represent the key activities and procedures that must be defined and controlled to enable an IT organisation to plan and deliver IT solutions, and to measure the business value outcomes of its initiatives and daily activities. These critical capabilities consist of integrated activities around behaviours, actions, methods and metrics that are essential tin the process of value creation.
- Three hundred and eight (308) capability building blocks and individual maturity profiles.

The value of the IT-CMF is that it enables organisations (it is targeted at CIO's and IT leadership) to benchmark their critical capabilities against a proven maturity model, and that outcomes of that assessment indicate what value can be realised when improving, with concrete practices, outcomes and metrics. It hence offers a roadmap to increase value. The maturity model underpinning the benchmark consists of five levels, from low to high maturity: initial, basic, intermediate, advanced, optimising – and is labelled for each of the four macro-capabilities.

The assessment done within IT-CMF enables CIO's to gain insight across the breadth of their IT organisation, to understand what is going well and also where gaps exist (possibly unknown issues too), and how the results compare to peers and similar organisations (included in a significant database) – with the ambition to develop a capability improvement plan.

The success of the IT-CMF provides valuable lessons-learned for the development of a digital capability reference framework:

- The framework allows to map from organisational point of view to individual point of view;
- The IT-CMF bring IT and business closer together. It creates a common language in an organisation, and offers clarity on how IT can support/enable key-priorities of the organisation;
- Part of the success is in that it stimulates discussion in the organisations about current state-of-play, and what is needed to move forward;
- Throughout the years, IT-CMF managed to build a solid base of data, research and practices – which offers unique insights for an organisation in relation to their market.

The digital capability reference framework, that is the ambition of this European Commission initiative, is of a different kind but, following the success of IT-CMF, should take into account the following design-principles:

- Transparency: offering clear overview to the user, for instance by mapping the huge variety of existing IT management and organisational frameworks to a structure such as the e-CF provides;
- Uniformity: a common language is essential for users, and could be the value-add of this framework when it maps descriptions of competences in the huge variety of existing IT management and organisational frameworks to the standard of e-CF;
- Connection: between organisation level and individual level, not just in mapping, but also because it will trigger discussion in the organisation on where it stands and needs to improve with regard to the process of transformation it is in;

Since the digital capability reference framework is a reference framework, it will not provide as much depth. It does primarily refer to the specific knowledge foundations, which are responsible for the various frameworks that can offer such depth.

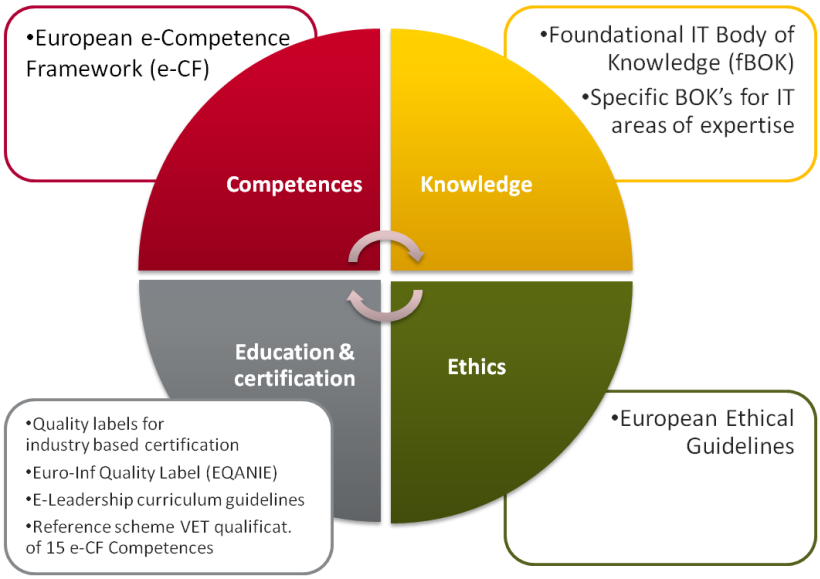
3.5 Potential benefits of using frameworks in conjunction with the e-CF

3.5.1 IT professionalism building blocks

While technology is changing our world, with these potential greater opportunities also comes a greater responsibility. The extent to which IT is embedded in our lives is inevitably growing. The physical and digital world are blurring, imposing challenges on us as regards personal privacy, data security and even our personal relationships. Failing to take steps to mature the IT profession, could cause risks to society from IT to grow to unacceptable levels. Trust is the key word here. We must continue to nurture trust in IT professionals. Continuous development of knowledge, skills and competences is vitally important to reach that goal. Professionalism is absolutely fundamental to the effective practice of IT. The IT profession is relatively young and maturing the profession will undoubtedly take time, but the time for engagement and action is now. Obtaining the status of a profession requires professional bodies to set suitable standards of knowledge and codes of conduct. Standardizing is a means to further mature a profession. This is also the direction that the European Commission and stakeholders are following: the European e-Competence Framework (e-CF) has become a standard in 2016, and the ambition is to do more. A standard that includes not only competences, but also other essentials for any IT professional: knowledge, ethics, and education and certification.

Any organisation would want its IT staff to be professional in their practice, and to be recognised and accepted as being professionals. A Framework for the IT profession helps employers in providing a common language for professional development of IT professionals across Europe (and potentially beyond), while stimulating the mobility of employees and offering them tools to develop their careers. The benefits to organisations and society include practitioners having an adequate level of knowledge, providing a higher level of products and services, and abiding by professional standards and codes of ethics[34].

Figure 3-10: The building blocks of the IT Professionalism Framework



The European Framework for IT Profession is designed to be more than the sum of its parts. There are four building blocks and each of them includes standards or instruments to support further development of the IT professional as well as the IT profession itself. These four building blocks are: (Bodies of) Knowledge, Competences (e-CF), Education, Training & Certification, and Professional Ethics. The main strength of the proposed framework is the combination of stable components with a high degree of flexibility allowing rapid adaption of IT changes and emerging market requirements. The report[35] showcases examples of how these building blocks establish synergies for both the IT professionals as well as for the many users that exist in Education, Government, Professional Associations, Certification providers and Employers. The European Framework for IT Profession is user-centric and offers value in each stage of the IT professional's career path. Managing the four building blocks in an integrated and complementary way is the key success factor for developing a European Framework as a point of reference for all beneficiaries dealing with IT professionalism in Europe. It will serve students and IT professionals while orienting and planning their education and career as well as support education and training providers, professional associations, industry, government and public sector, in creating the right conditions to mature and promote greater IT professionalism, and ultimately increase Europe's digital talent pool and competitiveness.

The current state of play of the IT profession shows a disparity in the level of maturity of the four building blocks and, more in general, reflects the insufficient integration between them. The European IT Professionalism Framework is a first attempt to advance the maturity.

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[34] Ridge, J., Australian Computer Society, Available online here: http://press.anu.edu.au/apps/bookworm/view/Professionalism+in+the+Information+and+Communication+Technology+Industry/10791/ch02.xhtml

[35] Van der Linden, Siebes, Bonazzoli, Dimauro, Cattaneo, Kolding, Development and Implementation of a European Framework for IT Professionalism, 2017. Online available here: http://ictprofessionalism.eu/wp-content/uploads/Final-report_EASME_COSME-5.pdf .

The objective of the work in this initiative on digital organisational frameworks is to connect to the building blocks of the IT professionalism framework. The previous paragraph demonstrated how the Foundational IT Body of Knowledge was used to ensure a coherent overview of selected frameworks. The following paragraph will illustrate how these frameworks relate to the e-CF and the job profiles (now: role profiles).

3.5.2 The relationship between frameworks and the e-CF

The European e-Competence Framework (e-CF)[36] is a key achievement of the CEN Skills Workshop. The e-CF is an early significant response to the need for standardization and guidance to IT practitioners (students or experienced) in their performance, training and development Europe wide. The e-CF supports the definition of jobs, training courses, qualifications, career paths, formal and non-formal learning paths, certifications etc. in the IT sector. In this way, local, national, European and global IT vendor and user companies as well as qualification and certification providers have access to a shared reference. It offers a uniform language.

The European e-Competence Framework is not based on job profiles but rather on competences as this approach is more flexible. Its purpose is to provide general and comprehensive e-Competences specified at five proficiency levels that can then be adapted and customised into different contexts from IT business and stakeholder application perspectives[37]. The 40 competences of the framework are classified according to five main IT business areas and relate to the European Qualifications Framework (EQF).

The four dimensions of the European e-Competence Framework reflect different levels of business and human resource planning requirements in addition to job/ work proficiency guidelines. They are specified as follows:

Dimension 1	5 e-Competence areas, derived from the IT business processes PLAN – BUILD – RUN – ENABLE – MANAGE
Dimension 2	A set of reference e-Competences for each area, with a generic description for each competence. 40 competences identified in total provide the European generic reference definitions of the framework.
Dimension 3	Proficiency levels of each e-Competence provide European reference level specifications on e-Competence levels e-1 to e-5, which are related to EQF levels 3-8.
Dimension 4	Samples of knowledge and skills relate to e-Competences in dimension 2. They are provided to add value and context and are not intended to be exhaustive.

Complementary to the e-CF, the European IT Professional Role Profiles contribute to a shared European reference language for developing, planning and managing IT Professional needs in a long-term perspective and to maturing the IT Profession as a whole. The profiles are considered a flexible tool for IT professional development and profile construction. Implementing the e-CF competences from a profile construction perspective, the European IT Professional Role Profiles provide a tool and entry point for e-CF application to individuals and organisations working with the e-CF EN 16234-1 standard[38]. The profiles have been recently updated and now consist of 30 profiles clustered in seven groups (‘families’).

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[36] Published for the first time in 2008, and updated by version 3.0 in 2016. Update 4.0 expected in 2018. See: www.ecompetences.eu

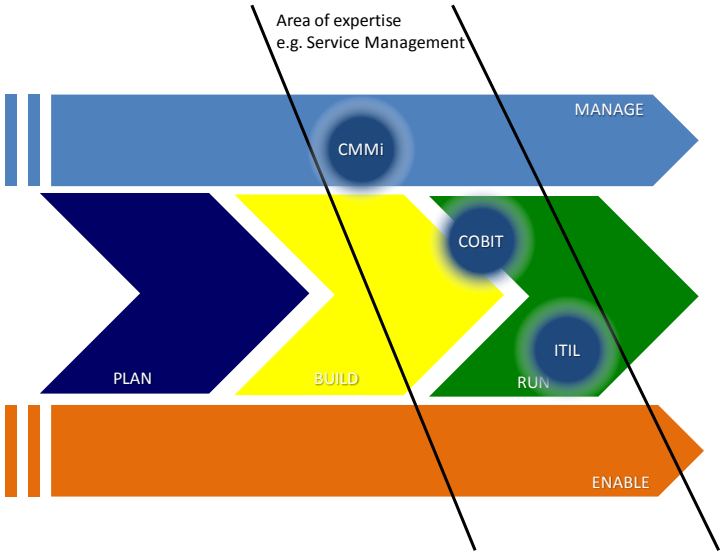
[37] Taken from www.ecompetences.eu

[38] Source: http://www.ecompetences.eu/wp-content/uploads/2018/01/CWA_Part_1_EU_ICT_PROFESSIONAL_ROLE_PROFILES_DRAFT.pdf

An IT professional is working in a specific area of expertise. These areas of expertise are characterized to have a specific skill set (IT, personal and business competences) and standards (frameworks). The areas of expertise can be linked to the European IT professional profiles (CWA 16458:20112[39]).

The choice and use of frameworks can benefit organisations in their digital transformation if it is clear how they are structured and correspond to areas of expertise. Some frameworks are based on best practices, others on processes, but the core of every framework is knowledge. The previous section already showed the relationship of frameworks and the Foundational IT Body of Knowledge (knowledge areas). The following picture illustrates which frameworks are relevant for the Service Management area of expertise, and how these correspond to the areas as defined in the e-CF. This way it also becomes clear for which roles these frameworks are important. A service manager plans, implements, and manages the solution provision. For this, the service manager should know what the maturity is of the sourcing organisation (CMMi). The IT governance must be implemented and COBIT can be helpful in this. Governance processes can be described using ITIL. The service manager uses MANAGE, RUN (e.g. Service Delivery and Problem Management), and ENABLE (e.g. Contract Management) competences.

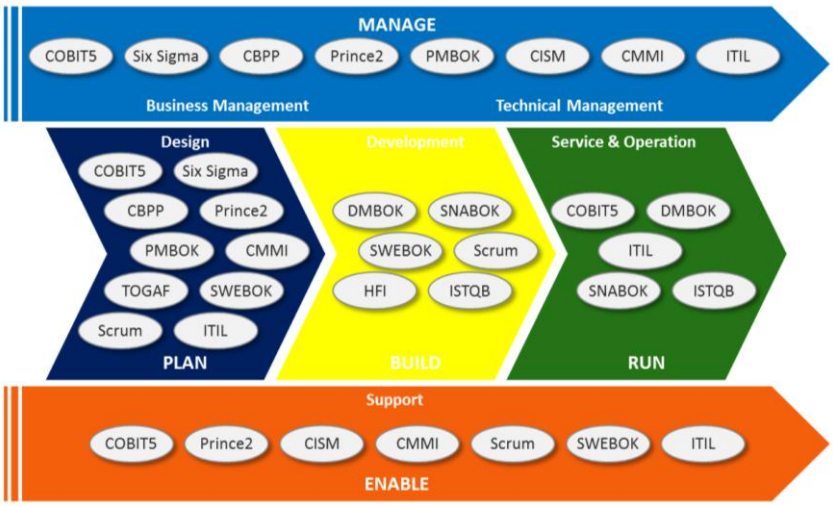
Figure 3-11: Areas of expertise with some characteristic IT frameworks



Some frameworks can be used in several areas of expertise and some are specific for one. Frameworks like PRINCE2®, ITIL and Scrum are most effective when all IT-professionals have at least some knowledge about it. Other frameworks, like BABOK and COBIT are only relevant for a limited number of IT-professionals in a company. Same is true for a mapping of frameworks against the business processes of the e-CF (as is demonstrated below).

[39] Available online here: ftp://ftp.cen.eu/CEN/Sectors/List/ICT/CWAs/CWA%2016458.pdf

Figure 3-12 Relationship between frameworks and main areas of the e-CF



All frameworks promise advantages. Companies implement these frameworks for several purposes:

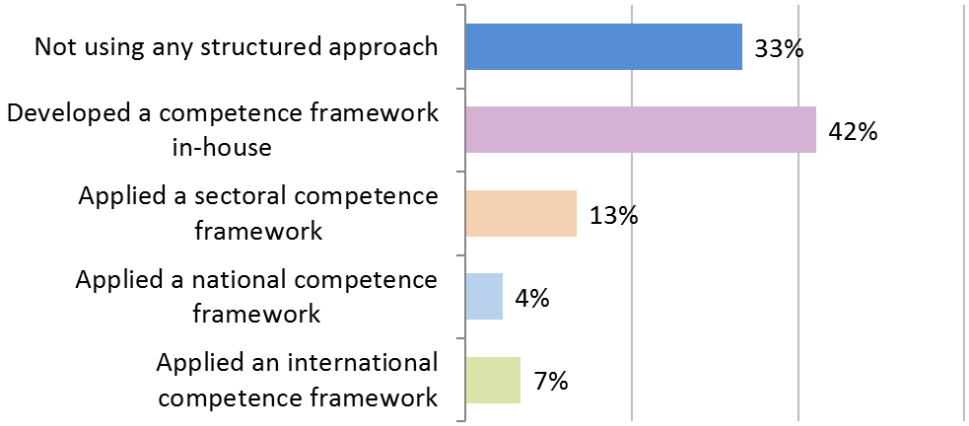
- Professionalization, interchangeability, uniformity in way of working, base for personal development, improving quality of results;
- Cost savings, not reinventing the wheel but use existing best practices instead on one hand, increasing efficiency on the other hand;
- Using industry standards, enabling them to cooperate easier with other companies;
- External communication, reinforce image, e.g. by communicating CMMI-level to increase customer trust;
- Access to trainings, by using standards, a large number of trainings and e-learnings is available, no need for customization;
- Laws and regulations, certifications are a good way to prove compliancy.

The trigger for implementing a framework is often related to the need to develop digital capabilities. A prerequisite for increasing digital capabilities is a well-organised base. The foundational building blocks, concerning infrastructure and applications, should be managed with minimum effort. Implementing a framework is a proven way to reduce this effort.

3.5.3 How could frameworks and e-CF complement and enrich each other?

At the moment, and as illustrated by the survey results, many organisations are either not using any competence framework at all, or developed something in-house. With digital transformation forcing every organisation, in every market to change, and requiring strategic choices as regards capabilities to invest in, also comes a need to apply an internationally recognised competence framework.

Figure 3-13 What kind of competence framework is your organisation using?

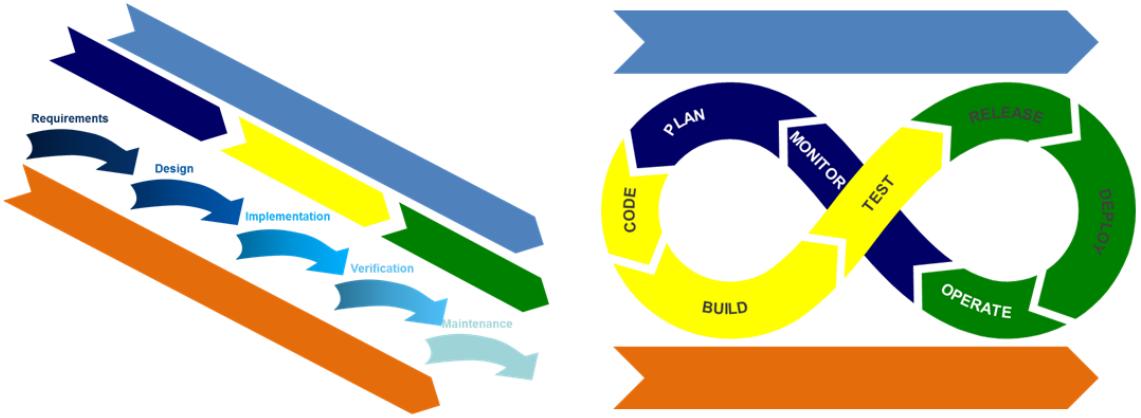


Perhaps even the Digital Single Market in the European Union support the cross-border operations of entrepreneurs and hence their need for a uniform language when hiring, recruiting, developing staff. **The urgency that digital transformation brings to organisations, at the same time offers a huge opportunity for the e-CF to grow in take-up**.

The essence of efficiently applying e-CF in such transformation processes is in establishing a clear link to the capabilities of an organisation. The various IT organisational and management frameworks are the tools to increase knowledge and grow competences and contribute to capability development.

However, the structure of the e-CF sometimes is associated with a traditional way of working, in waterfall processes rather than in new digital, agile, ways of working. But even as more and more organisations are exploring and applying DevOps or Scrum, there are still organisations that use a waterfall approach. Large companies that have a bi-modal balance between traditional backbones and innovative front-ends for example. And even though the e-CF would surely benefit from adding competences around agile development and design thinking in the coming update to 4.0, if not too rigidly applied, the e-CF can also work in DevOps environments. The picture below illustrates that.

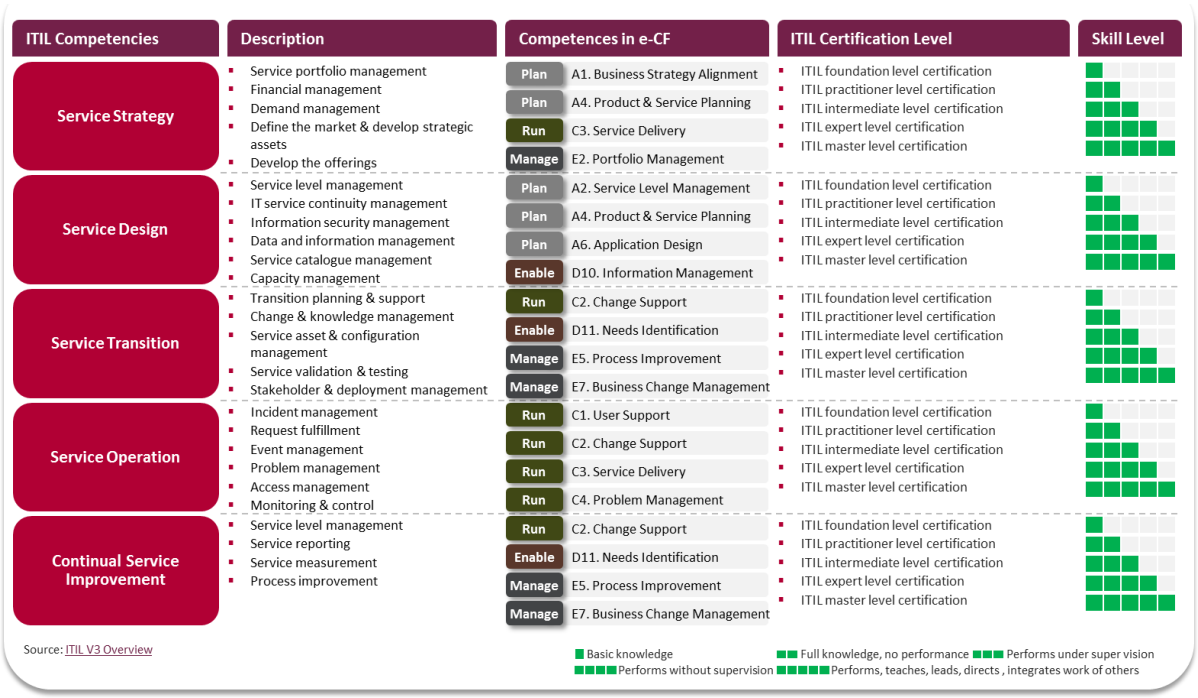
Figure 3-14 Application of e-CF in both traditional and agile environment



For the selected most relevant frameworks we have included a mapping of competences as described in those frameworks to the e-CF competences. This allows to apply those frameworks together, using the uniform language of e-CF. An example is included in the figure below for ITIL. The example lists competencies as described in ITIL (on the left of the picture) and translates these to competences in the e-CF (middle). It also includes certification and skill levels (to the right). The mapping of the other selected frameworks to e-CF is

included in the Annex B. The annex C includes a mapping of IT professional job profiles to the various frameworks.

Figure 3-15 Example of mapping framework competences (ITIL) to e-CF



A clear call for more IT professionals, and with a different skill set, was echoed by Ms **Caroline van Rompuy**, CIO of the Agfa-Gevaert Group[40]. Ms Van Rompuy explained the transformation Agfa-Gevaert is in, and the careful balancing between innovation and a more traditional workforce. She also explained the role of IT organisational and management frameworks in that process as well as competence development of new roles that appear in the organisation. Finding common grounds is important, and can help in explaining the importance of IT to the business. **She underlined that universal languages, such as the e-CF, are very useful in the process of developing capabilities in tandem with competences of employees**. Frameworks contribute to professionalise and structure the organisation. Agfa-Gevaert also invests in certification of own staff in order to further develop competences and increase capabilities.

[40] The Agfa-Gevaert Group develops, manufactures and distributes an extensive range of analogue and digital imaging systems and IT solutions, mainly for the printing industry and the healthcare sector, as well as for specific industrial applications.

4 Towards a digital capability reference framework for enterprises

The previous chapter presented the insights gathered on IT organisational and management frameworks, and analysed and provided the connection with IT professionalism building blocks such as the e-CF and EU-BOK. This section aims to provide an understanding of how capabilities and competences are related, and how a **digital capability reference framework** could be of use in practice.

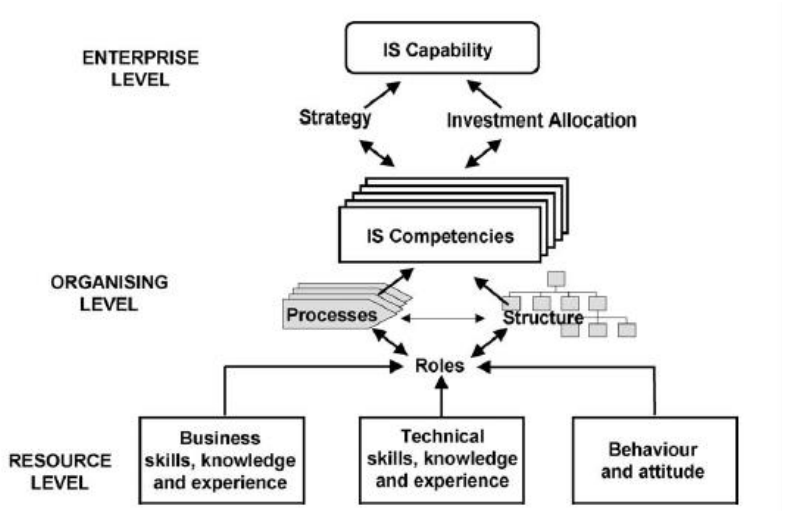
4.1 Understanding the interplay of capabilities, competences and IT organisational and management frameworks

The objective of this initiative is to develop 'an integrated digital organisational reference framework' with the purpose of establishing a connection between capabilities of the organisation and competences of the employees. This requires first to better understand that connection. Competence and capability can be defined, respectively, as:

- Competence: the demonstrated ability to apply IT knowledge, skills and attitudes for achieving observable results;
- Capability: the ability of an organisation to systematically and repeatedly mobilise processes, people and technology towards achieving specific outcomes.

Peppard and Ward illustrated the relationship between capability and competencies, and how competencies are fulfilled by (different) roles in an organisation. Resources carrying out a role require not only technical knowledge and skills, but also an understanding of the business they operate in, and personal skills (soft skills, or 'behaviour and attitude' in the figure below). Improving organisational capability requires improving individual skills and competences (and vice versa). Managing the relationship between them is important and non-trivial[41].

Figure 4-1 A model of the IS capability according to Peppard and Ward[42]



[41] Thornley, Integrating Skills and Capabilities Development with IT- CMF, presentation for DIGIFRAME workshop on 8 December 2017

[42] Peppard & Ward (2004) Beyond strategic information systems: towards an IS capability. *Journal of Strategic Information Systems*, 13 (2): 167-194

If an organisation wants to invest in a certain capability for strategic reasons, it will have to understand:

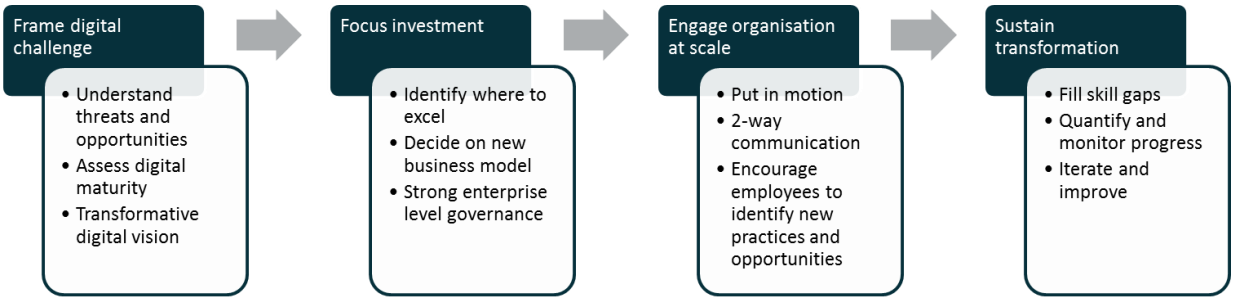
- which competences are relevant for developing that capability,
- who in the organisation is carrying out a role associated with those competences, and:
- if the employee involved is matching the requirements for that role.

Based on the assessment of the latter, decisions can be taken as regards upskilling, recruiting or outsourcing. This is where IT organisational and management frameworks can add value, as they provide the knowledge and skills related to a certain area of expertise. There is a clear mapping possible from roles in the organisation to related frameworks, which also allows understanding a career path of an employee in a certain role. For this reason, we made a mapping of IT professional job profiles to IT organisational and management frameworks (in annex C). This report also included a mapping of e-CF competences to the competences described in these frameworks (annex B).

But does this also work for an organisation that is in a process of transformation?

A digital transformation process can be described in four steps (as captured in the figure below): frame the digital challenge, focus investment engage the organisation at scale, and sustain the transformation. Understanding the connection between capabilities and competences in an organisation seems relevant in most of the steps of this process. Assessing current potential of the workforce can be input for understanding the organisation's digital maturity (frame), for deciding where to excel and invest in (focus), for identifying good or new practices (engage), or to understand which skill gaps need to be filled (sustain).

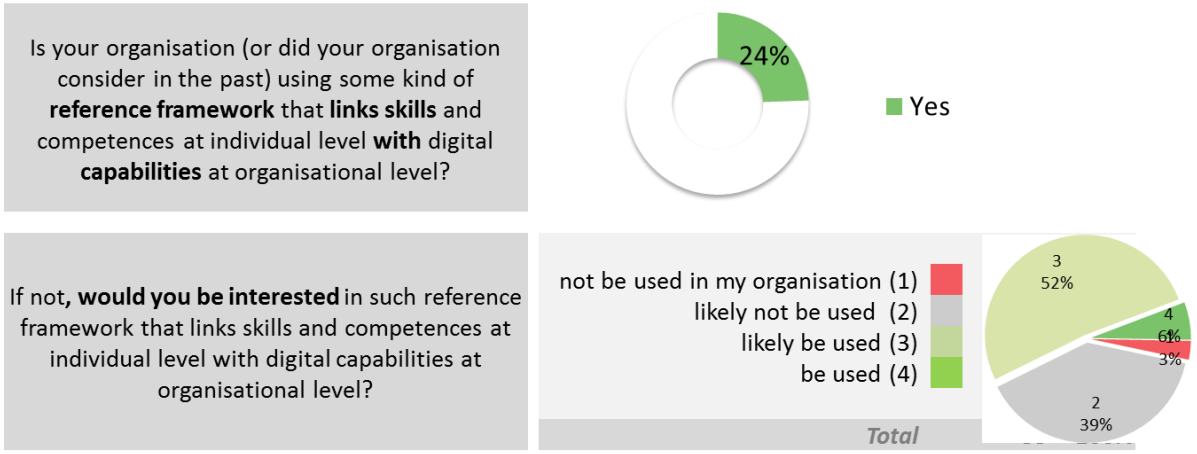
Figure 4-2 Four steps of driving digital transformation



4.2 Target audience

There seems to be a clear potential for a **digital capability reference framework**. According to the survey responses, only 1 in 4 organisations is using some kind of reference framework that links competences at the individual level with capabilities at the organisational level. Of those not using such a framework, at least 3 in 5 organisations indicate an interest in using such framework.

Figure 4-3 Potential use of a digital capability reference framework



Next step is to target the framework to specific users. Building on the three layers of the model of Peppard and Ward, we could identify potential users of a **digital capability reference framework**:

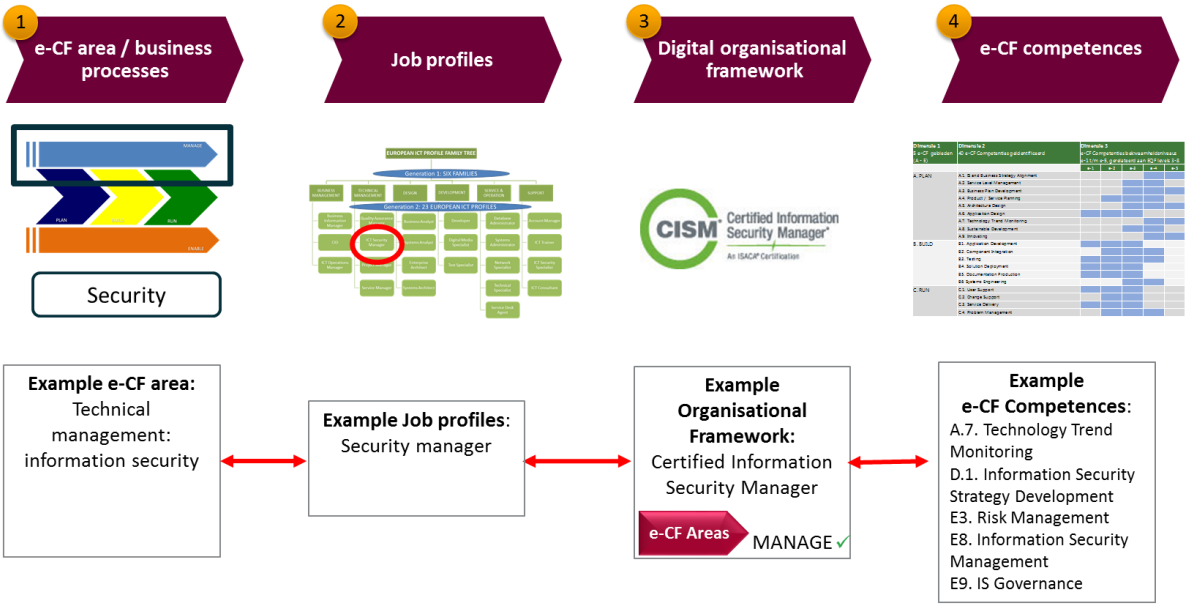
- At enterprise level: the level of the organisation that makes choices concerning the strategy and ambitions of the organisation, and the investments in capabilities to get there, i.e. leadership of the organisation (CxO);
- At organisational level: where the strategic choices related to process, people and technology are implemented, e.g. IT or HR management. Activities here consist of understanding what competences need to be developed, by whom and if the current workforce matches those requirements;
- At individual level: the employees within the organisation, and how they contribute to the overall strategy and success of the company, as well as for them to understand how they could develop their careers within the company in the best possible way.

At organisational level, for example for an IT manager or HR manager executing on the strategic choices, it is important to understand what frameworks and related certifications are important to develop an employee. A business analyst's career usually advances from pure needs identification in his first projects, to business planning to process improvement competences later in his/her career. In order to make those steps, certifications in CBPP, Agile/DevOps, BISL, and later on LEAN/Six Sigma offer opportunities to grow. Assuming organisations using different frameworks at the same time, but still would prefer one common language concerning competences, we drafted a mapping of IT professional job profiles to IT organisational and management frameworks (in annex C).

4.3 Examples of using a digital capability reference framework in practice

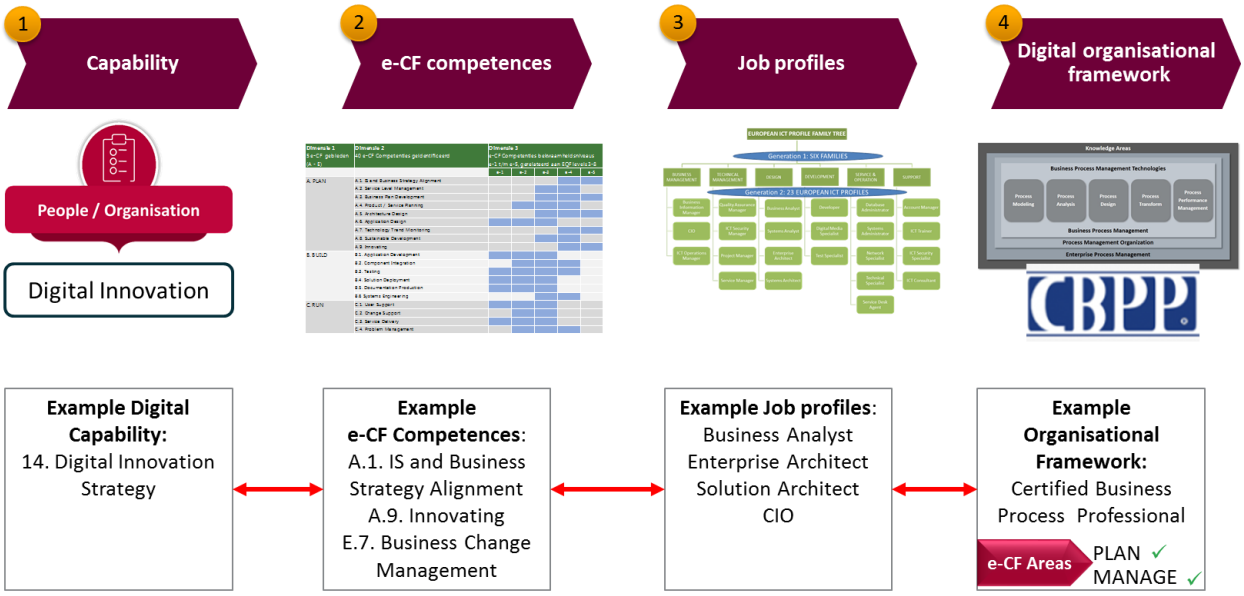
The previous chapter already illustrated how the various frameworks relate to the core IT processes that the e-CF is built upon (Manage, Plan, Build, Run, Enable), and hence consequently to competences and roles. If one would enforce the information security area of his organisation the following logic can be applied, leading to strengthening related e-CF competences by for instance a CISM certification of the security manager in the organisation.

Figure 4-4 Using frameworks to grow competences and business processes in the organisation



In similar fashion, should one apply a digital capability model that is different compared to the key processes of the e-CF, it is still possibly to follow a similar logic. Should you aim to increase your capabilities around digital innovation, and this could be done by building competences around IS and Business Strategy Alignment, Innovating, and Business Change Management (e-CF competences A.1, A.9, E.7), the next step would be to identify the people in your organisation fulfilling roles such as business analyst or enterprise architect, and suggest training/certification courses such as CBPP (which is aimed at improving business operations and enabling organisational transformation).

Figure 4-5 Using frameworks to grow digital capabilities and competences in the organisation



4.4 A SME perspective on digital transformation

SMEs are identified by employment size and annual turnover or balance sheet total[43] and can be grouped according to a wide range of characteristics such as for instance industrial activity, growth, internationalisation activity (level of export/import), innovation intensity, technological intensity etc.

Most of the well-known studies in the field of digital transformation look at the multimillion companies and huge multinationals. Those companies are interesting examples, as they are widely known. However, SMEs account for roughly 99% of all companies in Europe.[44] It is needless to say that the same argument around the benefits of digital transformation – more revenue – also applies to SMEs. More tools need to be available for SMEs to stimulate digital transformation[45]. Numerous SMEs have difficulties to provide training to employees in the field of digital because of a financial constraint, or to find suitable employees in the first place. A 2014 study in the UK found that 25% of SMEs report that they do not possess basic digital skills.[46] Thereby, they do not benefit from the positive link between the level of digital skill and turnover growth. Furthermore, only a very small percentage (20%) of SMEs considered their overall ability to use digital technology as good.

