
HBO-i
DOMAIN DESCRIPTION

Colophon

Published by

HBO-i foundation

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- John Gorter, Iconica

Preface

The business world and society have high expectations when it comes to higher professional education: the students are expected to acquire the so-called 21st century skills and sufficient professional expertise. In a dynamic world where professional expertise quickly becomes dated and in which the working time of employees is further increasing, it is essential for the content of the programmes that a close collaboration with the work field takes place. This is the only way the latest knowledge and developments can quickly find their way into teaching. This applies to all programmes for higher professional education (hbo) and especially for the ICT programmes.

In compiling this new HBO-i domain profile, the work field was also therefore involved at an early stage. Representatives from dozens of organisations – including businesses, government agencies and branch associations – have all contributed to the creation of the profile. The profile has also been established in such a way that it offers room for individual universities to determine, in consultation with the regional work field, how a programme can best be designed to match the needs of that specific region.

A great example of how hbo and the work field can flexibly work together in educating the professionals of the future. This results in creating a variety of ICT experts; the one specialised in hardware and the other focused on the end user or rather the logistical side. But all of them will be armed with a thorough knowledge of their specific area of expertise and they will be capable of adapting to the rapid dynamics of the work field. Ready to make a contribution to our knowledge-based economy.

Drs. Ron Minnée,

Secretary Association of the Universities of Applied Sciences

Contents

1 Introduction

The HBO-i domain description serves as a functional qualifications framework for universities and focuses on the starting proficiency of future ICT professionals. ICT plays a large role in virtually every facet of societal, commercial and personal life. ICT is not only a crucial sector of economic activity; it is also an invaluable engine for innovation in every knowledge-intensive domain in our society. The Netherlands has a great need for quality, trained ICT specialists.

The ICT domain is expanding and developing all the time. Not only is the demand for ICT specialists increasing, so is the demand for ICT sub-domains. In order to be able to respond to new applications, labour market issues, needs and innovations, regular updating of the HBO-i domain description is required.

Besides the developments in the ICT domain, the field of education is also changing. We are seeing increased interest in Associate degrees and Professional Master Programmes and the focus on the match between the work field and the training objectives has led to added interest in prof. skills.

1.1 What is it?

The HBO-i domain description is a national framework for the final qualifications for graduates of Dutch programmes for higher professional education (hbo) in the ICT domain at an Associate, Bachelor and Professional Master degree level. The domain description is maintained by the HBO-i foundation. Related to and inspired by international developments, frameworks and formats, the domain description is periodically updated in collaboration with the business community and is established by The Netherlands Association of Universities of Applied Sciences.

1.2 For who is it intended?

The domain description is compiled by various target groups. It is primarily intended as a framework document for hbo programmes in the ICT domain. As of mid 2018, the ICT public education domain shall offer the following active training courses in the Central Register of Studies in Higher Education (CROHO): B HBO-iCT (30020, 81033), B Technical Computer Science (34475), B Computer Science (34479) and B Business IT & Management (39118). In addition, there are also training courses at the level of an associate degree (Ad): Ad Technical Comp. Science (80022), Ad IT Service Management (80024, 80901), Ad Comp. Science (80075), Ad ICT Service Management (80083), Ad Software Dev. (80130) and Ad ICT (80132).

Courses can derive their own course profile, learning goals and curricula from the domain description. The explicit linkage of the own course profile to the domain description safeguards the content and the final (completed) level of the course.

For *businesses*, the domain description provides insight into the final level of the graduates. Due to the variety of available ICT programmes, the general domain description offers a stronghold to better understand the actual skills of the graduates.

For prospective *students*, the domain description provides information on the content of the courses and how they are positioned in the overall context of the educational domain as a whole.

The fringes of this domain description designate the adjoining *domains* of the HBO-i domain. These fringes make the connection to the domains of Engineering, Creative Technologies and Business Administration.

1.3 About HBO-i

The HBO-i foundation is the umbrella organisation of hbo ICT-programmes in The Netherlands. The foundation is committed to the exchange of knowledge and transfer of information in subject matter and educational areas. Through collective activities and products the foundation is also dedicated to increasing the influx of new talent. This domain description is one of the products of the HBO-i.

HBO-i
HOGER BEROEPSONDERWIJS
ICT – OPLEIDINGEN

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HOGESCHOOL UTRECHT
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Fontys

1.4 Development of the domain description

Since 1994, HBO-i has provided an up-to-date framework document for affiliated programmes. This HBO-i domain description is the fourth in a series that represents the subject matter domain of ICT programmes as well as the three dimensional space with more or less orthogonal dimensions. We again decided for this representation because we still believe that it offers the best opportunities for positioning programmes, programme and professional profiles.

In order to keep up with the rapidly developing ICT field, the specific field subjects have been actualised in this domain description. To give structure to the professional skills needed to successfully carry out ICT subject matter related professional duties, this version also includes a description of implementation. It has also been indicated how these professional skills are connected to ICT professional duties. Also to create a framework for the development of Associate degree and Master programmes, this domain description also includes a characterisation of such programmes in regard to Bachelor programmes. For the characterisation of Professional Master programmes, the dimension of proficiency levels and thereby the description of subject matter related to professional duties has been expanded with another level (level four). Because the description of the proficiency levels in the former version was acquired through the development of professional skills and because the interpretation of the highest proficiency level led to some confusion, the descriptions of the proficiency levels have been further detailed.

The model in this HBO-i domain description is especially developed for the description of the supply side of the Dutch hbo ICT programmes. This model finds itself in a context of a large number of national and international models that describe educational and functional levels on one side and especially outline the work field from the demand side on the other. For an interpretation and further detailing of this HBO-i domain description, we will delve further into that context of other models and descriptions.

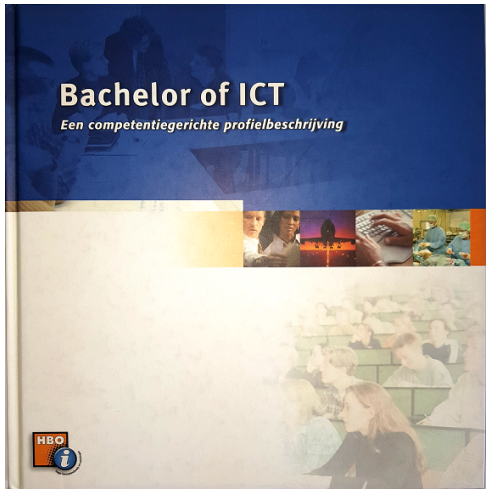
Because of the increasing role and possibilities of digital publications, we have chosen for a digital first publication. This makes it possible to clearly represent aspects and relations and it is practical to use. Each of the components of the model can be approached directly.

It is also possible to consult the entirety in a linear form, and if necessary, to download and print it.

Background

HBO-raad (2009), Kwaliteit als opdracht.

Previous domein descriptions



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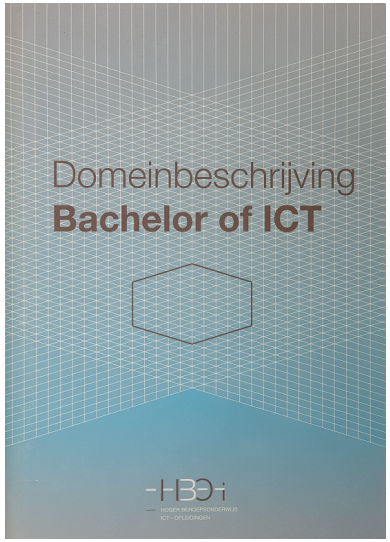
HBO-i foundation (2009). *Bachelor of ICT, domeinbeschrijving.* ISBN 978-90-814684-1-1.



HBO-i foundation (2014). *Domeinbeschrijving Bachelor of ICT.*

HBO-i foundation (2014). *Aan de slag met de domeinbeschrijving Bachelor of ICT.*

1.5 Accountability, coordination and support base

This domain description has been compiled by representatives of the affiliated HBO-i programmes. Feedback has been provided by large number of companies, members of the HBO-i Advisory Council[1] with representatives from branch organisations and expertise groups and members of professional field committees of the programmes that participate in the HBO-i foundation.

[1] To see the composition of the Advisory Council, please go to: http://www.HBO-i.nl/organisatie

Organisations consulted


PHILIPS
Research


SERVITECT


studyportals


Technolution


THALES


think
wise.

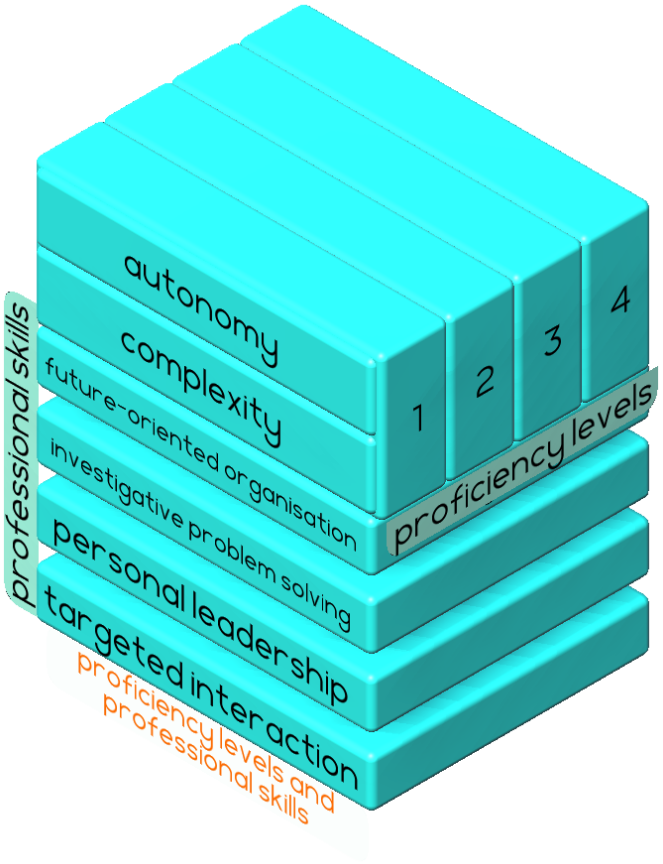

topicus


TRIMM
DIGITAL CRAFTSMANSHIP


UNET

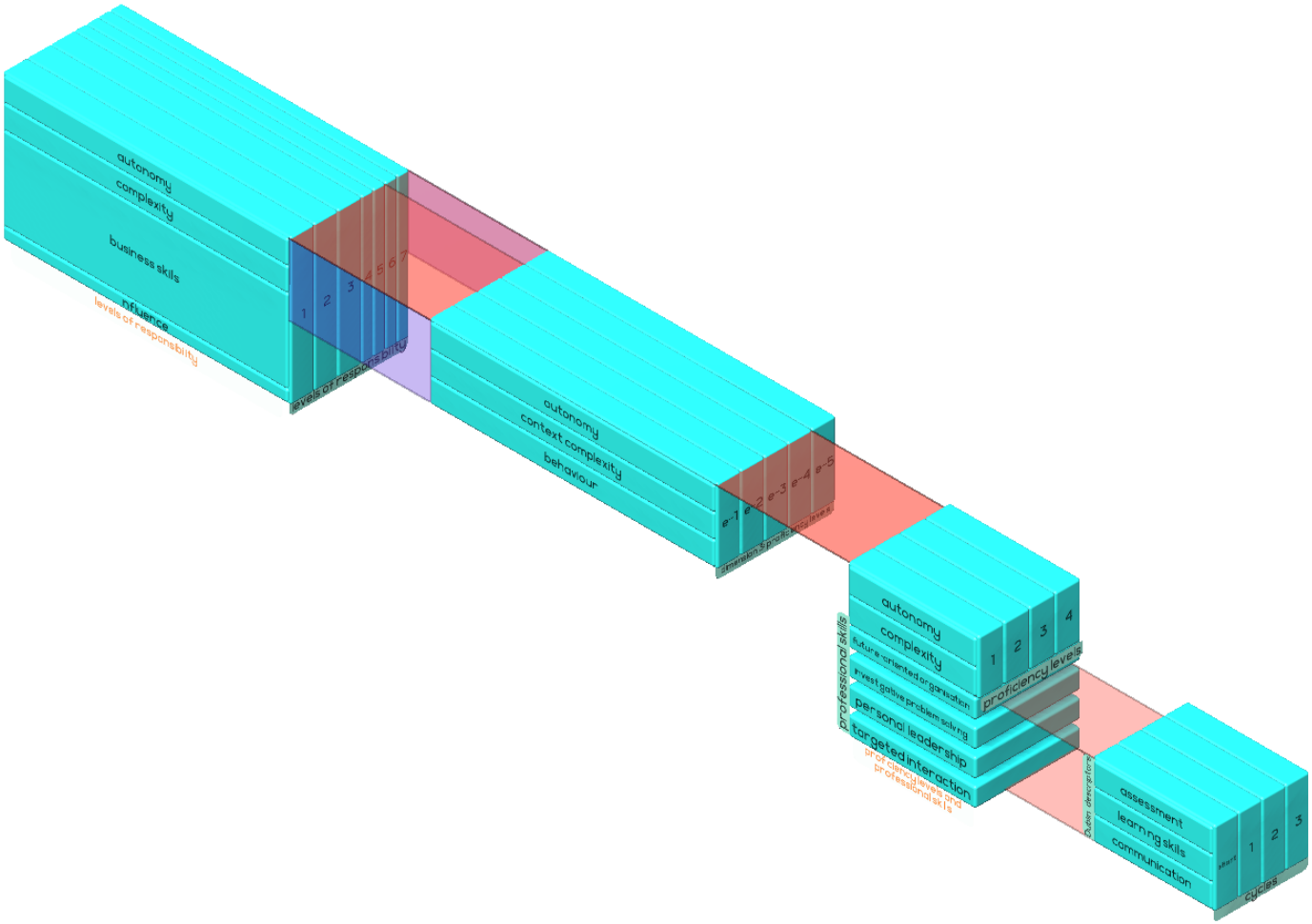
2 The model: proficiency levels and professional skills

In this section, we delve into the factors that – in correlation with the content of professional duties in a sense – characterise the professional functioning at a certain level.



Relation to other frameworks

- *QF-EHEA*
  Characterises the level in terms of professional skills for ‘assessment’, ‘learning skills’ and ‘communication’.
- *e-CF: dimension 3: proficiency level (NEN-EN 16234-1:2016, o.a. annex B)*
  Dimension three of the e-CF characterises levels as based on autonomy, context complexity and behaviour: competence.
- *SFIA: level of responsibility*
  SFIA characterises levels as based on autonomy, complexity, business skills and influence.



2.1 Proficiency levels

One of the dimensions of the HBO-i domain description concerns the proficiency level. It is important in determining the level of education. Within the HBO-i domain, programmes and students can place an emphasis on different areas. This results in a variation within a level which requires proficiency in certain sub-areas. In order to make comparison possible within that diversity, we have defined four proficiency levels. The proficiency level is determined by the complexity of the context, the complexity of the content and level of autonomy involved in carrying out the assignment. A proficiency level is achieved when two of these facets reach the level concerned. For the third proficiency level, the autonomy and the complexity can be at level three of the context level, for example, while the complexity of the content is at level two. But it is also possible that the complexity of the context and the content are at level three while the autonomy is at level two. The characterisation of the proficiency level in the overview below corresponds with the level description in dimension three of the e-CF and the level classification described by the Expert group protocol of the Association of Universities (Andriessen et al., 2014).