However, digital transformation solutions should be tailored to the sector they operate in. Specific digital skills challenges differ between Member States and the industrial sectors. One example that was provided is the difference between Spain that is facing particular problems with youth employment, whereas SMEs in Germany have difficulties to apply digital in their sales model.[47] The Strategic Policy Forum on Digital Entrepreneurship also recognised the important role of cities and regions. They prepared the 'Blueprint for cities and regions as launch pads for digital transformation' that identifies four key activities stakeholders need to focus on to help their cities and regions to become more digital:[48]

- Leadership and collaboration for a smart governance of the local digital ecosystem;
- Digital talent and entrepreneurs to accelerate the digital transformation process;
- Access to data and technologies for applied solutions to local challenges;
- Key Infrastructures and investments for digital launch-pads.

Undoubtedly, defining strategies for skills development must account for the heterogeneity of the SME landscape. However, this is not the only aspect to consider. Within an enterprise, the profiles of employees are also heterogeneous: from managers, over professionals to trainees. Their job activities, responsibility and future opportunities require different skill development strategies.

What is key for all SMEs, regardless their characteristics, is the Innovativeness and competitiveness of the enterprise and its workforce. This is influenced by their characteristics and involves a process of adapting or overhauling existing business processes to incorporate digital strategies and technology into the company: a digital transformation.

A **digital capability reference framework** could help SMEs to better understand – when deciding to invest in certain capabilities - what they need in terms of competences development, and provides an overview of the relevant frameworks (and related certification) for selection. Surely, SME's will have a different attitude

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43 This is subject to the current definition of SME, which is under revision.

44 http://ec.europa.eu/eurostat/statistics-explained/index.php/Statistics_on_small_and_medium-sized_enterprises

45 One of the possible solutions for this problem on a European level could be the introduction of training vouchers. Those vouchers enable SMEs to overcome the financial barriers preventing them from financing the trainings required for the adoption of new digital solutions and technologies: http://ec.europa.eu/DocsRoom/documents/17926/attachments/1/translations/en/renditions/native

46 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/457750/BIS-15-509-digital-capabilities-in-SMEs-evidence-review-and-re-survey-of-2014-small-business-survey-respondents.pdf

47 http://ec.europa.eu/DocsRoom/documents/15856/attachments/1/translations/en/renditions/native

48 http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=8820

compared to large companies when selecting frameworks for instance. Small companies will likely skip heavier frameworks and select what they really need (for instance from ITIL or Agile DevOps). A medium-sized company might already need more rigour around for instance programme and project management, architecture governance and security (and for instance add components of TOGAF, project management frameworks such as Prince2, PMBOK or IPMA, and security frameworks such as CISM or CISSP).

4.5 Conclusions on designing a digital capability reference framework & next steps

Following the previous sections, a **digital capability reference framework** will consist of:

- An overview of digital capabilities, or the five core IT processes as described in the e-CF,
- mapped to competences in the e-CF and consequently to
- professional IT role profiles and further to
- related IT organisational and management frameworks.

If structured efficiently, it would allow users to tap into the references (mapping) independent of the starting point. The business leaders likely start with capabilities and follow the thread, whereas IT might start the other way around.

At this stage of the initiative we drafted various mappings already – such as a mapping of IT professional job profiles to IT organisational and management frameworks (in annex C), and a mapping of e-CF competences to the competences described in these frameworks (annex B). Obviously, the description of European IT Professional Profiles to e-CF competences is provided by the CEN on www.ecomptences.eu. We've also described how the various frameworks can be categorised, in terms of both the five core IT processes of e-CF (both in Waterfall as in DevOps environment) as well as the knowledge areas of the European IT Foundational Body of Knowledge (EU-BOK).

To further complete a **digital capability reference framework** we foresee:

- A mapping of the digital capabilities to e-CF competences, where it could occur that the existing e-CF 3.0 competences might not cover all capabilities (and hence this could provide input for the e-CF update to version 4.0) similar as for some capabilities no proven frameworks exist – i.e. further elaborating on chapter 3;
- General guidelines for its effective use enabling enterprises to assess their digital capabilities and for appropriate and effective use of the e-CF with IT organisational management frameworks – i.e. further elaborating on section 4.1 and 4.2;
- Designing an "ideal scenario" in which the benefits of an agreed upon combined use of the e-CF with an integrated digital organisation reference framework and the most relevant existing IT organisational and management frameworks could be reaped – i.e. further elaborating on the section 4.3.

The next phase will also aim to gather data on certifications and distribution across various regions.

Part C - Latest statistics and forecasts on the evolution of the demand and supply of IT professionals and e-leaders in Europe.

5 Supply and demand of ICT professional labour – status quo and foresight

The ICT labour market in Europe and globally has been very dynamic both in terms of new jobs created and in terms of pace of change with regards to occupational tasks and requirements. Digital skills and e-leadership are a major policy concern in Europe in order to create employment as well as to drive innovation and growth. Requirements in terms of skills and competencies are evolving from technical digital skills and expertise towards a broader portfolio of skills that include domain, organisational and sector knowledge as well as transversal skills, such as communication and other "soft" skills, as reflected for instance in the T-shaped skills metaphor.

The digital transformation of the economy so increasingly blurs the borders between technical and non-technical jobs. Methodologies such as agile affect more and more non-tech workers and tech skill demands reach beyond the industry into non-tech fields such as managerial, finance, marketing or design.

But what digital skills exactly will Europe need to teach to its current and future digital workforce in order to be as sustainable as possible in a fast-changing tech environment? From mining into the Labour Force statistics of the past years, it emerges that there have been strong patterns in very recent years that give hints as to the actually massive structural changes that are ongoing within the ICT workforce.

In the following we look into these patterns and develop a foresight scenario for the coming years with regards to labour market developments.

Data source:

The Labour Force Survey (EU LFS) is conducted in the 28 Member States of the European Union, 2 candidate countries and 3 countries of the European Free Trade Association (EFTA) in accordance with Council Regulation (EEC) No. 577/98 of 9 March 1998. The EU LFS is a large household sample survey providing quarterly results on labour participation of people aged 15 and over as well as on persons outside the labour force.

(http://ec.europa.eu/eurostat/web/microdata/european-union-labour-force-survey)

Occupations are defined here according to the International Standard Classification of Occupations (ISCO). The current version, ISCO-08, was published in 2008 and has been used to deliver data since 2011. Therefore, there is a break in series between 2010 (ISCO-88, which had significantly fewer ICT related occupations) and 2011.

Data have been kindly made available in several aggregated formats from Eurostat. Aggregation delivers data points as an estimation of workforce totals in a cell, i.e. a combination of categories (country, industry, and ISCO-08 2-digit (sub-major), 3-digit (minor) and 4-digit (unit) groups, and other categories, which have not been used here, such as age and sex). For estimating the ICT workforce totals data are preferably used and represented at ISCO-08 4-digit level. In some cases (some occupations in some countries), only 3-digit data are available. In these cases, the relative distribution of the higher-level totals across lower level categories was estimated using the distribution from all other countries. Another (very rare) case for estimation appears where higher level aggregate sums do not equal the sum of lower level cells. In these cases, the known lower level relative distribution is applied to the higher-level total, i.e. the residual is distributed according to relative weight of cells.

5.1 e-Skills supply and demand in Europe

5.1.1 ICT workforce and the ICT-professional core

Our definition of e-skills through occupation statistics largely follows the Eurostat definition[49]. **The ICT workforce, according to our broad definition, in Europe in 2016, comprises 8.5 million workers, or 3.8% of**

[49] Minor deviations due to different practice with regards to imputation of missing data apply. Eurostat imputes data using a methodology explained in Sabadash, 2012 and here: http://ec.europa.eu/eurostat/cache/metadata/en/isoc_skslf_esms.htm.

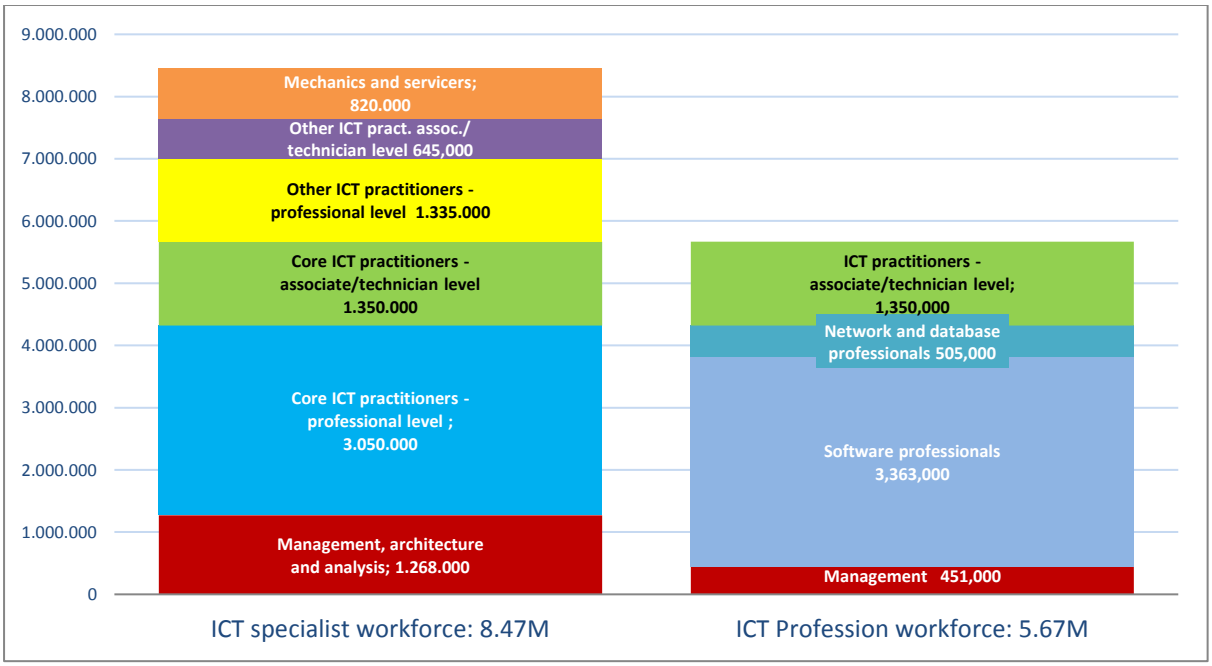
the European workforce. This definition includes all the occupation categories which are included in the table overleaf (Figure 5-2).

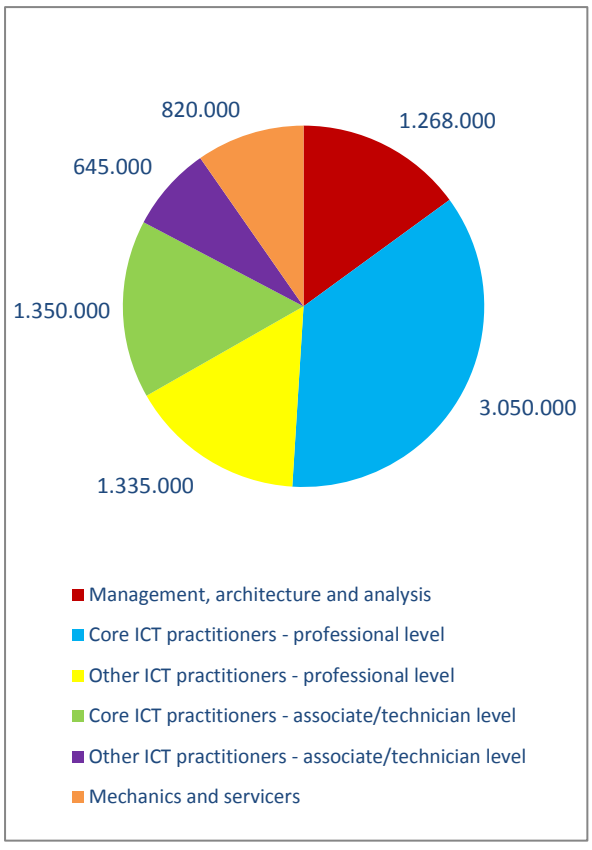
A second, narrower definition, which is a subset of the ICT specialist workforce, comprises only the **core of the ICT profession**: ICT management functions, software, database and network professionals and key technician's categories. In this core category, there have been **5.7 million core ICT professionals**. The categories belonging to this definition are marked with an asterisk in the table overleaf (Figure 5-2).

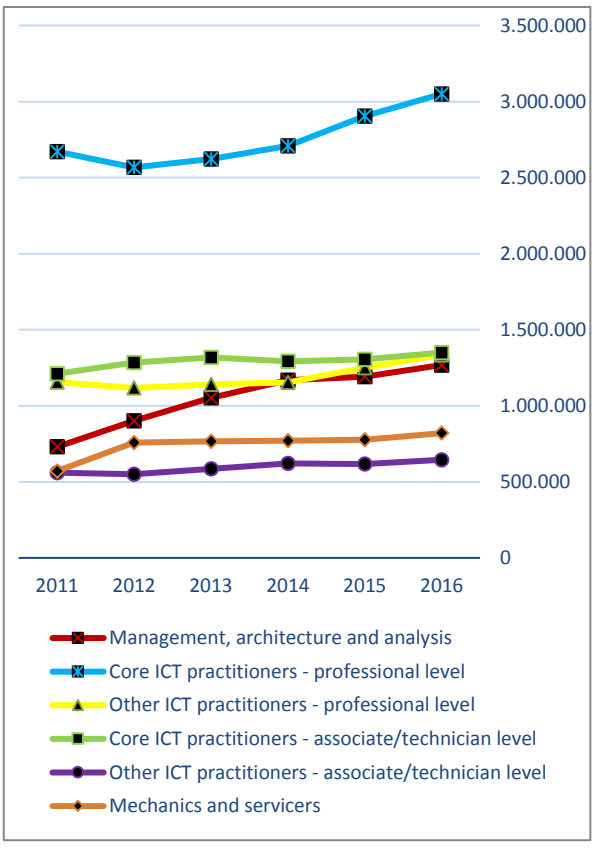
These two definitions will be used in the following as **ICT specialists** and **ICT profession** respectively.

We do not follow Eurostat in this approach and impute data based on the respective country's known data for the superset (in most cases the 3-digit ISCO data) and apply the average percentage distribution of the subsets (i.e. % of 4-digit ISCO data in the 3-digit group) in those countries that provide data to the countries that do not have this data. We justify this decision by the fact that also in the countries with a known 4-digit distribution there will be many ICT practitioners without a formal ICT education background who in Eurostat's practice are counted in the total but those in the other countries where imputation is necessary are excluded. This inconsistency would in our view be more biased than the assumption that a certain share of a subset can be estimated by applying percentages taken from the known distributions in other countries.

Figure 5-1 ICT specialist workforce in Europe 2016 by ISCO-08 skills clusters[50]







[50] Source: empirica calculations based on LFS retrieval by Eurostat. Some further estimates apply as explained in FN49

The ICT workforce is here defined according to occupational categories from the ISCO – International Standard Classification of Occupations 2008 and quantifications are made using data from the Labour Force Surveys (LFS) of the EU-28 Member States provided by Eurostat.

Figure 5-2 ICT specialist workforce in Europe 2016[51]

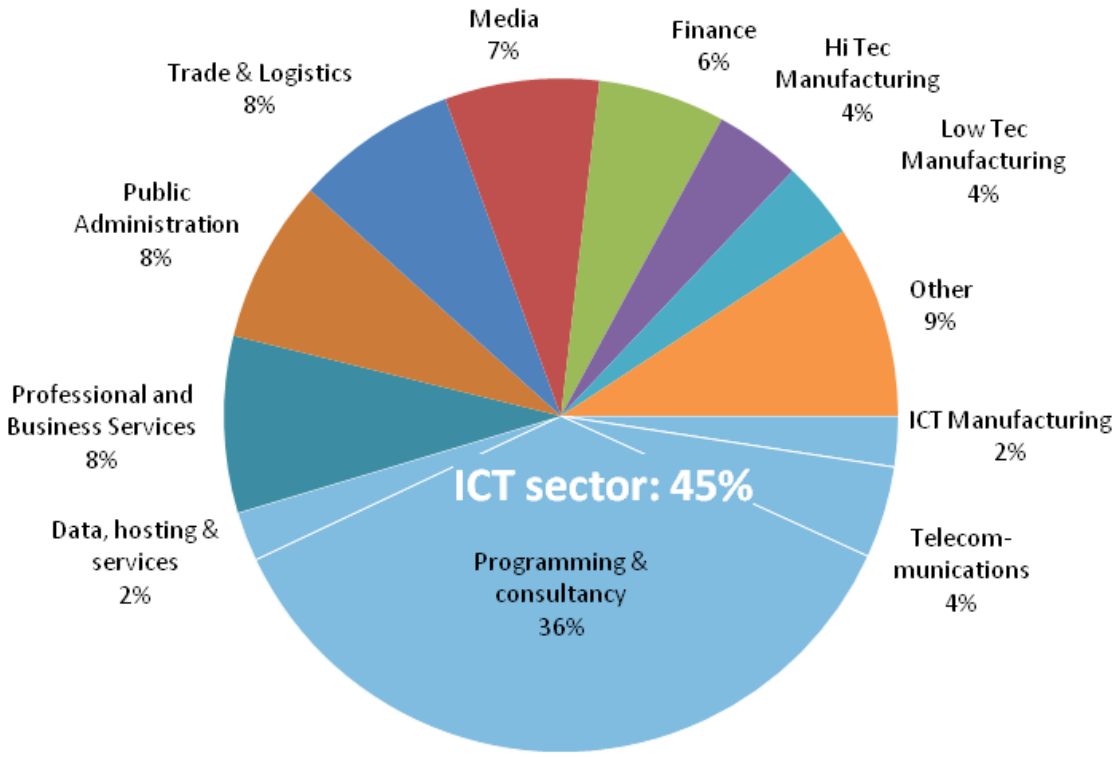
		ISCO-08 code	Worker totals (EU28)	% of total made up of imputed values [52]
ICT specialist workforce of which			**8,469,000**	**4.1%**
	Management, architecture and analysis		1,268,000	
*	ICT service managers	**1330**	**451,000**	**0%**
*	Systems analysts	2511	818,000	13.6%
	Core ICT practitioners - professional level		3,050,000	
*	Software developers	2512	976,000	13.6%
*	Web and multimedia developers	2513	159,000	13.6%
*	Applications programmers	2514	653,000	13.6%
*	Software and applications developers and analysts n.e.c.	2519	758,000	13.6%
*	Database designers and administrators	2521	62,000	25.3%
*	Systems administrators	2522	329,000	24.9%
*	Computer network professionals	2523	77,000	24.9%
*	Database and network professionals n.e.c.	2529	39,000	25.3%
	Other ICT practitioners - professional level		1,335,000	
	Electronics engineers	2152	289,000	20.6%
	Telecommunications engineers	2153	270,000	20.6%
	Graphics and Multimedia Designers	2166	615,000	26.7%
	Information technology trainers	2356	29,000	30.3%
	ICT sales professionals	2434	133,000	11.3%
	Core ICT practitioners - associate/technician level		1,350,000	0%
*	ICT operations technicians	3511	391,000	40.1%
*	ICT user support technicians	3512	698,000	40.1%
*	Computer network and systems technicians	3513	200,000	40.1%
*	Web technicians	3514	63,000	40.5%
	Other ICT practitioners - associate/technician level		645,000	
	Electronics engineering technicians	3114	211,000	20.1%
	Broadcasting and audio-visual technicians	3521	227,000	30.2%
	Telecommunications engineering technicians	3522	206,000	30.2%
	Mechanics and servicers		820,000	
	Electronics mechanics and servicers	7421	330,000	23.4%
	ICT installers and servicers	7422	490,000	23.4%
***: ICT profession**				

[51] Source: empirica calculations based on LFS retrieval by Eurostat.

[52] The higher percentages for single occupations as compared to the overall share of only 4.1% are the result of imputations concerning the unknown distribution of single occupations (subsets) within known sub-major or minor groups (supersets).

ICT practitioners are working in almost all industries of the economy and not just in the ICT industry sector.

Figure 5-3 ICT professional workforce in Europe 2016 by ICT and Non-ICT industry[53]

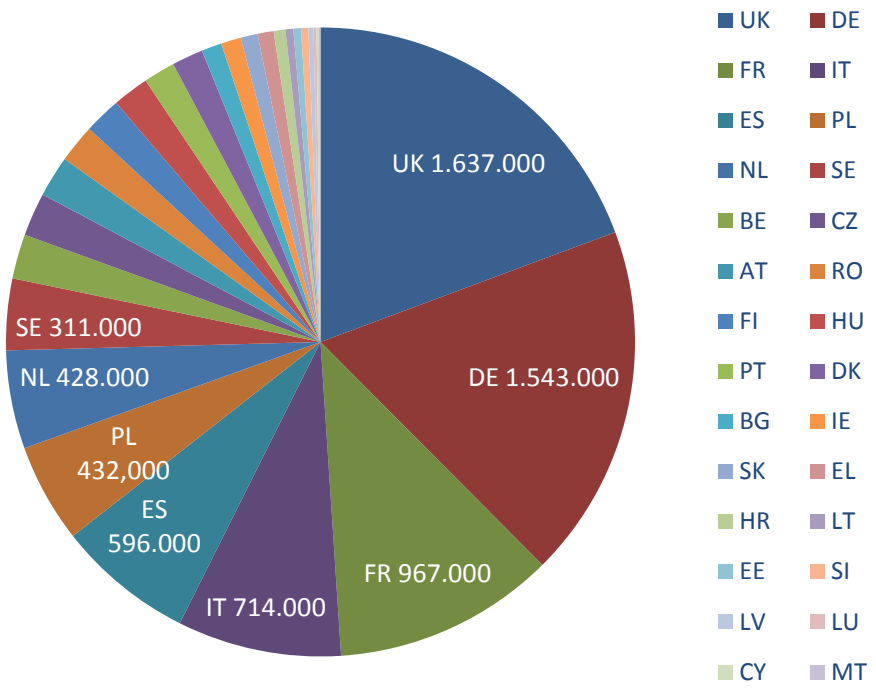


Based on ISCO-08 minor groups 25 and 35									
	ICT sector	Professional and Business Services	Public Administration	Trade & Logistics	Finance	Media	Hi Tec Manufacturing	Low Tec Manufacturing	Other
NACE rev. 2	26;61-63	68-74;77;78;82	84;85	45-53	64-66	58-60	20;21;27-30	10-19;22-25;31-33	1-9;35-43;55;56;75;79-81;86-99

Looking at the European ICT specialist workforce as a whole, it becomes apparent that three countries already account for half of today's jobs, namely the United Kingdom, Germany and France. These are followed by Italy, Spain, Poland and the Netherlands as is depicted in the figure below.

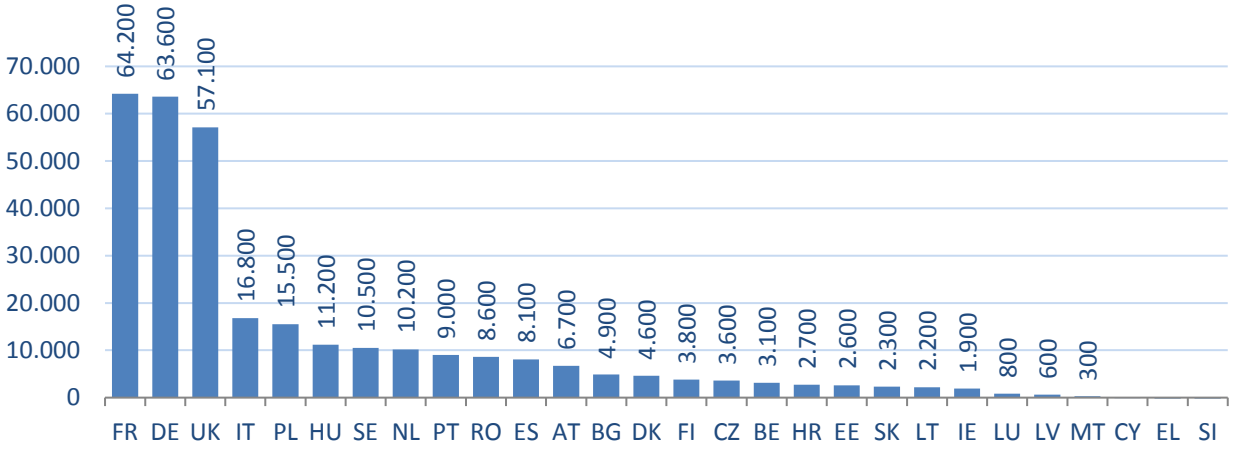
[53] Source: empirica calculations based on LFS retrieval by Eurostat.

Figure 5-4 ICT specialist workforce in Europe 2016[54]



France and Germany have each created more than 60,000 jobs (net) per year on average between 2011 and 2016, or together 40% of the total net employment growth. Estonia, Hungary and France are the countries with the biggest relative employments gains, that is: number of new jobs as percentage of the existing jobs.

Figure 5-4 Average annual[55] job creation 2011-2016



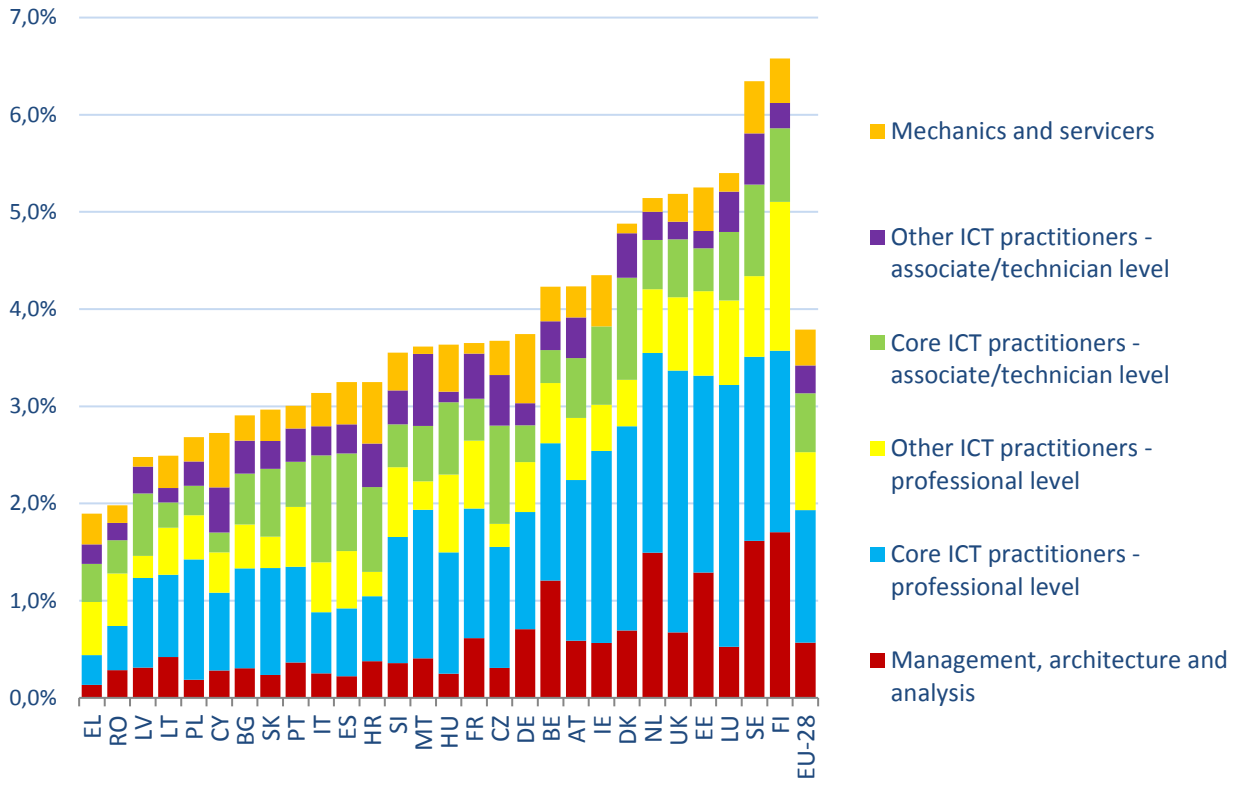
The share of the ICT specialist workforce within the total workforce is 3.8% in Europe and varies significantly across the European countries, as can be seen in the below figure. Eighteen EU Member States show shares below the EU-28 average with Greece, Romania, Latvia and Lithuania below 2.5%. The other extreme includes the Netherlands, the United Kingdom, Estonia, and Luxembourg with shares of above 5%, and for Sweden and Finland even above 6%.

[54] Source: empirica calculations based on LFS retrieval by Eurostat.

[55] Arithmetic average (i.e. assuming linear growth); ICT specialist workforce definition.

Between countries one can see significant differences in the workforce structure. There is an especially large share of top ICT jobs in the Netherlands, the UK, Estonia, Belgium and Luxembourg. The UK has the largest workforce, with a huge professional segment. France and Poland have a similar structure with many professional level workers. Spain and Italy on the other hand have far more associate level ICT workers and less highly skilled employees.

Figure 5-5 ICT specialist workforce as share of employed Labour Force in Europe 2016[56]



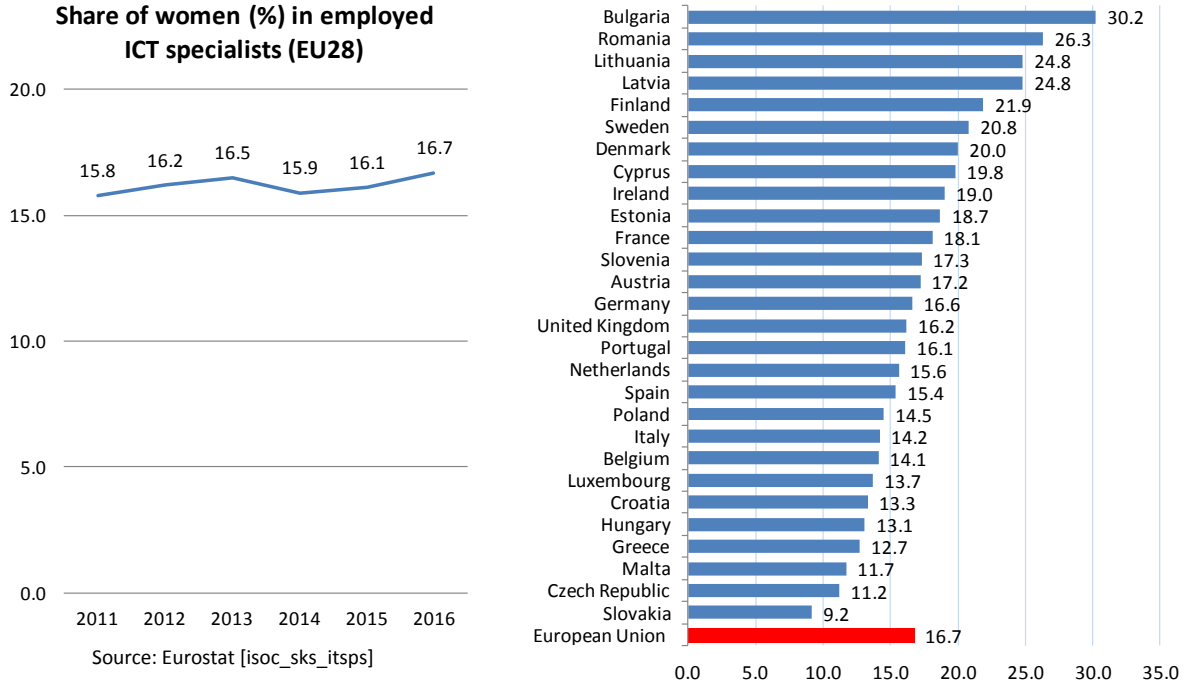
	ICT specialist workforce as % of total Workforce	Management, architecture and analysis	Core ICT practitioners - professional level	Other ICT practitioners - professional level	Core ICT practitioners - associate/technician level	Other ICT practitioners - associate/technician level	Mechanics and servicers	Total
		% of ICT specialist workforce						
FI	6.6%	26%	28%	23%	11%	4%	7%	100%
SE	6.3%	25%	30%	13%	15%	8%	8%	100%
LU	5.4%	10%	50%	16%	13%	8%	4%	100%
EE	5.3%	25%	39%	17%	8%	3%	9%	100%
UK	5.2%	13%	52%	15%	11%	4%	6%	100%

[56] Source: empirica calculations based on LFS retrieval by Eurostat.

NL	5.1%	29%	40%	13%	10%	6%	3%	100%
DK	4.9%	14%	43%	10%	21%	9%	2%	100%
IE	4.3%	13%	45%	11%	18%	0%	12%	100%
AT	4.2%	14%	39%	15%	15%	10%	8%	100%
BE	4.2%	29%	33%	15%	8%	7%	8%	100%
DE	3.7%	19%	32%	14%	10%	6%	19%	100%
CZ	3.7%	8%	34%	6%	28%	14%	10%	100%
FR	3.6%	17%	37%	19%	12%	13%	3%	100%
HU	3.6%	7%	34%	22%	21%	3%	13%	100%
MT	3.6%	11%	42%	8%	16%	21%	2%	100%
SI	3.6%	10%	37%	20%	12%	10%	11%	100%
HR	3.3%	12%	21%	8%	27%	14%	20%	100%
ES	3.3%	7%	21%	18%	31%	9%	13%	100%
IT	3.1%	8%	20%	16%	35%	10%	11%	100%
PT	3.0%	12%	33%	21%	15%	11%	8%	100%
SK	3.0%	8%	37%	11%	23%	10%	11%	100%
BG	2.9%	10%	35%	16%	18%	12%	9%	100%
CY	2.7%	10%	29%	15%	7%	17%	20%	100%
PL	2.7%	7%	46%	17%	11%	9%	9%	100%
LT	2.5%	17%	34%	19%	10%	6%	13%	100%
LV	2.5%	13%	37%	9%	26%	11%	4%	100%
RO	2.0%	14%	23%	27%	17%	9%	9%	100%
EL	1.9%	7%	16%	29%	21%	10%	17%	100%
EU-28	3.8%	15%	36%	16%	16%	8%	10%	100%

The share of women in the ICT specialist workforce is growing very slowly in Europe, being at 16.7% in 2016. The two countries with the highest shares of women in the workforce have been Bulgaria and Romania, which both feature a rather small total ICT workforce as percent of the total workforce.

Figure 5-6 Share of women in ICT specialist workforce in Europe 2016



5.1.2 In focus: software professionals

Software and applications developers and analysts

Between 2011 and 2016, the number of new jobs created (net) in software related professional jobs[57] amounted to 747,500 in Europe. This was an increase by 29% in five years, or 5.2% CAGR.

In total, there were 3.4 million Software and applications developers and analysts in 2016, with the UK being the most important market (960,000 professionals).

Countries with the largest relative share of software professionals are the three Nordic countries, the UK, the Netherlands and Ireland.

The most dynamic countries in terms of relative growth are Portugal, Luxemburg and Estonia.

[57] Containing the following job categories (ISCO-08 code): Systems analysts (2511); Software developers (2512); Web and multimedia developers (2513); Applications programmers (2514) and Software and applications developers and analysts n.e.c. (2519).

Figure 5-7:Number of software and applications developers and analysts (ISCO-08 minor group 251) in the EU in 2016

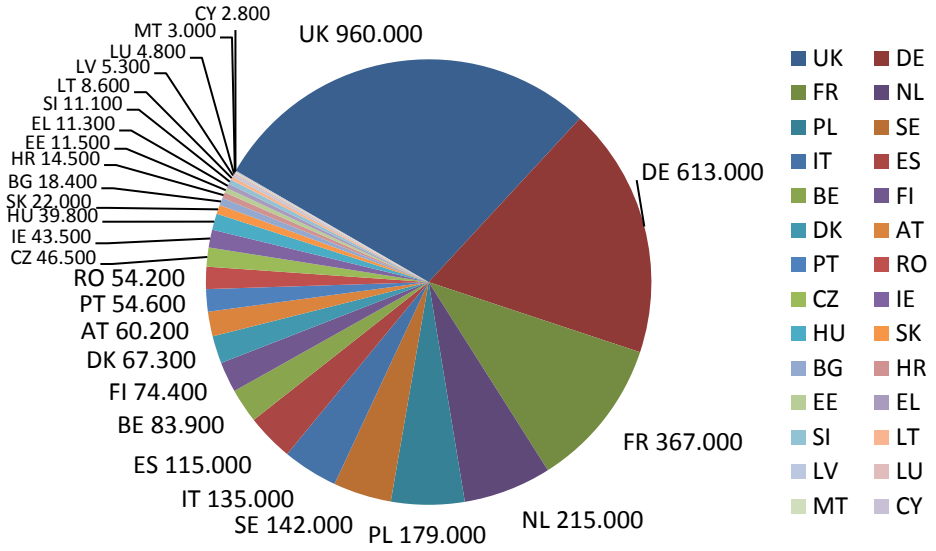


Figure 5-8: Share of software and applications developers and analysts (ISCO-08 minor group 251) in total workforce, EU in 2016

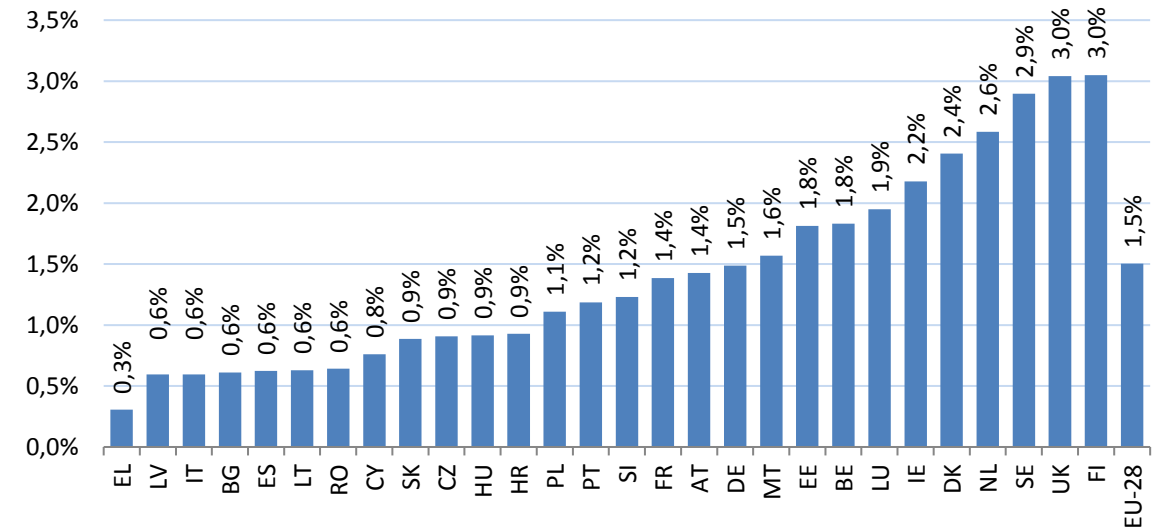
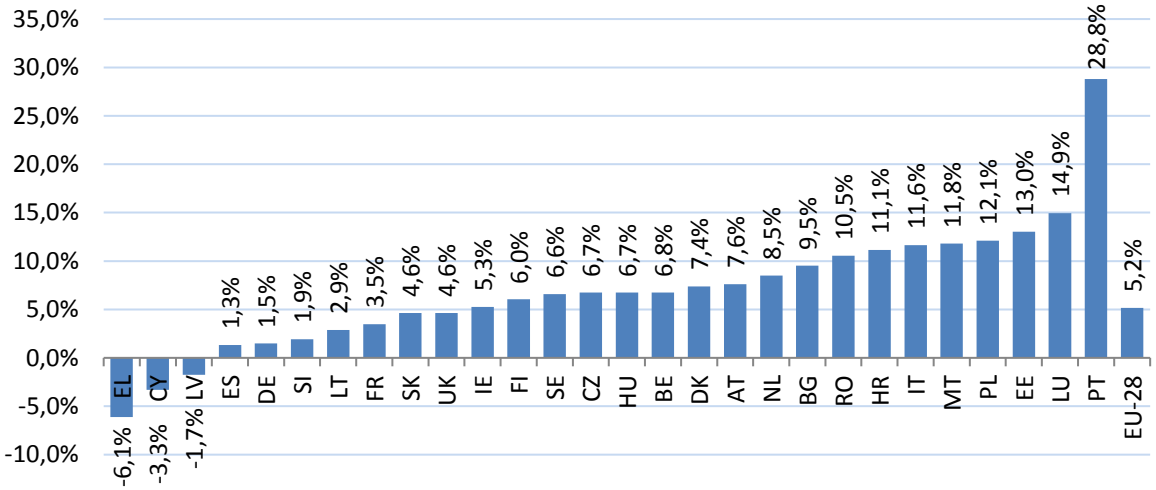


Figure 5-9: Annual growth (CAGR) in the number of software and applications developers and analysts (ISCO-08 minor group 251) in the EU-28 between 2011 and 2016



5.1.3 Order of magnitude sketch of e-skills as a policy concern

Digital skills have become a concern in many domains of policy making and therefore it may be helpful to further elaborate about the scope of the analysis of e-skills here, the target groups involved and the main policy concerns affected.

Digital skills have been in the focus in domains as diverse as inclusion, civil society and democratic participation or labour market integration, but also in, e.g., health or education. A look at, and assessment of, the sizes of the different target groups shall be undertaken in the following.

The EU- Population of 512 million is the largest possible target group of policies concerned with digital skills and many policies should undoubtedly aim at the whole of the population. 57% of the population have been found in surveys[58] to have at least basic user skills, which would translate into 220 million people across Europe and there are 31% who have above basic skills (i.e. 159 million people). The main policy concerns for this target group as a whole can probably be found in encouraging civic participation, empowerment, e-inclusion, media competence and basic digital literacy.

In Europe, there are currently around 217 million people in gainful employment. Many digital skills policies aim specifically at this population. To assess the size, this number should of course be enlarged by including people who seek employment (e.g. unemployed) or will do so in the foreseeable future (e.g. pupils, students). Anyway, if one takes those in employment as a basis, there are 67%, or 145 million workers who have at least basic level skills. Main digital skill related policy concerns for this group as whole would probably include digital skills for employability and work quality.

At a next step, there are so-called “advanced users” who make up some 7% of (or 80 million) individuals in employment. They have above basic level digital skills, and the figure varies between non-manual workers (47%) and manual workers (15%). Policy concerns relating to digital skills in this target group include the skills needed for new ways of working, the broad array of “future of work”, including the theories and expectations around the „race against the machine“ and the gig economy.

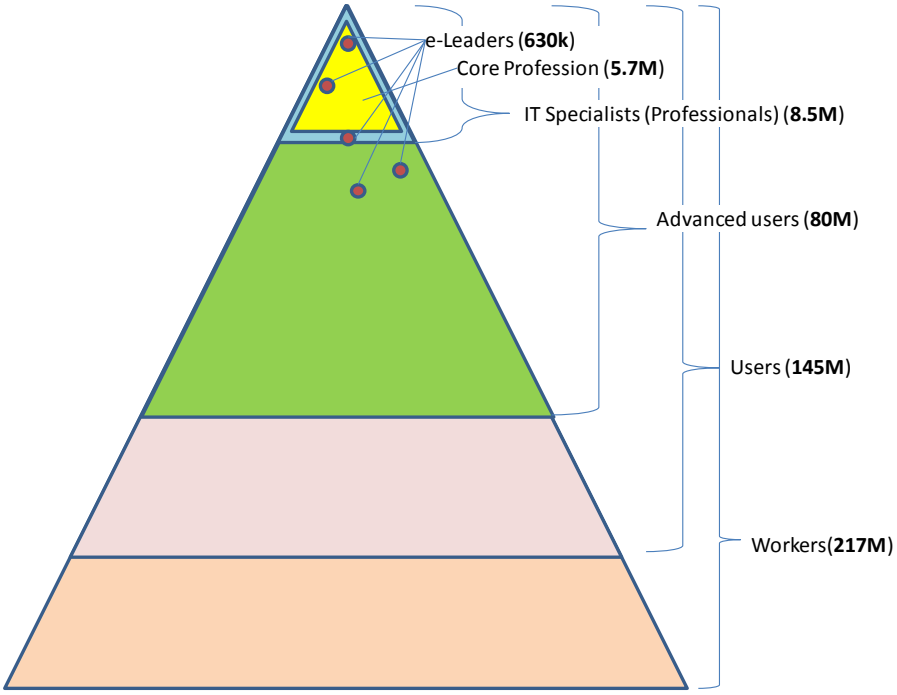
The main concern of our analysis has a narrower focus than this as it concentrates on ICT specialists (8.2M), and the subset of the core IT Profession (5.7M), as well as e-leaders who are not a subset of ICT specialists (for the definition of e-leaders, see the next chapter.) The (core) IT profession consists of the occupation groups of ICT Management (450k), software professionals (3.4M), network and data base professionals (505k) and the core IT technician’s category (1.4M).

For both ICT specialists, and ICT profession, the policy concerns relate to fostering the professionalism, avoiding systemic risk from neglected quality standards, but also their contribution of industrial competitiveness, innovation, and value and job generation.

e-Leaders (~630,000), finally, are a highly selective group of business leaders who combine strategy, ICT and business skills and who enable innovation to be made in the first place, and then brought to bear in the market. The reason of monitoring and supporting the efficacy of e-leadership lies in their great contribution to industrial competitiveness, innovation and value and job generation.

[58] Eurostat: isoc_sk_dskl_i. The survey population is aged 16-74 years to be precise, so the absolute figures would be lower, actually.

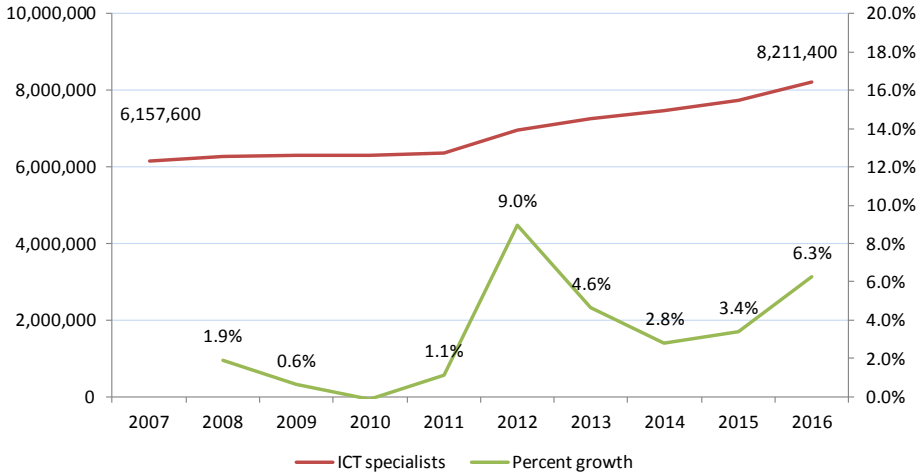
Figure 5-10 The e-Skills pyramid as a sketch of orders of magnitude of digital skills policies' target groups in Europe 2016



5.1.4 Developments

The development of the ICT workforce in Europe between 2000 and 2016 has been very dynamic. Using a minimum definition (equivalent to ISCO-08 codes 25 and 351, i.e. the ICT Profession without the manager's category (ISCO 1330)), because this allows for comparability across breaks in the time series, in the first decade of the millennium, from 2000-2010, we have seen an average compound growth rate of the number of ICT professionals of 4.3% and of 3.6% between 2011 and 2016 (with a break in series 2010/11).

Figure 5-11 Development of ICT employment and average annual growth rates in Europe 2007 – 2016[59]



2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	CAGR 07-16
6,157,600	6,275,700	6,314,900	6,305,100	6,376,500	6,947,200	7,269,800	7,474,400	7,726,300	8,211,400	
	1.9%	0.6%	-0.2%	1.1%	9.0%	4.6%	2.8%	3.4%	6.3%	**3.2%**

5.1.5 ICT graduates

The major inflows into the ICT workforce would obviously come from the ICT graduates from Higher, and in some countries Vocational, Education. The e-skills supply in Europe in 2016 from ICT graduates from Higher Education can be estimated to sum up to 111,000 ICT graduates[60].

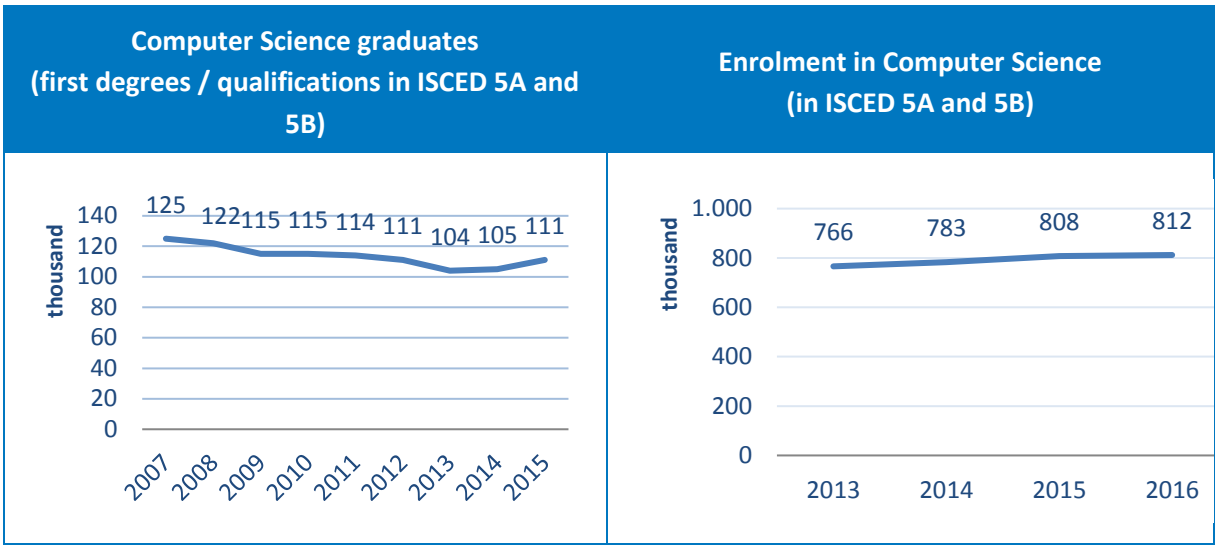
[59] Source: Eurostat website. Please note: Due to different missing data imputation methods used by Eurostat and us when using the LFS, the totals differ , for "our" method of calculation the total is 8.49M in 2016 as in Figure 5-2.

[60] This figure represents a count of first degrees in ISCED 5A and first qualifications in 5B. The number of students entering the labour force in a given year does not equal but is approximated by this number of graduates, as many will go on to second or further degrees (master, PhD). However, also counting second degrees would mean that every student is counted more than once, even if in different years.

By counting only first degrees/qualifications, every graduate will be counted only once (except the supposedly very rare cases of doing both a 5A and 5B degree), even if labour market entry may be at a later point in time. However, there may be an issue of double counting with initial vocational degrees (ISCED 3 and 4), to which individual learners may later add an ISCED level-5 degree.

Another issue with this method lies in a poor representation of those graduates who earn a second (master's) degree but switch subjects. On the one hand, ICT related bachelors may switch to other subjects and not enter the workforce as ICT professionals, while on the other hand there are numerous ICT related masters that are addressed to non-ICT bachelors.

Figure 5-12: Enrolment in and Graduates from Computer Science studies (ISCED 5A and 5B) in Europe (EU28)[61]



The interest in pursuing ICT careers has been diminishing since the middle of the last decade, when the number of graduates had reached a peak. The number of computer science graduates grew even after the dot com bubble burst, but has been in decline in Europe since 2006. However, the number of enrolments has been increasing since 2013 and the number of graduates now follows, with a recent increase (latest available data are for 2015). The country with the highest increase in enrolments is Romania, followed by Luxembourg, the Netherlands, Lithuania, Germany and Latvia.

An increase in the number of graduate entrants to the ICT workforce is badly needed at a time of an increasing number of retirements as ICT practitioners leave the workforce[62]. However, the figures of the years 2005-2008, when almost 130,000 European Higher Education graduates in ICT would enter the labour markets are not yet within reach. The countries with the highest relative increase in number of graduates since 2007 are Malta, Italy, Ireland, Denmark, Slovenia, Bulgaria and Croatia.

5.1.6 e-Skills demand

Demand for ICT workers has been outstripping supply in most of Europe for most of the past decade. We have analysed online vacancy data provided through jobfeed[63] to estimate the number of open posts for ICT professionals. Jobfeed has been developed by Textkernel BV as a Big Data tool for jobs and provides a database of real time and historical online job data. Online job postings were mapped to the definition of ICT jobs presented in this paper. Jobfeed gave us data for 3 EU Member States: United Kingdom, France and Germany. From these we extrapolate for the whole of Europe[64].

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61 Source: Eurostat, some imputations and assumptions apply, for instance in some countries missing years were interpolated or the latest available data was used. Unfortunately, data for 2016 graduations has not been available at the time of writing, while enrolments are only available since 2013.

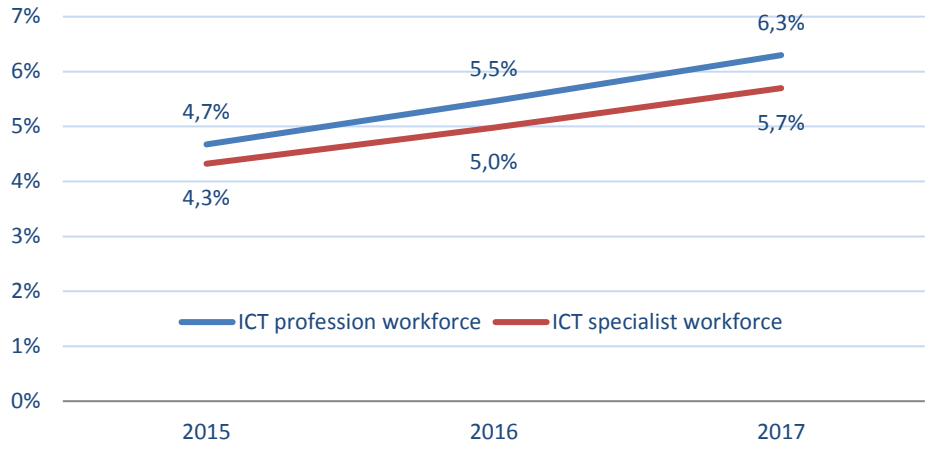
62 Unfortunately, exact data for retirements are not available, but CEDEFOP publishes estimations of replacement demand per country and per ISCO minor group for a twelve year time horizon Detailed data can be accessed for Skillsnet members here: http://www.cedefop.europa.eu/en/events-and-projects/projects/forecasting-skill-demand-and-supply/detailed-forecasting-data. All cautionary disclaimers by CEDEFOP do apply

63 www.jobfeed.com and www.textkernel.com/

64 See Annex E for the detailed calculations

Applying the different vacancy rates to the numbers of jobs per country, we estimate that there were **434,000 open positions for ICT specialists** in Europe in 2016, of **which 279,000 are in the ICT profession set of occupations**.

Figure 5-13 Vacancy Rates of ICT specialist and ICT profession workforce (vacancies per 100 jobs)[65]



When we speak of demand in the following, we add the number of open vacancies to the number of people in employment. This figure represents our estimate for current demand at market wages. The **total demand in 2016 is thus estimated to be at 8.903 million** in the EU-28.

5.2 ICT-specialist workforce foresight scenarios

5.2.1 Previous forecasts

The following table collates previous forecasts by empirica in collaboration with IDC Europe published in various contexts. Although partly differing definitions have been used previously and taking this into account, it is now possible to assess all these forecasts based on the predictions they made for the year 2016 against the now known figures of 2016 as have been reported above.

It becomes obvious that the **forecasts have missed actual developments when it comes to the speed of the workforce growth**. All forecasts have included figures for both workforce and vacancy potential. The growth of the workforce between the baseline year of the respective foresight endeavour has been underestimated throughout from 2013 and still in 2017.

The **estimate for the vacancy potential has been more apt**, with deviations ranging between -38% and +15% of the actual increase in numbers of vacancies.

[65] Source: Jobfeed

Figure 5-14 Previous foresights compared to actual 2016 data

Foresight date		Jan 2017	Dec 2015	May 2015	2013
Occasion		High-Tech and Leadership Skills for Europe Conference 26th January 2017[66]	Working paper update[67]	Working paper V.1[68]	"Monitor" contract, middle scenario[69]
Definition		ICT specialist	Empirica broad definition	Empirica broad definition	Empirica broad definition
Based on latest jobs data for		2015	2014	2013	2012
Jobs at the time (definition used in forecast, which has changed over time)	a	8,033,000	7,535,000	7,325,000	7,403,000
Jobs at the time in ICT specialist definition		8,033,000	7,715,000	7,484,000	7,178,000
Vacancies estimated at the time	b	363,000	373,000	270,000	274,000
Foresight for 2016: Jobs	c	8,186,000	7,767,000	7,598,000	7,571,000
Actual data for 2016: Jobs	d	8,469,000	8,469,000	8,469,000	8,469,000
Foresight job increase	e=c-a	153,000	232,000	273,000	168,000
Actual job increase	f=d-a	436,000	934,000	1,144,000	1,066,000
Foresight missed actual jobs by	g=d-c	283,000	702,000	871,000	898,000
Foresight for 2016: Vacancies /Potential	h	370,000	472,000	462,000	598,000
Actual data (estim.) for 2016: Vacancies /Potential	k	434,000	434,000	434,000	434,000
Foresight increase	l=h-b	7,000	99,000	192,000	324,000
Actual increase	m=k-b	71,000	61,000	164,000	160,000

66 Presentation given at the High-Tech and Leadership Skills for Europe Conference, Brussels, 26th January2017 http://leadership2017.eu/fileadmin/scale_conference/documents/huesing_20170126.pdf

67 Hüsing, Tobias, W.B. Korte, E.Dashja: e-Skills in Europe. Trends and Forecasts for the European ICT Professional and Digital Leadership Labour Markets (2015-2020) http://eskills-lead.eu/fileadmin/lead/documents/working_paper_-supply_demand_forecast_2015_a.pdf

68 T. Hüsing, W.B. Korte, E. Dashja (2015): E-skills and e-leadership skills 2020. Trends and forecasts for the European ICT professional and digital leadership labour market. Empirica Working Paper. Bonn

69 e-Skills for Jobs in Europe – Measuring Progress and Moving Ahead (2014) http://eskills-monitor2013.eu/fileadmin/monitor2013/documents/country_reports/brochure/e-skills_monitor_broschuere.pdf

foresight missed actual vacancies by n=k-h	64,000	-38,000	-28,000	-164,000
missed by % of vacancies o=n/l	15%	-9%	-6%	-38%
Foresight for 2020: Jobs p	8,675,000	8,209,000	7,984,000	7,950,000
Foresight for 2020: Vacancies /Potential q	500,000	756,000	825,000	913,000

The positive message from the analysis of the most recent data is, that the European industry and the national education & training systems have over the last three years managed to create significantly more than originally estimated ICT jobs and ICT employees (8.5 million as opposed to an estimated 8.2 and 7.8 million in our estimates from 2017 and 2015). The demand for IT services has over the past three years also increased much more than anticipated, and even stronger than the number of IT jobs needed to cope with this demand. As a result, Europe finds itself in a situation of a larger than anticipated workforce of ICT professionals on the one hand and an ever-increasing demand for IT services and ICT professionals.

Why has the development of the size of the workforce not been foreseen? The answer, in short, is that the forecast model results were for most of time restricted by the supply side, i.e. the number of ICT graduates going into the workforce and the assumptions about "lateral entries", i.e. labour market entrances by people without a recent and domestic (!) degree in ICT. The following table shows the growth of the ICT workforce and the number of degrees. It becomes obvious, that the growth of the workforce is not in sync with the number of graduates entering the labour market, but that it is unanimously higher, in recent years by 6-digit figures. It even also has to be taken into account that the growth of the workforce is a net figure, and that presumably more than 200,000 replacement demand (the demand stemming from people retiring or leaving the workforce for other reasons) need to be added every year.

While the foresight models have taken account of some extent of lateral labour market entries, it has to be conceded that hard data for even the order of magnitude of this phenomenon is not available. The assumptions made in previous foresights have obviously been too conservative.

Figure 5-15 Disconnect between growth of the ICT workforce and total ICT graduates 2011 – 2016

	Growth ICT workforce (net, i.e. even without replacement demand)	Total graduates (vocational and tertiary first degrees)
2011		181,000
2012	280,300	183,000
2013	305,700	237,000
2014	231,100	190,000
2015	328,300	205,000
2016	426,200	

As a consequence, we have included a second scenario that takes account of these lessons in that it:

a) extrapolates future demand from past developments (instead of using the market intelligence approach that uses insight about future IT spending plans provided by IDC) and

b) uses the previous market growth averages as minimum inflow variable, i.e. even if the number of graduates is lower than the previous average market growth, the inflow is at least of the size of the latter.

We nevertheless also provide a traditional approach scenario.

5.3 Forecasts

The following results are preliminary and may be subject to review, especially with regards to future demand development scenarios.

Two forecast scenarios represent two different yet likely future pathways as we foresee it possible for the time horizon of 2016 to 2020. Technically, the forecasting models differentiate between stocks and flows, or between a baseline market (stock) and dynamic entries and exits (annual flows) and so make assumptions about flows on a yearly and per country (at least for the largest economies) basis. The baseline basically consists of statistics about the number of existing jobs, number of vacancies and number of unemployed ICT practitioners which are based on the data available. Flows are modelled on the supply side as future entries of graduates and others, as well as exits of professionals, and on the demand side as percentage growth rates of labour demand. These flows are modelled on a year-by-year basis and are necessarily based on assumptions about future demand, retirements, graduations and the rate of graduate entries into IT as well as lateral entries (i.e. “outsider” entries, i.e. non-graduates/non-IT graduates or migrant workers) to the labour market. For every year the model so comes up with a new set of the stock parameters (aggregate demand, supply, vacancies, unemployment), which then feed back into other parameters for talent adaptability for the following year, such as the likelihood of cross-border labour mobility and the propensity of outsiders to enter the ICT labour market. In this way, the model includes feedback loops that to some degree can balance out disequilibria. For the demand side, no feedback loops are included, demand growth is an exogenous variable derived from IDC’s forecasts (moderate growth scenario) or simple extrapolation (high growth scenario).

The following charts feature the interrelations and feedbacks between variables and parameters of the model.

Figure 5-16 Stylised supply side model

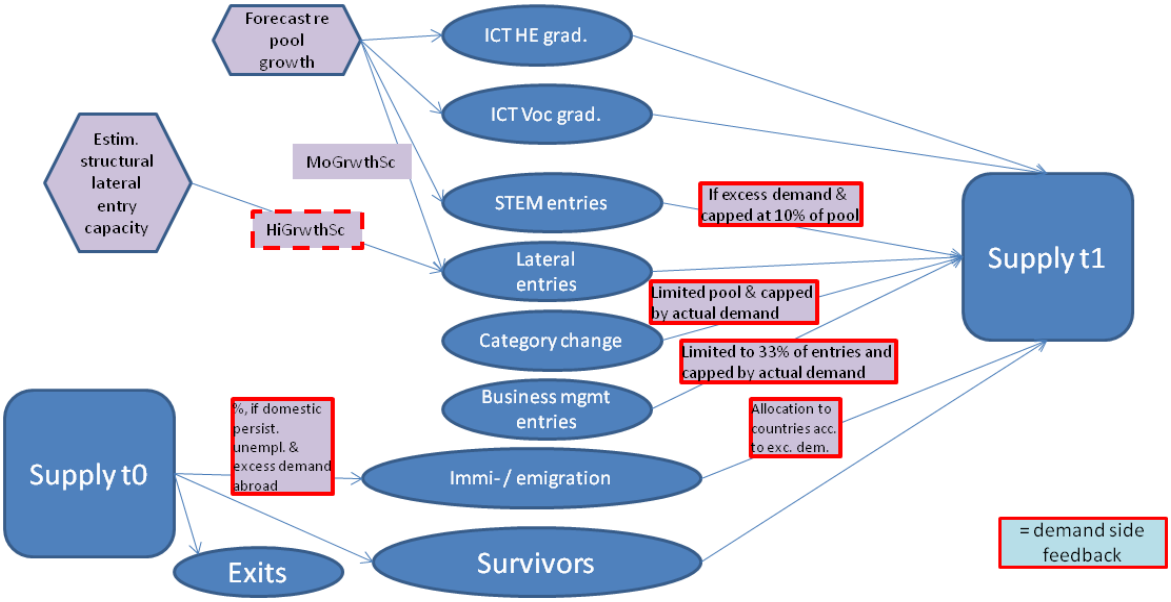
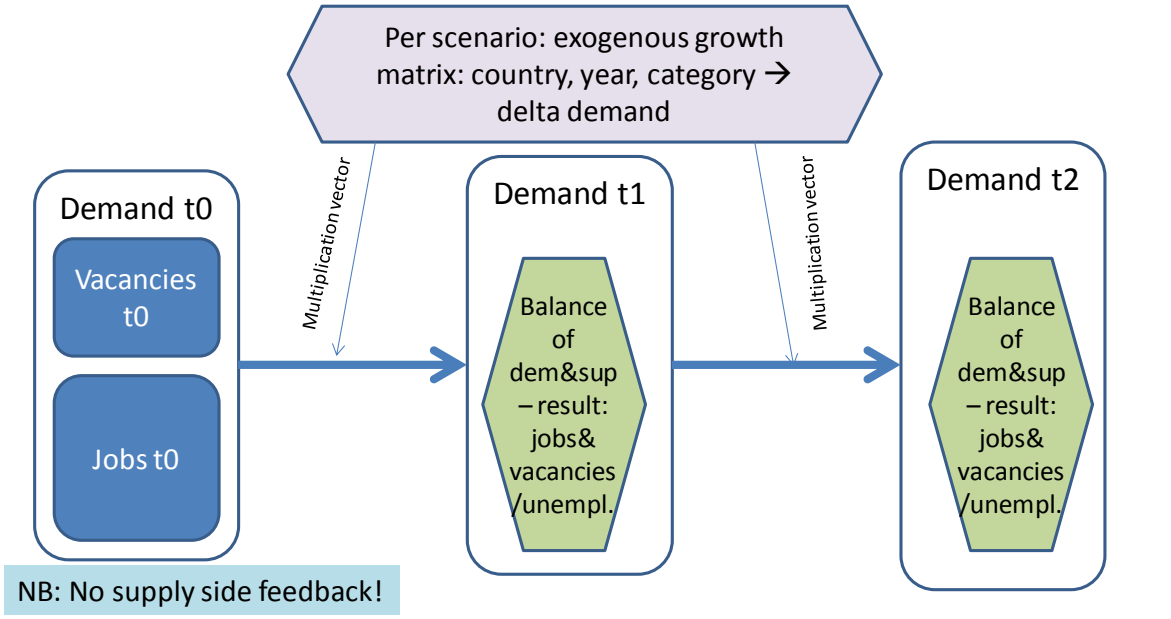


Figure 5-17 Stylised demand side model



The two scenarios make different assumptions about the flow variables. They are built to represent the extreme cases of a 2x2 matrix plotting talent supply and demand on the axes. In the **high growth scenario**, there are both an increased demand for ICT specialists as well as an increased adaptability and therefore availability of talent. This means that the aggregate supply of talent is rather detached from the expectable number of IT graduates. This is a pattern that has obviously allowed the rather unexpected growth of the IT workforce previously as shown in Figure 5-15 in the previous subchapter. This observation is in line with anecdotal evidence from a number of industries where people without an ICT related degree are trained into their jobs using short upskilling tracks or vendor certification courses. Many of such programmes are even funded or otherwise supported by governments or official bodies.

The high growth scenario is thus a scenario where the ICT profession grows not only because of more students graduating from formal education (Higher or vocational) in computer science, but also because of people entering from other professions, from abroad, or from other studies. This scenario actually relates in many ways to the use cases developed when building the IT Professionalism Framework. Or in other words, the

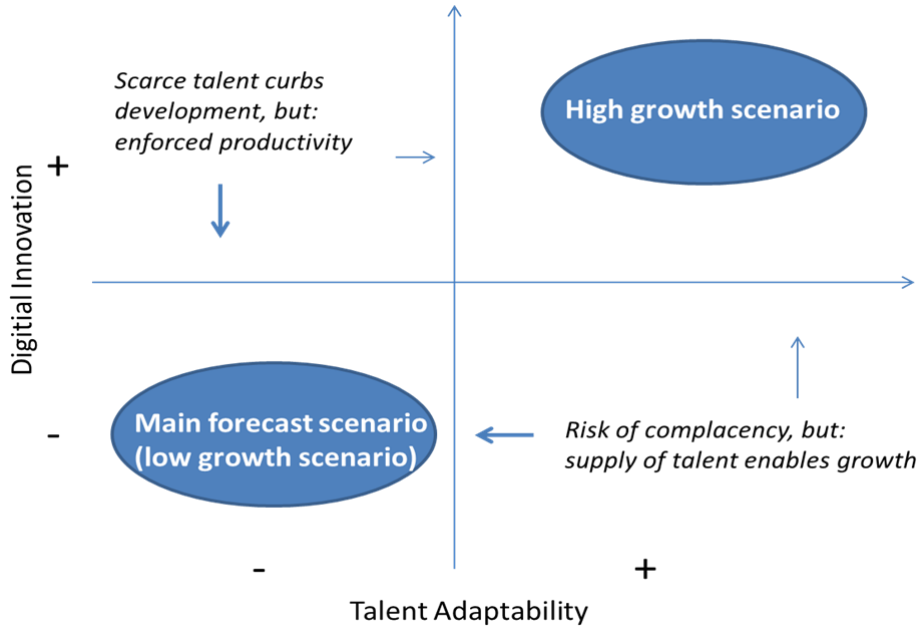
higher the diversity of pathways into the profession, the more there is probably a need for exactly these efforts to foster professionalism.

The **moderate growth forecast scenario** builds on an expectation of rather low demand growth for reasons explained in chapter 5.3.1 and low growth with regards to supply and basically takes on the assumptions we had in our previous forecasts[70], namely that supply is strongly defined by the number of graduates.

In order to avoid delivering too many scenarios, and hence an abundance of figures to be understood by the reader, we refrain from explicating the two other scenarios in the 2x2 matrix, namely (increased demand X flat supply) and (increased supply X flat demand). It can be argued that these scenarios would have a tendency towards either of the two elaborated scenarios, as is depicted in the chart below. In case of scarce talent and increased demand, the impossibility to find suitable talent may curb developments and keep innovation beneath its full potential, dragging this scenario towards the low growth quadrant. Enforced productivity gains may lead to more innovation (substituting labour through technology) which may be a small counter force in the other direction however.

In the case of increased supply and flat demand, tensions on the labour market will ease and pent up demand for IT specialists may finally be satisfied. This will look like a very healthy development with a moderate increase in employment, and less skills shortages reported. In this scenario, the supply catches up with demand eventually and it will look like the industry might be sailing into calmer waters. This might turn out as a fallacy as it bears the risk of losing connection with global dynamics and expectations of less digital innovation. There may however also be an effect of the increased availability of talent in that it enables pent up innovation and so drives this scenario towards the high growth scenario.

Figure 5-18 Scenarios



5.3.1 Moderate growth forecast scenario

This scenario reflects the continuation of the scenario approach that was followed over the past years, therefore it should be treated as our main forecast scenario[71]. To start with the main results: the skills gap still

[70] See footnotes 66- 69.

[71] There are good reasons to include a higher growth scenario, however, as the respective sub-chapter will demonstrate.

remains at around 526,000 in 2020 (an increase from 434,000 in 2016) which is in a similar range compared to the previous forecasts.

This scenario builds on a moderate economic outlook generally, and technological developments where gains in productivity do no hold back entirely but nevertheless significantly curb the demand growth for IT specialists. **The total demand for IT specialists in this scenario grows by only 1.8% annually between 2016 and 2020.** 1.8% is the resulting average of demand growth which we take form IDC's projections of demand growth for the major European markets and Europe as a whole. The reasons for this moderate growth rate are that in this scenario an increasing share of IT budgets are still spent on automation and productivity increase, such as outsourcing and AI and a continuing movement to the cloud. **Maturing technologies can so be maintained by a smaller workforce while emerging technologies are increasingly not very labour intense (yet) but require few extremely high skilled specialists.**

On the supply side, expected graduate figures are flat, i.e. they remain mostly as before. The supply side allows for a moderate inflow of outsider entrants into the IT labour market. Around 252,000 IT graduates from tertiary and vocational education will enter the labour market per year compared to on average 125,000 lateral entries. At the same time, around 230,000 retirements and other exits need to be replaced per year.

As a result, in the 'moderate growth forecast scenario', the ICT specialist workforce in Europe will grow from 8.5 million in 2016 to 9.0 million in 2020, of which 7.6 million will be ICT practitioners and 1.5 million ICT management and analysis level employees. Demand is increasing despite the modest economic circumstances, from 8.9 million in 2016 to 9.6 million in 2020.

Figure 5-19 e-Skills Jobs – 'Moderate growth forecast scenario' – ICT workforce: Development e-skills Jobs in Europe 2016 – 2020

EU28 (millions)	2016	2017	2018	2019	2020
ICT Management	1,268,000	1,323,000	1,348,000	1,402,000	1,463,000
ICT Practitioners	7,201,000	7,295,000	7,393,000	7,488,000	7,564,000
Total	8,469,000	8,618,000	8,741,000	8,890,000	9,027,000
% Growth	+5.3%	1.8%	1.4%	1.7%	1.5%

Figure 5-20 e-Skills Demand Potential - 'Moderate growth forecast scenario' – ICT specialist workforce: Development of e-skills Demand Potential in Europe 2016 – 2020

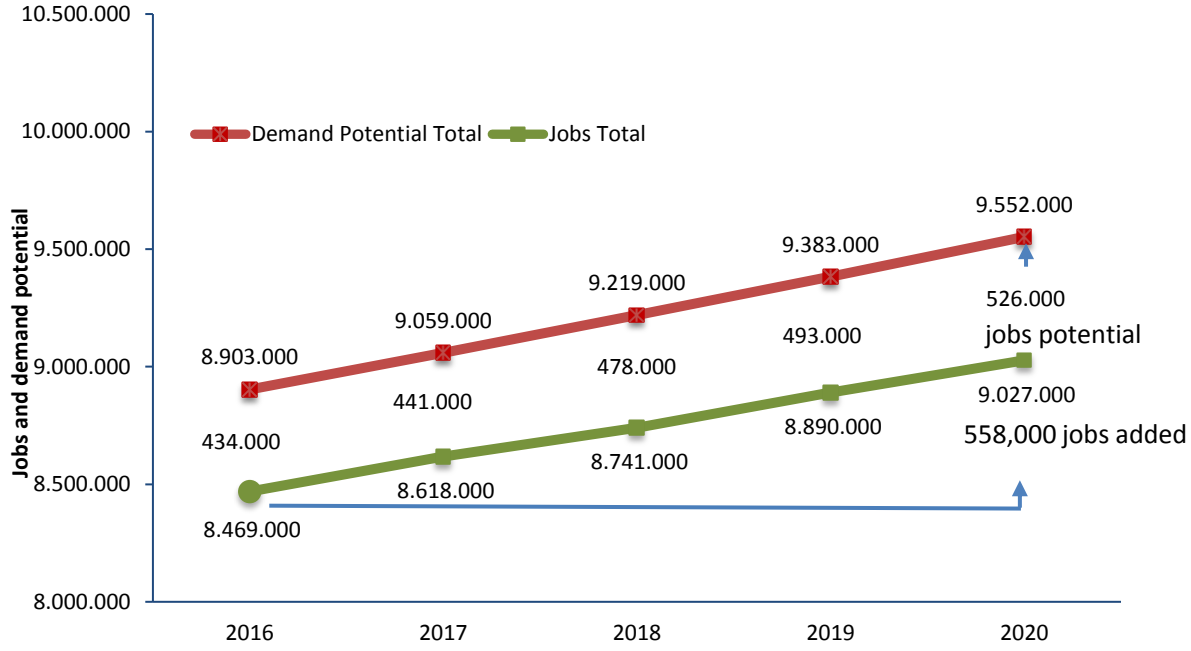
EU28 (millions)	2016	2017	2018	2019	2020
ICT Management	1,314,000	1,371,000	1,430,000	1,492,000	1,557,000
ICT Practitioners	7,589,000	7,688,000	7,789,000	7,891,000	7,995,000
Total	8,903,000	9,059,000	9,219,000	9,383,000	9,552,000
% Growth		+1.8%	+1.8%	+1.8%	+1.8%

The **excess demand** or shortage (calculated as the number of open posts)[72] amounts to **434,000 in 2016** and **526,000 in 2020**. Of these 526,000 there are 432,000 potential additional jobs in ICT practitioner occupations and around 94,000 at ICT management level.

Figure 5-21 e-Skills Vacancies Estimate- 'Moderate growth forecast scenario' – ICT specialist workforce: Summing-up of National ICT Specialist Excess Demand in Europe 2016 – 2020

EU27	2016	2017	2018	2019	2020
ICT Management	46,000	48,000	82,000	90,000	94,000
ICT Practitioners	388,000	393,000	396,000	403,000	432,000
Total	434,000	441,000	478,000	493,000	526,000

Figure 5-22 Moderate growth forecast scenario: ICT specialist jobs and demand in Europe (EU-28) 2016 – 2020



The bottom line is that supply, although growing, is still being outperformed by an increasing demand. Europe will need to continue with its efforts in ICT education and training at all levels and continue to utilise the ability and capabilities of its industry in finding talent and training outsiders to fill the increasing demand for ICT professionals. The estimated increase of the ICT practitioners skills gap of 5.7% until 2020 is somewhat lower than the one of the high-level skilled professionals which is likely to be at 6.4%.