The description of the professional duties for each architectural layer is divided into four proficiency levels. In general, a higher proficiency level here requires the proficiency of the professional duties at the underlying proficiency levels. In the architectural layer hardware interfacing, this is only partially the case because the professional duties from the two identified sub-areas of embedded software and process automation are described. At a certain proficiency level within an educational programme, one can choose to focus on only one of these sub-areas.

Sources

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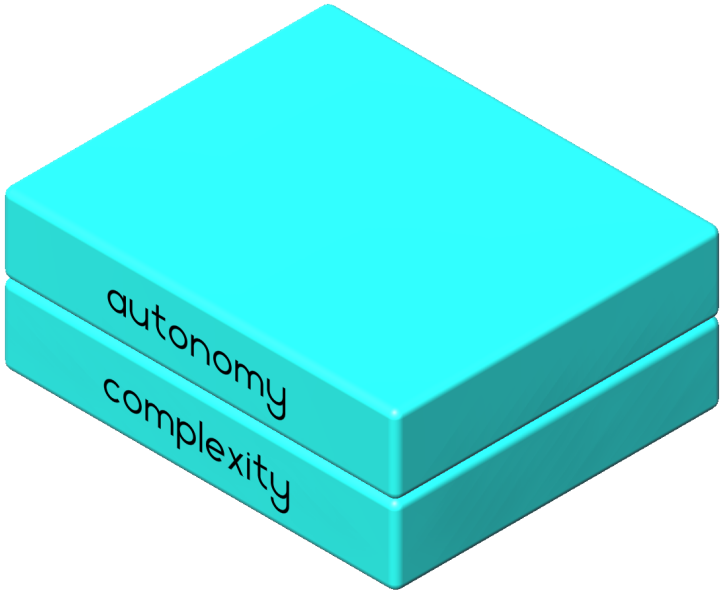
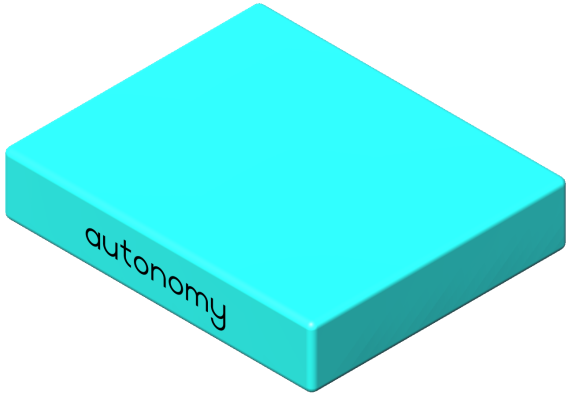
- Andriessen, D., Manders, P., Greve, D., Hermans, P., Jakobs, L., te Lintelo, L., … Straetmans, G. (2014). *Beoordelen is mensenwerk. Bevindingen over de wenselijkheid en mogelijkheid van een gezamenlijk protocol voor het beoordelen van (kern) werkstukken*. The Hague. Retrieved from www.verenigingh ogescholen.nl

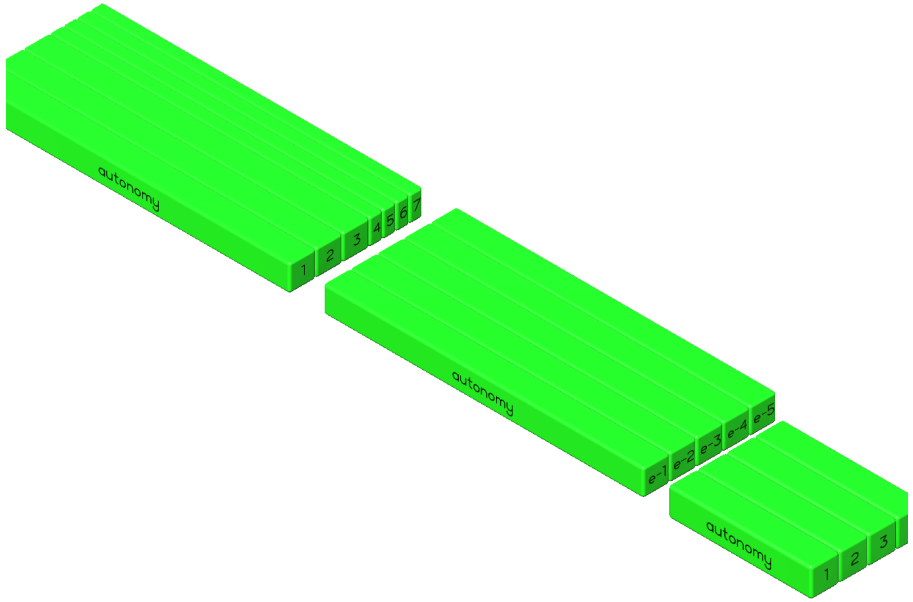

autonomy
complexity

2.1.1 Autonomy



Relation to other frameworks

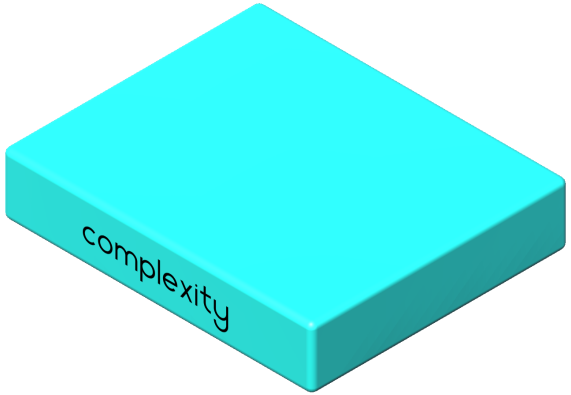
- *e-CF: dimension 3: proficiency level (NEN-EN 16234-1:2016, among others annex B)*
  Dimension three of the e-CF characterises context complexity at five different levels.
- *SFIA: level of responsibility*
  SFIA characterises complexity at seven different levels.



Separate tasks

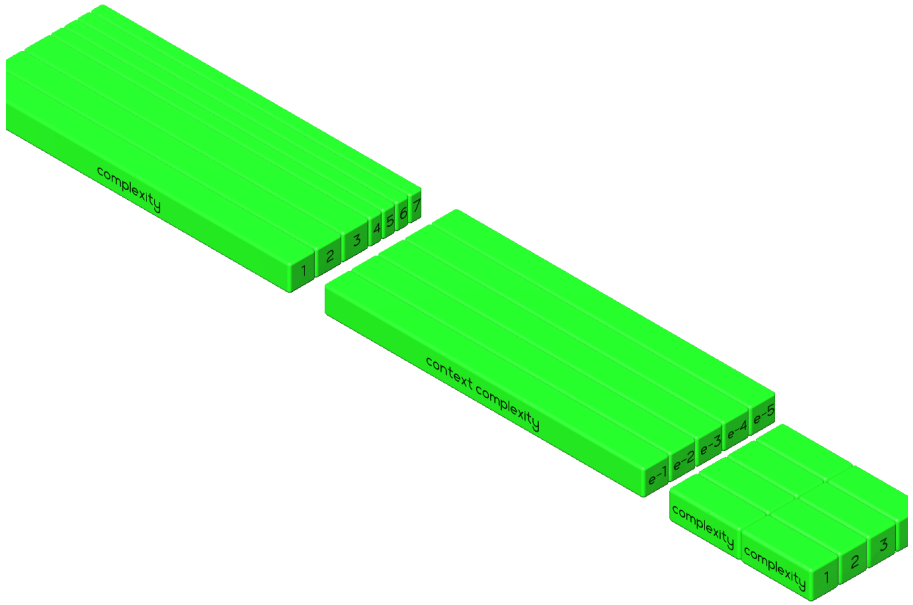
	Proficiency levels			
	1: Task-oriented	***Problem-oriented***	***3: Situation-oriented***	***Profession-oriented***
Proficiency levels ***Autonomy***	Works under general guidelines in an environment where unpredictable changes take place.	Solves autonomously interactive issues that arise from project activities.	Works autonomously to solve interactive problems. Has a positive effect on team performance.	Coordinates and manages. Raises issues with much interacting factors.

2.1.2 Complexity



Relation to other frameworks

- *e-CF: dimension 3: proficiency level (NEN-EN 16234-1:2016, among others annex B)*
  Dimension three of the e-CF characterises autonomy at five different levels.
- *SFIA: level of responsibility*
  SFIA characterises autonomy at seven different levels.



Separate tasks

		Proficiency levels			
		1: Task-oriented	***Problem-oriented***	***3: Situation-oriented***	***Profession-oriented***
Proficiency levels	***Context***	Structured predictable context, problem defined, approach and solution known by client.	Structured – unpredictable context, problem given, choice of approach and solution area limited.	Structured – unpredictable context, vague problems, approach and solution area open.	Unstructured multi-disciplinary and/or specialised context.
	Contents	A few basic concepts that build on the pre-education	Combination of several basic concepts and a few in-depth concepts that build on basic concepts	Combination of several concepts for delving deeper into an innovation in a local situation.	New concepts for delving deeper and innovation that is transferable to other situations.

2.2 Professional skills

In order to be able to successfully complete an ICT assignment comprised of one or more ICT professional duties, professional skills are required together with professional expertise. An integral part of these skills is that an ICT professional learns from every assignment and this way develops their own profile for future work. ICT professional duties, skills en personal development are thereby inseparably linked. To make all of this operational and have it connect to the ICT professional duties, the professional skills have been formulated into four areas of interest: *future-oriented organisation*, *investigative problem solving*, *personal leadership* and *targeted interaction*. The four areas of interest overlap one another and complement each other.

In the chosen set-up, we strive for recognisability, feasibility, and transferability so that both the educational and business worlds can work with it. The set-up is based on the Dublin descriptors, the hbo standard, the results from the HBO-i work group ‘The Other Skills’ and the shared vision concerning investigative capacity and problem solving that has been built up at various universities of applied sciences (Andriessen et al., 2014; Losse, 2016; Turnhout et al., 2013).

In carrying out each ICT professional duty, professional skills are needed to bring the assignment to successful conclusion. The areas of interest of the professional skills are the same for all assignments. The behaviour that is necessary as a professional skill to carry out ICT professional duties will be described here later. The level of these skills is determined by the proficiency level that is required for the assignment as described elsewhere for each architectural layer and activity for four levels. This offers opportunities to enable the level of those skills to grow over the course of the programme. At level 1, for example, the client may indicate that a presentation must be given and what the criteria are for that, while the student at level 3 must determine themselves which forms of communication best match the context and they must be able to substantiate this.

There is also room for profiling at the required level of the skills by, for example, having the assignment emphasise the (organisational) complexity of the context or instead, emphasising the (technical) complexity of the (professional) content.

How we define professional skills can be elaborated on later for each of the four areas of interest in the three sub-areas.

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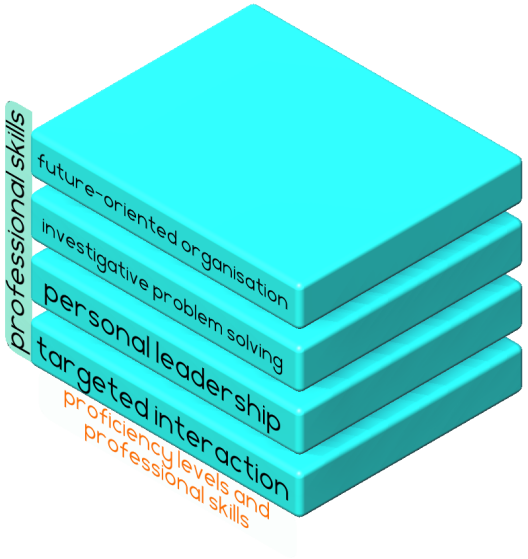
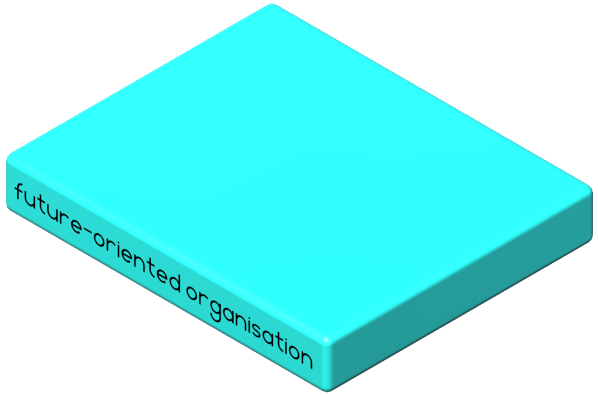

professional skills
future-oriented organisation
investigative problem solving
personal leadership
targeted interaction
proficiency levels and
professional skills

2.2.1 Future-oriented organisation



Relation to other frameworks

- *SFIA: level of responsibility*
  Aspects of the ‘Business skills’ section.

Related bodies of knowledge and skills

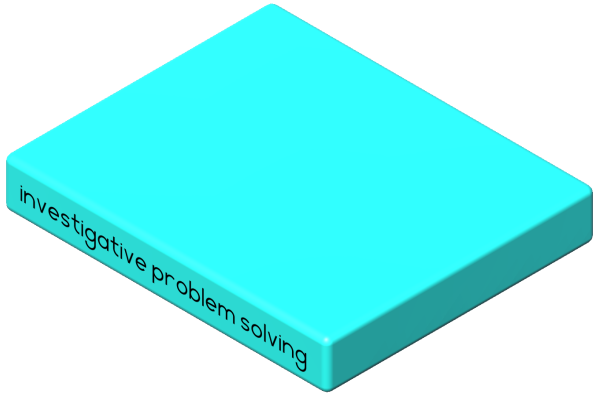
- European Foundational ICT Body of Knowledge – IT legal, ethical, social and professional practices
- ACM/IEEE-CS Software Engineering Code of Ethics and Professional Practice
- ACM Code of Ethics and Professional Conduct
- Gedragscode Nederland ICT
- IEEE Code of Ethics
- (ISC)2 Code of Ethics
- Ten Commandments of Computer Ethics
- APM Body of Knowledge 6th edition
- PRINCE2
- European Foundational ICT Body of Knowledge – Project management
- European Foundational ICT Body of Knowledge – Quality management
- M_o_R – Management of Risk
- MSP – Managing Succesful Programmes
- MoP – Management of Portfolios
- P3M3 – Portfolio, Programme, and Project Management Maturity Model
- P3O – Portfolio, Programme and Project Offices
- PMBOK – Project Management Body of Knowledge

Separate tasks

The organisational context of ICT assignments explore making corporate, sustainable and ethical considerations and managing all aspects of carrying out the assignment.

Sub-area	*Explanation*
Organisational context	Identifies the hallmarks and roles of the environment of the assignment and knows the business legitimisation
Ethics	Knows the ethical standards, involves social ethical themes in the judgement process, recognises own boundaries and those of others and acts accordingly.
Management	Inventories subtasks, plans and monitors time, money, quality and ethics of the execution of the work activities, recognises opportunities and risks and ensures a future-oriented embedding of the solution in the organisation.

2.2.2 Investigative problem solving



Sources

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Relation to other frameworks

- *QF-EHEA*
  Dublin descriptor ‘Assessment’.
- *SFIA: level of responsibility*
  Aspects of the ‘Business skills’ section.