An appropriate policy focus would be on the development and training of higher-level IT and business skills. Concerns which may be raised relate to the quality of skills of those entering the market as outsiders with

[72] This model simply adds up the national balances of supply and demand, but only where they reveal an excess demand. It should be noted that this is still a very conservative estimate, as within countries a perfect geographical match is assumed. Mismatches thus only occur between countries. Migration, which alleviates the geographical mismatch, is already built into the model, as described in the assumptions section. Apart from geographical mismatches, skills mismatches only exist between management and practitioner level skills, but the assumptions on management level recruitment out of the pool of practitioners are also conservatively estimated, rather overestimating the mobility between these categories.

regards to their vocational or Higher education, called 'lateral entrants' in the model, as opposed to fully fledged and thoroughly educated and trained ICT professionals. The activities targeting 'ICT professionalism' to which our contributes are aimed at exactly this issue.

5.3.2 High growth scenario

This is a 'watch out'-scenario based on recent developments which we have observed over the last couple of years. The high growth scenario differs from the previous one in two main respects, namely on the demand as well as on the supply side. This scenario is based on extrapolating the experience of previous years in that it assumes a continuous demand growth on the one hand and on the other hand a supply side that is largely detached from graduation numbers. Previous years have shown that industry manages to find talent in numbers well beyond those that come out of Higher Education and vocational education. This is built into the model in this scenario.

We therefore also developed the alternative 'high growth' scenario which entails an increased speed of innovation and significantly higher share of value added by ICT workers, and includes a very healthy growth of the workforce to over 9.5 million in 2020, compared to the 9.0 million in the previous one.

On the demand side, the average growth of 3.6% was assumed across the board (in all countries). 3.6% has been the average growth (CAGR) between 2002 and 2016 for the core category of ICT professionals[73].

On the supply side, the supply is set to include per country at least as many new entrants so as to equal the average market growth. So, additional inflow was modelled in some countries where graduate figures have been below the labour force growth because obviously the capacity exists, if not, the growth could not have occurred. In some countries, the supply of graduates is anyway bigger than this figure and therefore in these countries no changes are made to the model inflows. The main countries affected by the raise of inflow are France and Germany, followed by Sweden. This additional inflow might represent in-migration or outsider recruitment from STEM or other disciplines.

In the 'high growth scenario', the ICT specialist workforce in Europe will grow from 8.5 million in 2016 to 9.5 million in 2020, of which 8.1 million will be ICT practitioners and 1.4 million ICT management and analysis level employees. Demand is increasing by 3.6% per year, from 8.9 million in 2016 to 10.3 million in 2020.

Figure 5-23 e-Skills Jobs – 'High growth scenario' – ICT workforce: Development e-skills Jobs in Europe 2016 – 2020

EU28 (millions)	2016	2017	2018	2019	2020
ICT Management	1,268,000	1,314,000	1,338,000	1,385,000	1,435,000
ICT Practitioners	7,201,000	7,460,000	7,663,000	7,872,000	8,071,000
Total	8,469,000	8,774,000	9,002,000	9,257,000	9,507,000
% Growth	+5.3%	+3.6%	+2.6%	+2.8%	+2.7%

Figure 5-24 e-Skills Demand Potential - 'High growth scenario' – ICT specialist workforce: Development of e-skills Demand Potential in Europe 2016 – 2020

EU28 (millions)	2016	2017	2018	2019	2020

[73] The average growth for the ICT specialist category is only available for the time bracket 2011 to 2016 and is 4.2%.

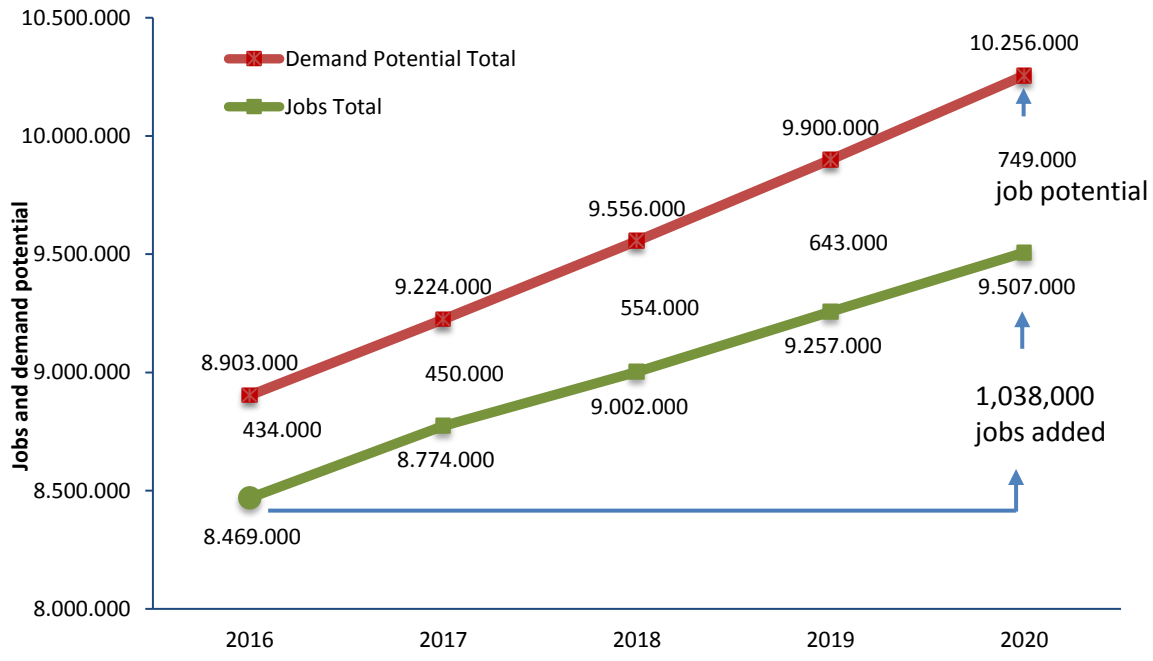
ICT Management	1,314,000	1,361,000	1,410,000	1,461,000	1,514,000
ICT Practitioners	7,589,000	7,862,000	8,145,000	8,438,000	8,742,000
Total	8,903,000	9,224,000	9,556,000	9,900,000	10,256,000
% Growth		+3.6%	+3.6%	+3.6%	+3.6%

The **excess demand** or shortage (calculated as the number of open posts) amounts to **434,000 in 2016** and **749,000 in 2020**. Of these 749,000 there are 671,000 potential additional jobs in ICT practitioner occupations and around 78,000 at ICT management level.

Figure 5-25 e-Skills Vacancies Estimate- 'High growth scenario' – ICT specialist workforce: Summing-up of National ICT Specialist Excess Demand in Europe 2016 – 2020

EU27	2016	2017	2018	2019	2020
ICT Management	46,000	48,000	72,000	76,000	78,000
ICT Practitioners	388,000	402,000	482,000	567,000	671,000
Total	434,000	450,000	554,000	643,000	749,000

Figure 5-26 High growth scenario: ICT Professional Jobs and Demand in Europe (EU-27) 2016 – 2020



5.3.3 Future research

Given the findings above, it should be considered to put further research into the reasons behind the obvious disconnect between workforce growth and graduate figures. One topic for future research could be to analyse

the labour **force survey data with regards to educational backgrounds of different cohorts of ICT specialists**. It may turn out that some educational subjects (e.g. STEM) are particularly overrepresented among "lateral entries", which may also differ according to the different ICT occupations or in individual countries. Another would be to **track cohorts of ICT labour market entrants through their career** to better understand the dynamics and trajectories behind the statistics.

5.4 Core ICT profession workforce forecasts

The following results are preliminary and may be subject to review, especially with regards to future demand development scenarios.

The model follows the same specifications as the one above, but takes account only of the narrower definition of the core ICT profession.

5.4.1 Moderate growth forecast scenario (core ICT profession)

In the 'Moderate growth forecast scenario', the ICT profession workforce in Europe will grow from 5.7 million in 2016 to 6.0 million in 2020, of which 4.6 million will be ICT practitioners and 1.4 million ICT management and analysis level employees. Demand is increasing despite the modest economic circumstances, from 5.9 million in 2016 to 6.4 million in 2020.

Figure 5-27 e-Skills Jobs – 'moderate growth forecast scenario' – ICT workforce: Development e-skills Jobs in Europe 2016 – 2020

EU28 (millions)	2016	2017	2018	2019	2020
ICT Management	1,268,000	1,328,000	1,339,000	1,389,000	1,448,000
ICT Practitioners	4,401,000	4,467,000	4,518,000	4,555,000	4,590,000
Total	5,669,000	5,795,000	5,857,000	5,945,000	6,037,000
% Growth	+5.0%	+2.2%	+1.1%	+1.5%	+1.5%

Figure 5-28 e-Skills Demand Potential - 'moderate growth forecast scenario' – ICT specialist workforce: Development of e-skills Demand Potential in Europe 2016 – 2020

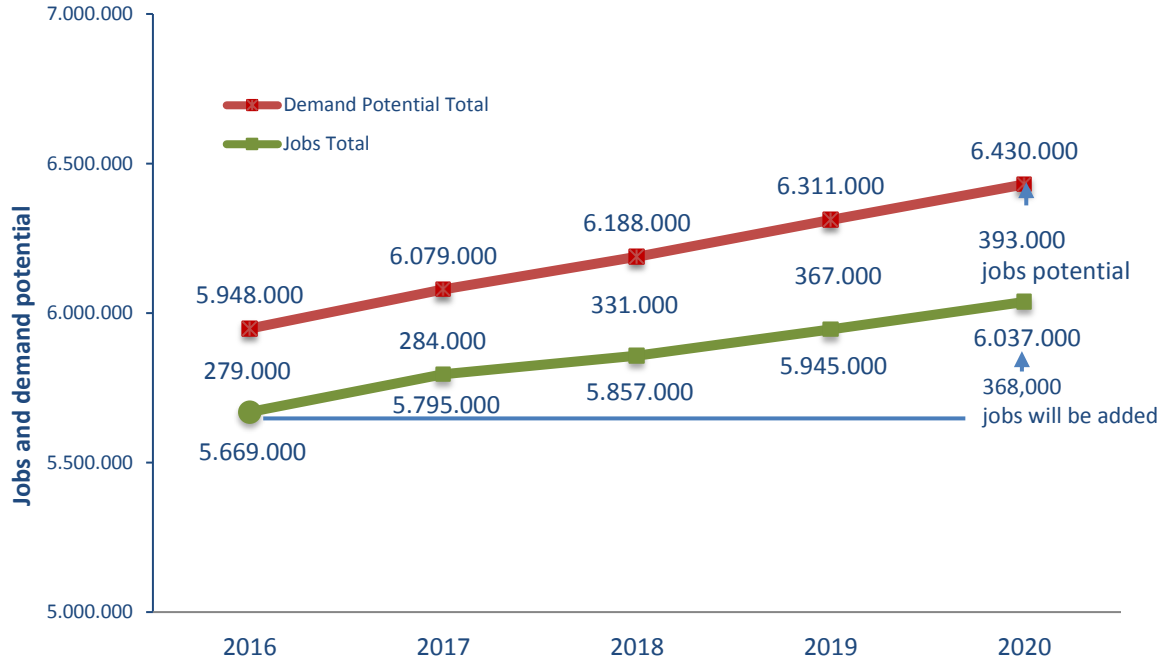
EU28 (millions)	2016	2017	2018	2019	2020
ICT Management	1,314,000	1,376,000	1,434,000	1,498,000	1,557,000
ICT Practitioners	4,634,000	4,703,000	4,754,000	4,813,000	4,874,000
Total	5,948,000	6,079,000	6,188,000	6,311,000	6,430,000
% Growth		2.2%	1.8%	2.0%	1.9%

The **excess demand** or shortage (calculated as the number of open posts) amounts to **279,000 in 2016** and **393,000 in 2020**. Of these 393,000 there are 284,000 potential additional jobs in ICT practitioner occupations and around 109,000 at ICT management level.

Figure 5-29 e-Skills Vacancies Estimate- 'moderate growth forecast scenario' – ICT specialist workforce: Summing-up of National ICT Specialist Excess Demand in Europe 2016 – 2020

EU27	2016	2017	2018	2019	2020
ICT Management	46,000	48,000	95,000	109,000	109,000
ICT Practitioners	233,000	236,000	237,000	258,000	284,000
Total	279,000	284,000	331,000	367,000	393,000

Figure 5-30 Moderate growth forecast scenario': ICT Professional Jobs and Demand in Europe (EU-27) 2016 – 2020



5.4.2 High growth forecast scenario (core ICT profession)

In the 'high growth scenario', the ICT profession workforce in Europe will grow from 5.7 million in 2016 to 6.3 million in 2020, of which 4.8 million will be ICT practitioners and 1.4 million ICT management and analysis level employees. Demand will grow from 5.95 million to 6.85 million.

Figure 5-31 e-Skills Jobs – 'high growth scenario' – ICT workforce: Development e-skills Jobs in Europe 2016 – 2020

EU28 (millions)	2016	2017	2018	2019	2020
ICT Management	1,268,000	1,314,000	1,330,000	1,373,000	1,421,000
ICT Practitioners	4,401,000	4,559,000	4,653,000	4,747,000	4,832,000

Total	5,669,000	5,873,000	5,983,000	6,120,000	6,253,000
% Growth	+5.0%	3.6%	1.9%	2.3%	2.2%

Figure 5-32 e-Skills Demand Potential - 'high growth scenario' – ICT specialist workforce: Development of e-skills Demand Potential in Europe 2016 – 2020

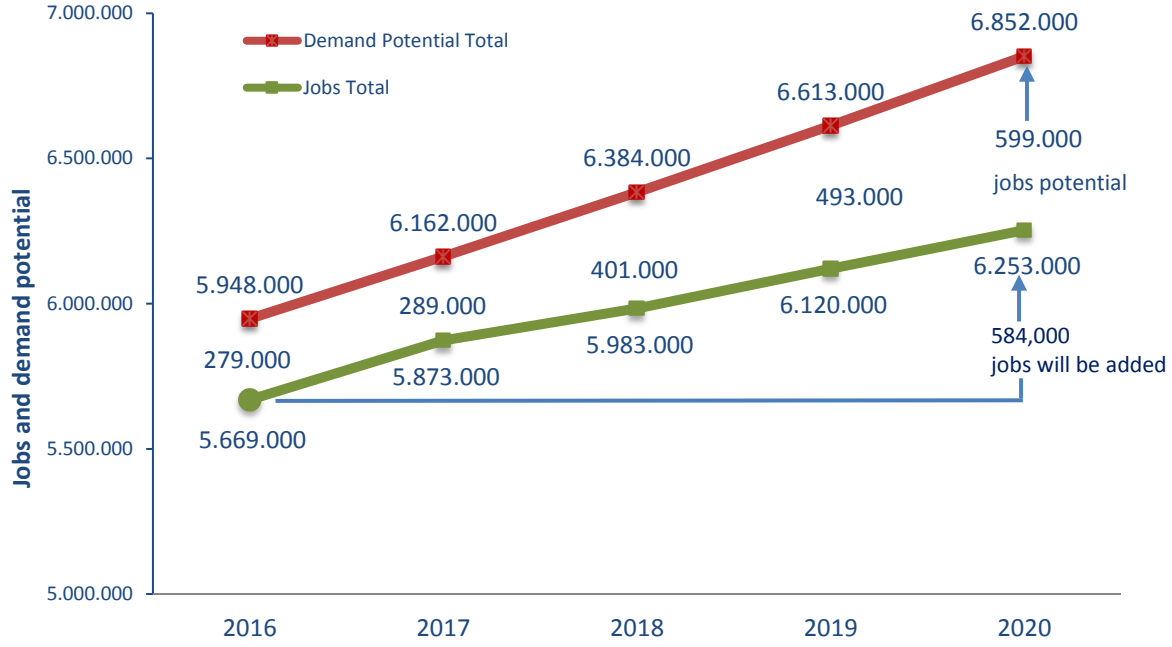
EU28 (millions)	2016	2017	2018	2019	2020
ICT Management	1,314,000	1,361,000	1,410,000	1,461,000	1,514,000
ICT Practitioners	4,634,000	4,800,000	4,973,000	5,152,000	5,338,000
Total	5,948,000	6,162,000	6,384,000	6,613,000	6,852,000
% Growth		3.6%	3.6%	3.6%	3.6%

The **excess demand** or shortage (calculated as the number of open posts) amounts to **279,000 in 2016** and **599,000 in 2020**. Of these 599,000 there are 506,000 potential additional jobs in ICT practitioner occupations and around 93,000 at ICT management level. Demand is increasing despite the modest economic circumstances, from 5.9 million in 2016 to 6.4 million in 2020.

Figure 5-33 e-Skills Vacancies Estimate- 'high growth scenario' – ICT specialist workforce: Summing-up of National ICT Specialist Excess Demand in Europe 2016 – 2020

EU27	2016	2017	2018	2019	2020
ICT Management	46,000	48,000	81,000	88,000	93,000
ICT Practitioners	233,000	241,000	320,000	405,000	506,000
Total	279,000	289,000	401,000	493,000	599,000

Figure 5-34 High growth scenario: ICT Professional Jobs and Demand in Europe (EU-27) 2016 – 2020



5.5 e-Leadership Skills

5.5.1 Definition

e-Leaders have been defined as leaders with high tech leadership and innovation skills (short e-leadership skills) and as people capable of driving successful innovation and capitalizing on new digital and key enabling technologies. These skills are not usually captured in any statistical system and hence assumption about their prevalence needs to be made when trying to quantify the "order of magnitude" or range of likely size of these skills in the labour market.

Sufficient supply of high-tech leadership skills to the economy can arguably be attributed to fostering innovation, economic growth and creating jobs. These competences are key inputs to initiating, guiding and establishing digital innovation at all levels of enterprise, from the start-up to the largest of corporations, from private to public.

On an individual level, high tech and innovation leaders are defined as both business and digitally savvy, and having the capability to lead strategically. They might be digital leaders who are also business-savvy or business leaders who are digitally-savvy. E-leadership involves leading and managing e-skilled professionals as well as other professionals.

Figure 5-35 The e-Leadership triangle[74]

[74] From: Hüsing, Tobias, E. Dashja, K. Gareis, W.B. Korte, T. Stabenow, P. Markus: e-Leadership Skills for Small and Medium Sized Enterprises. Final Report. Bonn 2015

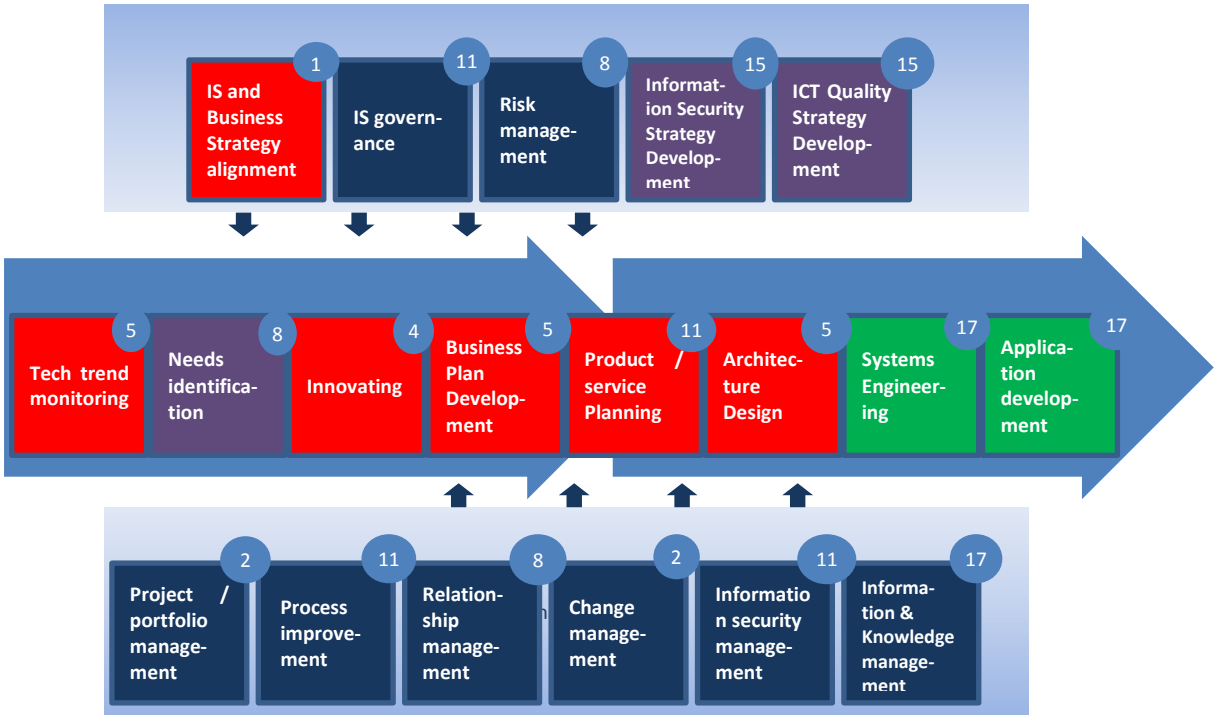
The three domains of skills **digital skills**, **business skills** and **strategic leadership skills** have been further spelled out into specific skills within the taxonomy of the e-CF[75], and most of these skills are well defined, enabling and following through the innovation process. In defining e-leadership through the e-CF, these have been organised as strategic, management, innovation/transformation and creative/implementation skills[76]:

Figure 5-36 Mapping key e-CF e-Leadership competences[77]

[75] http://ecompetences.eu

[76] See fn 1.

[77] For the e-CF taxonomy, see: http://ecompetences.eu. The current version (3.0) - released in December 2013 - does not fully cover the definition of e-Leadership. This will be addressed in the new version.



Legend:

15 e-Leadership relevance ranking of e-CF compentences

High tech and innovation leadership skills needs are rather diverse across industries, enterprise sizes and enterprise or product life-cycle stages. Also, due to the dynamics of technological developments, in entrepreneurship and management science will evolve over time. High tech and innovation leadership skills are combinations of a sufficient number and level of skills from all three domains.

Competences that are arguably not covered well by the e-CF include **industry specific** knowledge, skills and competences (such as the knowledge about the automotive sector that an e-leader in that sector needs. Also, **product specific** knowledge, skills and competences (which may also be **company specific**) are not covered by the e-CF. As the e-CF is a generic tool, including these competences would clearly stretch it beyond its purpose.

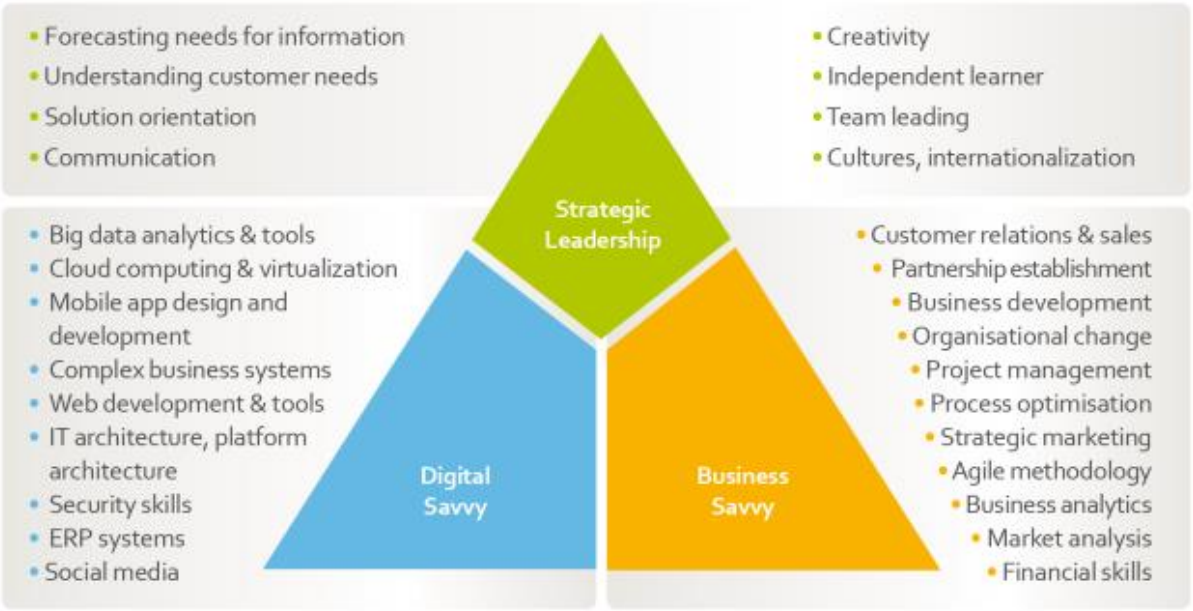
5.5.2 Requirement analysis

High tech and innovation leadership skills requirements by SMEs and entrepreneurs were researched in the LEAD project[78]. Requirements of e-leadership education appear very diverse, yet some patterns emerge from the analysis. Fast growing SMEs and entrepreneurs have many competence needs in the three skill areas that constitute e-leadership: IT savvy, business acumen and strategic leadership skills.

The following picture contains the competence requirements as gathered through qualitative research.

Figure 5-37 Entrepreneurial and fast growing SMEs' competence requirements gathered through qualitative research

[78] See footnote 74



5.5.3 Quantification of e-Leadership demand and employment

Previous work under service contracts for the European Commission relating to e-leadership skills in Europe has relied on different methods used to estimate the e-leadership demand and supply in Europe. In a first instance, for the VISION service contract[79] an estimation of the demand has been based **on the sector and size structure of businesses in Europe**, for complete lack of empirical data simply assuming that an enterprise of a certain size and in a certain, more or less ICT intensive sector needs on average a certain number of e-leadership skilled employees. Supply estimation was based on occupational data and assumed that a certain percentage of several occupations (such as ICT and R&D executives) are e-leaders. This resulted in an estimate of a **demand for 594,000 e-leadership positions in Europe in an updated calculation in 2015. We will present an update of this estimation further below.**

A second, **survey based methodology** was used in the service contract *New Curricula for e-Leadership Skills: Guidelines and Quality Labels for New Curricula for e-Leadership Skills in Europe*. In 2013, empirica surveyed 900 enterprises of the business economy and public sector with the intention to estimate the number of employees that could be seen as e-leaders[80]. The result of this method was an **estimated stock of e-leaders of 568,000 in Europe in 2013.**

In addition to the exercises to estimate the incidence of e-leadership skills in Europe, a **third method** was tried in **2015** under the service contract *Promotion of e-Leadership Skills in Europe* to capture the current demand for e-leadership skills that is **based on posted online vacancies**. For this estimation, we want to present an update for 2018 data.

5.5.4 Method: online vacancy analysis

The first quantification is based on identifying vacancies posted (job advertisements) that require a set of skills that can likely be of e-leadership quality.

[79] Hüsing, T, W. Korte, N. Fonstad, B. Lanvin, G. Cattaneo, M. Kolding, R. Lifonti, D. van Welsum: e-Leadership e-Skills for Competitiveness and Innovation. Vision, Roadmap and Foresight Scenarios. Final Study Report. Bonn 2013.

[80] Robinson, S. S. Manwani, L. Hendriks, B. Hanny, T- Hüsing, P. Jaschke: New Curricula for e-leadership skills. Guidelines and quality labels for new curricula for e-leadership skills in Europe. Interim Study Report. Bonn 2013.

“e-Leaders” are a meta-class of jobs, and given job titles of people who would actually be identified as “e-Leaders” based on their skills and job tasks, will quite probably not indicate e-leadership. However, we assume that at least a subset of desired e-leadership skills and criteria will be used in the formulation of job postings. Analysing job posts, it should be possible to rate vacancies and identify and classify some as e-leadership positions to a satisfactory degree.

For such an endeavour, one needs a database of online vacancies which is satisfactorily complete, reduplicated and searchable.

Another assumption is furthermore that a certain, stable and significant proportion of all e-leadership positions are advertised online. Given the fact that many leadership positions are not, in fact, posted in a manner as it is common for non-leadership professionals, it is important to develop an idea of what share of vacant leadership positions are in fact publicly visible. Hiring for many of these positions will be either through internal recruiting, through personal communication or through staffing service providers such as “head hunters”.

Another prerequisite of using online data for e-leadership quantification is to define and validate e-leadership skills, personal attributes or job tasks in such a way that they can be satisfactorily enumerated as string text for text mining approaches. This is not trivial, as text strings need to be selected so as to minimise both false positive and false negative hits. It relies also on the assumption that e-leadership skills and attributes are mentioned in the advertisement text body and not just tacitly assumed (i.e. taken as givens for certain hierarchy levels or job titles) from applicants.

We used jobfeed, an online database by Textkernel B.V. to identify e-leadership vacancies. Jobfeed is a proprietary database storing full text job ads scraped from the internet. We used data from five countries (DE, UK, FR, NL, AT) in 2015 which together cover 66% of the European employment of ICT management, architecture and analysis job. In 2018, we can also use data from Belgium as sixth country as well.

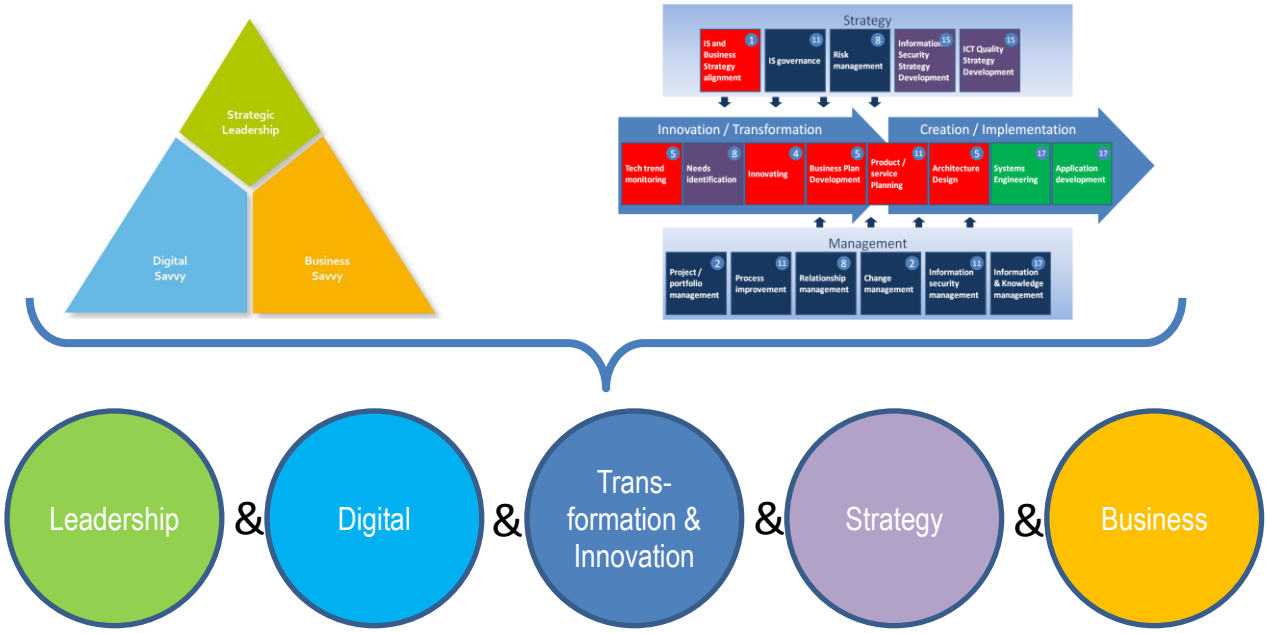
The operationalisation of e-leadership was based on conceptual work carried in the project “e-Leadership – digital skills for SMEs and start-ups”. To be classified as an e-Leadership job advert, a posting needed to cover five areas of requirements:

- Leadership
- Digital
- Transformation and innovation
- Strategy and
- Business

For each of these areas, search terms were derived from a text analysis of 100 hand selected e-leadership positions.

Figure 5-38 e-Leadership concept for keyword operationalisation and search algorithm

The e-Leadership pyramid *e-Leadership expressed in e-CF competences*



An iterative approach to hone selection of terms was used, reviewing many query results for (presumed) hits, but also false positives and (more difficult) false negatives. The challenge here is to create discriminatory keywords while not excluding too many would-be e-leaders. Certain industries or job categories could be excluded based on jobfeed's built in taxonomies. Co-occurrence analyses were run to select the best fitting search phrases.

The result presented concerns all jobs active (i.e. still online, checked daily) on the 17-11-2015 and on 21-02-2018, posted no more than 4 months prior to that date and fulfilling the developed search term query. For the five countries covered, these were as follows.

Figure 5-39 Identified online vacancies matching the e-leadership search algorithm in November 2015

	DE	AT	UK	NL	FR	BE
Number of vacancies 2015	2,481	157	939	603	1,245	N/A
Number of vacancies 2018	3,384	283	16,906	3,244	16,920	4,468*
Increase	+36%	+80%	+1700%	+438%	+1259%	N/A

* In Belgium, there were 1,859 job ads in Dutch and 2,609 job ads in French. It is however unclear how many of these are translated duplicates.

In total, 5425 e-leadership vacancies were found in the five countries in 2015 compared to 45,205 ads in six countries in 2018. Given that two thirds of Europe's ICT management, architecture and analysis jobs are found in the five countries covered, using this ratio to extrapolate to Europe gives us an estimated number of **8,168 *posted online* vacancies for e-Leaders in Europe in 2015** and an estimation for Europe for **2018 of 64,489 *posted online* vacancies for e-Leaders**.

To arrive at an estimation of the number of actual open posts, an assumption is necessary about the share of published vacancies in all e-leader vacancies. For leadership positions, the share of vacancies not posted but hired through personnel service providers (head hunters) or otherwise is rather high, as research with CIOs

and personnel service providers has indicated. We therefore use a 50% parameter. The estimation of open e-leadership positions therefore is multiplied by the inverse of 50%, 2, returning **an e-leadership vacancy total of 16,336** for the EU-28 in November 2015 and **an e-leadership vacancy total of 128,978** for the EU-28 in February 2018.

Given the **estimation of 600,000** actual e-leadership jobs in 2015, and given the estimation of 16,336 vacancies, the resulting vacancy rate were to amount to 2.65%. This compares to an overall Job vacancy rate (JVR) for the total economy of 1.8%, and 2.1% for the service sectors. In the information and communication sector, the JVR amounts to 2.9%.

Applying the **2.65%** vacancy rate to the 2018 data would give us **an e-leadership skilled workforce of 4,867,092 in 2018.**

The vacancy rate of ICT professional jobs based on vacancy counts and ISCO data has been estimated to be **5.7%** in 2017, which is a rather high value due to skills shortages. Applying this JVR to the 2018 data we would come to a result of **2,744,211 e-leadership jobs. This is obviously a very unreliable figure, given the comparison with previous estimates.**

As a conclusion, one may say that open vacancy measurement is possible, under several assumptions which may strongly influence the end result. This statistic is presently giving us a very volatile metric and for the time being no conclusions other than that a significant growth in e-leadership must have taken place can be made. Further research into why there has been such a tremendous growth of online vacancies which feature the developed term for e-leadership identification is needed.

5.5.5 Method: economic business structure analysis

As mentioned already above, there has been a first attempt at estimating the demand for e-leadership already in 2013. This demand estimation is based **on the sector and size structure of businesses in Europe**, for complete lack of empirical data simply assuming that an enterprise of a certain size and in a certain, more or less ICT intensive sector needs on average a certain number of e-leadership skilled employees.

Our estimation in 2016 resulted in an estimated total demand of 594,000 e-leaders.

Figure 5-40**: e-Leadership skills demand proxy: business structure 2016**[81]

2016 Type of sector	Size of firm	Assumed demand of e-leaders per enterprise	Number of enterprises	Estimated TOTAL demand of e-leaders by firm type
ICT sector	medium	**4**	7,000	28,000
	large and very large	**8**	1,500	12,000
High ICT intensity sectors	medium	**2**	65,000	130,000
	large and very large	**5**	15,000	75,000
Low ICT intensity sectors	medium	**1**	155,000	155,000
	large and very large	**2**	27,000	54,000
All sectors	high growth SMEs	**1**	140,000	140,000
TOTAL				**594,000**

Source: Eurostat: [sbs_sc_sca_r2] and [bd_9pm_r2]

An updated data gathering of the European Business Structure in 2018 resulted in the following business structure:

Figure 5-41**: e-Leadership skills demand proxy: business structure 2018**

2018 Type of sector	Size of firm	Assumed demand of e-leaders per enterprise	Number of enterprises	Estimated TOTAL demand of e-leaders by firm type
ICT sector	medium	**4**	**8,300**	**33,200**
	large and very large	**8**	**1,800**	**14,400**
High ICT intensity sectors	medium	**2**	**67,000**	**134,000**
	large and very large	**5**	**16,000**	**80,000**
Low ICT intensity sectors	medium	**1**	**154,000**	**154,000**
	large and very large	**2**	**28,000**	**56,000**
All sectors	high growth SMEs	**1**	**158,000**	**158,000**
TOTAL				**629,600**

Source: Eurostat: [sbs_sc_sca_r2] and [bd_9pm_r2]

The growth of demand as a result of the growth of the number of firms in the respective business sectors between 2016 and 2018 would thus amount to 35,600, which would correspond to a CAGR of 3.0%.

5.5.6 Conclusions

There is quite probably a continuing trend towards more e-Leadership skilled employment. As e-Leadership skills are acquired by a mix of work experience, education and training – these are key levers for supply side measures to improve European e-leadership.

However, measurement is problematic as yet. A fully satisfactory statistic that might present a reliable figure of the status quo of e-leadership skills present in the current workforce is not available. To arrive at order-of-magnitude estimations, bold assumptions need to be made to arrive at figures of labour market incidence.

In 2015 and 2016, different estimations that we have carried out, seemed to support the presumption that the order of magnitude of digital leadership skills in the EU lies at roughly 600,000 digital innovation leaders. It has

[81] See http://leadership2017.eu/fileadmin/scale_conference/documents/huesing_20170126.pdf

to be stressed that this figure is very tentative and that without actual measurement of skills no statistical detection of growth or decline of these skills in the workforce is possible.

The methods used in this estimation do not strictly lend themselves to producing time series data. The industrial structure changes over time for many reasons, so that taking this structure as an indication of e-leadership demand can give rough estimates about the order of magnitude, but not concerning changes over short periods of time. However, using the indicator approach, there has been a 3% y/y growth recently in demand for e-leadership positions.

Open vacancy measurement is possible, under several assumptions which may strongly influence the end result. This statistic is, however, for the time being, providing a very volatile metric and for the time being no conclusions other than that a significant growth in e-leadership must have taken place can be made. More big data based research into job advertisements, e.g. what are the emergent job titles of e-leaders, and are maturing job roles discernible from task descriptions might one day result in “e-leader” being a discernible set of classification categories with the potential of translation into official standards such as ISCO.

Appendix A: Longlist of IT organisational and management frameworks

A.1.1 Recognised IT organisational and management frameworks

IT Development	
Agile/DevOps DevOps: a clipped compound of software development and information technology operations	Agile: set of principles for software development under which requirements and solutions evolve through the collaborative effort of self-organizing cross-functional teams. DevOps: set of practices that emphasize the collaboration and communication of both software developers and information technology (IT) professionals while automating the process of software delivery and infrastructure changes.
ASL Application Services Library	Vendor independent set of practices that focus on application management.
Agile/Scrum	Agile: set of principles for software development under which requirements and solutions evolve through the collaborative effort of self-organizing cross-functional teams. Scrum: is an iterative and incremental agile software development framework for managing product development
ISTQB International Software Testing Qualifications Board	Software testing qualification certification organisation that operates internationally.
TMAP TMAP: Test Management Approach	Test method for software
HFI Human Factors International	Process to integrate human factors and ergonomics into the systems engineering process.
SWEBOK Software Engineering Body of Knowledge	Standard for the practice of Software engineers.
DMBOK Data Management Body of Knowledge	Standard for the practice of Data management network professionals.
TPI Next Test Process Improvement	Methodology to assess the maturity of an organisation's or project's test process

OpenStack	Free and open-source software platform for cloud computing, mostly deployed as infrastructure-as-a-service (IaaS), whereby virtual servers and other resources are made available to customers.
Waterfall	Sequential (non-iterative) design process, used in software development.

IT Management	
COSO / COSO II or ERMF Committee Of Sponsoring Organisations of the Treadway Commission / Enterprise Risk Management Framework	Frameworks and guidance on enterprise risk management, internal control and fraud deterrence.
ITIL Information Technology Infrastructure Library	Set of practices for IT service management that focuses on aligning IT services with the needs of business.
ISO 20000 International Standard Organisation	International standard for IT service management.
COBIT Control Objectives for Information and Related Technologies	Implementable set of controls over information technology and organizes them around a logical framework of IT-related processes and enablers.
CMMI Capability maturity model integration	Process level improvement training and appraisal program.
Lean-IT	Extension of lean manufacturing and lean services principles to the development and management of IT products and services
ISO 27001 International Standard Organisation	Information security standard for an information security management system.
CISSP Certified Information Systems Security Professional	Independent information security certification.
CISA Certified Information Systems Auditor	Independent information system auditing certification.
CISM Certified Information Security Manger	Independent information security management certification.

SNABOK System and Network Administration Body of Knowledge	Standard for the practice of IT network professionals.
ISO ; OSI International Standard Organisation; Open Systems Interconnection	Conceptual model that characterizes and standardizes the communication functions of a telecommunication or computing system.
ISO 9001:2000 International Standard Organisation	Specifies requirements for a quality management system
SIAM Service Integration and Management	Approach to managing multiple suppliers of services (business services as well as information technology services) and integrating them to provide a single business-facing IT organisation.

Architecture	
TOGAF The open group architecture framework	Framework for enterprise architecture that provides an approach for designing, planning, implementing, and governing an enterprise information technology architecture.
Archimate	Open and independent enterprise architecture modelling language to support the description, analysis and visualization of architecture within and across business domains in an unambiguous way

Project Management	
PMBOK Project Management Body of Knowledge	Set of standard terminology and guidelines for project management.
PMI Project Management Institute	US non-profit professional organisation for project management.
Prince2 Projects in controlled environments	Structured method for project management.
IPMA International Project Management Organisation	Member organisation for project management.

Business Management	
BABOK Business Analysis Body of Knowledge	Standard for the practice of business analysis.
BiSL (Business Information Services Library)	Vendor independent set of practices that focus on implementation of business information management.
Balanced Scorecard	is a strategy performance management tool – a semi-standard structured report, supported by design methods and automation tools, that can be used by managers to keep track of the execution of activities by the staff within their control and to monitor the consequences arising from these actions
Lean - Six Sigma	Methodology relying on a collaborative team effort to improve performance by removing waste and reducing variation. It combines lean manufacturing/lean enterprise and Six Sigma to eliminate of waste.
CBPP Certified Business Process Professional	Certification about Process management, Process improvement, Process transformation experience.
CBPA Certified Business Process Associate	Business Process Management (BPM) practitioner certification
Design thinking	Refers to creative strategies designers utilize during the process of designing.

A.1.2 Emerging IT organisational and management frameworks

Emerging frameworks	
SAFe	Scaled Agile Framework – Agile for programs and portfolio
DASA	DevOps Agile Skills Association – competence framework for Agile DevOps teams
LeSS	Large Scale Scrum – up scaling Agile teams
Nexus	Framework that binds scrum teams working on a single product
12 factor app	methodology for building software-as-a-service apps
CMAP	CMAP Mobile App Testing
Edison	Data Science framework
TRIZ	Innovation; theory of inventive problem solving

Appendix B: Characteristics most important digital organisational and management frameworks

A.1 Capability Maturity Model Integration (CMMI)

Summary

CMMI belongs to the CMMI® Institute, which helps organisations discover the true value they can deliver by building capability in their people and processes. CMMI® Institute is the global leader in the advancement of best practices in people, process, and technology. The Institute provides the tools and support for organisations to benchmark their capabilities and build maturity by comparing their operations to best practices and identifying performance gaps. For over 25 years, thousands of high-performing organisations in a variety of industries, including aerospace, finance, healthcare, software, defence, transportation, and telecommunications, have earned a CMMI maturity level rating and proved they are capable business partners and suppliers.

Objective for the IT professional

CMMI offers multiple models focusing on development, services, acquisition, people, and data management while it also comes in two flavours – staged and continuous. 5 CMMI maturity levels are a well-defined evolutionary plateau toward achieving a mature software process for continuous process improvement.

Key characteristics

Origin

In August 1991, the first version of the Capability Maturity Model for Software (SW-CMM) was published by the Carnegie Mellon University's Software Engineering Institute (SEI).

Popularity

Organisations use CMMI to elevate performance in 101 countries on all continents, but CMMI is less popular in Africa compared to other continents. CMMI® Institute completed a total of 1,600 appraisals in 2013. CMMI® Institute reported an 11% increase in CMMI appraisals in 2013 than the previous year.

Speciality and focus areas

CMMI for Development	Provides guidance for improving an organisation's capability to develop quality products and services that meet the needs of customers and end users
CMMI for Services	Helps an organisation to provide superior service by strengthening weak customer touch points and enhancing the customer experience
CMMI for Acquisition	Helps to define requirements to identify capable suppliers and vendors that can help reduce costs, manage quality, increase efficiency and mitigate delays
People Capability Maturity Model	Identifies skill gaps to break down workflow bottlenecks and empower team members to develop skills that will help the organisation succeed
Data Management Maturity Model	Enables to build a customized roadmap for data management

	improvement while providing best practices for implementing data strategy, governance, quality, operations, and architecture
SCAMPI Assessments	Includes Class A, B, and C appraisal methods while the SCAMPI A appraisal method is the officially recognised and most rigorous method which results in benchmark quality ratings
Integrated Capability Model	Includes a common set of process areas which form the core of an integrated capability model that integrates process improvement guidance for systems engineering, software engineering, and IPPD

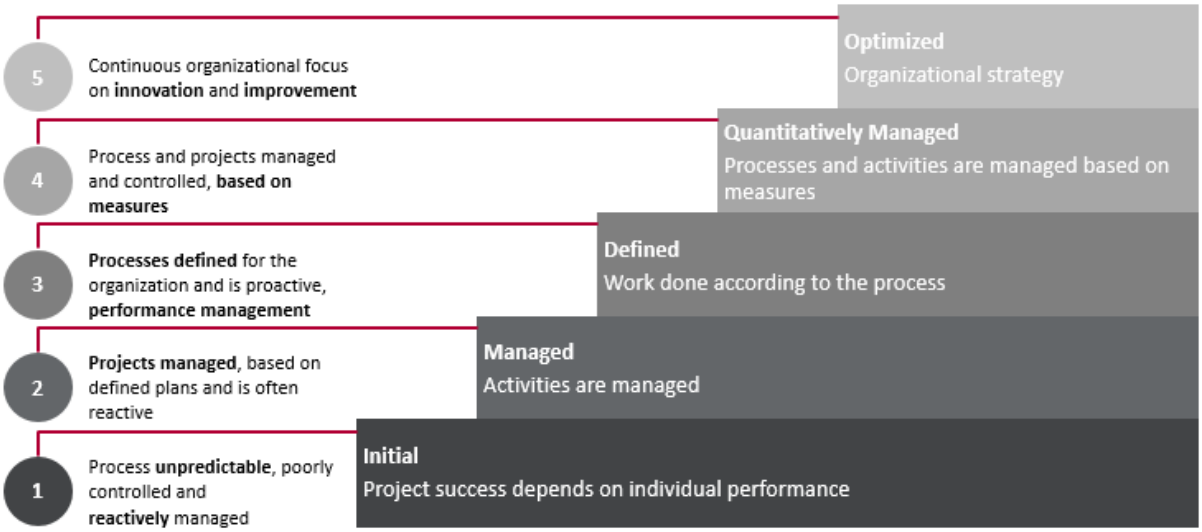
Certification levels

Certification includes continuous representation capability levels: Level 0 – Incomplete, Level 1 – Performed, Level 2 – Managed, Level 3 – Defined. It also includes staged representation maturity levels: Level 1 – Initial, Level 2 – Managed, Level 3 – Defined, Level 4 – Quantitatively Managed, Level 5 – Optimizing.

Good practice of application of the framework: Allianz UK[82]

Allianz UK began its CMMI change program to build foundational capabilities, targeting project management and engineering innovation, and data management. Performance improved with a 39 percent increase in project on-time delivery rates, a 123 percent increase in projects delivered on budget, and a 53 percent jump in customer satisfaction.

Structure



Mapping to e-CF competences

[82] http://cmmiinstitute.com/sites/default/files/CMMI_Allianz_Case%20Study_June%202016.pdf

CMMI Competencies	Description	Competences in e-CF	CMMI Certification Level	Skill Level
Achieving and Managing Agreements	▪ Reach, manage and support agreements with stakeholders and sponsors ▪ Monitor with corrective actions	Plan A2. Service Level Management Enable D8. Contract Management	▪ Certified CMMI Associate	
Decision Making and Problem Solving	▪ Identify issues and potential solutions ▪ Evaluate and mitigate risks ▪ Identify suitable decision-making method	Manage E3. Risk Management	▪ Certified CMMI Associate ▪ Certified Enterprise Data Management Expert	
Project Planning and Management	▪ Plan, monitor project status and progress ▪ Evaluate advantages & drawbacks ▪ Document information and share	Plan A4. Product & Service Planning Manage E2. Project & portfolio Mgmt	▪ Certified CMMI Associate	
Interpersonal Communication and Facilitation	▪ Conduct interviews & moderate group or team discussions ▪ Implement strategies to resolve conflict	Manage E4. Relationship Management	▪ Certified CMMI Associate ▪ CMMI Instructor Certifications	
Integration, Articulation, and Expression of Information	▪ Aggregate separate but related items of information ▪ Clearly and accurately communicate	Enable D10. Information and knowledge management	▪ Certified CMMI Associate ▪ Certified Enterprise Data Management Expert	
Understanding and Adapting to Organizational Contexts	▪ Identify defining aspects of a company ▪ Identify key questions and key observations highlighting specific issues	Enable D11. Needs Identification	▪ Certified CMMI Associate	
Model Interpretation	▪ Implementing the right CMMI model ▪ Mapping model terminology & concepts to corresponding local terminology	Enable D11. Needs Identification	▪ Certified CMMI Associate ▪ Certified Enterprise Data Management Expert	
Product or Service Tailoring, Adaptation, and Application	▪ Identify appropriate options for the circumstances surrounding a particular delivery of required product or service	Plan A4. Product & Service Planning Enable D11. Needs identification	▪ Certified CMMI Associate	
Professionalism	▪ Competence & skill needs analysis methodologies ▪ Learning & development support methods	Enable D9. Personnel Development	▪ Certified CMMI Associate ▪ CMMI Instructor Certifications ▪ People CMM Certification	

A.2 Six Sigma's Define, Measure, Analyse, Improve and Control (DMAIC) and Define, Measure, Design, Verify (DMADV)

Summary

The international Six Sigma Institute™ is an independent Institute which helps organisations and professionals get accredited with worldwide renowned and recognized Six Sigma Certifications and prove their competence in Six Sigma domain. They empower Six Sigma Professionals worldwide to build their careers and companies to sell their products and services.

Objective for the IT professional

With two widely accepted methodologies, DMAIC and DMADV, Six Sigma offers organisations to reduce defects. The Six Sigma DMAIC approach can be utilized for the customer experience transformation to cover the quality standards with the aim to achieve 99.9997% process efficiency.

Key characteristics

Origin

The Six Sigma methodology was introduced by Bill Smith & Mikel Harry at Motorola in 1986 to measure defects as parts per million. Later, Motorola registered and trademarked the phrase 'Six Sigma'.

Popularity

Six Sigma's Certification Programs have proven their worldwide acceptance and reputation by being the choice of more than 257'000 Six Sigma Practitioners in 143 Countries. Six Sigma's certification programs have been accredited by major global educational excellence institutions such as Global Accreditation and Certification Agency (GACA), American Engineering Council and Association (AECA), International Department of Higher Education (IDHE) and International Commission for Process and Software Engineering (ICPSE).

Speciality and focus areas

Process Variance Reduction	Uses data, measurements & statistics to identify process inefficiencies & applies strategic tools to eliminate defects per million opportunity (DPMO) by decreasing process variation
Six Sigma DMAIC	Defines, measures, analyses, improves and control existing processes, currently falling below Six Sigma Standard or not performing up to its highest standards
Six Sigma DMADV	Defines, measures, analyses, designs and verifies new services or products intended to attain Six Sigma Quality or when there's a failure while using DMAIC for a current project or process
Define, Measure & Analyse	First three steps of Six Sigma methodologies focus on defining a problem, measuring process performance and analysing processes to determine the root cause of variation or defects
Improve & Control	Helps in improving process performance by addressing root cause and preparing and implementing a control plan to keep an improved process at its current level
Design & Verify	Focuses on designing an improved process in line with customer's need and requirement, followed by verifying the design by pilot runs to check acceptance of new process to all stakeholders
Quality Management Tools	Along with DMAIC & DMADV, it offers multiple tools that are used alongside and outside of Six Sigma such as 5 whys, regression analysis, business process mapping, root cause analysis, etc.

Certification levels

The Six Sigma certification comes in various skill levels – White Belt, Yellow Belt, Green Belt, Black Belt and Master Black Belt offered by an accreditation body. There is not one particular accreditation body. There are professional associations, university certification programs and for-profit training organisations.

Good practice of application of the framework: DuPont[83][84]

DuPont is a company in the chemicals industry. To reduce costs and boost network reliability, DuPont used Six Sigma DMAIC to optimize the performance of its European-wide area network. The team identified outdated technology and steady network volume increases as sources of reliability issues. DuPont replaced 25 to 50 percent of WAN equipment and renegotiated a contract with a fixed pricing structure to allow for volume increases up to 25%. DuPont succeeded in saving 35% of WAN costs, a total of $2.6 million, and improved network uptime from 97 to 99.8%. DuPont continued to expand their use of Six Sigma in order to help customers improve their own operations.

[83] https://www.oecd.org/site/ictworkshops/year/2006/37599367.pdf

[84] https://www.isixsigma.com/industries/chemicals/dupont-six-sigma/

Structure

Mapping to e-CF competences

Six Sigma Competencies	Description	Competences in e-CF	Six Sigma Certification Level	Skill Level
Define Project Requirements	▪ Identify owners and stakeholders ▪ Define project scope & project metrics ▪ Apply project planning tools	Plan: A1. Business Strategy Alignment A3. Business Plan Development	▪ Six Sigma Yellow Belt ▪ Six Sigma Green Belt ▪ Six Sigma Black and Master Black Belt	
Measure System & Data	▪ Define measurement and metrology ▪ Identify use of measurement systems ▪ Measure tollgate review	Plan: A4. Product & Service Planning Manage: E1. Forecast Development	▪ Six Sigma Yellow Belt ▪ Six Sigma Green Belt ▪ Six Sigma Black and Master Black Belt	
Analysis	▪ Select and use contingency tables ▪ Undertake hypothesis testing ▪ Perform root cause, GAP & waste analysis	Plan: A7. Technology Trend Monitoring Manage: E1. Forecast Development	▪ Six Sigma Yellow Belt ▪ Six Sigma Green Belt ▪ Six Sigma Black and Master Black Belt	
Quality Control/ Facilitate Improvement	▪ Describe design of Experiments ▪ Select and apply various mitigation tools ▪ Plans for implementing improvements	Manage: E3. Risk Management E5. Process Improvement	▪ Six Sigma Yellow Belt ▪ Six Sigma Green Belt ▪ Six Sigma Black and Master Black Belt	
Control & Maintenance	▪ Review and evaluate measurement system capability ▪ Develop a control plan for maintenance	Manage: E5. Process Improvement E6. ICT Quality Management	▪ Six Sigma Yellow Belt ▪ Six Sigma Green Belt ▪ Six Sigma Black and Master Black Belt	
Project Management	▪ Project execution ▪ Project oversight & management ▪ Project management infrastructure	Manage: E7. Business Change Management	▪ Six Sigma Yellow Belt ▪ Six Sigma Green Belt ▪ Six Sigma Black and Master Black Belt	
Financial Review/ Validation	▪ Identify and apply tools for ongoing evaluation of the improved process ▪ Describe methods of Savings validation	Manage: E3. Risk Management E6. ICT Quality Management	▪ Six Sigma Yellow Belt ▪ Six Sigma Green Belt ▪ Six Sigma Black and Master Black Belt	
Organizational Process Management	▪ Define various types of benchmarking ▪ Describe performance and financial measures	Plan: A1. Business Strategy Alignment Manage: E6. ICT Quality Management	▪ Six Sigma Yellow and Green Belt ▪ Six Sigma Black Belt ▪ Six Sigma Master Black Belt	
Leadership & Team Management	▪ Understand leadership responsibilities ▪ Identify organizational roadblocks ▪ Use team formation theories	Plan: A4. Product & Service Planning Manage: E7. Business Change Management	▪ Six Sigma Yellow and Green Belt ▪ Six Sigma Black Belt ▪ Six Sigma Master Black Belt	

A.3 Information Technology Infrastructure Library (ITIL)

Summary

ITIL belongs to Axelos and is the most widely accepted approach to IT service management in the world. ITIL can help individuals and organisations use IT to realize business change, transformation and growth. ITIL advocates that IT services are aligned to the needs of the business and support its core processes. It provides guidance to organisations and individuals on how to use IT as a tool to facilitate business change, transformation and growth.

Objective for the IT professional

ITIL offers five certification levels while specializing on service strategy, service design, service transition, service operation, and continual service improvement. ITIL Service Management supports business transformation using the 5 stage Service Lifecycle, where each stage is dependent on processes and the other lifecycle stages. With a comprehensive, consistent and coherent set of best practices focused on the management of IT service processes, ITIL provides means for managing the IT projects.

Key characteristics

Origin

Originally, ITIL and was developed by the Central Computer and Telecommunications Agency (CCTA) as a set of comprehensive and inter-related codes of practice in 1989-96.

Popularity

One ITIL exam is taken every 1.5 minutes across the globe and 1.5 million ITIL exams are taken in over 150 countries worldwide so far.

Speciality and focus areas

IT Service Management	Supports business outcomes, enables business change, manages risk in line with business needs, optimizes customer experience, and shows value for money and continuous improvement
Service Strategy	The collaboration between business strategists and the IT service provider to develop IT service strategies that support the business strategy
Service Design	The design of the overarching IT architecture and each IT service to meet customers' business objectives by being both fit for purpose and fit for use
Service Transition	The management and control of changes into the live IT operational environment, including the development and transition of new or changed IT services
Service Operation	The delivery and support of operational IT services in such a way that they meet business needs and expectations and deliver forecasted business benefits
Continual Service Improvement	The process of learning from experience and adopting an

	approach which ensures continual improvement of IT services
ITIL Maturity Models	There are two models - high level self-assessment service, which is freely available and full self-assessment service, which is a paid for service

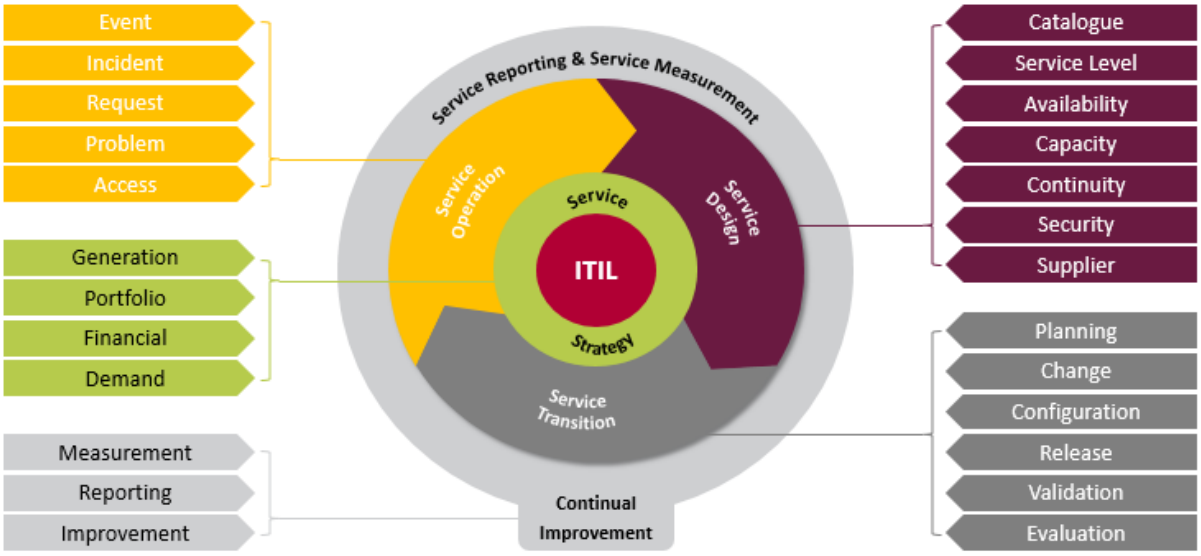
Certification levels

There are multiple maturity levels: Level 0 – Absence, Level 1 – Initial, Level 2 – Repeatable, Level 3 – Defined, Level 4 – Managed, Level 5 – Optimized. There are five certification levels within the scheme: foundation level, practitioner level, intermediate level, expert level, and master level.

Good practice of application of the framework: **Walt Disney**[85]

Disney began adopting ITIL best practice in the mid-2000s. They launched campaigns like "Lunch 'n' Learn", and internal social networking tool "BackLot" to raise employee awareness on ITIL. Moreover, 250 people were trained in the ITIL Foundation and 20 champions were selected, putting them on the path to expert level. This resulted in a great guest experience and assured better service management.

Structure



[85] https://www.axelos.com/case-studies-and-white-papers/disneys-itil-journey-case-study

Mapping to e-CF competences

ITIL Competencies	Description	Competences in e-CF	ITIL Certification Level	Skill Level
Service Strategy	▪ Service portfolio management ▪ Financial management ▪ Demand management ▪ Define the market & develop strategic assets ▪ Develop the offerings	Plan A1. Business Strategy Alignment Plan A4. Product & Service Planning Run C3. Service Delivery Manage E2. Portfolio Management	▪ ITIL foundation level certification ▪ ITIL practitioner level certification ▪ ITIL intermediate level certification ▪ ITIL expert level certification ▪ ITIL master level certification	
Service Design	▪ Service level management ▪ IT service continuity management ▪ Information security management ▪ Data and information management ▪ Service catalogue management ▪ Capacity management	Plan A2. Service Level Management Plan A4. Product & Service Planning Plan A6. Application Design Enable D10. Information Management	▪ ITIL foundation level certification ▪ ITIL practitioner level certification ▪ ITIL intermediate level certification ▪ ITIL expert level certification ▪ ITIL master level certification	
Service Transition	▪ Transition planning & support ▪ Change & knowledge management ▪ Service asset & configuration management ▪ Service validation & testing ▪ Stakeholder & deployment management	Run C2. Change Support Enable D11. Needs Identification Manage E5. Process Improvement Manage E7. Business Change Management	▪ ITIL foundation level certification ▪ ITIL practitioner level certification ▪ ITIL intermediate level certification ▪ ITIL expert level certification ▪ ITIL master level certification	
Service Operation	▪ Incident management ▪ Request fulfillment ▪ Event management ▪ Problem management ▪ Access management ▪ Monitoring & control	Run C1. User Support Run C2. Change Support Run C3. Service Delivery Run C4. Problem Management	▪ ITIL foundation level certification ▪ ITIL practitioner level certification ▪ ITIL intermediate level certification ▪ ITIL expert level certification ▪ ITIL master level certification	
Continual Service Improvement	▪ Service level management ▪ Service reporting ▪ Service measurement ▪ Process improvement	Run C2. Change Support Enable D11. Needs Identification Manage E5. Process Improvement Manage E7. Business Change Management	▪ ITIL foundation level certification ▪ ITIL practitioner level certification ▪ ITIL intermediate level certification ▪ ITIL expert level certification ▪ ITIL master level certification	

A.4 Control Objectives for Information and related Technology 5 (COBIT 5)

Summary

COBIT 5 belongs to ISACA is used for the governance and management of enterprise IT is a leading-edge business optimization and growth roadmap that leverages proven practices, global thought leadership and ground-breaking tools to inspire IT innovation and fuel business success.

Objective for the IT professional

COBIT 5 offers five certification levels to improve performance with a balanced framework for IT governance, risk management, security and auditing. The COBIT 5 process reference model defines and describes in detail the governance and management processes within an enterprise relating to IT activities.

Key characteristics

Origin

Information Systems Audit and Control Association (ISACA) released COBIT 1 in 1996, as a set of control objectives to help the financial audit community in IT environments.

Popularity

Around 27,000 COBIT 5 downloads took place in 2015. In 2015, 11,677 COBIT 5 foundation exams were taken. Since its launch in September 2014, 890,000 COBIT 5 online page views.

Speciality and focus areas

Governance of Enterprise IT	COBIT 5 is focused to provide end-to-end business view of the governance of enterprise IT that reflects the central role of IT in creating value for enterprise
Risk Management	COBIT 5 is responsible for establishing an appropriate risk management program and harmonizing it with the risk culture and

	maintaining IT-related risk at an acceptable level
Information Security	Provides guidance to help organisations understand, utilize, implement and direct important information security-related activities, and make more informed decisions
Regulatory & Compliance	Provides several processes to organisations to improve IT performance and meet regulatory and compliance requirements
Audit & Assurance	Provides a roadmap built from well-accepted assurance approaches that enable organisations to effectively plan, scope and execute IT assurance initiatives & demonstrate strategic values
COBIT5 Process Model	Process focus of COBIT 5 is illustrated by a process model that subdivides IT into four domains: Plan and Organise; Acquire and Implement; Deliver and Support; and Monitor and Evaluate
5 Principles and 7 enablers	COBIT 5 has 5 principles based on 7 enablers to help enterprises to create optimal value from IT by building effective governance and management framework

Certification levels

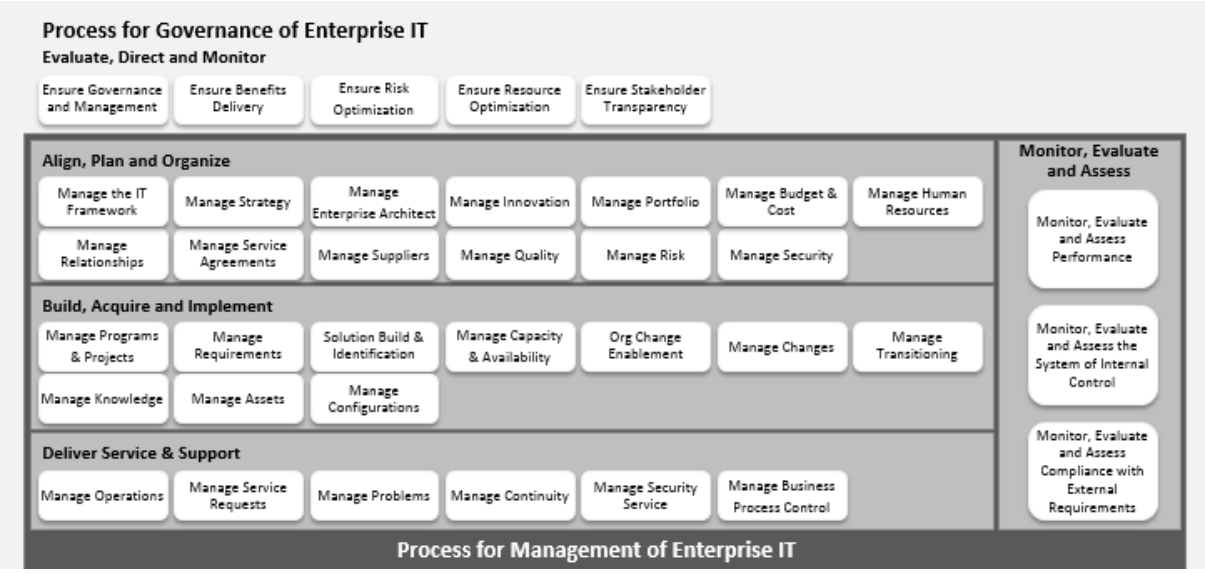
There are five types of courses/ certifications along with the framework: foundation, implementation, assessor, assessor for security and Implementing NIST Cyber Security Framework Using COBIT 5. An exam is associated with each course, once cleared certification is granted.

Good practice of application of the framework: **A Portuguese Private School**[86]

A Private School in Portugal implemented IT Governance using COBIT 5 with significant improvement in the quality of their services. They had a reduction in the execution time of tasks in about 23%, a reduction of 25% of the number of incidents resolved and closed by the several information technology services, and a reduction of 10% in the number of reopened incidents.

[86] http://ieeexplore.ieee.org/document/6263073/?reload=true

Structure



Mapping to e-CF competences

COBIT5 Competencies	Description	Competences in e-CF	COBIT5 Certification Level	Skill Level
Evaluate, Direct & Monitor (EDM)	▪ Governance of enterprise IT ▪ Evaluate stakeholder needs ▪ Prioritization and decision making ▪ Compliance and progress against agreed direction and objectives	Plan A3. Business Plan Development Plan A4. Product & Service Planning Plan A8. Sustainable Development Enable D11. Needs Identification	▪ COBIT5 Foundation ▪ COBIT5 Implementation ▪ COBIT5 Assessor ▪ COBIT Assessor for Security ▪ Implementing NIST Cyber security Framework Using COBIT 5	
Align, Plan and Organize (APO)	▪ IT policy formulation & IT strategy ▪ Enterprise architecture ▪ Innovation ▪ Financial management ▪ Portfolio management	Plan A1. Business Strategy Alignment Plan A5. Architecture Design Manage E1. Forecast Development Manage E2. Portfolio Management	▪ COBIT5 Foundation ▪ COBIT5 Implementation ▪ COBIT5 Assessor ▪ COBIT Assessor for Security ▪ Implementing NIST Cyber security Framework Using COBIT 5	
Build, Acquire and Implement (BAI)	▪ Business analysis & project management ▪ Usability evaluation & Requirements definition and management ▪ Programming & system ergonomics ▪ Software decommissioning ▪ Capacity management	Plan A4. Product/ Service Planning Enable D2. ICT Quality Strategy Dev. Enable D10. Information Management Manage E2. Project Management	▪ COBIT5 Foundation ▪ COBIT5 Implementation ▪ COBIT5 Assessor ▪ COBIT Assessor for Security ▪ Implementing NIST Cyber security Framework Using COBIT 5	
Deliver, Service and Support (DSS)	▪ Availability management ▪ Service desk and incident management ▪ Security administration ▪ IT operations ▪ Database administration	Enable D2. ICT Quality Strategy Dev. Manage E3. Risk Management Manage E4. Relationship Management Manage E9. IS Governance	▪ COBIT5 Foundation ▪ COBIT5 Implementation ▪ COBIT5 Assessor ▪ COBIT Assessor for Security ▪ Implementing NIST Cyber security Framework Using COBIT 5	
Monitor, Evaluate and Assess (MEA)	▪ Compliance review ▪ Problem management ▪ Performance monitoring ▪ Controls audit	Run C4. Problem Management Manage E3. Risk Management Manage E5. Process Improvement Manage E6. ICT Quality Management	▪ COBIT5 Foundation ▪ COBIT5 Implementation ▪ COBIT5 Assessor ▪ COBIT Assessor for Security ▪ Implementing NIST Cyber security Framework Using COBIT 5	

A.5 Projects in Controlled Environments, version 2 (PRINCE2)

Summary

PRINCE2 belongs to Axelos and provides a practical step-by-step guide to successfully manage any project. It is a flexible method that can be tailored to any organisation or role involved in managing projects and gives an accessible and globally-recognised certification which adds value to CVs.

Objective for the IT professional

PRINCE 2, a project management methodology, offers four levels of certification to cover planning, management, control and organisation of a project. PRINCE2 is a process-based approach for project

management where each process is defined with its key inputs and outputs together with the specific objectives.

Key characteristics

Origin

In 1989, CCTA adopted PROMPT II as a UK Government standard for information systems (IT) project management and renamed it as PRINCE (**PR**OMT II **IN** the **C**CTA **E**nvironment).

Popularity

One million Prince 2 exams have been taken in over 120 countries worldwide till date. More than 20,000 organisations have adopted Prince 2.

Speciality and focus areas

Project Management	PRINCE 2 is in the public domain and offers non-proprietary best practice guidance on how to manage a project
Business Cases	A PRINCE 2 project is driven by its business case which describes the organisation's justification, commitment and rationale for the project's deliverables or outcome
Organisation Structure	Offers a defined organisation structure for the project management team
Management of Risk & Control	With the defined processes, PRINCE 2 helps in evaluating the risks associated with a project and their occurrence and ways to control and minimize these risks
Quality Management	PRINCE 2 helps organisations in quality management by ensuring that the project deliverables satisfy quality criteria and provides assurance by evaluating performance on a regular basis
Planning	Prince provides a product-based start to the planning activity; It also provides planning framework which can be applied to any type of project
PRINCE 2 Architecture	Being a process driven model, PRINCE 2 contains 8 processes, 8 components, 3 techniques, product outlines, role descriptions & checklists to manage any project in every project stage

Certification levels

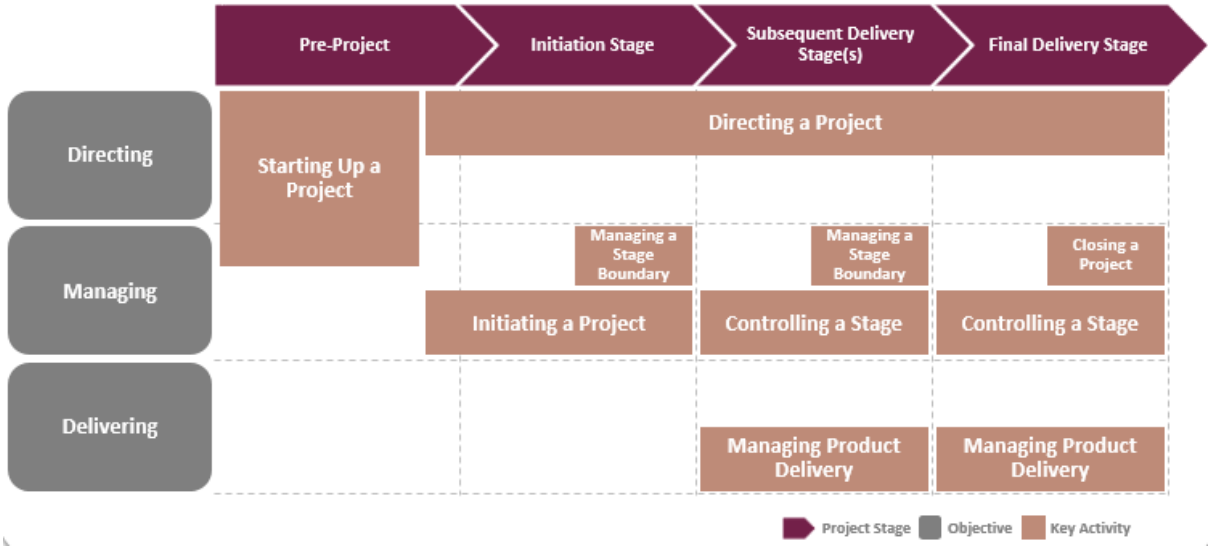
There are 4 levels of certification available: foundation, practitioner, professional and agile practitioner. All PRINCE2 Practitioners should be re-registered within three to five calendar years of their original certification to maintain the certification.

Good practice of application of the framework: Scheidt & Bachmann[87]

[87] https://www.axelos.com/case-studies-and-white-papers/use-of-prince2-by-scheidt-bachmann-gmbh

PRINCE 2 helped Scheidt & Bachmann GmbH deliver a project to develop new hardware and software to install 64 ticket vending machines. This increased common understanding and simplified decision-making, gave more transparency between the customer, supplier and sub-contractors, good customer communication and resulted in cooperative relationships with the customer and suppliers.