Related bodies of knowledge and skills

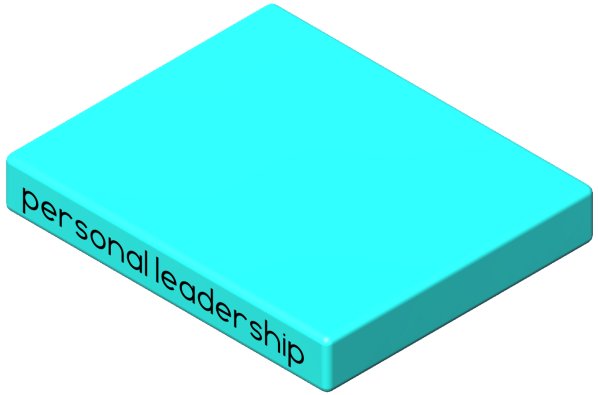
- HBO-i – ICT research methods

Separate tasks

Critically consider ICT assignments from various perspectives, identify problems, finding an effective approach and coming up with appropriate solutions.

Sub-area	*Explanation*
Approach to problems	Identifying the problem, determining the aim of solution and picking an appropriate approach.
Investigative	Being curious throughout the solving process and asking questions from various perspectives, matching these questions with fitting approach that is pragmatic, critical and based on answering sources.
Solving	Being able to methodically and creatively solve problems, finding alternatives and critically analysing own and others' line of reasoning.

2.2.3 Personal Leadership



Relation to other frameworks

- *QF-EHEA*
  Dublin descriptor ‘Learning skills’.
- *SFIA: level of responsibility*
  Aspects of the ‘Business skills’ section.

Related bodies of knowledge and skills

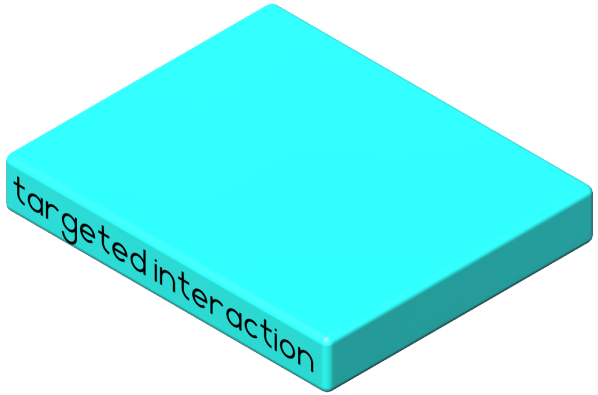
- The seven habits of highly effective people

Separate tasks

Being entrepreneurial in regard to the ICT assignments and personal development, while being aware of own learning capacity and keeping in mind what ambitions drive ICT professionals and/or which types of positions.

Sub-area	*Explanation*
Entrepreneurial	Being aware, seeing opportunities and seizing them, motivating oneself and others, being able to profile oneself, a team and others. Aware of own development, showing leadership and taking responsibility
Personal development	Making a well-considered choice of study, enhancing ones' own learning capacity, recognising a learning need in oneself and acting accordingly through reflection, evaluation, demanding and giving active feedback.
Personal profiling	Examining what type of professional one wants to be in the long term, which field and type of positions one aspires to and how one can stand out from others in the branch.

2.2.4 Targeted interaction



Relation to other frameworks

- *QF-EHEA*
  Dublin descriptor ‘Communication’.
- *e-CF*
  E.4 – Relationship Management
- *SFIA: level of responsibility*
  Aspects of the ‘Business skills’ section, the ‘Influence’ section.

Related bodies of knowledge and skills

- European Foundational ICT Body of Knowledge – Soft Skills

Separate tasks

Determine which partners play a role in the ICT assignment, constructively collaborate and fitting communication aimed at achieving the desired impact.

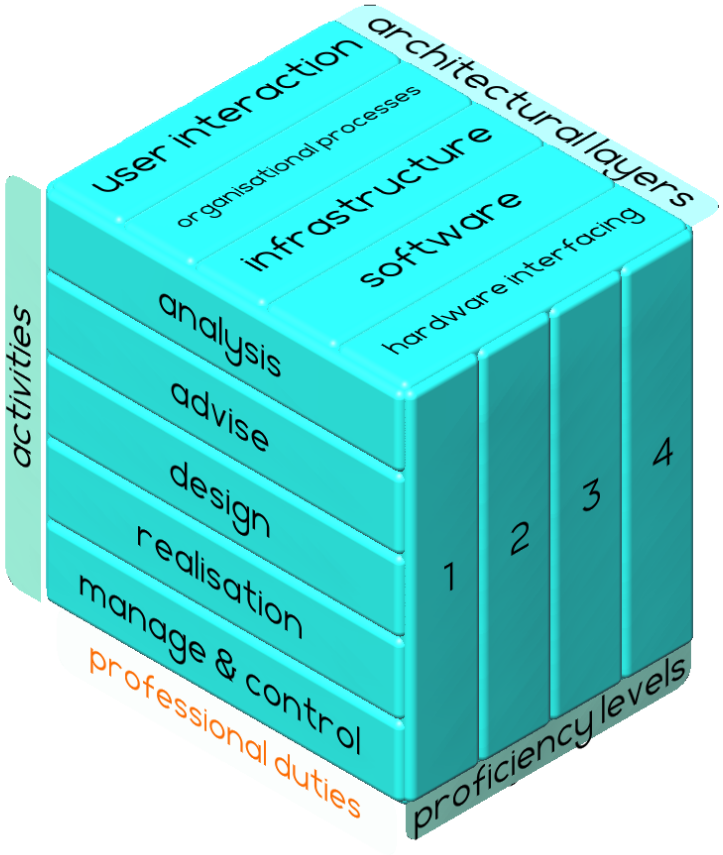
Sub-area	*Explanation*
Partners	Attention for the various groups of collaborative partners including the stakeholders, interest groups and own team members.
Communicate	Attention for what one wishes to communicate and the impact one wishes to make, the most appropriate form to achieve this and the actual execution thereof.
Collaborate	Attention for own role in the context of the ICT assignment, exploring and tackling the tasks involved, addressing others, searching for enrichment and building up trust in an inter-disciplinary and inter-cultural context.

3 The model: professional duties

The model provides a systematic description of the HBO-i domain. In it, the room needed for professional duties is embedded in the framework of the professional skills needed in order to operate as an ICT professional.
The professional model, complete with sample professional duties, has three dimensions: activities (what does an ICT professional do?), architectural layers (within which context?) and proficiency levels (how complex is it?)

Relation to other frameworks

- *e-CF: dimension 1 (area) and 2 (e-competence);*
  SFIA: categories, subcategories, skills
  These parts of e-CF and SFIA respectively describe the professional aspects. These are partially redundant with the domain description, either more or less thoroughly described. The other part supplements it, where it lies outside the core essence of the domain description.
- *Mbo programme domain Information and communication technology*
  This offers a substantive context for the lowest level of the domain description from the perspective of related mbo programmes.


architectural layers
user interaction
organisational processes
infrastructure
software
hardware interfacing
activities
analysis
advise
design
realisation
manage & control
professional duties
1
2
3
4
proficiency levels

3.1 Architectural layers

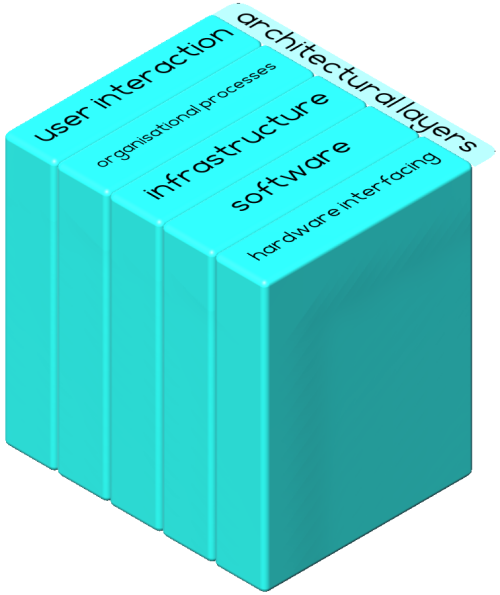
One of the three dimensions of the professional duties is formed by five architectural layers- inspired by enterprise and software architectural models. The activities as described elsewhere can apply to various aspects of ICT systems. This is why the activities may vary in terms of context. The architectural layers are intended to make this variation visible and to sketch a broad picture of the profile of the HBO-i domain. With this goal, the various architectural layers have been selected.

The order of the five architectural layers is not random. Every layer adds a ‘functionality’ or ‘value’ to the previous layer and uses ‘services’ of the next layer: *user interaction* is unlocked thanks to ICT-facilitated *organisation processes* that are built on a configured hard- and software *infrastructure* that is built up of (programmed) hard- and software components that are (possibly) *connected with the hardware systems* via hardware interfaces.

Relation to other frameworks

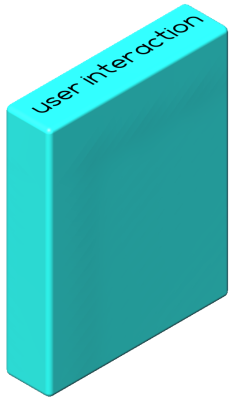
Related bodies of knowledge and skills

- ISO/IEC/IEEE 42010:2011 Systems and software engineering — Architecture description
- The Open Group Architecture Framework (TOGAF)
- Zachman Framework for Enterprise Architecture



3.1.1 User Interaction

The architectural layer *user interaction* relates to the communication between the (end)user and the ICT system. Here, the emphasis is not on the interaction with users which takes place during the creation of an ICT system; that is already covered in each of the architectural layers.



Relation to other frameworks

- *SFIA: categories, subcategories, skills*
  Category Development and implementation, subcategory User experience, skills: User experience analysis (UNAN), User experience design (HCEV), User experience evaluation (USEV)

Related bodies of knowledge and skills

- ISO 9241-151:2008 - Ergonomics of human-system interaction -- Part 151 Guidance on World Wide Web user interfaces
- ISO/IEC TR 25060:2010 - Systems and software engineering -- Systems and software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: General framework for usability-related information
- ISO/IEC 25062:2006 - Software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability test reports
- ISO/IEC 25063:2014 - Systems and software engineering -- Systems and software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: Context of use description
- ISO/IEC 25064:2013 - Systems and software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: User needs report
- IBM Ease of Use
- UXPA – Usability Body of Knowledge
- HHS – Usabilty Guidelines

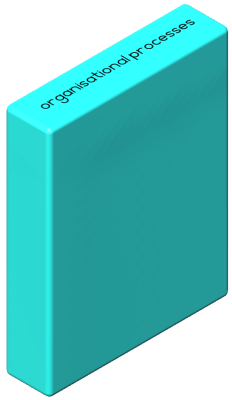
Separate tasks

		Proficiency levels			
		1	***2***	***3***	***4***
Activities	***Analysis***	Identification of the core elements of an external assignment whereby clarification is sought from the client, users and experts. Taking inventory at the client and of the user needs and translating these into IT solutions. Getting acquainted with the existing interactive concepts, services and products.	Benchmarking functionality, user interaction and UX design for the benefit of the assignment that is carried out within a company. Analysis of the client's core values, products or services, user needs and how these are expressed in the products or services. Evaluation of the progress of the project from the perspective of the user.	Analysis of the user, user interaction and experience, both individually (physical, psychological, personal characteristics) and in a larger social context (social / cultural / ethical / technological). Analysis of the actual and state-of-the-art interactive technologies. Analysis per iteration of the effect of the own intervention on/in the UX.	Analysis of social, domain and/or branch-specific trends and opportunities and communicating at a strategic level on this to the key stakeholders.
	Advise	Give advice on the interaction design that fits the assignment, client and user needs and previous acquaintance of these. Give recommendations on the basis of certain usability-analysis for the design of an interactive product, system or service.	Provide well-founded, concrete advice on the interactive techniques and/or interactive concepts to be used. Make proposals about the realisation choices, such as the technologies to be used, while keeping the users and company context in mind. Give advice on the objectives of the current and next iterations.	Translate the analysis into strategic recommendations (in the short, medium and long term) for the design or improvement or investigation of a UX by using interactive tools. Here, substantiated advice is also provided concerning the most suitable design process (for example, UCD). Give advice on the UX intervention(s) in the current or next iterations.	Extrapolate technological and societal trends and translate these into advice for the design and the strategic implementation of useful and innovative services and products. This advice describes a vision of the user experience and the relationship between the user and the product/service.
	Design	Translate the advisories into a simple user interaction with standard prototyping technique. Design a (usability) test with which essential interaction problems can be identified. Apply and carry out a standard interaction design process, including user-centered design.	Translate the advisories into a design of detailed user interaction with various prototyping techniques. Design a usability test with which the objectives of the iteration can be evaluated.	Translate the advisories into a concrete and detailed UX design appropriate to the project phases. Design a test with which the objectives can be evaluated from a user perspective.	Design a user experience that takes into account the long-term strategy and organisational goals of the client. Here, one should anticipate relevant societal trends and technological developments.
	Realisation	Realise and qualitatively test simple interactive products or services on the basis of an interactive design	Realise the interactive design with various tools and techniques.	Realise and test the UX of an interactive product, prototype, system or service on the basis of the	Realise future-proof products, services and prototypes on the following aspects:

	whereby use is made of accessible tools, design guidelines and/or house style.	Carry out the usability test in the field or in the lab. Monitor the interactive design with the realised interactive product or service.	design while using the appropriate tools and techniques during the project phases. Monitor the connection of the UX design and realised product in a predictable context.	- Innovative UX design - Innovative techniques and emerging standards. Validation of vision and strategy with key stakeholders.
Manage & Control	Record the most important decisions, results and insights concerning the interactive design in an iterative process.	Record the points of departure and findings concerning the user perspective between the iterations in a design and development process, and hereby make the connections between the iterations visible. Use and correctly apply the standards (design guidelines concerning the interactive design, protocols and methods) that are appropriate within the company context.	Monitor the core values and UX of the product/organisation or service in every phase of the development and production process. Communicate with stakeholders and record decisions related to core values and user experience design during all phases of the development process. Increase user acceptance by way of documentation, training and/or marketing and provide a substantiated choice for the right form of these.	Supervise a complex project from a UX perspective at a strategic level while respecting the short and long term, involving and convincing stakeholders both formally and informally.

3.1.2 Organisational Processes

The organisational processes architectural layer concerns facilitating organisational processes by way of ICT systems. Here, it concerns the functionality of the system as a whole (automated and non-automated parts) as seen from the context of the organisational goals to be realised.