Structure



Mapping to e-CF competences

Prince2 Competencies	Description	Competences in e-CF	Prince2 Certification Level	Skill Level
Start-UP	▪ Programme/ Project charter ▪ Programme/ Project management plan ▪ Start-up workshop	Plan: A1. Business Strategy Alignment A3. Business Plan Development	▪ Prince2 foundation ▪ Prince2 practitioner ▪ Prince2 professional and agile practitioner	
Project Requirements & Objectives	▪ Assessment and prioritizing ▪ Project plans & requirements management and project strategy	Plan: A3. Business Plan Development Enable: D11. Needs Identification	▪ Prince2 foundation ▪ Prince2 practitioner ▪ Prince2 professional and agile practitioner	
Scope, Time & Project Phases	▪ Deliverable design and control methods ▪ Life-cycle models and milestones ▪ Phase model	Plan: A4. Product & Service Planning Manage: E1. Forecast Development	▪ Prince2 foundation ▪ Prince2 practitioner ▪ Prince2 professional and agile practitioner	
Project Organization	▪ Decision models & interface management ▪ Resource evaluation and continuous learning & Responsibility matrix	Plan: A4. Product & Service Planning Manage: E2. Project Management	▪ Prince2 foundation ▪ Prince2 practitioner ▪ Prince2 professional and agile practitioner	
Quality	▪ Effectiveness and cost of quality management ▪ Process & product quality management	Manage: E5. Process Improvement E6. ICT Quality Management	▪ Prince2 foundation ▪ Prince2 practitioner ▪ Prince2 professional and agile practitioner	
Problem Resolution	▪ Identifying and assessment of alternative option ▪ Total benefit & value analysis	Manage: E4. Relationship Management E5. Process Improvement	▪ Prince2 foundation ▪ Prince2 practitioner ▪ Prince2 professional and agile practitioner	
Risk & Opportunity	▪ Risk identification techniques and tools ▪ Scenario planning & sensitivity analysis ▪ SWOT Analysis	Manage: E3. Risk Management	▪ Prince2 foundation ▪ Prince2 practitioner ▪ Prince2 professional and agile practitioner	
Change	▪ Change authority ▪ Change management ▪ Configuration management	Manage: E7. Business Change Management	▪ Prince2 foundation ▪ Prince2 practitioner ▪ Prince2 professional and agile practitioner	
Project Management Success	▪ PM assessment and audit ▪ PM planning and contracting ▪ PM success and failure criteria	Manage: E2. Project Management E9. IS Governance	▪ Prince2 foundation ▪ Prince2 practitioner ▪ Prince2 professional and agile practitioner	

A.6 The Open Group Architecture Framework (TOGAF)

Summary

TOGAF belongs to The Open Group and is a proven enterprise architecture methodology and framework used by the world's leading organisations to improve business efficiency. Enterprise architecture professionals fluent in TOGAF standards enjoy greater industry credibility, job effectiveness, and career opportunities.

TOGAF helps practitioners avoid being locked into proprietary methods, utilize resources more efficiently and effectively, and realize a greater return on investment.

Objective for the IT professional

With two certification levels, TOGAF provides an approach for designing, planning, implementing, and governing an enterprise information technology architecture. TOGAF Architecture Development Method (ADM) describes a way of developing and managing the lifecycle of an enterprise architecture and forms the core of TOGAF.

Key characteristics

Origin

The original development of TOGAF Version 1 in 1995 was based on the Technical Architecture Framework for Information Management (TAFIM), developed by the US DoD.

Popularity

There are 48,460 professionals TOGAF certified professionals. As of 2016, TOGAF is employed by 80% of Global 50 companies and 60% of Fortune 500 companies.

Speciality and focus areas

Enterprise Architecture	Defined as '“The fundamental organisation of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design & evolution"
Business Architecture **Data Architecture**	Provides support to align the business strategy, governance, organisation, and key business processes
Application Architecture	Builds the structure of an organisation's logical and physical data assets and data management resources
Technology Architecture	Provides a blueprint for the individual applications to be deployed, their interactions, and their relationships to the core business processes of the organisation
Staff Recruitment and Retention	Develops the logical software and hardware capabilities that are required to support the deployment of business, data, and application services
Member Forums	Helps to optimize the staff recruitment and retention process, and motivate staff to authenticate their skills and experience with using the TOGAF standard

Certification levels

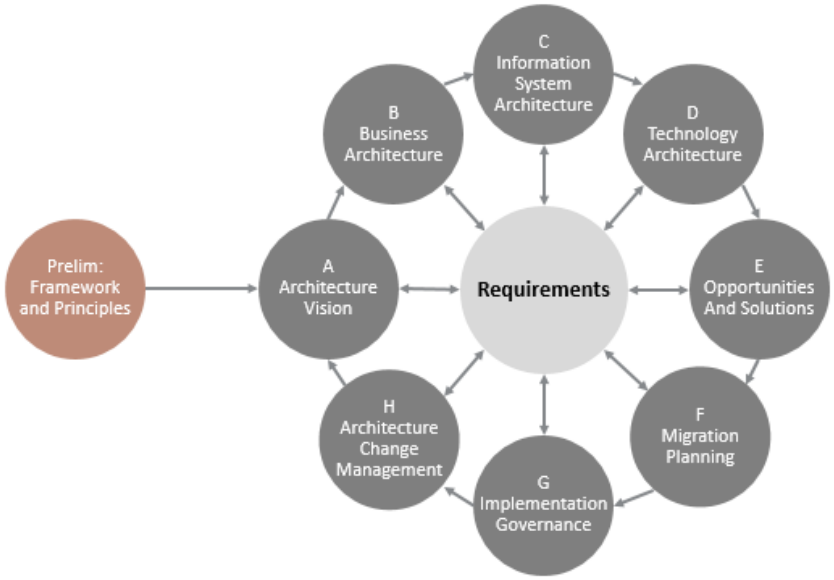
TOGAF 9 Professional Certification takes two forms:

- TOGAF 9 Foundation - Provides knowledge of the terminology, the basic concepts and the core principles of Enterprise Architecture and TOGAF
- TOGAF 9 Certified - Provides additional knowledge and comprehension

Good practice of application of the framework: The UK Department of Social Security[88]

The UK Department of Social Security (DSS) is the central governing entity that is responsible for the delivery and maintenance of the UK's social security - utilising Europe's largest civilian technology-based operation. The DSS utilised TOGAF® to classify and structure its IT applications - optimising architectural components to create a consistent framework. The utilisation was beneficial as it encouraged maintenance and communication of the Architect's vision to stakeholders, whilst continually supporting a variety of internal services.

Structure



Mapping to e-CF competences

TOGAF Competencies	Description	Competences in e-CF	TOGAF Certification Level	Skill Level
Generic Skills	▪ Leadership, inter-personal skills ▪ Team work and logical analysis ▪ Stakeholder and risk management ▪ Oral & written communication	Plan: A1. Business Strategy Alignment A4. Product & Service Planning	▪ TOGAF 9 Foundation (Level 1) ▪ TOGAF 9 Certified (Level 2)	
Business Skills & Methods	▪ Business scenario and business case ▪ Org & strategy planning and visioning ▪ Business process & budget management ▪ Business metrics & culture	Plan: A1. Business Strategy Alignment	▪ TOGAF 9 Foundation (Level 1) ▪ TOGAF 9 Certified (Level 2)	
Enterprise Architecture Skills	▪ Business process, data, application design ▪ Architecture principles, block design ▪ Solution modeling and benefit analysis ▪ IT industry standards	Plan: A3. Business Plan Development A5. Architecture Design	▪ TOGAF 9 Foundation (Level 1) ▪ TOGAF 9 Certified (Level 2)	
Program or Project Management	▪ Project management ▪ Program management ▪ Managing business change ▪ Value management	Plan: A8. Sustainable Development	▪ TOGAF 9 Foundation (Level 1) ▪ TOGAF 9 Certified (Level 2)	
IT Knowledge Skills	▪ IT application development tools ▪ Web-based services and networks ▪ Service management ▪ System management	Plan: A2. Service Level Management A6. Application Design	▪ TOGAF 9 Foundation (Level 1) ▪ TOGAF 9 Certified (Level 2)	
Technical IT Skills	▪ Security and user interface ▪ System, network & data management ▪ Network ▪ Operating system services	Plan: A7. Technology Trend Monitoring	▪ TOGAF 9 Foundation (Level 1) ▪ TOGAF 9 Certified (Level 2)	
Legal Environment	▪ Contract ▪ Data protection law ▪ Commercial and procurement law ▪ Fraud	Plan: A1. Business Strategy Alignment	▪ TOGAF 9 Foundation (Level 1) ▪ TOGAF 9 Certified (Level 2)	

[88] https://www.theknowledgeacademy.com/courses/togaf-training/what-organisations-use-togaf/

A.7 Scrum

Summary

Scrum is owned by the Scrum Alliance® and is part of the Agile movement. It is a simple yet powerful set of principles and practices that help teams deliver products in short cycles, enabling fast feedback, continual improvement, and rapid adaptation to change.

Objective for the IT professional

With four certification levels, Scrum organises the product development team into specific roles, allowing organisations to meet complex requirements and aggressive deadlines. Product owner, the developer team and the scrum master work together under the Scrum software development process to achieve continuous product improvement.

Key characteristics

Origin

Jeff Sutherland & Ken Schwaber created the Scrum in the early 90's. The term 'Scrum' is taken from 'The New Product Development Game', a 1986 paper by Takeuchi & Nonaka.

Popularity

Ken Schwaber co-founded the Scrum Alliance® in 2001. Since 2001, the Scrum Alliance® has 450,000+ certified practitioners worldwide.

Speciality and focus areas

Scrum Guide	Scrum is a framework for developing and sustaining complex products. Scrum Guide contains the definition of Scrum, it's roles, events, artefacts, and the rules that bind them together
Scrum Theory	Scrum theory is based on three pillars that uphold every implementation of empirical process control: transparency among teams, inspection of artefacts, and adaptation to requirements
Scrum Team	The Scrum Team consists of a Product Owner, the Development Team, and a Scrum Master. The team model is designed to optimize flexibility, creativity, and productivity
Events/ Sprint	Scrum prescribes and focuses on four formal events which are Sprint Planning, Daily Scrum, Sprint Review and Sprint Retrospective for inspection of development process
Transparency	Every aspect of the process must be visible to those responsible for the outcome. Scrum focuses on defining these aspects by a common standard, so observers share a common understanding
Inspection	Scrum helps in inspecting artefacts and progress towards a sprint goal to detect undesirable variances in a manner that it does not affect the development process timeline
Adaptation	In case one or more aspects of a process deviate outside the acceptable limits, Scrum ensures to make an adjustment to minimize further deviation immediately

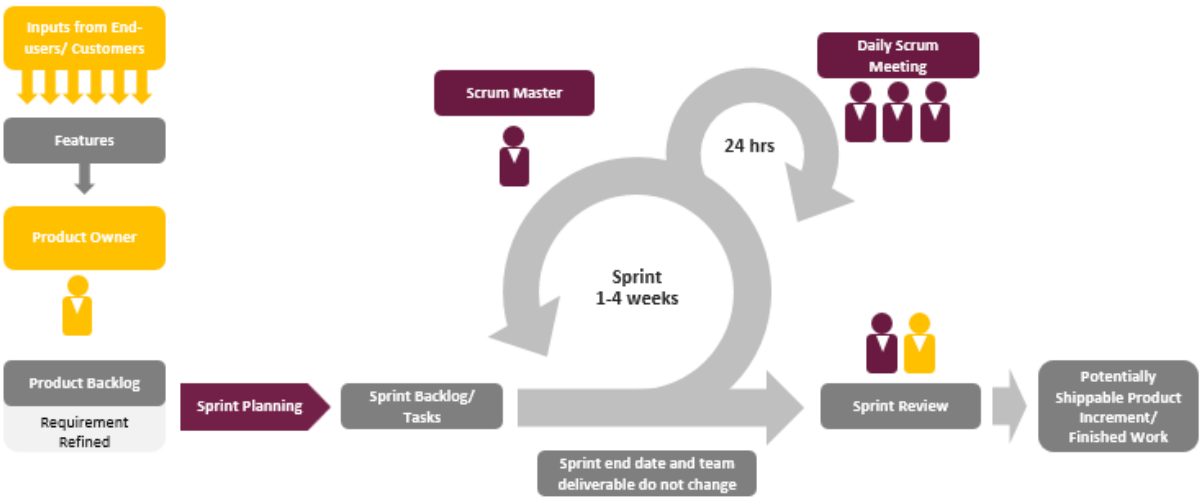
Certification levels

Scrum certification is for practitioners, trainers and coaches. There are 4 levels of certification for practitioners: Certified Scrum Master, Certified Scrum Product Owner, Certified Scrum Developer and Certified Scrum Professional. Besides this, one certification is for trainer and two certifications are for coaches.

Good practice of application of the framework: Intel[89]

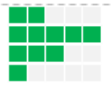
Intel implemented scrum to better coordinate and organise the efforts of the sub-teams within Product Development Engineering. This reduced cycle time by 66%, virtually eliminated schedule slips and missed commitments, uncovered bugs, impediments, weak tools, and poor engineering habits. Moreover, it improved communication and job satisfaction.

Structure



[89] http://www.scrumcasestudies.com/intel/

Mapping to e-CF competences

Scrum Competencies	Description	Competences in e-CF	Scrum Certification Level	Skill Level
Scope & Communication Management	▪ Build and manage the product backlog ▪ Closely partner with the business and the team to ensure everyone understands the work items in the product backlog ▪ Decide when to ship the product	Plan A3. Business Plan Development Plan A4. Product/ Service Planning	▪ Certified Scrum Professional ▪ Scrum Product Owner ▪ Certified Scrum Master ▪ Certified Scrum Developer	
Stakeholder Management	▪ Communicate with all stakeholders and bridge gaps ▪ Make tradeoff decisions between scope (value in expected ROI) and schedule (higher operating expense)	Enable D8. Contract Management Enable D11. Needs Identification	▪ Certified Scrum Professional ▪ Scrum Product Owner ▪ Certified Scrum Master ▪ Certified Scrum Developer	
Implement Scrum Framework	▪ Facilitates sprint planning, review & retrospective ▪ Finds and works to remove roadblocks ▪ Owns reporting on project status, to all directions	Manage E2. Project Management Manage E6. ICT Quality Management Manage E7. Business Change Management	▪ Certified Scrum Professional ▪ Scrum Product Owner ▪ Certified Scrum Master ▪ Certified Scrum Developer	
Teaching & Coaching	▪ Educates/Enforces agreed upon processes & methodology rules ▪ Educates/Enforces roles and responsibilities ▪ Coordinates other release support	Enable D3. Education & Training Enable D9. Personnel Development Enable D10. Knowledge Management	▪ Certified Scrum Professional ▪ Scrum Product Owner ▪ Certified Scrum Master ▪ Certified Scrum Developer	
Product Development	▪ Estimates size of backlog items ▪ Translation of backlog items into engineering design and logical units ▪ Evaluation of technical feasibility ▪ Implementation of backlog items	Build B1. Application Development Build B6. System Engineering Build B2. Component Integration	▪ Certified Scrum Professional ▪ Scrum Product Owner ▪ Certified Scrum Master ▪ Certified Scrum Developer	
Continuous Testing	▪ Prevents defects from entering the system ▪ Facilitates building integrity into the software product and development process	Build B3. Testing Manage E3. Risk Management Manage E8. IS Management	▪ Certified Scrum Professional ▪ Scrum Product Owner ▪ Certified Scrum Master ▪ Certified Scrum Developer	

A.8 Project Management Body of Knowledge (PMBOK)

Summary

PMBOK belongs to the Project Management Institute and recognises five basic process groups and ten knowledge areas typical of almost all projects. The aim of PMBOK is to provide organisations with the right approach for the right project. The basic concepts are applicable to projects, programmes and operations. The five basic process groups are:

- Initiating
- Planning
- Executing
- Monitoring and Controlling
- Closing

Objective for the IT professional

With PMBOK guide and 8 certifications, PMI offers a collection of knowledge areas and processes, accepted as best practices for project management, to organisations. PMBOK Guide divides a project's lifecycle into 5 major process groups; with execution of each group along with the help of areas of knowledge and tools, desired output is achieved.

Key characteristics

Origin

The first edition of the PMBOK guide was published by PMI in 1969. The 5th and the current edition were published by the Process Management Institute in 2013 and Recognised by ANSI, similar to its earlier versions.

Popularity

More than 2.9 million professionals are implementing Project Management Body of Knowledge Guide (PMBOK) to help their organisations worldwide.

Speciality and focus areas

Project Integration Management	Focus on the processes & activities needed to identify, define, combine and coordinate the various project management activities within the project management process groups
Scope & Time Management	Contains elaborative the processes required to ensure that the project includes all the work required and to manage the timely and successful completion of the project
Quality & Cost Management	Focus on processes involved in planning, estimating, budgeting, financing, managing and controlling cost and to determine quality policies, objectives and responsibilities to meet quality standards
Communication & HR Management	Includes processes that organise, manage, and lead the project team and ensure timely and appropriate planning, distribution, management, monitoring, and disposition of project information
Procurement Management	Involves the processes necessary to acquire products, services, or results needed from outside the project team such as Procurement Planning, Source Selection, Contract Administration, and Closeout
Risk Management	Consists of the processes of conducting risk management planning, identification, analysis, response planning, and controlling risk on a project
Stakeholder Management	Focuses on processes required to identify all the people, analysing stakeholder expectations, impact, and appropriate strategies for engaging stakeholders in project decisions and execution

Certification levels

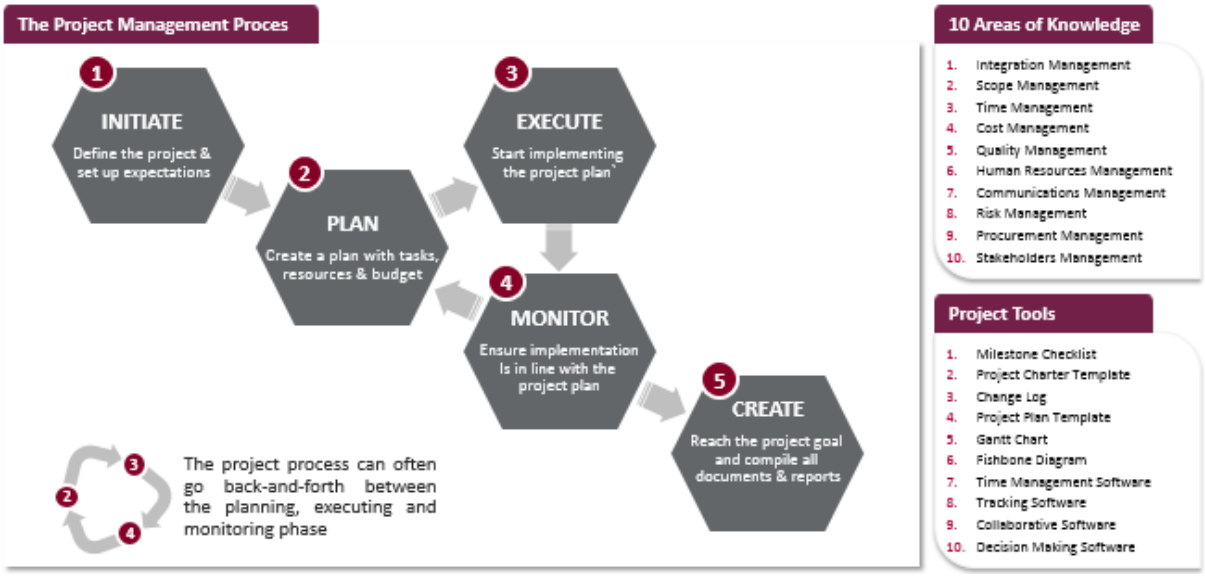
PMBOK offers 8 certification levels: Project Management Professional, Program Management Professional, Portfolio Management Professional, Certified Associate in Project Management, PMI Professional in Business Analysis, PMI Agile Certified Practitioner, PMI Risk Management Professional and PMI Scheduling Professional.

Good practice of application of the framework: CH2M[90]

CH2M, a global engineering firm, adopted PMBOK in daily practices to ensure timely delivery. CH2M is now one year ahead of its 2012 five-year plan, with a 100% increase in profit without increasing head count. Rankings in the industry improved from #7 to #3, domestically, and from #30 to #4, internationally.

[90] https://www.pmi.org/business-solutions/case-studies/transportation-business-at-ch2m

Structure



Mapping to e-CF competences

PMBOK Competencies	Description	Competences in e-CF	PMBOK Certification Level	Skill Level
Integration Management	▪ Identify and document project needs ▪ Perform an initial project feasibility study ▪ Develop project & stakeholder plan	Plan: A3. Business Plan Development A4. Product & Service Planning	▪ Project Management Professional (PMP) ▪ Program Management Professional (PgMP) ▪ Scheduling Professional (PMI-SP)	
Scope Management	▪ Prepare scope management plan ▪ Develop business case ▪ Establish work breakdown structure	Plan: A1. Business Strategy Alignment A4. Product & Service Planning	▪ Project Management Professional (PMP) ▪ Program Management Professional (PgMP) ▪ Scheduling Professional (PMI-SP)	
Time Management	▪ Fabricate project milestone plan ▪ Activity list with duration estimates ▪ Develop project schedule - baseline	Plan: A4. Product & Service Planning Manage: E1. Forecast Development	▪ Project Management Professional (PMP) ▪ Program Management Professional (PgMP) ▪ Scheduling Professional (PMI-SP)	
Cost Management	▪ Perform cost benefit analysis ▪ Develop cost management plan ▪ Baseline cost execution	Plan: A3. Business Plan Development Manage: E1. Forecast Development	▪ Program Management Professional (PgMP) ▪ Professional Business Analysis (PMI-PBA) ▪ Agile Certified Practitioner (PMI-ACP)	
Quality Management	▪ Create quality management plan ▪ Develop quality checklist ▪ Maintain quality requirements	Manage: E5. Process Improvement E6. ICT Quality Management	▪ Portfolio Management Professional ▪ Certified Associate in Project Management ▪ Agile Certified Practitioner (PMI-ACP)	
Human Resource Management	▪ Role and responsibility assignments ▪ Organizational breakdown structure ▪ Staffing management plan	Manage: E7. Business Change Management	▪ Certified Associate in Project Management ▪ Scheduling Professional (PMI-SP) ▪ Agile Certified Practitioner (PMI-ACP)	
Communication Management	▪ Develop communication management plan ▪ Maintain project progress reports	Manage: E4. Relationship Management E5. Process Improvement	▪ Project Management Professional (PMP) ▪ Program Management Professional (PgMP) ▪ Agile Certified Practitioner (PMI-ACP)	
Risk Management	▪ Create risk assessment matrix ▪ Develop probability impact matrix ▪ Perform sensitivity analysis	Manage: E3. Risk Management	▪ PMI Risk Management Professional	
Procurement Management	▪ Create procurement management plan ▪ Define statement of work and evaluation criteria	Plan: A4. Product & Service Planning Manage: A3. Business Plan Development	▪ Scheduling Professional (PMI-SP)	

A.9 The International Software Testing Qualifications Board (ISTQB)

Summary

ISTBQ is a non-profit association founded in 2002. It is the largest testing certification scheme in the world and has become an international de-facto reference on recommended testing practices. ISTBQ qualifies people to become a certified tester.

Objective for the IT professional

ISTQB offers a higher level of reliability of the applications being developed due to efficient and cost-effective testing practices derived from the ISTQB competencies ISTQB offers a higher level of reliability of the

applications being developed due to efficient and cost-effective testing practices derived from the ISTQB competencies. ISTQB emphasis on static and dynamic testing techniques in their certification to ensure the desired output in quality assurance.

Key characteristics

Origin

ISTQB was founded in November 2002. With its 'ISTQB Certified Tester' scheme, offers certification of competences in software testing

Popularity

As of December 2015, ISTQB has administered over 600,000 exams and issued more than 440,000 certifications in over 100 countries world-wide.

Speciality and focus areas

Fundamentals of Testing	ISTQB focuses on the importance of testing, effect of bugs in software on professionals, environment and the organisation, finding defects and fitting testing for quality assurance
Testing Through-out Software Life	ISTQB establishes relationship between development, test activities and work products in the development life cycle to achieve project aim and meet deadlines
Static Testing	ISTQB Static testing technique focuses on improving the quality of software work products by assisting engineers to recognise and fix their own defects early in the software development process
Dynamic Testing	ISTQB Static testing technique tests the software by compiling and executing the software and analysing variable quantities such as memory usage, CPU usage, response time and overall performance
Test Management	ISTQB modules provide complete test management at each step of testing cycle ranging from organisation, planning, progress, control monitoring, configuration management to incident management
Tool Support for Testing	ISTQB provides various tools for test management, requirement management, incident management, configuration management, test design, static analysis tools and test execution
7 Testing Principles	7 testing principles are: testing shows presence of defects; exhaustive testing is impossible; early testing; defect clustering; pesticide paradox; context dependent; absence of error fallacy

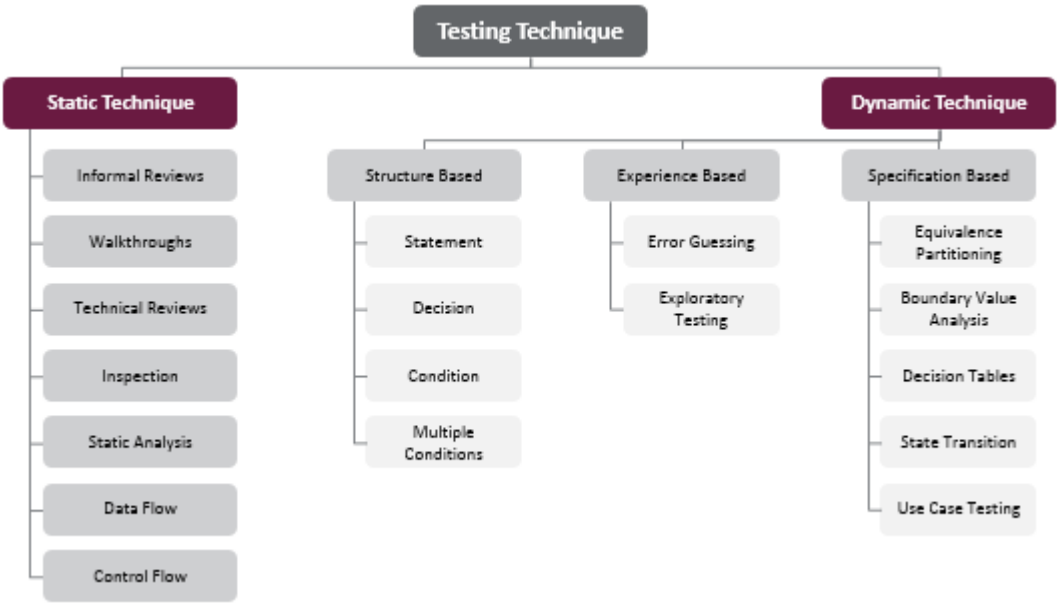
Certification levels

ISTQB offers three level of certification: certified tester foundation level (CTFL), certified tester advanced level (CTAL) and certified tester expert level (CTEL). Each certification scheme is split into three streams: core, agile and specialist with various specific learning modules associated to each stream.

Good practice of application of the framework

Not available.

Structure



Mapping to e-CF competences

ISTQB Competencies	Description	Competences in e-CF	ISTQB Certification Level	Skill Level
Test Process Management	Understanding fundamental test process: - Test planning and control - Test analysis and design - Test implementation and execution - Evaluate exit criteria and reporting	Build B3. Testing Run C3. Service Delivery Manage E5. Process Improvement	Certified Tester Foundation Level (CTFL) Certified Tester Advanced Level (CTAL) Certified Tester Expert Level (CTEL)	
Testing Thought-out Software Cycle	Develop software development models Understand test levels (component, integration, system and acceptance) Testing of functional & non-functional software characteristics Maintenance testing	Run C3. Service Delivery C4. Problem Management Build B2. Component Integration B3. Testing	Certified Tester Foundation Level (CTFL) Certified Tester Advanced Level (CTAL) Certified Tester Expert Level (CTEL)	
Test Design Techniques	Static technique and test process Specification-based or black-box technique Structure-based or white-box technique Experience-based technique	Run C2. Change Support C4. Problem Management Build B3. Testing B4. Solution Deployment	Certified Tester Foundation Level (CTFL) Certified Tester Advanced Level (CTAL) Certified Tester Expert Level (CTEL)	
Test Management	Test planning and estimation Test process monitoring and control Configuration management Incident management	Build B3. Testing Run C1. User Support C4. Problem Management Manage E8. IS Management	Certified Tester Foundation Level (CTFL) Certified Tester Advanced Level (CTAL) Certified Tester Expert Level (CTEL)	
Tool Support for Testing & Security	Tool support for: - Management of testing & tests - Static testing - Test specification - Test execution and logging - Test performance & monitoring	Build B3. Testing B6. System Engineering Manage E8. Information Security Management	Certified Tester Foundation Level (CTFL) Certified Tester Advanced Level (CTAL) Certified Tester Expert Level (CTEL)	

A.10 Certified Information Security Manager (CISM)

Summary

CISM belongs to ISACA. CISM certification:

- Demonstrates your understanding of the relationship between an information security program and broader business goals and objectives;
- Distinguishes you as having not only information security expertise, but also knowledge and experience in the development and management of an information security program;
- Puts you in an elite peer network;

- Is considered essential to ongoing education, career progression and value delivery to enterprises.

Objective for the IT professional

CISM certification enhances the capabilities of information security managers by providing with the knowledge of risk, governance, incident response and the IS program. CISM demonstrates a deep understanding of the relationship between information security programs and broader business goals and objectives.

Key characteristics

Origin

CISM is a certification for information security managers awarded by ISACA. In 2005, the US DoD approved CISM for its "Information Assurance Workforce Improvement Program".

Popularity

As of 2015, more than 30,000 professionals have earned CISM certification since its establishment in 2002.

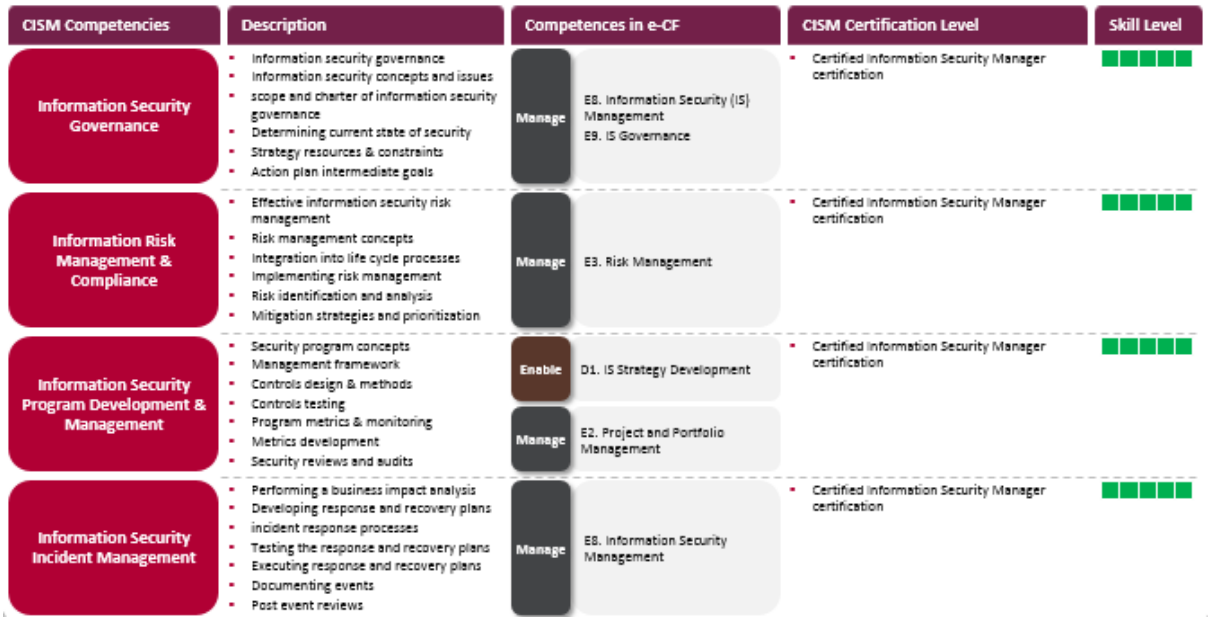
Speciality and focus areas

IS Management Areas	The current CISM exam covers 4 IS management areas (as highlighted below), each of which is further defined and detailed through Tasks & Knowledge statements
Information Security Governance	Focuses on Establishing and maintaining an IS governance framework and supporting processes to ensure that the OS strategy is aligned with organisational goals and objectives
Information Risk Management and Compliance	Manage information risk to an acceptable level to meet the business and compliance requirements of the organisation and identifying risk treatment options to manage risk to minimum levels
IS Program Development & Management	Establish and maintain the information security program in alignment with the information security strategy and identify, acquire, and manage requirements for execution of the IS program
Information Security Incident Management	Establish and maintain an organisational definition of, and severity hierarchy for, information security incidents to allow accurate identification of and response to incidents
ANSI Accredited	The American National Standards Institute (ANSI) has accredited the CISM certification program under ISO/IEC 17024:2003 and CISM is globally accepted standard of achievement
Linking IS to Business Objectives	Along with technical competence, CISM demonstrates a deep understanding of the relationship between information security programs and broader business goals and objectives

Certification levels

CISM or Certified Information Security Manager certification is a single level certification. By clearing the CISM exam and fulfilling the pre-requisite of 5 years of work experience in the field of information security, CISM certification can be earned.

Mapping to e-CF competences



CISM Competencies	Description	Competences in e-CF	CISM Certification Level	Skill Level
Information Security Governance	Information security governance Information security concepts and issues scope and charter of information security governance Determining current state of security Strategy resources & constraints Action plan intermediate goals	Manage: E8. Information Security (IS) Management E9. IS Governance	Certified Information Security Manager certification	
Information Risk Management & Compliance	Effective information security risk management Risk management concepts Integration into life cycle processes Implementing risk management Risk identification and analysis Mitigation strategies and prioritization	Manage: E3. Risk Management	Certified Information Security Manager certification	
Information Security Program Development & Management	Security program concepts Management framework Controls design & methods Controls testing Program metrics & monitoring Metrics development Security reviews and audits	Enable: D1. IS Strategy Development Manage: E2. Project and Portfolio Management	Certified Information Security Manager certification	
Information Security Incident Management	Performing a business impact analysis Developing response and recovery plans incident response processes Testing the response and recovery plans Executing response and recovery plans Documenting events Post event reviews	Manage: E8. Information Security Management	Certified Information Security Manager certification	

A.11 Human Factors International (HFI)

Summary

HFI is an organisation that provides UX design consulting, staff augmentation, training and products to make companies more user-centric. HFI has proven expertise in creating award-winning User Experience Design-UX is the key differentiator for a successful digital experience.

Objective for the IT professional

HFI designed projects ensure an unbroken golden thread, from executive intent, through digital strategy and innovation, to structural and detailed design and validation The HFI Framework is a complete User Centric Design process assembled from best practices for optimising user experience. HFI customizes this process to fit the organisational needs.

Key characteristics

Origin

In 2004, Dr. Eric Schaffer, CEO and founder of HFI, wrote his first book - *The Institutionalization of Usability: A Step-by-Step Guide.*

Popularity

Since 2011 HFI offers certification to organisations & individuals. HFI has certified 6 organisations and more than 6,399 professionals across the world since 2011 and has six offices in Asia, Europe, North America and Africa.

Speciality and focus areas

Digital Strategy	HFI helps organisations in articulating their digital user experience

	strategy and develop it holistically, with a focused, coherent, research-driven approach grounded in user expectations
PET design Review	Through an analysis of Persuasion, Emotion, and Trust, HFI provides deep insight into the users' decision-making processes to create positive relationships with consumers & impact conversion
PET Research	PET Research is specifically focused on the decision point. Wherever, professionals in organisation are needed to be converted to making a decision, HFI provides PET methods
User Interface Structure (UIS)	HFI integrates visual branding elements into the overall architecture, providing a solid foundation for detailed design and future expansion
UX Enterprise	HFI's UX Enterprise is the relational database of UX objects. It is the fully interlinked model of your customer ecosystems, design, projects, design specifications, standards, and methods
User Interface Standards	HFI has created hundreds of highly specialized standards based on user-centred principles to speed up development time
Ecosystem Research	HFI uses ethnographic skills and methods to understand and optimize their designs to enable them to fit into the organisational ecosystem

Certification levels

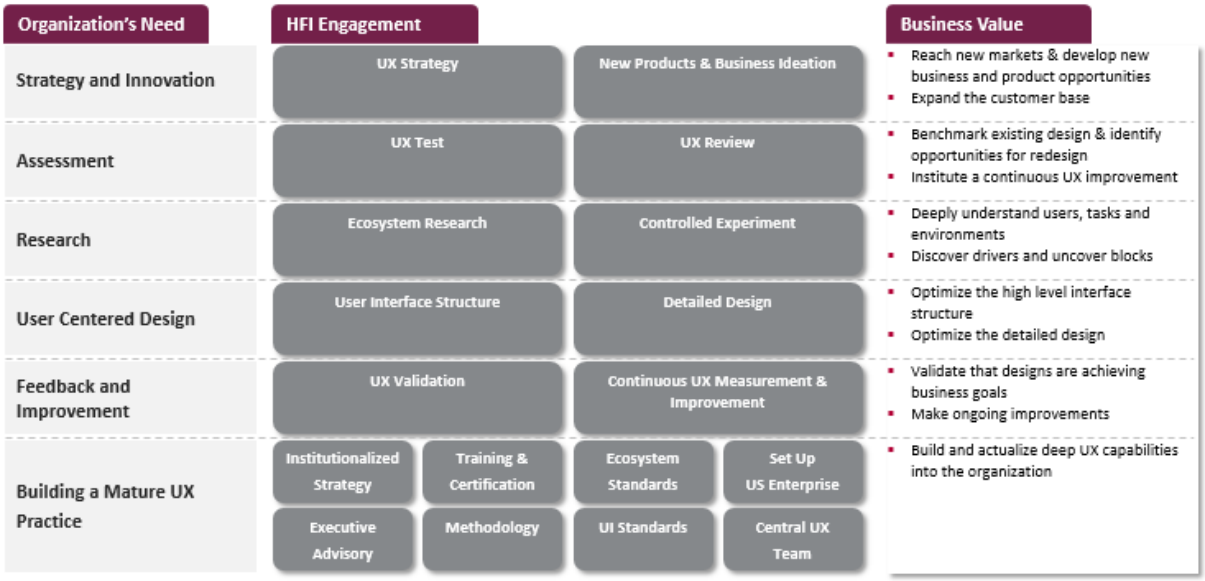
HFI offers three levels of certification to organisations: Certified Practice in Usability and Certified Usable Design at three levels: Level III, Level IV, Level V. HFI also offers 3 level of certification to professionals: Certified Usability Analyst, Certified User Experience Analyst and Certified Digital Persuasion Analyst.

Good practice of application of the framework: Staples[91]

To make its site "customer-driven" – to support customer needs in an easy-to-use, intuitive way, Staples implemented the HFI framework. HFI helped Staples.com boost repeat customers by 67%, reduce drop-off rates by 31-45%, increase shopping experience by 10% and increase sales in the third quarter of 2000 with 491% compared to the previous year.