Relation to other frameworks

Related bodies of knowledge and skills

- Babok Guide BPMN – Business Process Model and Notation

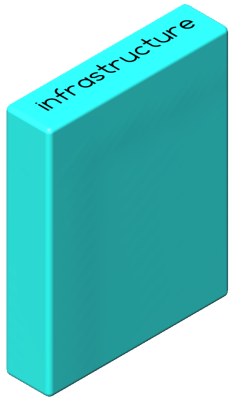
Separate tasks

		Proficiency levels			
		1	***2***	***3***	***4***
Activities	***Analysis***	Analysis of a certain organisational process, organisation, data stream, data need and process control at an operational level. Analysis of bottlenecks and cause-effect relationships from the perspective of the information provision.	Analysis of several operational and tactical organisational processes and the quality of the current ICT provision. Analysis of the correlation of the bottlenecks and cause-effect relationships. Record the ICT requirements from the perspective of the needs of the relevant stakeholders. Analysis of available ICT options in the field.	Analysis of the consequences of a (strategic) change of direction on organisational processes and their information provision. Analysis (quantitative and/or qualitative) of the current and future situation in the area of, for example, policy, strategy, alignment and architecture, while applying the most commonly used methods. Analysis of the current acceptance of new technologies and possible resistance. Analysis of structured and unstructured internal and external data.	Carry out thorough, theoretically supported research into technological (inter-organisational) process innovations (AI, machine & deep learning, digital twins, blockchain, etc.).
	Advise	Provide advice on improvements for a single organisational process in the area of organisation (structure), processes and information provision, while respecting the ICT options.	Provide advice on solutions for bottlenecks in the area of organisation structure (and roles), (organisation)process structure, cohesion and information provision. Provide advice on new ICT possibilities, including package selection and advice.	Provide advice on the internal and external coordination between business and ICT (alignment and governance) while taking into account the goals of the organisation (including mission, visions, strategy and KPIs). Provide advice on a professional change approach for the implementation of new ICT possibilities. Provide advice on solutions for structured an unstructured data.	Provide advice concerning technological (inter-organisational) process innovations, whereby you also take into account the social context (mankind and organisation). Create a broad base of support among all the relevant stakeholders.
	Design	Design a particular organisation process, particular data streams, an organisation component and/or a part of the information provision.	Design related organisation processes: a data structure (model), the process management of organisation processes, the functional organisation structure and/or the information provision,	Design the architecture of organisation processes and control models, including related control, information provision and change process.	Design technological (inter-organisational) process innovations. Evaluate and validate possible process innovations.

		while taking security and privacy legislation into account. Design the layout of a standard application. Design the interfaces for an application in the application landscape (mapping).	Design a professional change approach with related interventions. Design solutions for structured and unstructured data.	
Realisation	Describe and compile work instructions, function and role descriptions and procedures for an (adapted) process. Test the connection of the organisation processes to the supplied information provision. Draft a simple implementation plan.	Realise the implementation and acceptance of procedures in correlation with new or adapted information provision and control. Educate and train end users in the renewed processes and use of a new ICT. Build and validate a Proof of Concept. Structure a standard application (for example, CRM, ERP, BI).	Realise the implementation and acceptance of adapted organisation processes as based on an implementation plan. Arrange solutions for structured and unstructured data.	Build and validate prototypes of new and technological solutions for (inter-organisational) process innovations.
Manage & Control	Carry out maintenance activities on the process documentation (for example, business rules, principles and process models). Describe the change needs of a particular sub-process.	Structure, maintain and actualise functional control processes. Identify and inventory the change needs of several operational and tactical organisation processes	Guide and actualise principles, business rules and models of process architecture. Proactively identify the change needs in all organisation processes and commence with related change processes.	Devise new technological solutions for the management of (inter-organisational) process innovations.

3.1.3 Infrastructure

The architectural layer *infrastructure* concerns all of the ICT-systems with which organisation processes can be facilitated. Here, it concerns the making available and keeping available and configuring of the traditional hardware infrastructure, and certainly also the software infrastructure.



Relation to other frameworks

Related bodies of knowledge and skills

- European Foundational ICT Body of Knowledge – Network and systems integration
- ITIL – Information Technology Infrastructure Library
- SABOK – System Administration Body of Knowledge
- IEEE – WEBOK – Wireless Engineering Body of Knowledge

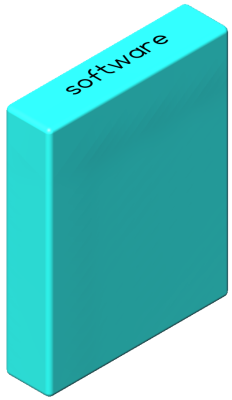
Separate tasks

		Proficiency levels			
		1	***2***	***3***	***4***
Activities	***Analysis***	Analysis of a local/small infrastructure according to a standard method and based on given (non)functional requirements.	Analysis of the quality of a medium-sized infrastructure and the services present on it based on accessible methods and standards. Analysing infrastructure-related incidents, problems and security threats.	Analysis of trends on the area of infrastructures and translating this into desired or necessary developments in company infrastructure. Carry out a requirements-impact or gap analysis for an enterprise infrastructure to chart out (non)functional requirements, needs and/or shortcomings.	Carry out a requirements-impact or gap analysis for an enterprise infrastructure to chart out (non)functional requirements, needs and/or shortcomings.
	Advise	Give recommendations about the set-up of, or adjustments to be made to, a local/small infrastructure.	Provide advice about the arrangement and management of an infrastructure with supported choices for (non)functional requirements, and for available technology, management models and management methods. Propose methods that improve the information protection of an infrastructure of an SME.	Provide advice about components of an enterprise infrastructure, including management, protection and privacy aspects in relation to information and reference architectures, innovation, societal and international developments. Provide advice about the migration to, or choice for a public, private or hybrid cloud.	Provide advice about components of an enterprise infrastructure, including management, protection and privacy aspects in relation to information and reference architectures, innovation, societal and international developments.
	Design	Compile specifications for a local/small infrastructure according to a standard method.	Advice about components of an enterprise infrastructure, including support, protection and privacy aspects in relation to information and reference architectures, innovation, societal and international developments. Describe support processes and agree on service level agreements Automate the support and the roll-out of an infrastructure in a medium-sized environment. Compiling a technical design for a medium-sized infrastructure with related protection on the basis of (non) functional requirements.	Design components of an enterprise infrastructure while respecting all the requirements in a private, public or hybrid cloud environment. Design an incident response organisation (CSIRT) and systems in order to be able to adequately respond to incidents of every nature and scale.	Design components of an enterprise infrastructure while respecting all the requirements in a private, public or hybrid cloud environment.

Realisation	Organise, test and make available of a local/small infrastructure	Setting up a medium-sized infrastructure that meets the requirements with regard to performance, usability, security and compliance. Setting up the basic monitoring of the infrastructure. Compiling and carrying out a test plan for a medium-sized infrastructure in order to evaluate the quality based on the compiled (non)functional design.	Design components of an enterprise infrastructure while respecting all the requirements in a private, public or hybrid cloud environment. Compile components of an environment in which the quality of a safe service provision is monitored centrally. Compile and carry out a pilot/migration trajectory that includes transfer to management.	Realise an enterprise infrastructure or complex aspects or components thereof while respecting all the requirements in a private, public or hybrid cloud environment. Compile an environment in which the quality of a safe service provision is monitored centrally.
Manage & Control	Compile and document standard management processes and work procedures including system and network configuration for the benefit of the management of a local/small infrastructure.	Incorporate the management of new technological developments concerning the infrastructure. Implement components of the management processes. Record the specifications of a management environment with which the quality of the ICT services can be measured, including the receipt and handling of customer requests, and being able to report on the level of services.	Set up management processes and carry out a public, hybrid or private cloud-based infrastructure. Record the specifications of a proactive management environment of a public, hybrid or private cloud infrastructure.	Give form to the Business - IT alignment and IT governance in relation to an enterprise infrastructure.

3.1.4 Software

The architectural layer *software* concerns the development of various kinds of software. This concerns software that after commissioning can be incorporated into an ICT infrastructure.



Relation to other frameworks

Related bodies of knowledge and skills

- European Foundational ICT Body of Knowledge – Software design and development
- European Foundational ICT Body of Knowledge – Testing
- ISO/IEC TR 19759:2015 - Software Engineering -- Guide to the software engineering body of knowledge (SWEBOK)
- ISO/IEC/IEEE 24765:2017 - Systems and software engineering -- Vocabulary
- CPRE – Certified Professional for Requirements Engineering
- SEVOCAB – Software and Systems Engineering Vocabulary
- TMap – Test Management Approach

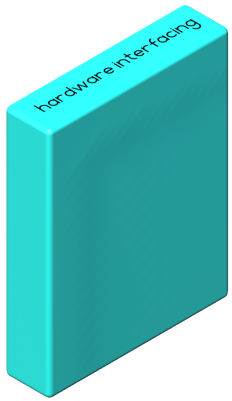
Separate tasks

		Proficiency levels			
		1	***2***	***3***	***4***
Activities	***Analysis***	Collect and validate functional requirements for a software system with one stakeholder according to a standard method. Define acceptance criteria for functional requirements stated above.	Carry out a requirement analysis for a software system with various stakeholders, while taking into account the quality properties including security. Carry out an analysis to formulate and validate functionality, security, design, interfaces etc. of an existing system or component. Set up an acceptance test based on quality properties.	Carry out a requirement analysis for a software system with various stakeholders in a context of existing systems. Define acceptance criteria based on quality properties and a risk analysis carried out with, among others, attention for security aspects.	Carry out an analysis for complex software-in-software systems including all non-functional requirements such as safety, security and privacy.
	Advise	Give recommendations on specific requirements of a software system based on research into existing, comparable systems.	Provide advice on the purchase and selection of software components during the development of a software system whereby the cost aspect plays a role. Provide advice on a section of the architecture or a limited software system. Give advice on the use of prototypes in validating the requirements.	Give advice concerning the choice of software architecture or existing software frameworks whereby cost aspects and quality properties such as availability, performance, security and scalability play a role. Provide advice about the approach to take during the processing and consultation of large quantities of data with attention for privacy. Provide advice on the organisation of a software development process, including the test process.	Define a vision in regards to future technology and software architecture in collaboration with stakeholders.
	Design	Create a design for a software system, including a data base with model techniques according to a standard method.	Compile a design for a software system while taking into account the use of the existing components and libraries. Apply design-quality criteria while taking into account security aspects and various types of devices. Create a design for a system that can process and consult a large quantity of data.	Compile a software architecture for a software system that is comprised of existing and new systems, and takes several stakeholders quality properties into account, including security and scalability. Compile a test strategy for system tests.	Design a system for solving a generic class of problems. Design a framework.

		Record the quality of the design, for example by testing or prototyping, taking into account the formulated quality properties. Compile test subjects according to a given test strategy,		
Realisation	Build, test and make available a simple software system. The set-up, filling and querying of a data base is part of the software system.	Build and make available a software system that is comprised of several sub-systems while using existing components. Integrate software components into an existing system whereby you safeguard the integrity, security and system performance. Carry out, monitor and report on unit integration, regression and system tests, with attention for security aspects.	Build and make available a scalable software system that correlates with existing systems, perhaps in the cloud, according to the designed architecture while using existing frameworks. Application of test automation in carrying out tests.	Coding of algorithmically complex problems. Build AI related software.
Manage & Control	Organise and make use of a management system to support the software development in teams.	Manage and use a development environment to support software development in teams, including, among others, continuous integration as an option. Apply methods and techniques to manage a software development process and safeguard the quality	Carry out configuration, change and release management in conjunction with infrastructure management. Organise a development environment with automated build and test infrastructure.	Design and realise a development environment with automated build and test infrastructure.

3.1.5 Hardware Interfacing

The architectural layer *hardware interfacing* concerns software that interacts with available hardware. Here, it concerns situations in which the software must explicitly take into account the possibilities and limitations of the available hardware. In the description within this architectural layer, ‘computer system’ has been chosen as the generic, all-encompassing term. Depending on the context, this can later be specified as ‘embedded system’, ‘industrial system’, ‘virtual system’, etc.



Relation to other frameworks

- *SFIA: categories, subcategories, skills*
  Hardware design (HDWDE)

Related bodies of knowledge and skills

- ISA – A guide to the automation body of knowledge

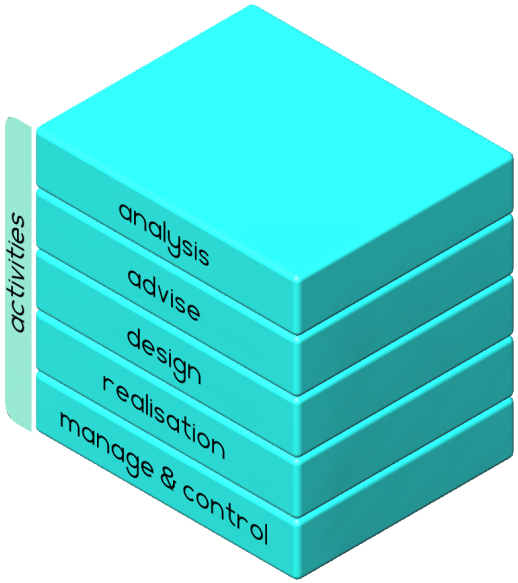
Separate tasks

		Proficiency levels			
		1	***2***	***3***	***4***
Activities	***Analysis***	Describe the architecture of a computer system. Describe the working of actuators and sensors and measure these. Compile (non)functional requirements and acceptance criteria for a computer system in, for example an embedded or AI system.	Identify detection and control aspects of the environment of a computer system in, for example, a sensor network. Methodic specification of a computer system. Carry out a protocol analysis. Compile an acceptance test for a computer system.	Specify a distributed computer system including timing, resource use and performance. Describe security aspects of computer systems that are connected to or via (public) networks. Compile an acceptance test plan and an integration plan.	Investigate emerging technologies for application in distributed systems. Investigate security aspects within emerging technologies.
	Advise	Verify and substantiate a given technical advisory. Verify and describe the initial architecture and the functionality of a given system configuration (microprocessor, memory or other building blocks).	Provide technical advice for the architecture of a computer system and the hardware and software components. Provide advice about the linking of systems.	Provide a technical advisory on the (distributed) computer system that is to be realised, including the hardware and software components and links.	Provide a technical advisory on the application of emerging technologies to realise a distributed computer system. Provide advice on future-oriented organisation of distributed computer systems. Define the vision on a technology road map and coordinate this with key stakeholders.
	Design	Design a simple computer system, for example, an embedded or industrial automation system based on given hardware.	Methodically design a computer system by way of requirements with self-chosen hardware and software components. - Compile an application driver design. - Design a protocol.	Design a distributed computer system including determining actuators, sensors, timing, resource use and performance.	Design a distributed computer system with the use of hardware synthesis and/or artificial intelligence.
	Realisation	Write software for a simple, given computer system equipped with actuators and sensors.	Organise a simple computer system and realise the links with hardware components via software. Write and test application driver software. Implement and test a protocol.	Realise a complete computer system including network, hardware and system software. Compile and carry out an acceptance procedure in, for example a virtual environment, including aspects such as timing, resource use and performance.	Realise a complete computer system whereby use is made of hardware synthesis (vhdl) or artificial intelligence.

Manage & Control	Organise a development and test platform by way of co-design for the hardware/software, including tools.	Assess a given development environment on quality and performance. Organise a management and test environment for a computer system.	Set up and make use of: - version management, - release management, - teamwork support, - automated testing for hard- and software systems.	Supervise co-design teams in the management of the realisation process of the hardware, software and synthesis, including the development environment.

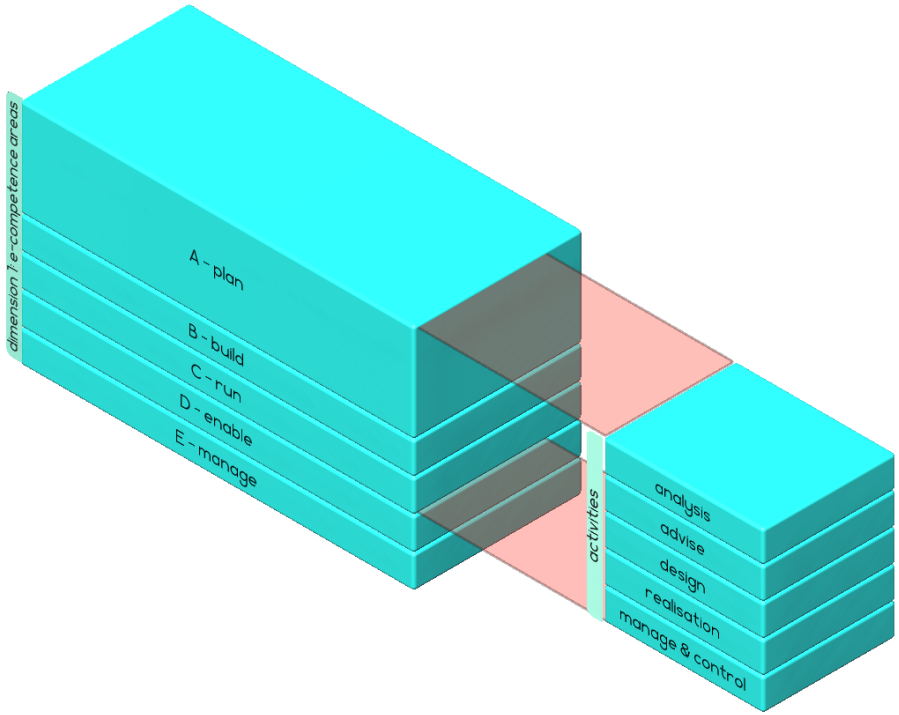
3.2 Activities

One of the three dimensions of the professional duties is comprised of the five *activities* ‘analyse’, ‘advice’, ‘design’ ‘realise’ and ‘manage & control’ – inspired by the system and the software development life cycle. Every student in the HBO-i programme domain must be able to carry out these activities within their own professional context. In doing so, a broad spectrum of processes can be applied, ranging from a more linear approach with clearly defined phases, to agile approaches with an iterative process in which various activities must be carried out simultaneously. The ‘manage & control’ activity encompasses the organisation and the management of this process. This activity is now listed last on the list of activities in order to be able to make a better correlation to other models. The execution of a professional duty will often begin with manage & control. With all activities, quality aspects, such as security, budget and time are hugely important.



Relation to other frameworks

- *e-CF: dimension 1 (area)*
  The various activities all roughly fall under one of the first three “areas” that are defined in dimension 1.

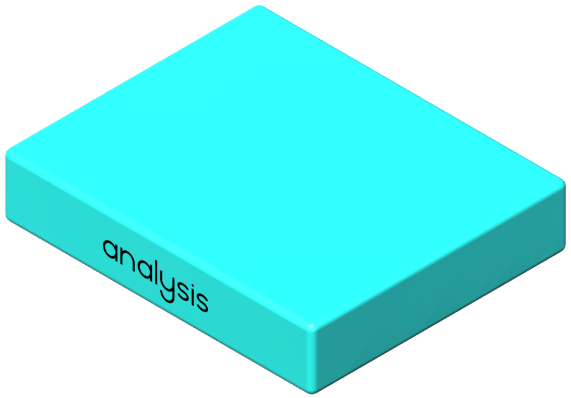


Related bodies of knowledge and skills

- ISO/IEC 12207:2017 - Systems and software engineering -- Software life cycle processes
- ISO/IEC/IEEE 15288:2015 - Systems and software engineering -- System life cycle processes
- ISO/IEC/IEEE 24748-3-2012 - IEEE Guide:--Adoption of ISO/IEC TR 24748-3:2011, Systems and software engineering-Life cycle management-Part 3: Guide to the application of ISO/IEC 12207 (Software life cycle processes)

3.2.1 Analysis

Analysing the *activity* is comprised of the analysis of processes, products and information flows in their collective cohesion and context.



Relation to other frameworks

- *e-CF: dimension 1 (areas)*
  'Analysing' the activity roughly falls under a part of the 'area' 'Plan' that is defined in dimension 1.
- *SFIA: categories, subcategories, skills*
  'Analysing' the activity is related to apart of the Development and implementation category. Therein, it mostly concerns the subcategory Systems development, skill Systems design (DESN), as well as the subcategory User experience, skill User experience analysis (UNAN).

Separate tasks

		Proficiency levels			
		1	***2***	***3***	***4***
Architectural layers	***User Interaction***	Identification of the core elements of an external assignment whereby clarification is sought from the client, users and experts. Taking inventory at the client and of the user needs and translating these into IT solutions. Getting acquainted with the existing interactive concepts, services and products.	Benchmarking functionality, user interaction and UX design for the benefit of the assignment that is carried out within a company. Analysis of the client's core values, products or services, user needs and how these are expressed in the products or services. Evaluation of the progress of the project from the perspective of the user.	Analysis of the user, user interaction and experience, both individually (physical, psychological, personal characteristics) and in a larger social context (social / cultural / ethical / technological). Analysis of the actual and state-of-the-art interactive technologies. Analysis per iteration of the effect of the own intervention on/in the UX.	Analysis of social, domain and/or branch-specific trends and opportunities and communicating at a strategic level on this to the key stakeholders.
	Organisational Processes	Analysis of a certain organisational process, organisation, data stream, data need and process control at an operational level. Analysis of bottlenecks and cause-effect relationships from the perspective of the information provision.	Analysis of several operational and tactical organisational processes and the quality of the current ICT provision. Analysis of the correlation of the bottlenecks and cause-effect relationships. Record the ICT requirements from the perspective of the needs of the relevant stakeholders. Analysis of available ICT options in the field.	Analysis of the consequences of a (strategic) change of direction on organisational processes and their information provision. Analysis (quantitative and/or qualitative) of the current and future situation in the area of, for example, policy, strategy, alignment and architecture, while applying the most commonly used methods. Analysis of the current acceptance of new technologies and possible resistance. Analysis of structured and unstructured internal and external data.	Carry out thorough, theoretically supported research into technological (inter-organisational) process innovations (AI, machine & deep learning, digital twins, blockchain, etc.).
	Infrastructure	Analysis of a local/small infrastructure according to a standard method and based on given (non)functional requirements.	Analysis of the quality of a medium-sized infrastructure and the services present on it based on accessible methods and standards. Analysing infrastructure-related	Analysis of trends on the area of infrastructures and translating this into desired or necessary developments in company infrastructure.	Carry out a requirements-impact or gap analysis for an enterprise infrastructure to chart out (non)functional requirements, needs and/or shortcomings.

		incidents, problems and security threats.	Carry out a requirements-impact or gap analysis for an enterprise infrastructure to chart out (non)functional requirements, needs and/or shortcomings.	
Software	Collect and validate functional requirements for a software system with one stakeholder according to a standard method. Define acceptance criteria for functional requirements stated above.	Carry out a requirement analysis for a software system with various stakeholders, while taking into account the quality properties including security. Carry out an analysis to formulate and validate functionality, security, design, interfaces etc. of an existing system or component. Set up an acceptance test based on quality properties.	Carry out a requirement analysis for a software system with various stakeholders in a context of existing systems. Define acceptance criteria based on quality properties and a risk analysis carried out with, among others, attention for security aspects.	Carry out an analysis for complex software-in-software systems including all non-functional requirements such as safety, security and privacy.
Hardware Interfacing	Describe the architecture of a computer system. Describe the working of actuators and sensors and measure these. Compile (non)functional requirements and acceptance criteria for a computer system in, for example an embedded or AI system.	Identify detection and control aspects of the environment of a computer system in, for example, a sensor network. Methodic specification of a computer system. Carry out a protocol analysis. Compile an acceptance test for a computer system.	Specify a distributed computer system including timing, resource use and performance. Describe security aspects of computer systems that are connected to or via (public) networks. Compile an acceptance test plan and an integration plan.	Investigate emerging technologies for application in distributed systems. Investigate security aspects within emerging technologies.

3.2.2 Advise

The ‘advice’ activity encompasses providing advice about the organisation of processes and/or information for a new ICT system, or one that is to be purchased or an existent ICT system that has to be modified.

Relation to other frameworks

- *e-CF: dimension 1 (areas)*
  The activity of providing advice roughly falls under a part of the ‘area’ ‘Plan’ that is defined in dimension 1.

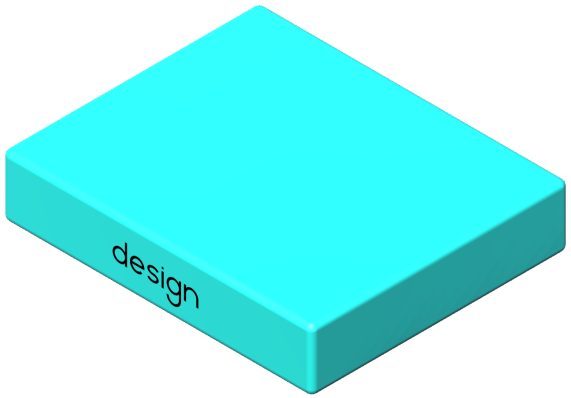
Separate tasks

		Proficiency levels			
		1	***2***	***3***	***4***
Architectural layers	***User Interaction***	Give advice on the interaction design that fits the assignment, client and user needs and previous acquaintance of these. Give recommendations on the basis of certain usability-analysis for the design of an interactive product, system or service.	Provide well-founded, concrete advice on the interactive techniques and/or interactive concepts to be used. Make proposals about the realisation choices, such as the technologies to be used, while keeping the users and company context in mind. Give advice on the objectives of the current and next iterations.	Translate the analysis into strategic recommendations (in the short, medium and long term) for the design or improvement or investigation of a UX by using interactive tools. Here, substantiated advice is also provided concerning the most suitable design process (for example, UCD). Give advice on the UX intervention(s) in the current or next iterations.	Extrapolate technological and societal trends and translate these into advice for the design and the strategic implementation of useful and innovative services and products. This advice describes a vision of the user experience and the relationship between the user and the product/service.
	Organisational Processes	Provide advice on improvements for a single organisational process in the area of organisation (structure), processes and information provision, while respecting the ICT options.	Provide advice on solutions for bottlenecks in the area of organisation structure (and roles), (organisation)process structure, cohesion and information provision. Provide advice on new ICT possibilities, including package selection and advice.	Provide advice on the internal and external coordination between business and ICT (alignment and governance) while taking into account the goals of the organisation (including mission, visions, strategy and KPIs). Provide advice on a professional change approach for the implementation of new ICT possibilities. Provide advice on solutions for structured an unstructured data.	Provide advice concerning technological (inter-organisational) process innovations, whereby you also take into account the social context (mankind and organisation). Create a broad base of support among all the relevant stakeholders.
	Infrastructure	Give recommendations about the set-up of, or adjustments to be made to, a local/small infrastructure.	Provide advice about the arrangement and management of an infrastructure with supported choices for (non)functional requirements, and for available technology, management models and management methods. Propose methods that improve the information protection of an infrastructure of an SME.	Provide advice about components of an enterprise infrastructure, including management, protection and privacy aspects in relation to information and reference architectures, innovation, societal and international developments. Provide advice about the migration to, or choice for a public, private or hybrid cloud.	Provide advice about components of an enterprise infrastructure, including management, protection and privacy aspects in relation to information and reference architectures, innovation, societal and international developments.
	Software	Give recommendations on specific	Provide advice on the purchase and	Give advice concerning the choice	Define a vision in regards to future

	requirements of a software system based on research into existing, comparable systems.	selection of software components during the development of a software system whereby the cost aspect plays a role. Provide advice on a section of the architecture or a limited software system. Give advice on the use of prototypes in validating the requirements.	of software architecture or existing software frameworks whereby cost aspects and quality properties such as availability, performance, security and scalability play a role. Provide advice about the approach to take during the processing and consultation of large quantities of data with attention for privacy. Provide advice on the organisation of a software development process, including the test process.	technology and software architecture in collaboration with stakeholders.
Hardware Interfacing	Verify and substantiate a given technical advisory. Verify and describe the initial architecture and the functionality of a given system configuration (microprocessor, memory or other building blocks).	Provide technical advice for the architecture of a computer system and the hardware and software components. Provide advice about the linking of systems.	Provide a technical advisory on the (distributed) computer system that is to be realised, including the hardware and software components and links.	Provide a technical advisory on the application of emerging technologies to realise a distributed computer system. Provide advice on future-oriented organisation of distributed computer systems. Define the vision on a technology road map and coordinate this with key stakeholders.

3.2.3 Design

The ‘design’ activity encompasses the design of an ICT system (or part thereof) as based on specifications.



Relation to other frameworks

- *e-CF: dimension 1 (areas)*
  The design activity roughly falls under a part of the ‘area’ ‘Plan’ that is defined in dimension 1.

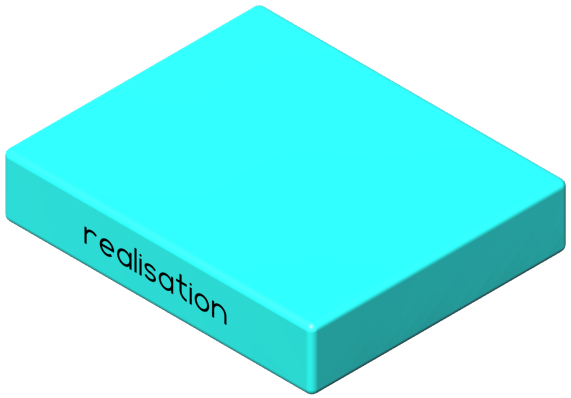
Separate tasks

		Proficiency levels			
		1	***2***	***3***	***4***
Architectural layers	***User Interaction***	Translate the advisories into a simple user interaction with standard prototyping technique. Design a (usability) test with which essential interaction problems can be identified. Apply and carry out a standard interaction design process, including user-centered design.	Translate the advisories into a design of detailed user interaction with various prototyping techniques. Design a usability test with which the objectives of the iteration can be evaluated.	Translate the advisories into a concrete and detailed UX design appropriate to the project phases. Design a test with which the objectives can be evaluated from a user perspective.	Design a user experience that takes into account the long-term strategy and organisational goals of the client. Here, one should anticipate relevant societal trends and technological developments.
	Organisational Processes	Design a particular organisation process, particular data streams, an organisation component and/or a part of the information provision.	Design related organisation processes: a data structure (model), the process management of organisation processes, the functional organisation structure and/or the information provision, while taking security and privacy legislation into account. Design the layout of a standard application. Design the interfaces for an application in the application landscape (mapping).	Design the architecture of organisation processes and control models, including related control, information provision and change process. Design a professional change approach with related interventions. Design solutions for structured and unstructured data.	Design technological (inter-organisational) process innovations. Evaluate and validate possible process innovations.
	Infrastructure	Compile specifications for a local/small infrastructure according to a standard method.	Advice about components of an enterprise infrastructure, including support, protection and privacy aspects in relation to information and reference architectures, innovation, societal and international developments. Describe support processes and agree on service level agreements Automate the support and the roll-out of an infrastructure in a medium-sized environment.	Design components of an enterprise infrastructure while respecting all the requirements in a private, public or hybrid cloud environment. Design an incident response organisation (CSIRT) and systems in order to be able to adequately respond to incidents of every nature and scale.	Design components of an enterprise infrastructure while respecting all the requirements in a private, public or hybrid cloud environment.