[91] http://www.humanfactors.com/about_us/case_studies_staples.asp

Structure



Mapping to e-CF competences

HFI Competencies	Description	Competences in e-CF	HFI Certification Level	Skill Level
UX Strategy & Innovation	Understanding user experience Stakeholder envisioning Business & product strategies Market & channel strategies	Plan A1. Business Strategy Alignment Plan A9. Innovating	Certified Usability Analyst (CUA) Certified User Experience Analyst (CXA) Certified Digital Persuasion Analyst (CDPA)	
User-Centered Analysis	Strategy for analyzing user/ environment profiling Scenario development Task analysis and design	Run C1. User Support Run C4. Problem Management	Certified Usability Analyst (CUA) Certified User Experience Analyst (CXA) Certified Digital Persuasion Analyst (CDPA)	
Conceptual Design	Information architecture Usability specifications Data gathering methods	Plan A5. Architecture Design Build B1. Application Development	Certified Usability Analyst (CUA) Certified User Experience Analyst (CXA) Certified Digital Persuasion Analyst (CDPA)	
Web & Application Design	Web site & application prototyping Accessibility & internationalization Content & interaction Beyond Design Knowledge	Plan A6. Application Design Build B1. Application Development	Certified Usability Analyst (CUA) Certified User Experience Analyst (CXA) Certified Digital Persuasion Analyst (CDPA)	
Practical Usability Testing	Exploratory testing Early prototype testing Advanced prototype testing Live-Site analysis	Build B3. Testing Run C4. Problem Management	Certified Usability Analyst (CUA) Certified User Experience Analyst (CXA) Certified Digital Persuasion Analyst (CDPA)	
PET Design	Initial assessment methods PET-Focused personas & scenarios User research methods Design & validation methods	Build B6. System Engineering Run C1. User Support	Certified Usability Analyst (CUA) Certified User Experience Analyst (CXA) Certified Digital Persuasion Analyst (CDPA)	
PET Architecture	Deriving a core PET meme Customer retention Strategy & innovation Site or application design	Plan A5. Architecture Design Run C1. User Support	Certified Usability Analyst (CUA) Certified User Experience Analyst (CXA) Certified Digital Persuasion Analyst (CDPA)	

A.12 Software Engineering Body of Knowledge (SWEBOK)

Summary

The IEEE Computer Society formally approved and published the Guide to the Software Engineering Body of Knowledge (SWEBOK) in 2004. The guide is available for free and describes generally accepted knowledge about software engineering. Its 15 knowledge areas (KAs) summarize basic concepts and include a reference list pointing to more detailed information.

Objective for the IT professional

The SWEBOK guide defines 15 knowledge areas which are focused upon software requirement identification, validation & development throughout software life cycle. SWEBOK provides a characterization of the bounds of the software engineering discipline as well as a topical access to the body of knowledge supporting software engineering.

Key characteristics

Origin

The Software Engineering Coordination Committee (SWECC), sponsored jointly by the ACM and IEEE Computer Society developed SWEBOK version 1.0 in 1999.

Popularity

IEEE has certified 300,000+ professional with SWEBOK Certification Program across the world until 2014.

Speciality and focus areas

Knowledge Aras (KAs)	With the main objective to establish an appropriate set of criteria and standards for the professional practice of software engineering, SWEBOK defines 15 KAs to summarize basic concepts
Software Design & Requirements	By elicitation, analysis, specification and validation of software requirements, SWEBOK ensures to define the architecture, interfaces, and other characteristics of a software
Software Testing & Maintenance	With functional test, disaster recovery test, performance test, access control test, interface test and volume test, SWEBOK provides testing & maintenance throughout development cycle
Configuration & Engineering Management	SWEBOK provides software configuration management process that provides resources for the identification, development, and auditing of the artefacts created during the software development
Software Process Management	SWEBOK Process Engineering helps in activities related to the definition, implementation, evaluation, measurement, management, change and improvement cycle process software life
Software Tools & Methods	SWEBOK software development tools are designed to assist in the software life cycle and automate some activities of the development process, sparing time for project management team
Software Quality	Since the quality of software is directly linked with the quality of the process by which the software is developed, therefore, SWEBOK provides well defined and documented processes

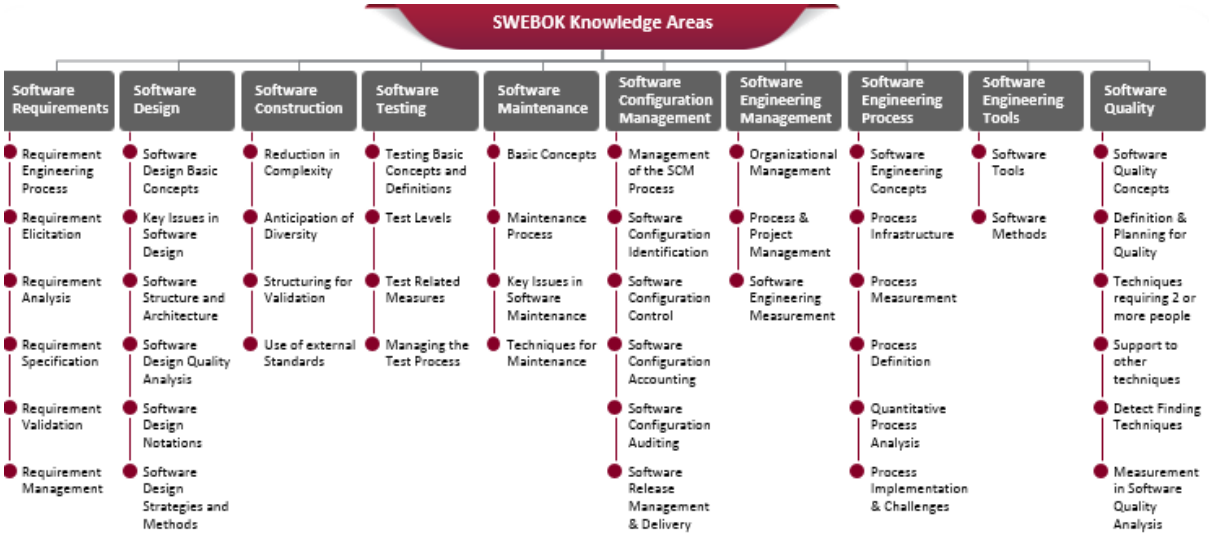
Certification levels

SWEBOK Certification Program (SCP) has four modules: Software Foundations, Software Management, Software Development, and Software Professional Practices. On successful completion of each module, a certification is granted to the respective professional.

Good practice of application of the framework

Not available.

Structure



Mapping to e-CF competences

SWEBOK Competencies	Description	Competences in e-CF	SWEBOK Certification Level	Skill Level
Software Requirement Skills	▪ Software requirements analysis ▪ Software requirements verification Software requirements process mgmt	Enable D11. Needs Identification	▪ Software Foundations ▪ Software Management & Development ▪ Software Professional Practices	
Software Design & Construction Skills	▪ Software design strategies and methods ▪ Software architectural design ▪ Software construction planning	Build B1. Application Development B2. Component Integration	▪ Software Foundations ▪ Software Management & Development ▪ Software Professional Practices	
Software Testing Skills	▪ Software test planning ▪ Software testing infrastructure ▪ Software testing techniques	Build B3. Testing B4. Solution Deployment	▪ Software Foundations ▪ Software Management & Development ▪ Software Professional Practices	
Software Sustainment Skills	▪ Software transition ▪ Software support ▪ Software maintenance	Plan A8. Sustainable Development Build B5. Documentation Production	▪ Software Foundations ▪ Software Management & Development ▪ Software Professional Practices	
Software Process & Life Cycle Skills	▪ Software development life cycle implementation ▪ Process definition and tailoring	Build B2. Component Integration	▪ Software Foundations ▪ Software Management & Development ▪ Software Professional Practices	
Software System Engineering Skills	▪ System development life cycle modeling ▪ System requirements engineering ▪ System integration and verification	Build B6. Systems Engineering	▪ Software Foundations ▪ Software Management & Development ▪ Software Professional Practices	
Software Quality Skills	▪ Software quality management ▪ Audits & reviews ▪ Statistical control	Build B3. Testing B6. System Engineering	▪ Software Foundations ▪ Software Management & Development ▪ Software Professional Practices	
Software Security & Safety Skills	▪ Requirements ▪ Design & construction ▪ Testing, process & quality	Build B1. Application Development B6. Systems Engineering	▪ Software Foundations ▪ Software Management & Development ▪ Software Professional Practices	
Software Configuration Management (SCM) Skills	▪ Plan SCM and conduct SCM ▪ Plan measurement process ▪ Perform measurement process	Build B1. Application Development B2. Component Integration	▪ Software Foundations ▪ Software Management & Development ▪ Software Professional Practices	

A.13 Data Management Body of Knowledge (DMBOK)

Summary

The Global Data Management Community (DAMA) created the DAMA International Guide to Data Management Body of Knowledge (DAMA DMBOK ®). The guide defines a standard industry view of data management functions, terminology and best practices, without detailing specific methods and techniques. While DAMA-DMBOK is not a complete authority on any specific topic, it will point readers to widely recognised publications, articles and websites for further reading.

Objective for the IT professional

DMBOK provides a definitive introduction to data management with presenting a standard industry view of data management functions, terminology and best practices. DMBOK defines standard terms and definitions for data management processes cited consistently with the help of 10 data management functions & 7 environmental elements.

Key characteristics

Origin

DMBOK version 1.0 was introduced by Mark Mosley, DMBOK Editor, DAMA International in March 2006. The currently circulated version is DMBOK 3.0.2.

Popularity

Not available.

Speciality and focus areas

Data Management Functions	The DAMA-DMBOK Functional Framework Version 3 identifies 10 major Data Management Functions, each described through 7 Environmental Elements to help organisation in data management
Data Governance & Architecture Management	Focuses on planning, supervision and control over data management and application as well as works as an integral part of the enterprise architecture
Data Development	Data development management function of DMBOK is entirely focused on analysing, designing, building, testing, deployment and maintenance of data
Database Operations Management	Planning, control and support for structured data assets across the data lifecycle, from creation and acquisition through archival and purge
Data Security Management	Planning, implementation and control activities to ensure privacy and confidentiality and to prevent unauthorized and inappropriate data access, creation or change
Data Warehousing & BI Management	Planning, implementation and control processes to provide decision support data and support knowledge workers engaged in reporting, query and analysis
Meta Data & Data Quality Management	Responsible for integrating, controlling and delivering meta data and defining, monitoring and improving data quality

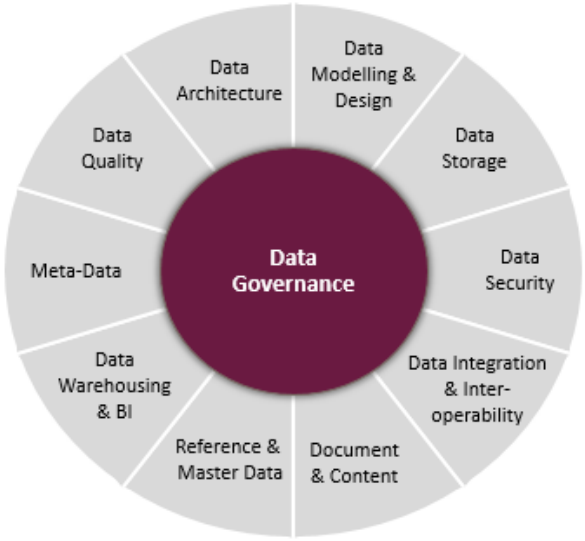
Certification levels

DAMA offers the Certified Data Management Professional (CDMP) Program to help professionals build expertise in the data management field. Under the CDMP certification program, there are four certification levels: CDMP Associate, CDMP Practitioner, CDMP Master and CDMP Fellow.

Good practice of application of the framework: Vitens[92]

Vitens water supply company organised its data governance in line with DMBOK. DMBOK was used to assess the maturity of the organisation and to shape the method used to organise management and governance. The SAP Business Objects BI tool was used to access and combine data from a data warehouse and DMBOK was used for data analysis.

Structure



Data Management Knowledge Areas

7 Environmental Elements

Mapping to e-CF competences

DMBOK Competencies	Description	Competences in e-CF	DMBOK Certification Level	Skill Level
Data Governance	▪ Explain the reasons for maintaining data over time ▪ Describe the data lifecycle (e.g., acquire, , use, refine, archive, and delete data) ▪ Promote the value of data governance and the need to comply	Manage E9. IS Governance	▪ Data Management Program Associate ▪ Data Management Program Practitioner ▪ Data Management Program Master ▪ Data Management Program Fellow	
Data Analysis	▪ Analyze data and oversee the maintenance of data stores and data-related solutions ▪ Cross-correlate data between different domains and data stores to ensure accuracy, consistency, and coherence	Run C3. Service Delivery C4. Problem Management Manage E1. Forecast Development	▪ Data Management Program Associate ▪ Data Management Program Practitioner ▪ Data Management Program Master ▪ Data Management Program Fellow	
Data Quality Management	▪ Apply quality management methods to assess, improve, and ensure the fitness of data for business use in accordance with industry and organizational business rules ▪ Apply standard industry business rules to data	Run C2. Change Support C4. Problem Management Manage E6. ICT Quality Management	▪ Data Management Program Associate ▪ Data Management Program Practitioner ▪ Data Management Program Master ▪ Data Management Program Fellow	
Data Security	▪ Explain and comply with organizational policies and processes for data security management ▪ Comply with necessary security policies ▪ Explain different security categories by domain and role of systems of record	Build B6. System Engineering Manage E8. Information Security Management	▪ Data Management Program Associate ▪ Data Management Program Practitioner ▪ Data Management Program Master ▪ Data Management Program Fellow	
Master Data Management	▪ Describe the rationale for master data management within an organization ▪ Describe the impact of master data management on daily activities ▪ Identify master data sources and contributors	Build B6. System Engineering Manage E8. Information Security Management	▪ Data Management Program Associate ▪ Data Management Program Practitioner ▪ Data Management Program Master ▪ Data Management Program Fellow	

[92] https://www.quintgroup.com/nl-nl/klantverhalen/data-governance-op-basis-van-dmbok/

A.14 Certified Business Process Professional (CBPP)

Summary

CBPP belongs to the Association of Business Process Management Professionals International (ABPMP). The examination is specifically designed to challenge people's knowledge and ability to apply the BPM CBOK® concepts and techniques used to improve business operations and enable organisational transformation.

Objective for the IT professional

CBPP certification enables project management professionals with capabilities to ensure business process management.

Key characteristics

Origin

ABPMP launched Certified Business Process Professional (CBPP) certification under their Business Process Management Common Body of Knowledge (BPM-CBOK) in 2008.

Popularity

Not available.

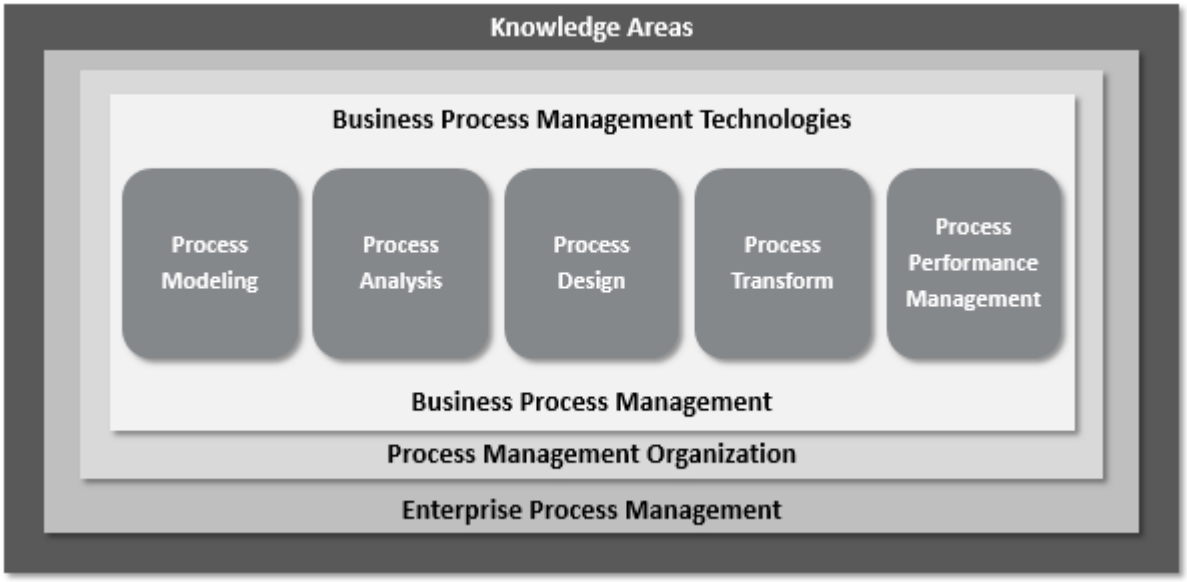
Specialty and focus areas

Business Process Management (BPM)	BPM is a disciplined approach to identify, design, execute, document, measure, monitor, and control both automated and non-automated business process to achieve targeted results
Process Modelling	Business process modelling enables professionals to understand, communicate, measure, and manage the primary components of business processes
Process Analysis	Focuses on the use of process models and other process documentation to validate and understand both current and future state of process using a variety of process analysis tools
Process Design	Process design explores process design roles, techniques, and principles of good design along with an exploration of common process design patterns and considerations
Transformation of processes	BPM process transformation addresses various process improvement, redesign and reengineering methodologies, including the tasks associated with implementing process change
Process management and organisation	Defines the cultural considerations, the cross-functional-team-based performance of a process driven enterprise as well as the importance of business process governance
Process management technologies	BPM technologies includes technologies available to support the planning, design, analysis, operation, and monitoring of business processes

Certification levels

Currently, there is only one level under CBPP certification focused on general knowledge of and the practical experience in BPM application. Recertification is every 3 years to maintain continuous professional development. In the future, ABPMP plans to introduce further specific certifications i.e. expert in BPM-technologies, process design and process modelling.

Structure



Mapping to e-CF competences

CBPP Competencies	Description	Competences in e-CF	CBPP Certification Level	Skill Level
Process Modeling, Analysis & Design	▪ Identify problems & their impact to the business functions and activities ▪ Define internal audit policy ▪ Define rules that control the activities ▪ Create business & technical system change requirements/ specification	Plan A1. Business Strategy Alignment A4. Product / Service Planning Plan A5. Architecture Design A6. Application Design	▪ Certified Business Process Professional (CBPP)	
Process Methodology	▪ Focus on performance, efficiency and quality; ▪ Supply of the necessary resources ▪ Control by prioritizing, controlling and escalating process needs ▪ Results measurement and analysis	Plan A1. Business Strategy Alignment A4. Product / Service Planning Plan A8. Sustainable Development A9. Innovating	▪ Certified Business Process Professional (CBPP)	
Process Measurement & Management	▪ Responsible for Enterprise Process Management (EPM), that includes the strategy, values and culture, structures and roles, and a whole set of end-to-end processes with their associated goals and indicators, IT, and people	Manage E2. Project and Portfolio Management Manage E5. Process Improvement	▪ Certified Business Process Professional (CBPP)	
Change Management & Facilitation	▪ Strategic change management ▪ IT change management ▪ Organization change management ▪ Defining the impact of the change and the actions required ▪ Identifying resistances and concerns	Manage E6. ICT Quality Management Manage E7. Business Change Management	▪ Certified Business Process Professional (CBPP)	
Technology	▪ Process modeling, simulation of new designs and performance reporting ▪ Rules definition and management ▪ Application generation ▪ Service Oriented Architecture (SOA) ▪ Enterprise Application Integration (EAI)	Manage A7. Technology Trend Monitoring Manage A8. Sustainable Development	▪ Certified Business Process Professional (CBPP)	

A.15 Scaled Agile Framework (SAFe)

Summary

SAFe is an online freely revealed knowledge base of proven, integrated patterns for implementing Lean-Agile development. It provides comprehensive guidance for work at the Portfolio, Large Solution, Program, and Team Levels.

Objective for the IT professional

SAFe 4.5 reflects the latest Lean-Agile thinking, more visibly incorporating scalable DevOps and the Continuous Delivery Pipeline. It shows improvements in configurability, implementation guidance and capabilities for improving user experience and accelerating time-to-market.

Key characteristics

Origin

The initial release of SAFe 1.0 was in 2011. There have been four major updates in the meantime and continues to be a work in progress. The current version of SAFe is version 4.5.

Popularity

SAFe is spreading rapidly around the world. Over 70% of the Fortune 100 US companies have certified SAFe practitioners and consultants on-site. There are now 160,000 SAFe-trained professionals in more than 100 countries around the world.

Certification levels

SAFe has seven types of certification: Agilist, Program Consultant, Practitioner, Scrum Master, Advanced Scrum Master, Release Train Engineer and Product Owner/Product Manager.

Good practice of application of the framework: Sony PlayStation Network[93]

In 2014, Sony Interactive Entertainment (SIE) chose to implement SAFe in order to bring greater organisation and collaboration development in their Sony PlayStation Network. SAFe made demos optional for developers. Demos used to take a full day, but after the implementation of SAFe only 5-10 minutes. The benefits that came with the implementation of SAFe are greater visibility/transparency for developers, better coordination, dependency management, clearer priorities and $30 million of cost savings.

A.16 DevOps Agile Skills Association (DASA)

Summary

DevOps Agile Skills Association (DASA) is an open global community for DevOps and Agile Skills development. It is organized as a community-driven organisation open for participating member organisations to help define role-based competencies and learning curricula. DASA aims to:

[93] http://www.scaledagileframework.com/sony-playstation-network-case-study/

- Promote a knowledge and skills framework for DevOps, based on a defined set of principles
- Develop and evangelize a vendor neutral DevOps qualification program for professionals
- Generate interest and awareness for the need for knowledge and skill development
- Advance quality of training and open source certification for DevOps knowledge and skills
- Map member training content to the role-based competence baseline

Objective for the IT professional

Not available.

Key characteristics

Origin

Not available.

Popularity

More than 80 Forerunners from across industries and six continents have used DASA Open Source, Community Model for DevOps Agile Skills Development.

Speciality and focus areas

DASA distinguishes four skill areas:

Courage	Evangelism, coaching, self-confidence, proactivity, reflection, trust, open discussions, experimentation, fail fast, courage to change
Teambuilding	Understand the other's point of view, collaboration, mutual accountability, common purpose, ability to integrally support the service/product
DevOps Leadership	Facilitating teams to high performance, humility, transparency, Service lifecycle mindset, Stakeholder management
Continuous improvement	Improvement of work quality, kaizen mindset, quality at the source, first time right, knowledge-sharing, ability to adapt

Besides these skill areas, DASA distinguishes eight knowledge areas:

Business Value Optimization	Use of the IT service in real life, including direct feedback loop of user comments to team, service level management, definition of done, business activity/performance monitoring, business case management
Business Analysis	Functional requirements, non-functional requirements, longer term development of business process (based on translation of market developments), data analysis, and refinement
Architecture & Design	Ensuring fit between developments and current situation, overall service design, patterns & styles
Programming	Software engineering mastery, everything as code, data management
Continuous Delivery	Automated testing, deployment and release management,

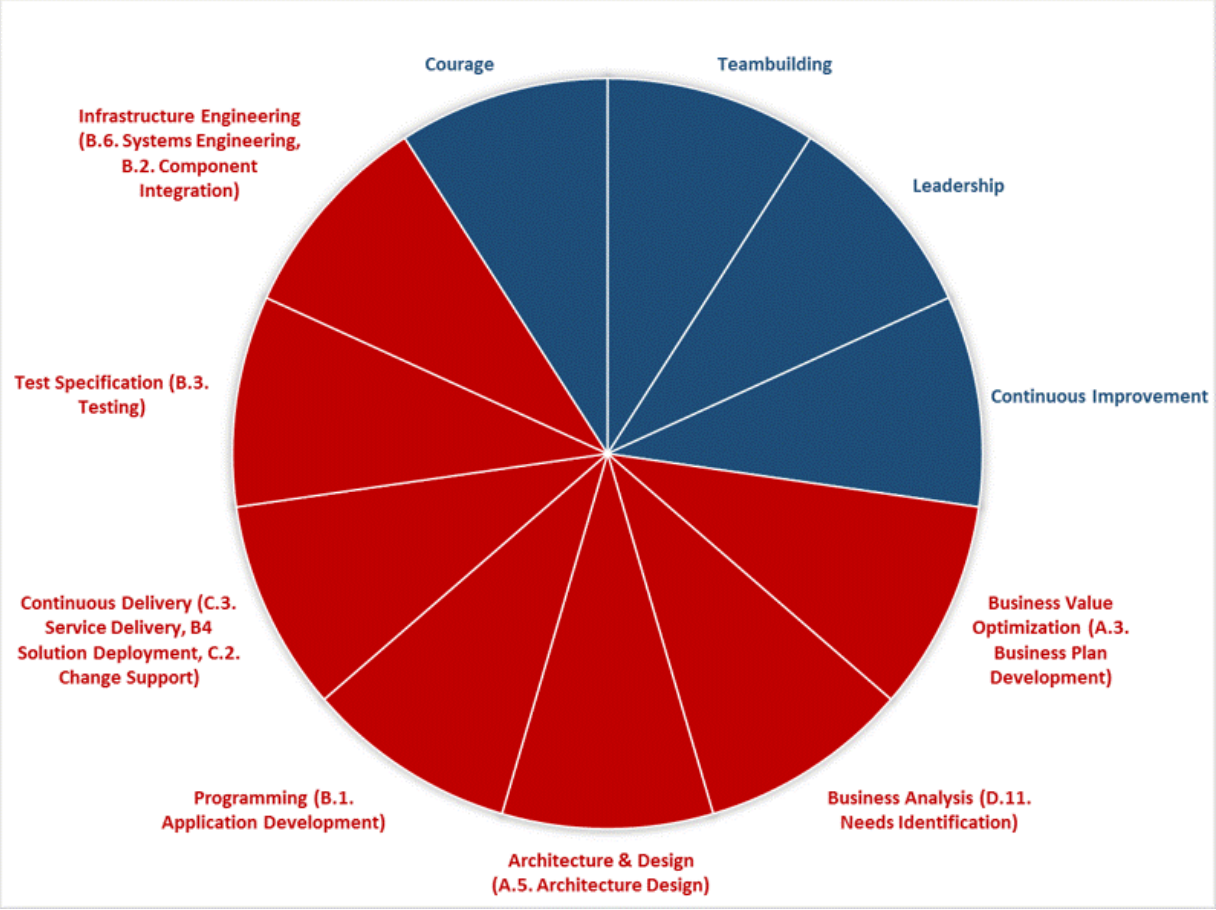
	configuration management, version control, cloud, containerization, feature-driven delivery
Test Specification	Design of test cases, test concepts
Infrastructure Engineering	Technical monitoring, performance management (e.g. load balancing etc.), capacity and availability management, reliability engineering, cloud, containerization
Security, Risk & Compliance	Security, service continuity planning

Certification levels

DASA offers certifications in three levels:

- The competent level: DevOps Fundamentals
- The proficient level: DevOps Practitioner
- The expert level: DevOps Specialisation: Enable and Scale, DevOps Specialisation: Specify and Verify, DevOps Specialisation: Create and Deliver

Mapping to e-CF competences



A.17 Edison Data Science Framework (EDSF)

Summary

EDISON is a project with the purpose of accelerating the creation of the Data Science profession. It is funded by the European Union's Horizon 2020 research and innovation programme. The EU-funded EDISON Project is putting in place foundation mechanisms that will speed-up the increase in the number of competent and qualified Data Scientists across Europe and beyond. The EDISON initiative is doing this through various measures aimed at reducing the gap between the supply side of educators and trainers and the demand side of employers.

Objective for the IT professional

The EDISON Data Science Framework (EDSF) is a comprehensive collection of interrelated documents that can be used by a range of stakeholders to construct their own structured solutions for educating, training, certifying, recruiting, managing, and otherwise supporting data scientists and other data-dependent professionals. It has been developed to support, guide and ultimately accelerate the education process of Data Science Professionals.

Key characteristics

Origin

EDISON started in September 2015 and is a two-year project. It is currently being used by EDISON Champion universities to design new Data Science curricula that meet identified industry standards.

Popularity

Implementation is aimed at Europe and beyond.

Speciality and focus areas

Data Analytics	Machine Learning, statistical methods and Business Analytics
Data Management	Data curation, preservation and data infrastructure
Data Science Engineering	Software and infrastructure engineering
Research Methods	Research methods and project management
Business Process Management	*Not available.*

Certification levels

There are three proficiency levels in EDSF: 1) general understanding of the Data Science concepts, 2) the ability to apply these concepts to solve concrete problems, and 3) the ability to further assess and develop these concepts to create new knowledge.

Good practice of application of the framework

Not available.

Appendix C: Mapping of frameworks to e-CF job profiles

The below mapping is based on the European IT Professional Profiles based on the e-CF CWA CEN Workshop IT Skills of March 2012. Available here: http://relaunch.ecompetences.eu/wp-content/uploads/2013/12/EU_ICT_Professional_Profiles_CWA_updated_by_e_CF_3.0.pdf

During project phase 2 the newly defined profiles will be added and mapped to relevant frameworks.

	Business Management			Technical management				Design				Development			Service & operation					Support			
PROFILES > < FRAMEWORKS	3. Business information manager	4. CIO	10. ICT operations manager	16. Quality assurance manager	11. ICT security manager	15. Project manager	18. Service manager	2. Business analyst	20. Systems analyst	8. Enterprise architect	21. Systems architect	6. Developer	7. Digital Media specialist	23 Test specialist	5. Database administrator	19. systems administrator	14. Network specialist	22. Technical specialist	17. Service desk agent	1. Account manager	12. ICT security specialist	13. ICT trainer	9. ICT consultant
IT Development																							
Agile/DevOps							■	■			■	■		■							■		
ASL	■						■																
Agile/Scrum								■				■											
ISTQB				■										■									
TMAP				■										■									
HFI												■											
SWEBOK									■			■											
DMBOK												■			■								
TPI Next														■									
OpenStack										■	■	■					■	■					
Waterfall									■			■											
IT Management																							
COSO / COSO II or ERMF			■	■																			■
ITIL							■									■			■		■		
ISO 20000							■												■		■		
COBIT			■							■													■
CMMi		■	■							■													■
Lean-IT								■															
ISO 27001					■																■		
CISSP					■																■		
CISA					■																■		
CISM					■																■		
SNABOK																	■						

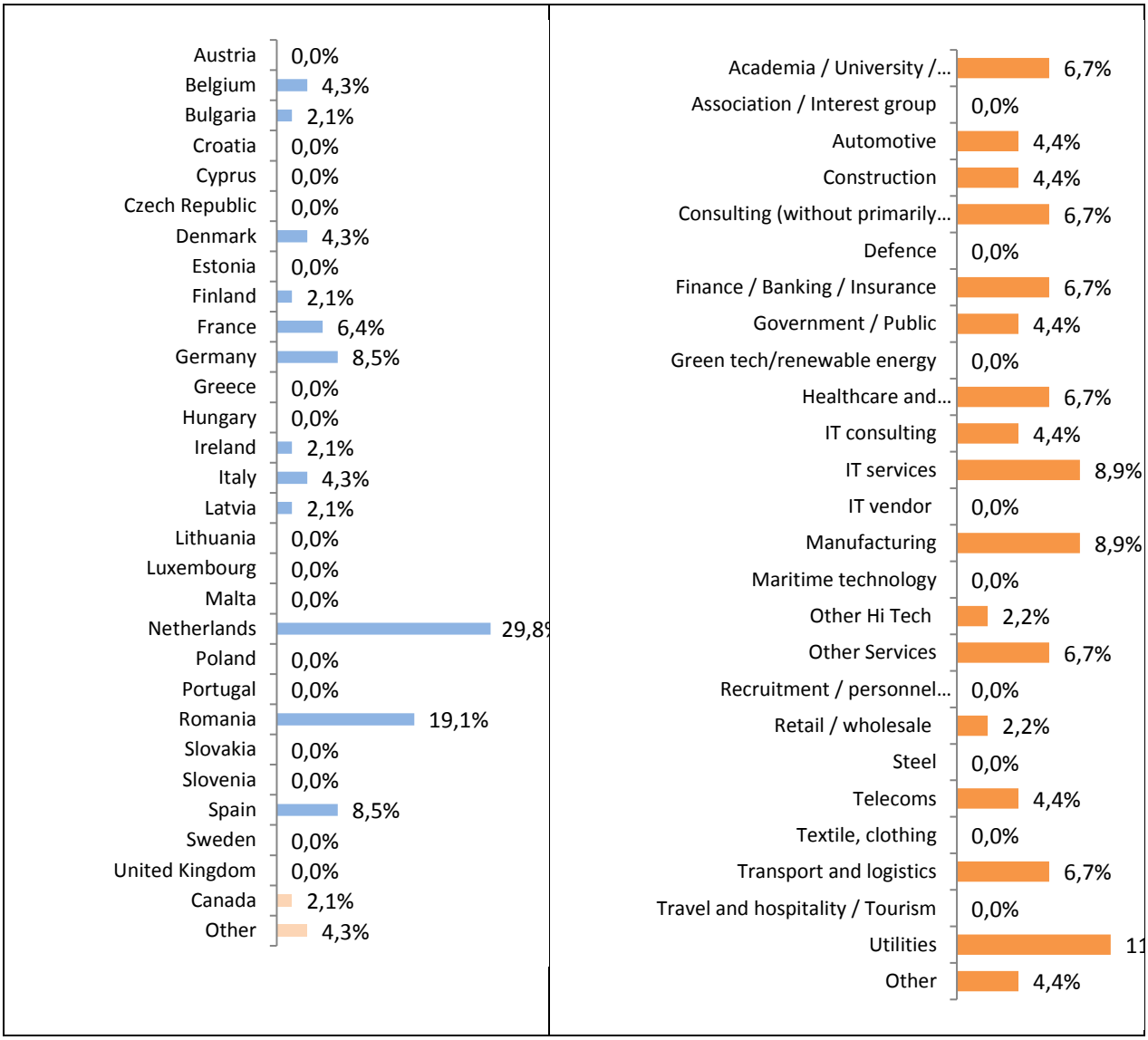
ISO: OSI																							
ISO 9001:2000																							
SIAM																							
Architecture																							
TOGAF																							
Archimate																							
Project Management																							
PMBOK																							
PMI																							
Prince2																							
IPMA																							
Business Management																							
BABOK																							
BiSL																							
Balanced Scorecard																							
Lean - Six Sigma																							
CBPP																							
CBPA																							
Design thinking																							
Emerging frameworks																							
SAFe																							
DASA																							
LeSS																							
Nexus																							
12 factor app																							
CMAP																							
Edison																							
TRIZ																							

Appendix D: Detailed survey output

During October and November 2017, we carried out an online survey of business professionals active in the implementation of IT standards, certification and frameworks. 833 individuals were identified and invited from empirica's e-skills data base, such that only those experts were selected who had a business affiliation (excluding e.g. purely academics, and professionals in associations & interest groups, but also policy makers). In doing so, we wanted to ensure to give the practitioners and decision makers "on the ground" a voice rather than experts with a more mediated view on the issues at stake. Additionally, the survey invitation was posted on LinkedIn in several postings, and more importantly, Euro-CIO and the CIO-Platform Netherlands were willing to support the survey in an e-mail newsletter to their members. During field time, we noticed 279 visits, of which 67 usable responses could be yielded.

85% of respondent came from large enterprise (> 250 employees), leaving SMEs in a minority position. Given the prevalence of the topic for larger organisations, we think this is an advantage, giving voice to practitioner with broad experience in the application of IT standards to organisational practice.

Figure 5-42: Country and sector distribution of survey response



D.1 Investing in capabilities

Respondents were asked about the importance of different capabilities in the context of digital transformation of their organisation. The following table highlights the number of mentions of each kind of investment in the respective capabilities.

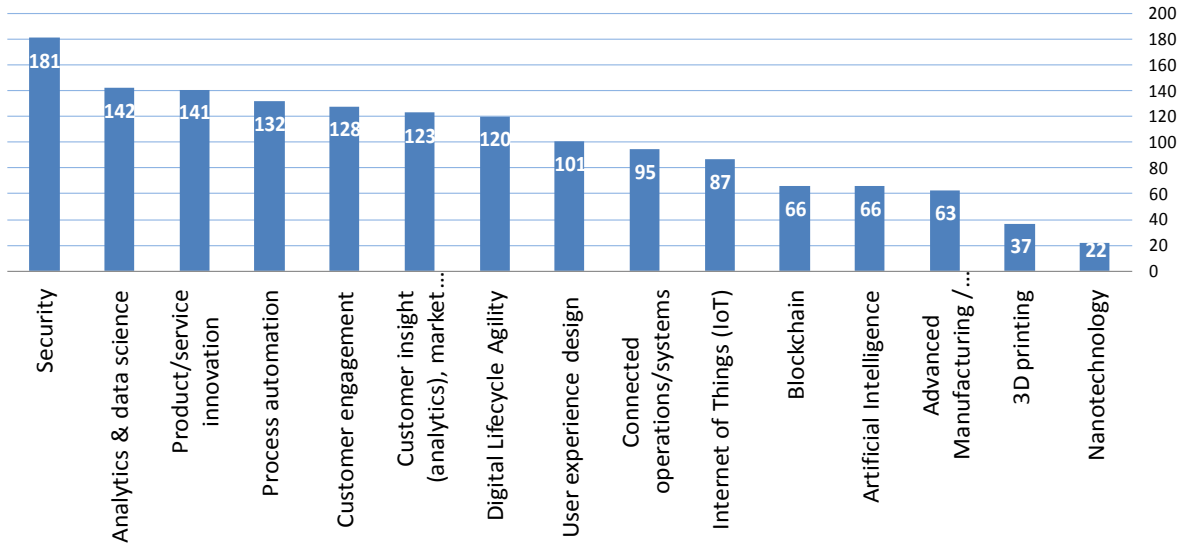
	Investing in training	Hiring talents	Investing in consulting	Engaging in certification (individual level)	Acquiring technologies (soft/hard)	Implementing standards & best practices
Cross-cutting digital capabilities						
Analytics & data science	37	38	26	13	6	26
Artificial Intelligence	20	16	17	6	2	9
Advanced Manufacturing / Robotics	15	14	16	8	4	8
Internet of Things (IoT)	25	19	18	8	5	15
3D printing	11	6	7	4	3	6
Blockchain	23	14	10	7	4	8
Nanotechnology	5	6	3	3	2	3
Security	39	30	32	25	23	39
Digital Lifecycle Agility	29	23	25	17	8	23
Other: xxx						
Operational processes						
Product/service innovation	37	33	29	12	11	23
Process automation	32	27	30	16	9	22
Connected operations/systems	22	20	25	12	8	14
Customer experience						
Customer engagement	29	32	29	11	5	25
Customer insight (analytics), market intelligence	29	33	28	6	5	23
User experience design	30	27	32	7	6	0

Figure 5-43: Investing in capabilities

From their answers, there is a ranking of importance (or of dynamic) of capabilities visible in the investments made. Security is mentioned most often, followed by data science. A surprise might be that innovation is ranked third as a capability enterprises invest in, even before process automation and customer engagement.