		Compiling a technical design for a medium-sized infrastructure with related protection on the basis of (non) functional requirements.		
Software	Create a design for a software system, including a data base with model techniques according to a standard method.	Compile a design for a software system while taking into account the use of the existing components and libraries. Apply design-quality criteria while taking into account security aspects and various types of devices. Create a design for a system that can process and consult a large quantity of data. Record the quality of the design, for example by testing or prototyping, taking into account the formulated quality properties. Compile test subjects according to a given test strategy,	Compile a software architecture for a software system that is comprised of existing and new systems, and takes several stakeholders quality properties into account, including security and scalability. Compile a test strategy for system tests.	Design a system for solving a generic class of problems. Design a framework.
Hardware Interfacing	Design a simple computer system, for example, an embedded or industrial automation system based on given hardware.	Methodically design a computer system by way of requirements with self-chosen hardware and software components. - Compile an application driver design. - Design a protocol.	Design a distributed computer system including determining actuators, sensors, timing, resource use and performance.	Design a distributed computer system with the use of hardware synthesis and/or artificial intelligence.

3.2.4 Realisation

The 'realisation' activity encompasses the realisation of an ICT system (or part thereof) based on a design.



Relation to other frameworks

- *e-CF: dimension 1 (areas)*
  The ‘realisation’ activity roughly falls under the ‘area’ ‘Build’ that is defined in dimension 1.

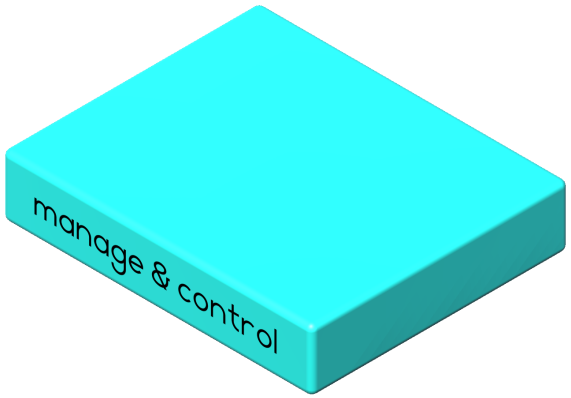
Separate tasks

		Proficiency levels			
		1	***2***	***3***	***4***
Architectural layers	***User Interaction***	Realise and qualitatively test simple interactive products or services on the basis of an interactive design whereby use is made of accessible tools, design guidelines and/or house style.	Realise the interactive design with various tools and techniques. Carry out the usability test in the field or in the lab. Monitor the interactive design with the realised interactive product or service.	Realise and test the UX of an interactive product, prototype, system or service on the basis of the design while using the appropriate tools and techniques during the project phases. Monitor the connection of the UX design and realised product in a predictable context.	Realise future-proof products, services and prototypes on the following aspects: - Innovative UX design - Innovative techniques and emerging standards. Validation of vision and strategy with key stakeholders.
	Organisational Processes	Describe and compile work instructions, function and role descriptions and procedures for an (adapted) process. Test the connection of the organisation processes to the supplied information provision. Draft a simple implementation plan.	Realise the implementation and acceptance of procedures in correlation with new or adapted information provision and control. Educate and train end users in the renewed processes and use of a new ICT. Build and validate a Proof of Concept. Structure a standard application (for example, CRM, ERP, BI).	Realise the implementation and acceptance of adapted organisation processes as based on an implementation plan. Arrange solutions for structured and unstructured data.	Build and validate prototypes of new and technological solutions for (inter-organisational) process innovations.
	Infrastructure	Organise, test and make available of a local/small infrastructure	Setting up a medium-sized infrastructure that meets the requirements with regard to performance, usability, security and compliance. Setting up the basic monitoring of the infrastructure. Compiling and carrying out a test plan for a medium-sized infrastructure in order to evaluate the quality based on the compiled (non)functional design.	Design components of an enterprise infrastructure while respecting all the requirements in a private, public or hybrid cloud environment. Compile components of an environment in which the quality of a safe service provision is monitored centrally. Compile and carry out a pilot/migration trajectory that includes transfer to management.	Realise an enterprise infrastructure or complex aspects or components thereof while respecting all the requirements in a private, public or hybrid cloud environment. Compile an environment in which the quality of a safe service provision is monitored centrally.
	Software	Build, test and make available a simple software system. The set-up,	Build and make available a software system that is comprised of	Build and make available a scalable software system that correlates with	Coding of algorithmically complex problems.

	filling and querying of a data base is part of the software system.	several sub-systems while using existing components. Integrate software components into an existing system whereby you safeguard the integrity, security and system performance. Carry out, monitor and report on unit integration, regression and system tests, with attention for security aspects.	existing systems, perhaps in the cloud, according to the designed architecture while using existing frameworks. Application of test automation in carrying out tests.	Build AI related software.
Hardware Interfacing	Write software for a simple, given computer system equipped with actuators and sensors.	Organise a simple computer system and realise the links with hardware components via software. Write and test application driver software. Implement and test a protocol.	Realise a complete computer system including network, hardware and system software. Compile and carry out an acceptance procedure in, for example a virtual environment, including aspects such as timing, resource use and performance.	Realise a complete computer system whereby use is made of hardware synthesis (vhdl) or artificial intelligence.

3.2.5 Manage & Control

The ‘manage & control’ activity encompasses the control, monitoring and optimisation of the development, commissioning and use of ICT systems.



Relation to other frameworks

- *e-CF: dimension 1 (areas)*
  The ‘manage & control’ activity roughly falls under the ‘area’ ‘run’ that is defined in dimension 1.

Separate tasks

		Proficiency levels			
		1	***2***	***3***	***4***
Architectural layers	***User Interaction***	Record the most important decisions, results and insights concerning the interactive design in an iterative process.	Record the points of departure and findings concerning the user perspective between the iterations in a design and development process, and hereby make the connections between the iterations visible. Use and correctly apply the standards (design guidelines concerning the interactive design, protocols and methods) that are appropriate within the company context.	Monitor the core values and UX of the product/organisation or service in every phase of the development and production process. Communicate with stakeholders and record decisions related to core values and user experience design during all phases of the development process. Increase user acceptance by way of documentation, training and/or marketing and provide a substantiated choice for the right form of these.	Supervise a complex project from a UX perspective at a strategic level while respecting the short and long term, involving and convincing stakeholders both formally and informally.
	Organisational Processes	Carry out maintenance activities on the process documentation (for example, business rules, principles and process models). Describe the change needs of a particular sub-process.	Structure, maintain and actualise functional control processes. Identify and inventory the change needs of several operational and tactical organisation processes	Guide and actualise principles, business rules and models of process architecture. Proactively identify the change needs in all organisation processes and commence with related change processes.	Devise new technological solutions for the management of (inter-organisational) process innovations.
	Infrastructure	Compile and document standard management processes and work procedures including system and network configuration for the benefit of the management of a local/small infrastructure.	Incorporate the management of new technological developments concerning the infrastructure. Implement components of the management processes. Record the specifications of a management environment with which the quality of the ICT services can be measured, including the receipt and handling of customer requests, and being able to report on the level of services.	Set up management processes and carry out a public, hybrid or private cloud-based infrastructure. Record the specifications of a proactive management environment of a public, hybrid or private cloud infrastructure.	Give form to the Business - IT alignment and IT governance in relation to an enterprise infrastructure.
	Software	Organise and make use of a management system to support the	Manage and use a development environment to support software	Carry out configuration, change and release management in conjunction	Design and realise a development environment with automated build

	software development in teams.	development in teams, including, among others, continuous integration as an option. Apply methods and techniques to manage a software development process and safeguard the quality	with infrastructure management. Organise a development environment with automated build and test infrastructure.	and test infrastructure.
Hardware Interfacing	Organise a development and test platform by way of co-design for the hardware/software, including tools.	Assess a given development environment on quality and performance. Organise a management and test environment for a computer system.	Set up and make use of: - version management, - release management, - teamwork support, - automated testing for hard- and software systems.	Supervise co-design teams in the management of the realisation process of the hardware, software and synthesis, including the development environment.

4 Application

The HBO-i domain description describes the entire domain of HBO-i programmes. It thereby forms a framework in which every programme, programme profile of specialism can position itself. That positioning in development and justification of curricula is the primary aim of this domain description. Within a programme, the model can later be applied in the educational practices and because it creates a broad framework, it can also play a role in connecting the programme to professional practices. All of these applications will be explained below.

4.1 Development and justification of curricula

With the implementation of the Bologna Accord (2005), European higher education was enriched by four sequential degrees: Associate degree (Ad), Bachelor degree (B), Master (M) degree and Doctor of philosophy (PhD). The Dublin descriptors of the “Framework of qualifications for the European Higher Education Area” (QF EHEA) describe the accepted European level of those degrees. At a national level, these are safeguarded by way of the Netherlands Qualification Framework (NLQF). The national level of the Bachelor is described in the standard for higher professional education (hbo).

Programme profiles that are derived from the domain description, encompass the Dublin descriptors and the hbo standard. When students meet the requirements of the programme profile, as well as the internationally and nationally accepted level of the degree concerned. See Figure 1 for the mutual relationship of these other relevant frameworks.

NLQF Netherlands Qualification Framework	*qualification*	basic education 1	mbo 1 be 2, …	mbo 2 be 3, …	mbo 3	mbo 4 havo	vwo	Ad	B	M	PhD
	level	entry	1	2	3	4	4+	5	6	7	8
QF EHEA Framework of Qualifications for the European Higher Education Area	*cycle*							short	1	2	3
EQF European Qualifications Framework	*level*		1	2	3	4		5	6	7	8
e-CF European e-Competence Framework, NEN-EN 16234-1:2016	*dimension 3: proficiency level*				e-1			e-2	e-3	e-4	e-5
SFIA Skills Framework for the Information Age	*level of responsibility*				1			2	3	4–7	
HBO-i Domain description	*proficiency level*				1			2	3	4	

Figure 1. Corresponding **proficiency levels** of various frameworks.

4.2 Programme level

A core question for a programme profile is whether it matches the level of the corresponding degree, for example, a Bachelor degree. Every programme profile is comprised of a programme-specific mix of professional duties combined with professional skills, so that the Dublin descriptors and the hbo standards are fulfilled. The mix of professional duties herein should be sufficiently broad and in-depth. Some programmes may be relatively small in terms of variety of professional duties, but may have many professional duties at the highest level of a degree. Other programmes may be relatively broader in terms of variety of professional duties, but offer fewer professional duties at the highest level of a degree. In both case it applies that the autonomy, complexity and professional skills are at a corresponding level. It must be noted that the scale expressed in expected course load of professional duties in certain cells in the HBO-i model varies greatly.

4.2.1 Associate degree (Ad)

An Associate degree programme is a function-specific task-oriented programme at an operational-tactical level. A corresponding programme profile in the HBO-i model shall therefore focus professionally on an architectural layer at level two. The encompassing professional skills are delved more deeply into at the tactical handling level. In comparison to the first two years of a Bachelor programme, more specialised professional orientation takes place and a specific task-orientation of the corresponding professional skills.

4.2.2 Bachelor (B)

A Bachelor programme leads to positions at a tactical-strategic level. A corresponding programme profile shall often focus on an architectural layer at level three. The range and depth of a profile determines the final level in other architectural layers. The professional skills shall often commence from the beginning of a programme in order to prepare students to ultimately function at a tactical-strategic level.

4.2.3 Professional Master (M)

With a professional Master programme, students are prepared for complex professional practices, multi-disciplinary work, coordination and guidance for the benefit of innovation of the ICT profession and functioning at a strategic level. The corresponding programme profile therefore delves deeper into level four. In addition, it may also be explicitly desired to delve more deeply into a connection with an area of application. In the encompassed professional skills, we see accents in the direction of coordination, innovation and specialisation.

4.3 Educational planning and implementation

The model can play a role in the educational implementation in representing the range of educational programmes and the choice of students. The form of the educational offer of a programme may vary from a standard programme that leads to established final terms to a programme that is fully based on demand with only criteria of the same nature as the final terms to be realised. In both cases, the model of the domain description can play role. A standard programme can by way of the model, be positioned within the entire domain. A programme driven more by demand can be given more room for choice within the model and can identify the relationship between the components.

The model can especially be of service when evaluating individual study paths and competencies (EVCs) acquired previously. This can take place as based on the criteria that is related to the model, for example, by referring to professional duties and the performance indicators linked to them.

4.4 Connecting to the work field

The connection to the work field is initially made via the professional field via critical review input that is provided when compiling the professional duties. I using the model, the connection to the work field can be supported in two directions. From the work field to the programme because the professional profiles for programmes and students can be represented in the model. This way, it will be clear for both a programme and the individual students what the goal is that they should strive for. In the other direction, from the programme to the work field, the profile of alumni can be mirrored by the profile of a job vacancy in order to identify the suitability of the candidates. With feedback from the work field to the programme, an identified match or mismatch among the profiles of the job vacancies and alumni in general can be provided.

The relationships that have been made in this domain description with other (international) frameworks support the possibility of connecting education and the work field or rather, connecting the supply and demand sides. A concrete example of this is the connection between the HBO-i model and the e-CF via the ICT Professional Profiles described in e-CF.

4.5 Purpose and scope

The domain description offers ICT programmes a framework and a de facto standard with which they can describe their content, tasks, competencies, position their programme within the domain, and set up, organise and validate their educational programmes. The model offers the possibility of creating a broad or specific programme, with a sound basis and enough room to offer specialisations and be able to respond to current developments while maintaining position and profile. This enables students and employers to know what to expect from someone who has just graduated with a Bachelor or ICT degree from a certain programme. It is up to the programmes themselves to utilise the framework to describe specific knowledge, skills and behaviour with in a context in order to achieve competencies and own “BOKS”. Programmes are given enough room to position themselves within the model and students can develop into becoming integrally competent professionals.

5 Context

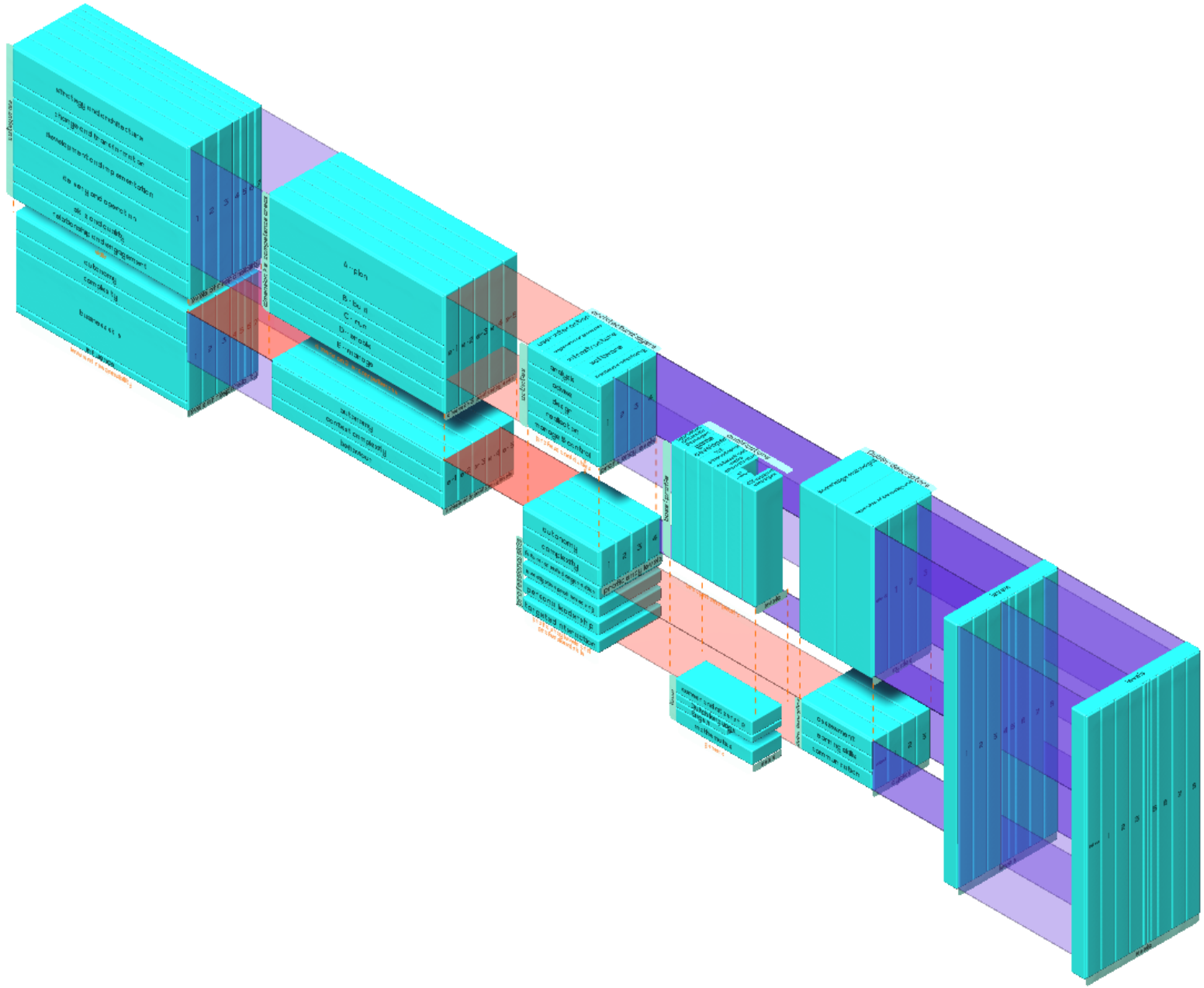
The domain description is not an end to itself. It fits within a context of national and international frameworks and bodies of knowledge and skills. These form the context for development. They also form the context for educational development of students and/or professional practitioners. Some are widely known and often used. Others are useful for specific sub-areas. And there are still others that legally determine the level of the education.

5.1 Andere raamwerken

The international character of the job market in the ICT domain is a key factor in training professionals, recruiting personnel and planning out careers. Over the past decades, we have seen that in Europe and worldwide, a whole range of initiatives cropping up, all aimed at making the descriptions of the ICT profession more transparent. These initiatives vary in terms of terminology, basic principles and area of application, among others. For the HBO-i domain description a number of national but also especially international frameworks apply. Each if these frameworks is briefly introduced on the basis of their objective. Next, the structure is explained as well as the relevance for the HBO-i domain description. This is then followed up with underlying sources and suggestions for additional information. In addition, an overview is provided concerning their structure and content. All of this, of course, insofar as is relevant in relation to the domain description.

This information is intended for two purposes. First, it makes clear in which context the domain description was created and is currently in. This can help provide insight and help application. Second, it makes it possible to add information to the domain description. The scope and content of the domain description have restrictions, of course. When programmes need more or other information, other frameworks for components can sometimes offer additional content. With information about the content of those frameworks and their relation to the domain description, it will be easier to make use of them.

The various frameworks have been selected for a whole host of reasons. The HBO-i domain description is first based on national and international frameworks as far the levels are concerned. These frameworks – QF-EHEA, EQF-LLL and NLQF – have been introduced globally. The level descriptions of specific ICT frameworks, such as SFIA and e-CF bolster that image. In terms of ICT content and context, these two previous frameworks also add to and a deeper explore (part of) the domain description.



5.1.1 Framework for qualifications of the European Higher Education Area (QF-EHEA)

The framework for qualifications of the European Higher Education Area (QF-EHEA) is intended to benefit the international comparability in the context of qualifications provided by higher education. It has by now been implemented in 48 countries, including The Netherlands. With the introduction of the Bologna Accord in 2005, European higher education now offers three consecutive degrees: Bachelor, Master and PhD. The Dublin descriptors describe the internationally accepted levels of these degrees, as well as the short cycle within the Bachelor degree. On the grounds of the Quality Act in The Netherlands, since 1 September 2013, higher education has made a structural distinction for the Associate degree that is on an equal level with the short cycle.

Structure

The whole structure is comprised of five descriptors, the so-called ‘Dublin descriptors’. These are detailed at four qualification levels, so-called ‘cycles’. The first cycle – ‘the short cycle’ – is actually only a part of the first cycle.

Relevance to the HBO-i Domain description

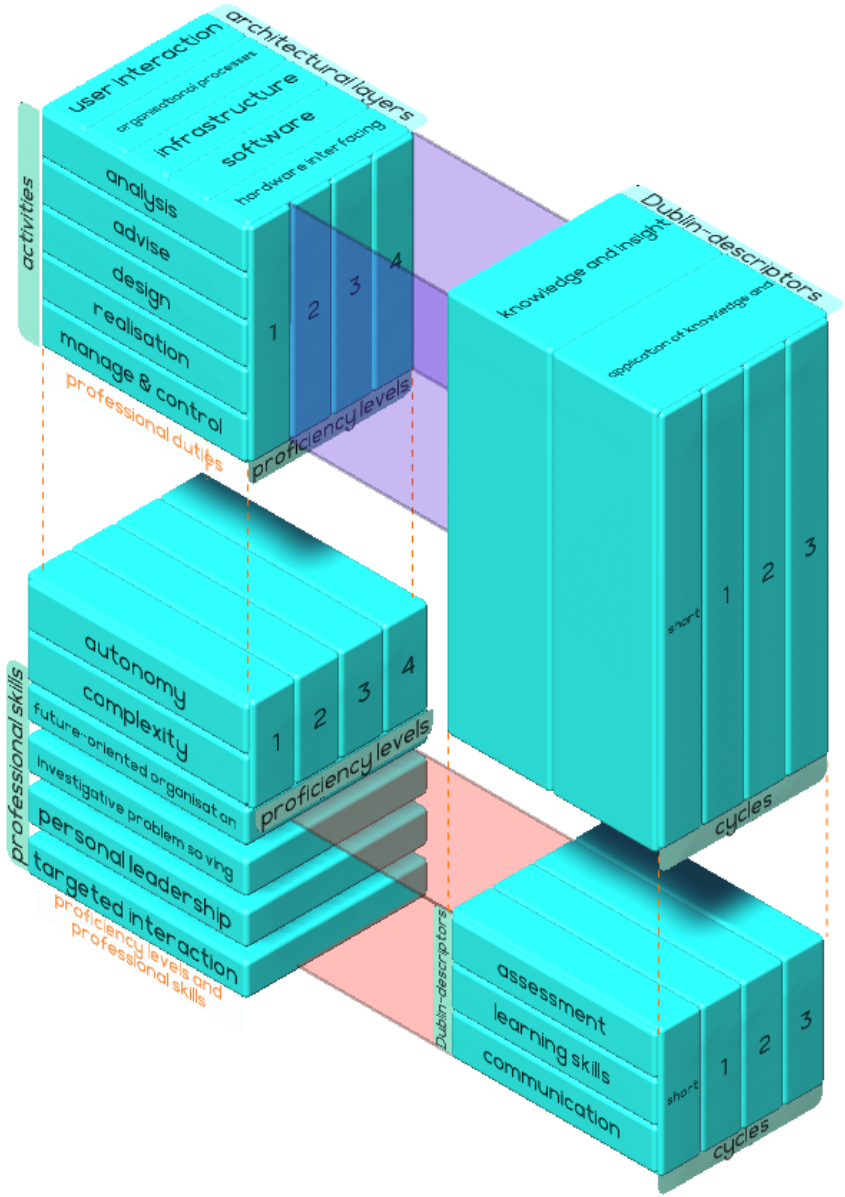
The first three levels define in general terms the final level for each Associate degree, Bachelor degree and Master degree. For the countries concerned, these form the normative framework for those levels. It thereby forms the concrete general content and context of levels two through four of the HBO-i domain description.

Sources

- Bologna Working Group on Qualifications Frameworks (2005). A Framework for Qualifications of the European Higher Education Area. Copenhagen, Denmark: Ministry of Science, Technology and Innovation. Appendix 8.
- Nederlands-Vlaamse Accreditatie Organisatie (2010). Protocol toetsing Associate-degreeprogramma door de NVAO. The Hague: Dutch-Flemish Accreditation Organisation. Official Dutch translation of the Dublin descriptors in the short cycle.

More information

- European Consortium for Accreditation – Joint Quality Initiative – the origin of the Dublin Descriptors - short history


architectural layers
user interaction
organisational processes
infrastructure
software
hardware interfacing
activities
analysis
advise
design
realisation
manage & control
professional duties
1
2
3
4
proficiency levels
Dublin-descriptors
knowledge and insight
application of knowledge and
short
1
2
3
cycles
professional skills
autonomy
complexity
future-oriented organisation
investigative problem solving
personal leadership
targeted interaction
proficiency levels and professional skills
Dublin-descriptors
assessment
learning skills
communication
short
1
2
3
cycles

Knowledge and insight

	Cycles			
	short	***1***	***2***	***3***
Dublin descriptor	Has demonstrable knowledge and insight into a professional field whereby secondary education* is elaborated on, generally functions at the level of advanced study books, has a foundation of knowledge for a field or profession, for personal development for further studies in order to complete the first cycle (Bachelor).	Has demonstrable knowledge and insight into a professional field, whereby the level achieved in secondary education is elaborated on and exceeded; generally functions at the level that with the aid of specialised manuals, certain aspects can be found which require knowledge of the latest developments in the field.	Has demonstrable knowledge and insight into a professional field, based on the level of a Bachelor degree and exceeding this and/or expanding on it, as well as a basis or opportunity to make an original contribution in the development and/or application of ideas, often research-related.	

Dublin-descriptors

Application of knowledge and insight

	Cycles			
	short	***1***	***2***	***3***
Dublin descriptor	Is capable of applying knowledge and insight in professional contexts.	Is capable of applying his/her knowledge and insight in such a way that this demonstrates a professional approach to his/her work, and further presides over competencies for the creation and substantiation of arguments and for solving problems in the professional field.	Is capable of applying knowledge, insight, and problem-solving abilities in new and unknown circumstances within a broader (multi-disciplinary) context that is related to the professional field; is capable of integrating expertise and handle complex issues.	

Dublin-descriptors

Assessment

	Cycles			
	short	***1***	***2***	***3***
Dublin descriptor	Has the skills to identify and use information to determine a response to clearly defined, concrete and abstract problems.	Is capable of collecting and interpreting (usually pertaining to the field) relevant information with the aim of making an assessment that is partly based on considering relevant social/societal, scientific and ethical aspects.	Is capable of making judgements on the grounds of incomplete or limited information while taking into account social/societal and ethical responsibilities that are related to the application of own knowledge and assessments.	
Dublin-descriptors				

Learning skills

	Cycles			
	short	***1***	***2***	***3***
Dublin descriptor	Possesses the learning skills required to pursue further education that demands autonomy.	Possesses the learning skills that are necessary to pursue further studies that require a high level of autonomy.	Possesses the learning skills that will enable him/her to pursue further studies that are largely self-guided or autonomous in character.	

Dublin-descriptors

Communication

	Cycles			
	short	***1***	***2***	***3***
Dublin descriptor	Can communicate with equals, superiors and clients about understanding, skills and activities.	Is able to convey information, ideas and solutions to an audience of specialists or non-specialists.	Is able to clearly and unequivocally communicate conclusions, as well as the knowledge, motives and considerations on which they are based, to an audience of specialists or non-specialists.	

Dublin-descriptors

5.1.2 European Qualifications Framework for Lifelong Learning (EQF-LLL)

The European Qualifications Framework for Lifelong Learning (EQF-LLL) is intended to compare European qualifications and qualification levels to one another. It describes the learning outcomes of this in terms of knowledge, skills and competencies. The scope is broader than that of the QF-EHEA considering that the EQF not only concerns higher education, but also the underlying levels.

Structure

The EQF gives an indication of the complexity and depth and distinguished eight different levels.

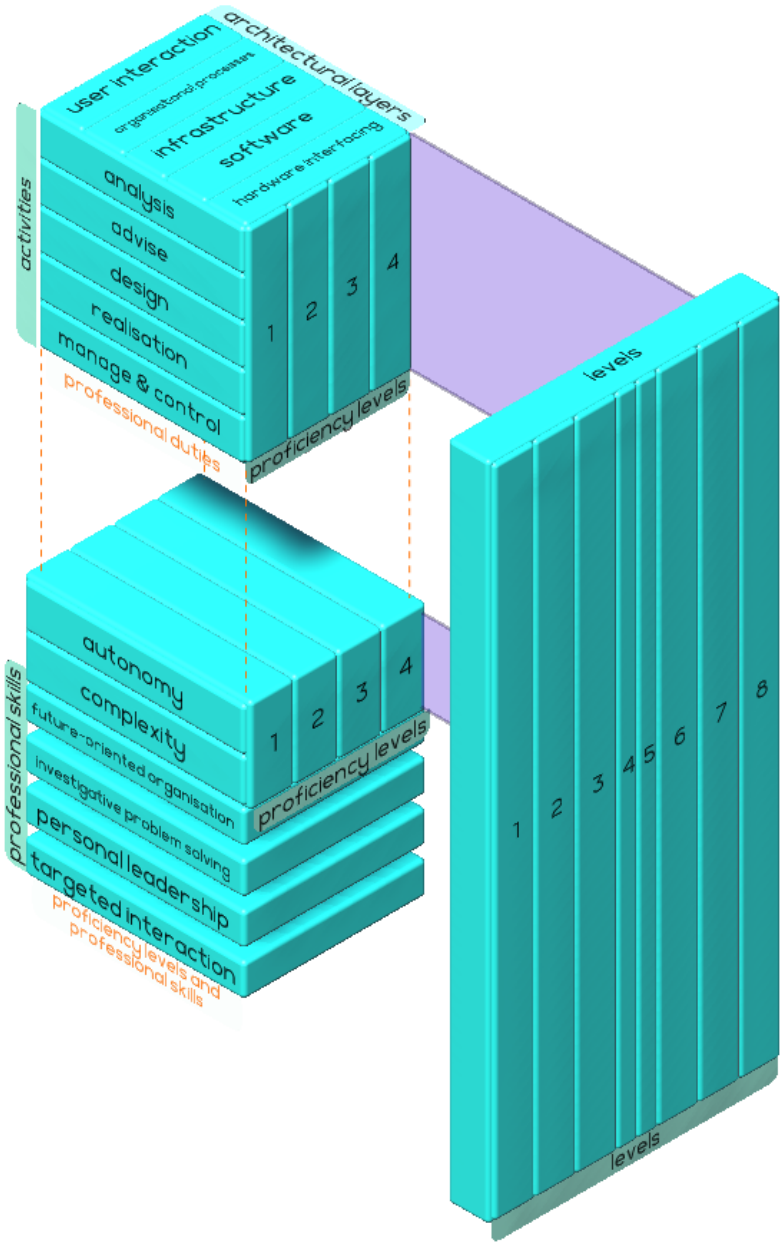
Relevance to the HBO-i domain description

The levels five through eight define in general terms the final level for each Associate degree, Bachelor degree and Master degree. Level four defines the present international level. For the countries concerned, these form the normative framework for those levels. It thereby forms the concrete general content and context of all four levels of the HBO-i domain description. It is especially important due to the direct relation to the level arrangement in the e-CF.