Agile, despite its hype cycle having reached maturity already, is „only“ to be found at number seven of the ranked list. Internet of things is apparently on the cusp of becoming an established capability in a number of enterprises. AI, AMT, 3d Printing, blockchain and nano-technologies appear not yet really as a priority.

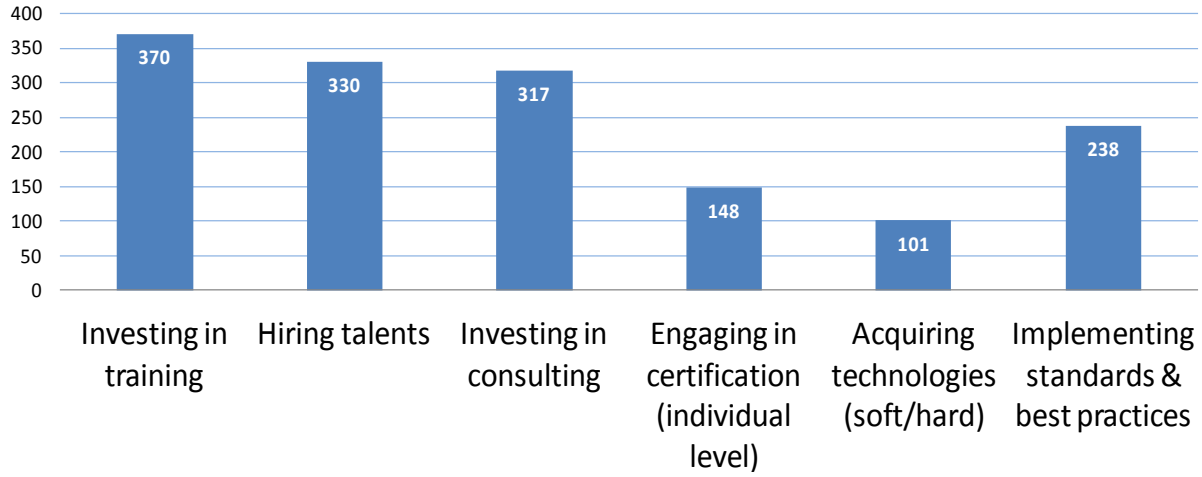
Figure 1: Capabilities by investment



Number of mentions across 6 categories, n = 67. Categories: Investing in training, Hiring talents, Investing in consulting, Engaging in certification (individual level), Acquiring technologies (soft/hard), Implementing standards & best practices

Analysed by type of investments, training and hiring are the top answers, suggesting that capability building in practice is foremost a skills building related activity. This is followed by buying-in solutions, either as often custom made development through consultants or more ready-made in the form of software and hardware. As for standards and certification, the former turn out more widespread than the latter.

Figure 2: Capabilities by building type investment



Mentions across 15 categories, n = 67

The response patterns can give hints as to which capability is addressed by which type of investment. Putting the six investment types in three different bins, standards and certification go together as investing in standards, hiring and training as investing in skills and technology and consulting as investing in tools (although

the end product of consulting is often also a way of practice and hence may belong in standards, however, consulting solutions may often be seen as "black boxes" in the sense of not involving internal talent).

In total, most investments fall under the skills category, with 700 mentions in total (see next table), followed by tools and finally standards.

Table 1: Investing in capabilities by three types

	Standards	Skills	Tools	
	Standards + certific.	Hiring + Training	Tech + Consulting	
Security	**61**	66	**54**	181
Analytics & data science	38	**73**	31	142
Product/service innovation	34	**68**	39	141
Process automation	**37**	57	38	132
Customer engagement	**36**	59	33	128
Customer insight (analytics), market intel	29	**62**	32	123
Digital Lifecycle Agility	**38**	50	32	120
User experience design	7	**57**	**37**	101
Connected operations/systems	24	39	**32**	95
Internet of Things (IoT)	22	42	23	87
Artificial Intelligence	14	**34**	18	66
Blockchain	15	**37**	14	66
Advanced Manufacturing / Robotics	15	28	**20**	63
3D printing	10	17	10	37
Nanotechnology	6	11	5	22
	386	700	418	1504

It might then be interesting to discern which capabilities have their focus in which type of approach. Standards for instance are most pertinent in security, followed by data science and Agile. However, data science has a disproportionate (higher) investment in skills. Analytics is even more skills focused than standards focused as yet, while Agile is more focused on the standards. Process automation and customer engagements are standards driven as well. UX on the other hand is not at all standards driven but implementation relies on skills of individuals more then on codified practice. Some other capabilities are also significantly skills driven: data science, product innovation, market intelligence and AI.

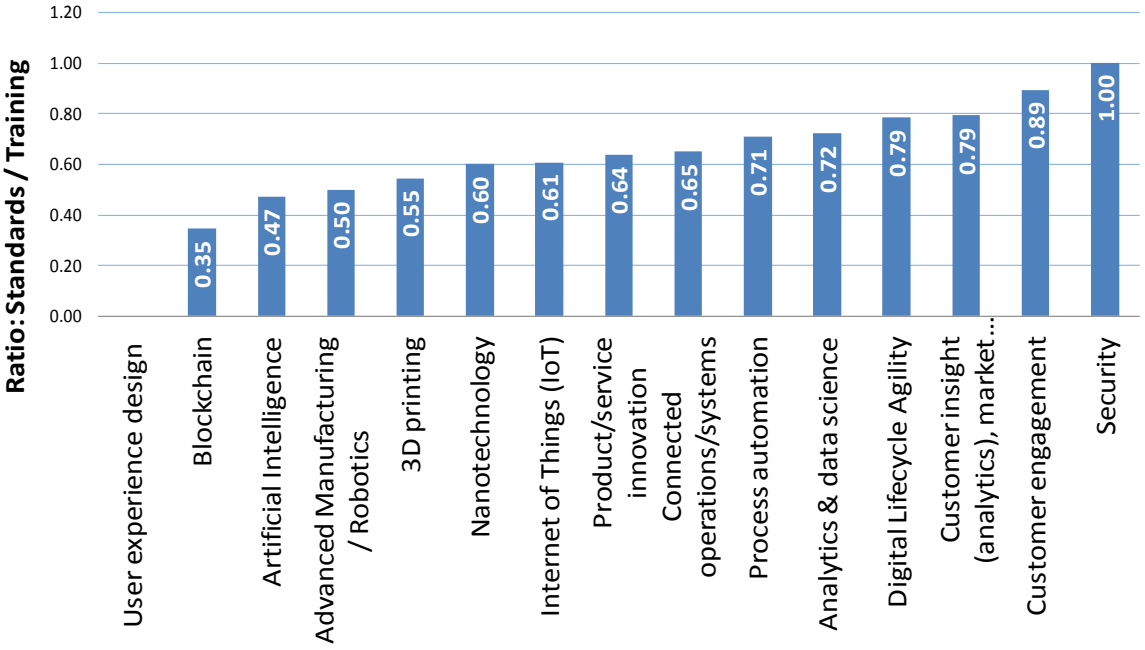
Security is interesting because it is disproportionately tools driven, also disproportionately high on standards, yet still has a high priority in skills.

Comparing again the single investment types "training" and "implementing standards", it is interesting to see that none of the capabilities surveyed has a higher priority on standards than on training, only for security both investments are equally important (i.e. their ratio=1 in the following chart).

If one would map these capabilities according to their maturity[94], one hypothesis that emerges could be that as solutions go from custom-built to commodity, capabilities go from training alone increasingly to both standards *and* training. Standards, in other words, appear high on the agendas only when a capability becomes at least to some extent commoditised.

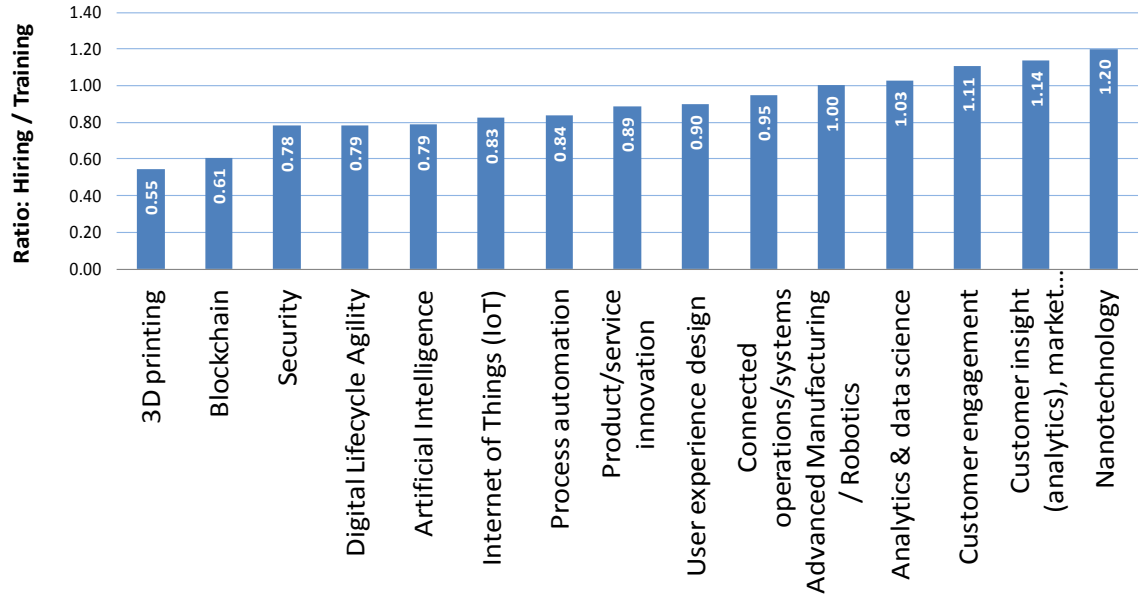
[94] E.g. following Simon Wardley's method of mapping, see e.g. https://medium.com/wardleymaps.

Figure 3: Comparison of relative importance of standards over training



Another view on the data is to compare hiring and training, i.e. in how far enterprises think new capabilities can be taken over by their current staff as opposed to new hires. Nanotechnology is the capability with the strongest leaning towards hiring, whereas 3-D printing and blockchain for the time being seem to be dealt with through training more than through getting on board external talents. It might be hypothesized that new capabilities would usually start off as add-on qualifications (catered for through add-on training), and that some of these will later be professionalised into full grown specialisms, with dedicated hiring.

Figure 4: Comparison of relative importance of hiring over training



D.2 Standards and Frameworks

Next, respondents were asked about IT organisational and management frameworks covering a wide range of specific aspects in IT which might be in use in their organisation such as IT service capability maturity models, CMMI, Six Sigma, ITIL, COBIT 5, Prince 2 etc. First of all the relative importance of different aspect of their motivation for using them were surveyed. The results can be seen in the following chart.

Figure 5: Reasons to implement standards

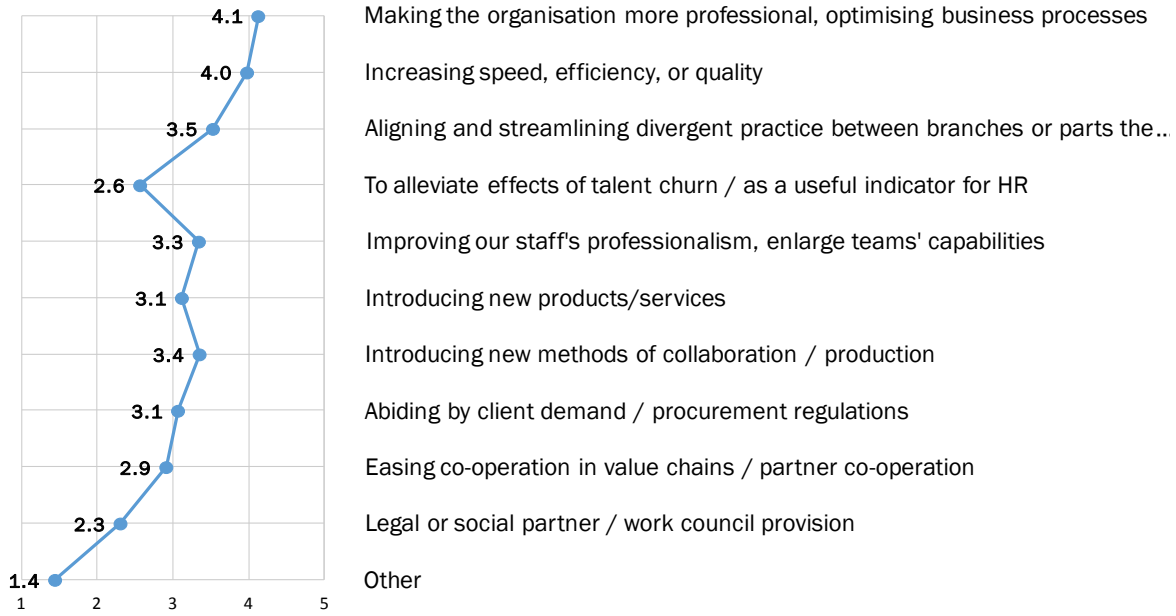
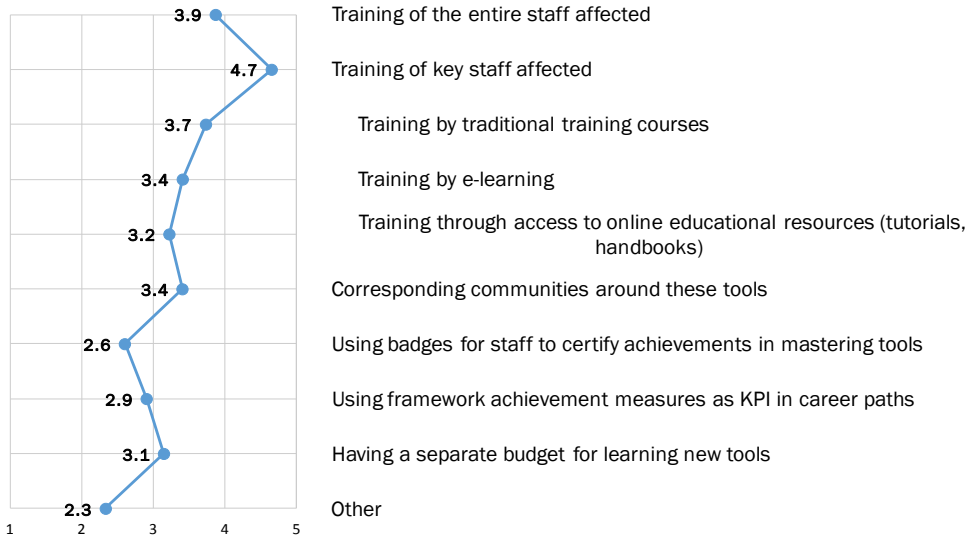


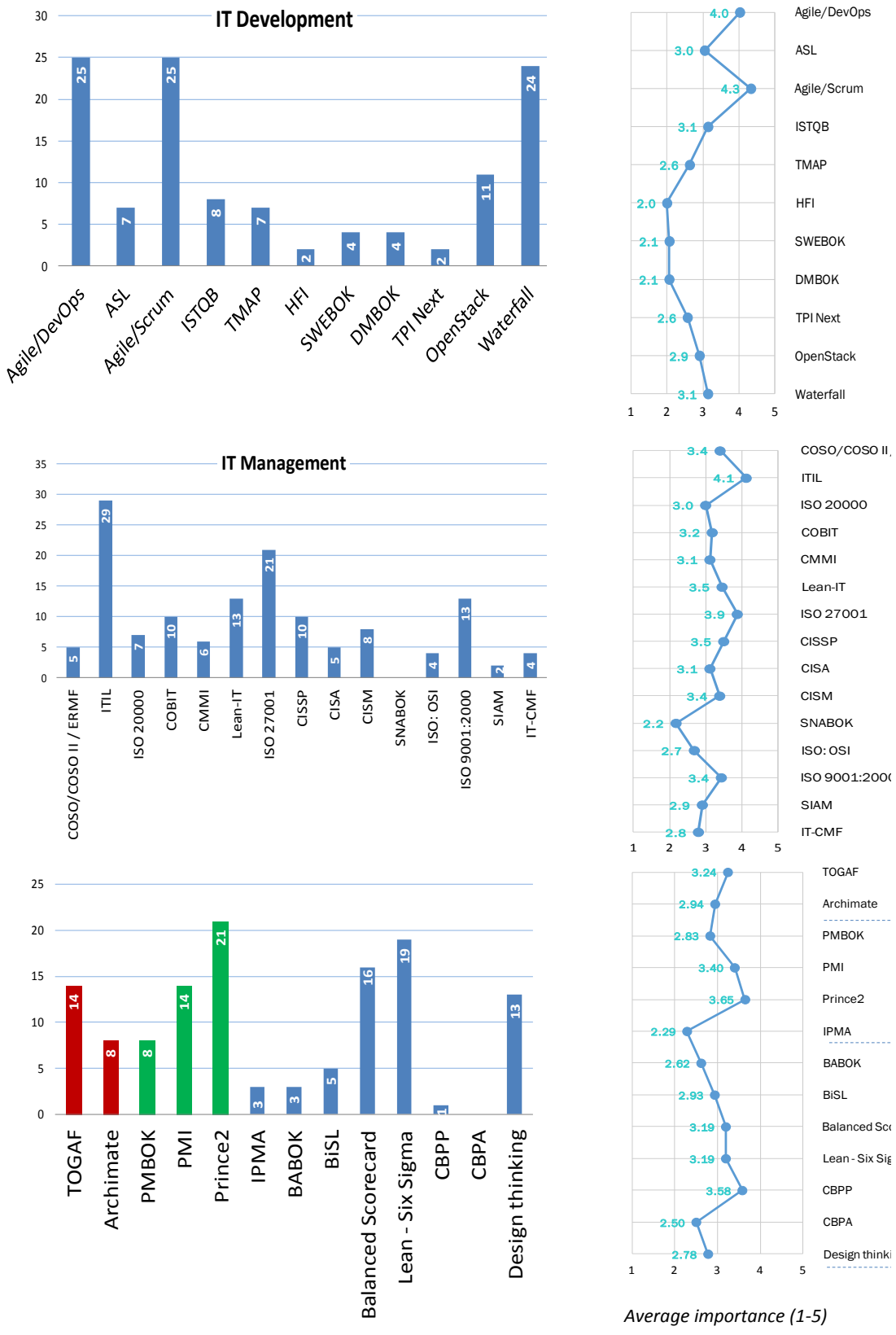
Figure 6: Importance of accompanying measures when implementing standards



Motivation for the implementation of standards can thus be understood as firstly being a way of professionalising the operations and processes of organisations, secondly as a means to achieve better output and are thirdly especially valuable in collaboration (internal and external), as they define the space of

appropriate and expectable action. When implementing standards, not quite surprisingly the training of key staff is the key activity to accompany the implementation of standards.

Figure 7 Standards in use – and their importance



Not surprisingly, the standards which are most widespread in use (left side of the above chart) are also those deemed most important (right side of the above chart). Most important standards are:

- In IT Development
  - Agile / DevOps,
  - Agile / SCRUM,
  - Waterfall
- In IT Management
  - ITIL
  - ISO 27001
  - ISO 9001:2000
- In Architecture
  - TOGAF
- In Project Management
  - Prince2
  - PMI
- In Business Management
  - Lean/ Six sigma
  - Balanced scorecard
  - Design Thinking (which arguably might fit in other categories, especially development, as well)

These are therefore likely to be the ones at least to be included in the final **digital capability reference framework**.

There are furthermore some emerging reference tools that were named by a number of respondents, namely the following:

Table 2: Emerging reference tools in use

SAFe (Scaled Agile Framework – Agile for programs and portfolio)	6
DASA (DevOps Agile Skills Association – competence framework for Agile DevOps teams)	3
TRIZ (Innovation; theory of inventive problem solving)	3
12 factor app (methodology for building software-as-a-service apps)	1
CMAP (CMAP Mobile App Testing)	1

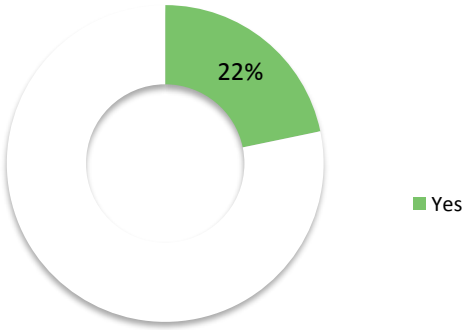
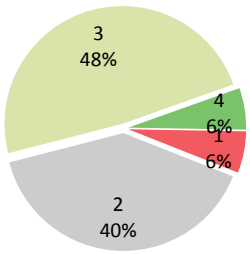
D.3 Skills and certification

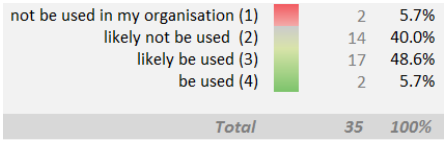
Respondents were also asked about skills frameworks in use in their organisations, the benefits they experience from them, and whether they expect any benefits from a mapping of skills and frameworks.

Only a minority of 22% have a skills framework that refers to standards in use at all. Of those who do not have such a framework in use, the expectations of such a framework are rather mixed with only 2 respondents expecting it to be certainly used, and little more than half of respondents thinking it at least likely to be used. The e-CF as an international scheme is not widely used as yet.

However, a majority of 63% do have at least any kind of skills framework in use, mostly self-developed (39%).

Figure 8 Use of skills frameworks

<table>
<tr>
<td>Is your organisation (or did your organisation consider in the past) using some kind of reference framework that links skills and competences at individual level with digital capabilities at organisational level?</td>
<td> 
</td>
</tr>
<tr>
<td>If not, would you be interested in such reference framework that links skills and competences at individual level with digital capabilities at organisational level?</td>
<td> 

A framework for IT competences at individual level with links with digital capabilities at organisational

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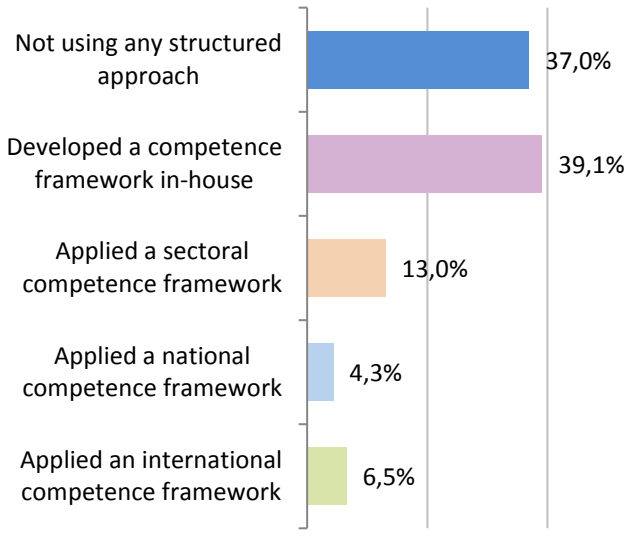
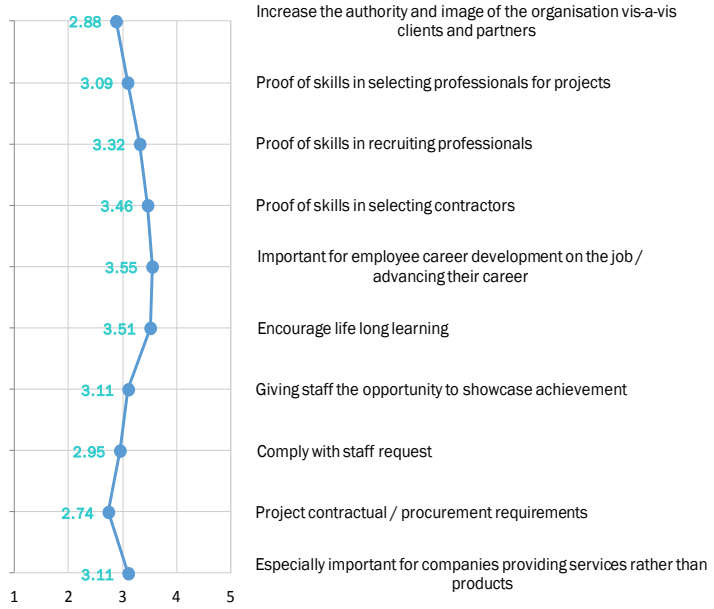
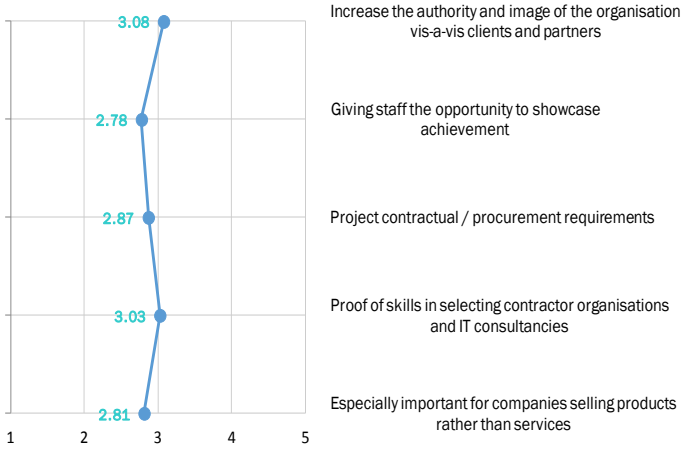
</tr>
<tr>
<td>What kind of competency framework is your organisation using for managing the further development of the competences of IT specialists?</td>
<td> 
</td>
</tr>
</table>

Regarding certification, employee certification is not seen as the number one priority, but its role in encouraging life-long learning and for career advancement is acknowledged. When selecting contractors and for recruiting, certifications as a quality indicator are quite common.

Figure 9 Use of skills frameworks

There are many certifications at individual level (both IT vendor issued and vendor neutral certification, e.g. CCNA, MCSE, ITIL, COBIT etc.) as well as organisational certification (such as ISO 9001) What are the main benefits of individual/employee certification?	
What are the main benefits of certifying your organisation as a whole?	

Appendix E: Methodological explanation calculation of supply and demand of ICT professional labour

E.1.1 Jobfeed data

The table below provides the numbers of reduplicated job postings which are active on 6 September in 2015, 2016 and 2017 (i.e. they had to be not older than 8 weeks and be still online and not republished or marked as expired).

For the three countries covered to a sufficiently mature degree for our research purposes, we can identify 186,000 ICT job vacancies in 2017. For 2016, where we also have jobs data, there were 159,000 vacancies. The job categories covered made up together 3.19 M jobs in the three countries covered in 2016. As a percentage of jobs, there are on average 5.0 vacancies per 100 ICT jobs.

Table 3: ICT practitioner online vacancies in September 2015-17[95]

Jobs (ISCO-08 codes)	**2015**	**2016**	**2017**
Managers (1330)	266,797	286,226	293,382*
Professionals (25**)**	1,987,895	2,080,446	2,132,457*
Technicians and Mechanics (351,3521, 7422)	789,169	823,619	844,210*
Total of job categories covered	3,043,860	3,190,291	3,270,048*
Share covered in ICT workforce as per Eurostat Definition	77.0%	76.9%	76.9%
Vacancies			
Managers	12,090	15,848	16,967
Professionals	98,838	121,736	143,651
Technicians and Mechanics	20,667	21,271	25,736
Total	131,595	158,855	186,354
Vacancy rate			
Managers	4.5%	5.5%	5.8%
Professionals	5.0%	5.9%	6.7%
Technicians and Mechanics	2.6%	2.6%	3.0%
Total	4.3%	5.0%	5.7%

How representative can these countries be for the rest of Europe? The three countries account for almost 50% of the European workforce. Applying the different vacancy rates to the country vectors of jobs, we estimate that there were 434,000 open positions for ICT professionals in Europe in 2016.

Among these, most are vacancies for highly qualified positions in ICT management and professional roles. Only a minority are vacancies for technician level ICT professionals, i.e. practitioners with usually less than tertiary education degrees in ICT.

[95] Source: Textkernel and Eurostat. Jobs totals for 2017 estimated as value for 2016 multiplied by 1.025

E.1.2 Supply side model and assumptions made

The availability of individuals with the different types of e-skills who are either gainfully employed or seeking employment is termed e-skills supply to the labour market. As mentioned above, the e-skills supply **stock** includes individuals in ICT practitioner positions and unemployed ICT practitioners. The scope of e-skills supply depends on the scope of the e-skills definition used and is obviously not static.

The supply total for 2016 is estimated at 8.64 million, of which 8.47 million are in employment and 169,000 unemployed.

E-skills **inflows and outflows** to/from the labour market need to be identified and statistically measured and future developments modelled to gain a comprehensive and complete picture of e-skills supply in the market. To capture market dynamics, i.e. the inflows and outflows of individuals in the pertinent e-skills categories, specific approaches need to be developed.

New market entrants typically are **computer science graduates** of **tertiary education** entering the labour market. In many countries (Germany and Poland in particular) also (post-) secondary **vocational training** plays a major role as supply pool. Computer science graduates are modelled to flow into the ICT workforce entirely.

Anecdotal evidence supports the observation that the share of computer science graduates has increased in ICT recruitment over the last decade[96], yet **other graduates**, from mathematics, natural sciences, engineering or social sciences who possess the IT skills demanded still today fill ICT positions that would otherwise remain vacant. In both scenarios, the number of non-ICT graduates to flow into the ICT workforce is modelled to follow demand but the number is capped at 10% of the number of STEM graduates (Italy 20%). There are about 640,000 STEM graduates per year in Europe.

While it is relatively easy to approximate an adequately accurate annual supply of university leavers and vocational school leavers with a major in ICT, any attempt to estimate the supply pool from the official statistics about natural science, maths, or social sciences graduates has to rely on evidence based assumptions and auxiliary hypotheses about the share of outsiders entering the ICT workforce.

Also **career changers** originally coming from a non-ICT background may take on ICT positions, furthermore re-entrants who had been out of the labour market previously. While certification has become crucial for ICT practitioners across all backgrounds, it can be assumed that especially for "educational outsiders" certification and re-skilling programmes play a crucial role in adapting the workforce skills to the demand side requirements.

Certifications and re-skilling programmes play a crucial role in adapting the workforce skills to the demand side requirements.

As we have recently underestimated the ability to recruit outsiders from the labour market, the number of outsiders entering the workforce through qualification and up-skilling measures was set to 0.5% of the 2015 workforce, or 34,300 annually in the moderate growth scenario.

In the high-growth scenario, outsider entries amount to between 148,000 and 151,000 annually for the reasons given in the scenario descriptions.

[96] A UK study of 2001 still found that „the majority of graduates working in ICT jobs do not hold a degree in an ICT related subject. While the most common degree subject is maths or computing (40 per cent), others include engineering and technology (21 per cent), physical sciences (11 per cent) and business studies (nine per cent). Graduates employed as computer analysts/programmers display the greatest range of degree subjects. Also, female graduates working in ICT occupations are more likely to have degrees in non-ICT or non-technical subjects (e.g. social sciences). (THE INSTITUTE FOR EMPLOYMENT STUDIES (2001): An Assessment of Skill Needs in Information and Communication Technology.) http://dera.ioe.ac.uk/15250/1/An%20assessment%20of%20skill%20needs%20in%20ICT.pdf)

The pool for ICT Management recruitment[97] (ICT managers, enterprise architects, ICT consultants) was specified as a percentage (1.75% per year) of individuals from the ICT practitioner pool getting promoted to management level and as a percentage (33% of demand) those coming from the business side (line management etc.) i.e. external entries, effectively limiting new supply of ICT management talent to 2.4%/year of the current professional workforce.

Finally, **immigration** is a source of additional supply to the market. We have for the time being not included immigration from outside the EU into our model, as anecdotal evidence has shown that the absolute figures of immigration directly into the labour market (i.e. not through the national education systems) remain to be proven significant. This may change in the near future as recent new immigration from outside the EU begins to gain access to the ICT labour market.

Migration between European countries happens based on the signals of unemployment and excess demand in countries. Countries with an excess demand can attract a certain number of people from countries with excess supply (modelled as percentage of the unemployment rate). Total figures across Europe are not significantly affected by this property of the model. Poland and Portugal have a significant out-migration of 19,000 and 7,000 respectively across the four year period in the moderate growth scenario, with France and Germany being the main receiving countries.

In the high growth scenario model, the result of the model is no (net) migration taking place at all since no country experiences a severe enough unemployment of practitioners.

Supply side **exits** may be due to **retirement, temporary leave** (e.g. parental leave) and **emigration** of ICT workers as well as promotion or other **career change** to non-ICT jobs (or jobs at least not statistically captured as ICT jobs). Replacement demand figures (subsumed under the supply side model here because in the model it lowers the supply) have been estimated at 2.5% for practitioners and 3.3% for management positions with some delay built in to allow for the fast growth of the workforce (which tends to lower the average worker age).

The necessary statistical data regarding university graduations is available from Eurostat (see annex and chapter 5.1.5). Further inflow indicators of relevance - which could be considered subject to availability of the necessary data - include data from immigration and career changers or market re-entrants.

Outflow data would mainly include statistics on retirements, emigration, career changers or re-entrants. This kind of data is hardly available across countries and estimates have to be based on analogies.

E.1.3 Demand side model

Conceptually, demand given as a specific figure, i.e. not as a function of wage (as in textbook economics), is the size of the workforce that the market would absorb shortly given that the current wage level prevailed. Markets tend to adjust via the price or quantity offered of the commodity. However, certain limitations apply in the labour market in the short term as regards the availability of skills, and obviously also with regards to the wages employers are willing to pay.

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[97] Advanced positions, especially ICT managers, can be recruited from the pool of ICT practitioners or through side entries of non-ICT practitioners (e.g. managers from other departments). In both cases, there are no statistical concepts of the pools of suitable candidates available, as is the case with university or vocational graduates for practitioner labour market entries. Seasoned practitioners are an obvious source for management jobs, but both working experience and life-long learning credentials have to match with the position. While bottlenecks are reported to exist by employers who claim to have a hard time finding good e-leaders, it is hard to model exact evidence-based parameters for these bottlenecks into our labour market model. We finally resorted to assuming external side entries to be 33% of new demand for management positions (with an unlimited pool), and 67% to be tried to recruited from the existing practitioner pool. For practitioners, a bottleneck of no more than 2.0% of existing practitioner workforce annually was introduced into the model. The breakdown of total number of vacancies into management and practitioner positions therefore has to be taken with a pinch of salt, as may underreport or overreport management vacancies and vice versa for practitioner vacancies.

While a short-term demand can be computed by adding existing and open posts, future demand will be highly path dependent. A planned demand that cannot be satisfied today and over a longer period and where prospects of filling it are meagre will eventually lead to evasion on the demand side, i.e. changes in the production structure. Therefore, it is crucial to understand the concept of future "**demand potential**" which will be a demand given the supply available is not actually too distant from the plans of the enterprises. It should therefore be noted that **an extremely high projected number of vacancies in a distant future will probably not actually be realised**, but derives from a demand potential for potential jobs which could be created if Europe manages to produce the skills needed for these jobs.

Demand potential up until 2020 in the moderate growth scenario is calculated and estimated using the following observations:

- The long-term trend of ICT workforce growth over the past decade
- Annual growth of ICT employment has remained very robust throughout the crisis
- The correlations between the ICT workforce growth rates, GDP growth rates and IT investment growth rates have been disappearing somewhat during recent years
- There seems to be less influence of economic cycles and a stronger indication of a "mega-trend"
- Consequence for foresight: Heavier weighting of "trend" in favour of "economic situation".

The approach contains the following inputs:

- Market insight data on enterprise IT spending
- Market insight data on hardware, software, services: IT Budgets
- Market insight data on Consulting Budgets
- (Semi-) Official Statistics on IT spending / IT investment
- An evidence based estimate on the split of IT budgets into hardware, software, services
- Estimation of Labour costs, internal and external
- Correlation with GDP growth, IT investment and IT labour market
- Scenario outputs on the assumptions of GDP growth, IT investment which leads to estimations of IT labour demand (costs)
- Assumptions on wage developments and IT labour costs result in an estimation of IT labour headcount.

Technological trends are included to take effect together with a beginning maturity of some markets in terms of outsourcing and off-shoring. Other major markets yet are still catching up through this period.

Scenarios furthermore deliver assumptions on the distribution of IT labour costs into a) management / business architecture level, b) core ICT practitioners and c) ICT technicians. Technological trends mainly put pressure on lower skilled ICT practitioner demand, while lifting demand for management / business architecture type of skills. As is inherent in the concept of demand potential, adjustments to supply shortage need to be made in the scenario.

The moderate growth scenario features an economic growth scenario that is taken from the 2016 forecast. It is based on a slow recovery for the time horizon 2015-2020. GDP growth across Europe from 2015 to 2020 is assumed at an average of 1.7 % annually. We expect moderate IT investment growth up to 3 % per year in the period of 2015 to 2020. In the education domain, we assume a slight increase in the number of ICT graduates (**1% increase per year on average**). We also assume labour mobility of ICT workers within the EU to increase from countries of low demand to countries with excess demand.

Table 4: 'Moderate growth forecast scenario': Real GDP growth[98]

	2016	2017	2018	2019	2020
France	1.6%	1.2%	1.3%	1.5%	1.7%
Germany	1.6%	1.3%	1.4%	1.6%	1.8%
Italy	0.8%	0.8%	0.9%	1.1%	1.3%
Poland	3.6%	3.5%	3.6%	3.8%	4.0%
Spain	1.9%	1.2%	1.3%	1.5%	1.7%
UK	1.5%	1.3%	1.4%	1.6%	1.8%
EU22	2.1%	1.8%	1.9%	2.1%	2.3%
EU28	1.7%	1.4%	1.5%	1.7%	1.9%

Table 5: 'Moderate growth forecast scenario': IT spending growth[99]

	2016	2017	2018	2019	2020
France	3.0%	3.4%	3.8%	4.2%	3.8%
Germany	2.8%	3.3%	3.6%	3.7%	3.7%
Italy	2.2%	2.1%	2.8%	5.1%	5.1%
Poland	4.9%	5.1%	5.2%	5.3%	4.6%
Spain	1.9%	2.7%	4.3%	4.1%	3.1%
UK	2.7%	2.5%	2.1%	1.7%	1.2%
EU22	3.4%	2.9%	2.3%	2.3%	2.1%
Total	2.9%	3.0%	2.9%	3.1%	2.9%

The demand model for the "High-growth scenario" is much simpler in that it simply assumes a cross-country consistent growth of demand of 3.6% for both practitioner as well as management positions.

[98] Source: IDC Europe

[99] Source: IDC Europe

Appendix F: Bibliography

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