Sources

More information

- European Commission – Descriptors defining levels in the European Qualifications Framework (EQF)


architectural layers
user interaction
organisational processes
infrastructure
software
hardware interfacing
activities
analysis
advise
design
realisation
manage & control
professional duties
1
2
3
4
proficiency levels
professional skills
autonomy
complexity
future-oriented organisation
investigative problem solving
personal leadership
targeted interaction
proficiency levels and professional skills
levels
1
2
3
4
5
6
7
8
levels

5.1.3 Netherlands Qualification Framework (NLQF)

The Netherlands Qualification Framework (NLQF) is intended to clearly standardise the various educational levels in The Netherlands. To achieve this it offers an overview of the various educational forms on the basis of level in relation to one another. In the context of the European collaboration, it fulfils the function of the National Qualification Framework (NQF) for The Netherlands. It thereby provides a comparison of the regulated educational qualifications of the national government of The Netherlands to the umbrella European framework EQF. As a result of this, it is possible to compare Dutch programmes with programmes from other European countries that have also provided an NQF.

Structure

The NLQF has a total of ten levels, to which qualifications such as a Bachelor, are related. The order and numbering of the level is completely the same as the EQF.

Relevance to the HBO-i domain description

The NLQF shows the HBO-i relevant levels for the Associate degree, Bachelor degree and Master degree in The Netherlands. It also shows how they relate to the previous and next levels that are relevant for both in and out flows. The NLQF also forms the linking pin to international frameworks such as the Dublin Descriptors and EQF, and thereby also to, for example, e-CF and SFIA. This also makes it possible to identify elements from the same level in the stated frameworks when using a component of the HBO-i domain description. This way, the specific knowledge from the frameworks can be used to support to the use of the HBO-i domain description.

Sources

- National coordination point Netherlands Qualification framework (NCP NLQF). *Schematisch overzicht generieke inschaling in NLQF en EQF van door de overheid gereguleerde kwalificaties.* Retrieved on 15 Feb. 2018 from http://www.nlqf.nl/images/downloads/Schema_def_05052015.jpg

More information

- National coordination point Netherlands Qualification framework (NCP NLQF)

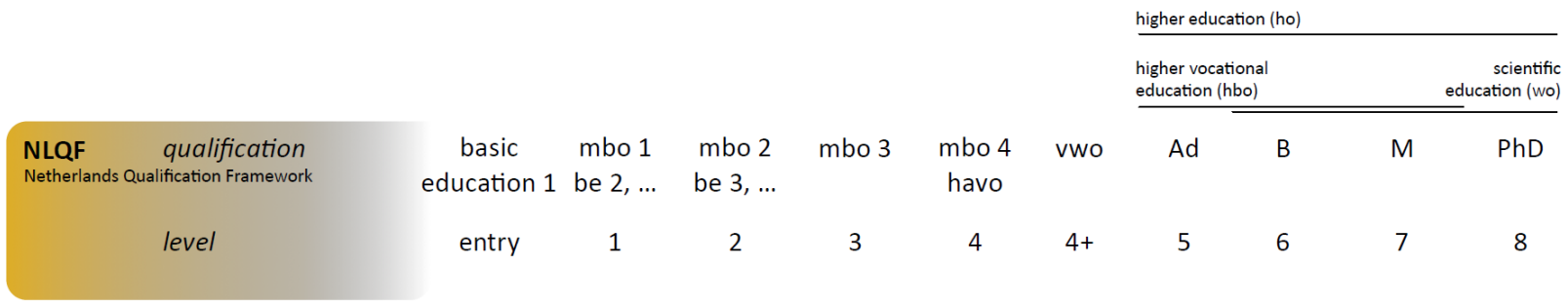
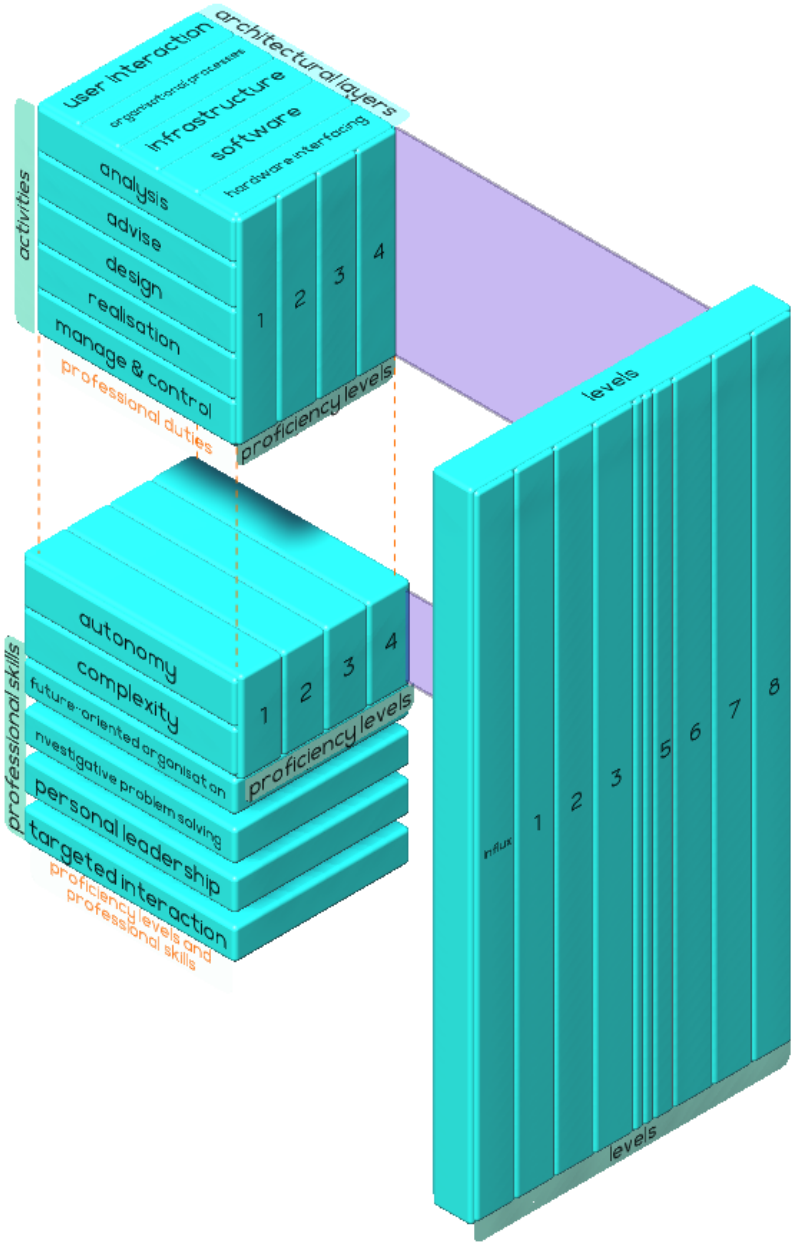


Figure 2. Netherlands Qualification framework with the most qualifications and all levels, supplemented by a designation of ho, hbo and wo.


architectural layers
user interaction
organisational processes
infrastructure
software
hardware interfacing
activities
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4
proficiency levels
professional duties
professional skills
autonomy
complexity
future-oriented organisation
investigative problem solving
personal leadership
targeted interaction
proficiency levels and professional skills
levels
influx
1
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8
levels

5.1.4 MBO education domain Information and communication technology

MBO qualification files – determinative for the content of the MBPO programmes – are substantially established by the Minister of OCW. Thus, it has been established what each ICT related MBO qualification is comprised of

Structure

Within the MBO, a distinction is made between (qualification) files, qualifications, basic components, profile components and choice components. “The qualification file describes the requirements that students must satisfy in order to obtain their diplomas. Every file contains one or more qualifications and each qualification leads to a diploma […] A qualification file consists of one basic component and one or more profile components. […] Choice components are an added plus to the qualification and make the programme complete.” Qualification files and qualifications have a Crebo code (Crebo: Central Register of Professional Programmes).
Every qualification file falls within a market segment, that, in turn, falls under a sector section. In this case, sector section five “ICT and creative industry” is relevant. The market segments "Arts and Entertainment (501), “Communication, media en design” (502) and “ICT” (503) fall under that sector section. The market segment “ICT and creative industry” is also “Cross-sector” (999) coupled with the educational domain “Information and communication technology” (Crebo number 79050). This results in the following representation of the “ICT” market segment:

Educational domain “Information and communication technology” (Crebo number 79050)

Qualification file	Qualification
Application development (Crebo-number 23088)	Application and media developer (level 4, Crebo-number 25187)
	Game developer (level 4, Crebo-number 25188)
ICT and media support (Crebo-number 23089)	ICT administrator (level 4, Crebo-number 25189)
	Network and media administrator (level 4, Crebo-number 25190)
ICT support (Crebo-number 23090)	ICT employee (level 2, Crebo-number 25192)
	ICT administration employee (level 3, Crebo-number 25191)

Relevance to the HBO-i domain description

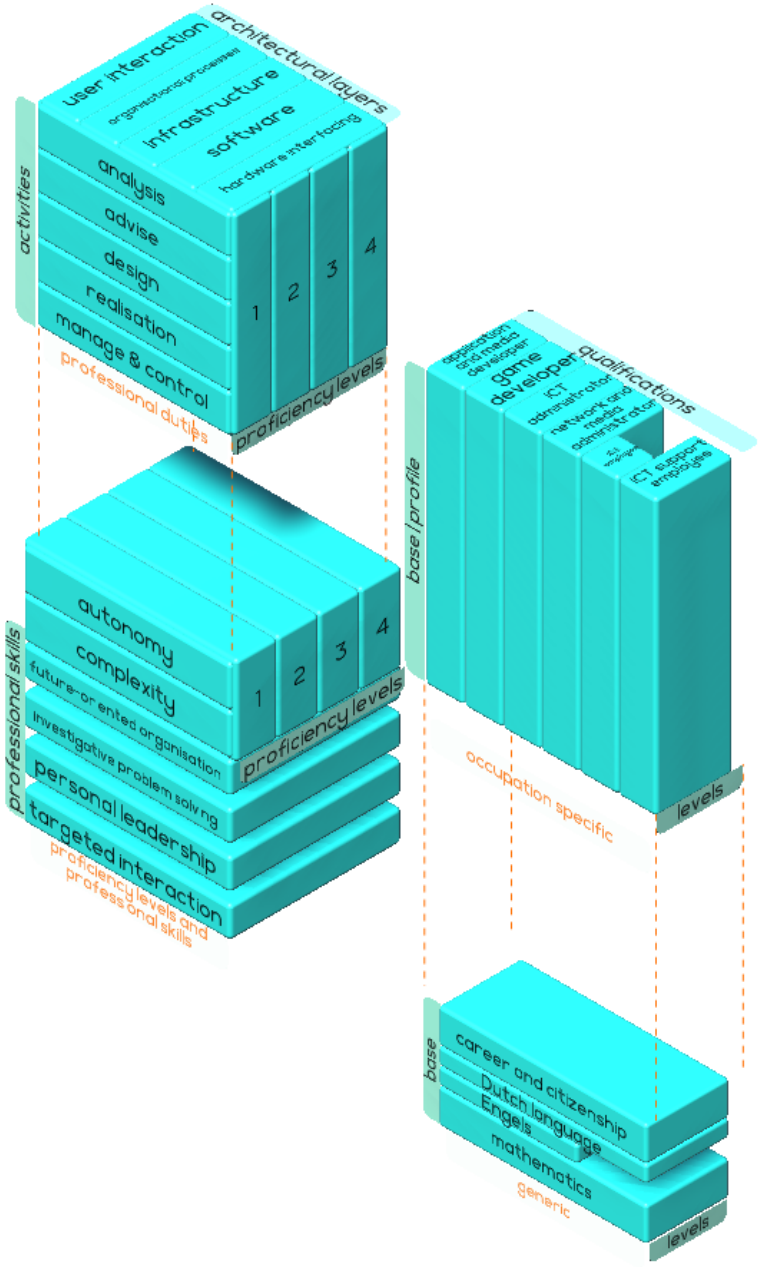
A considerable part of the inflowing students for an ICT programme at HBO level has received preliminary training within the MBO programme domain Information and communication technology. The MBO qualification files offer insight into the prior knowledge for each preliminary training. MBO 3 is at the same level as level 1 of the domain description.

Sources

- SBB. Qu*alification files.* Consulted on 6 April 2018 https://www.s-bb.nl/onderwijs/kwalificeren-en-examineren/kwalificatiedossiers
- SBB. *Arrangement of qualifications.* Consulted on 6 April 2018 https://kwalificaties.s-bb.nl/Lijsten/Groep/16

More information

- SBB – Kwalifications mbo


architectural layers
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proficiency levels
professional duties
base|profile
qualifications
application and media developer
game developer
ICT administrator
network and media administrator
ICT support employee
levels
occupation specific
professional skills
autonomy
complexity
future-oriented organisation
investigative problem solving
personal leadership
targeted interaction
proficiency levels and professional skills
base
career and citizenship
Dutch language
Engels
mathematics
generic
levels

5.1.5 European e-Competence Framework (e-CF)

In 2001, a number of large ICT firms expressed their concern about the shortage of ICT professionals on the job market. This led to the founding of the CEN ICT Skills Workshop in 2003. In 2006, further inventory was taken of the ICT profile within Europe which showed how greatly profiles varied in basic starting points, model and purpose, as, for example, SFIA (United Kingdom), AITTS (Germany) and CIGREF (France). This led to the development of the European e-Competence Framework (e-CF) that was published in September 2008 for the first time. In 2013, the third version was published. The framework was established in 2016 as the Dutch standard (NEN-EN 16234-1).

The e-CF was developed for the business world and human resource management and utilises proficiency levels for the entire expanse of the position profiles in the ICT work field, which resulted in domains such as human resource management and sales management also being included.

Structure

The e-CF consists of four dimensions:

- dimension 1: five e-competencies *(areas)*, derived from the ICT business processes ‘plan’, ‘build’, ‘run’, ‘enable’ and ‘manage’,
- dimension 2: a collection of 32 e-competencies,
- dimension 3: five management levels, related to the six highest EQF levels,
- dimension 4: examples of knowledge and skills related to the e-competencies.

The e-CF names five levels of proficiency at the workplace and integrates three facets in the competency definition of proficiency:

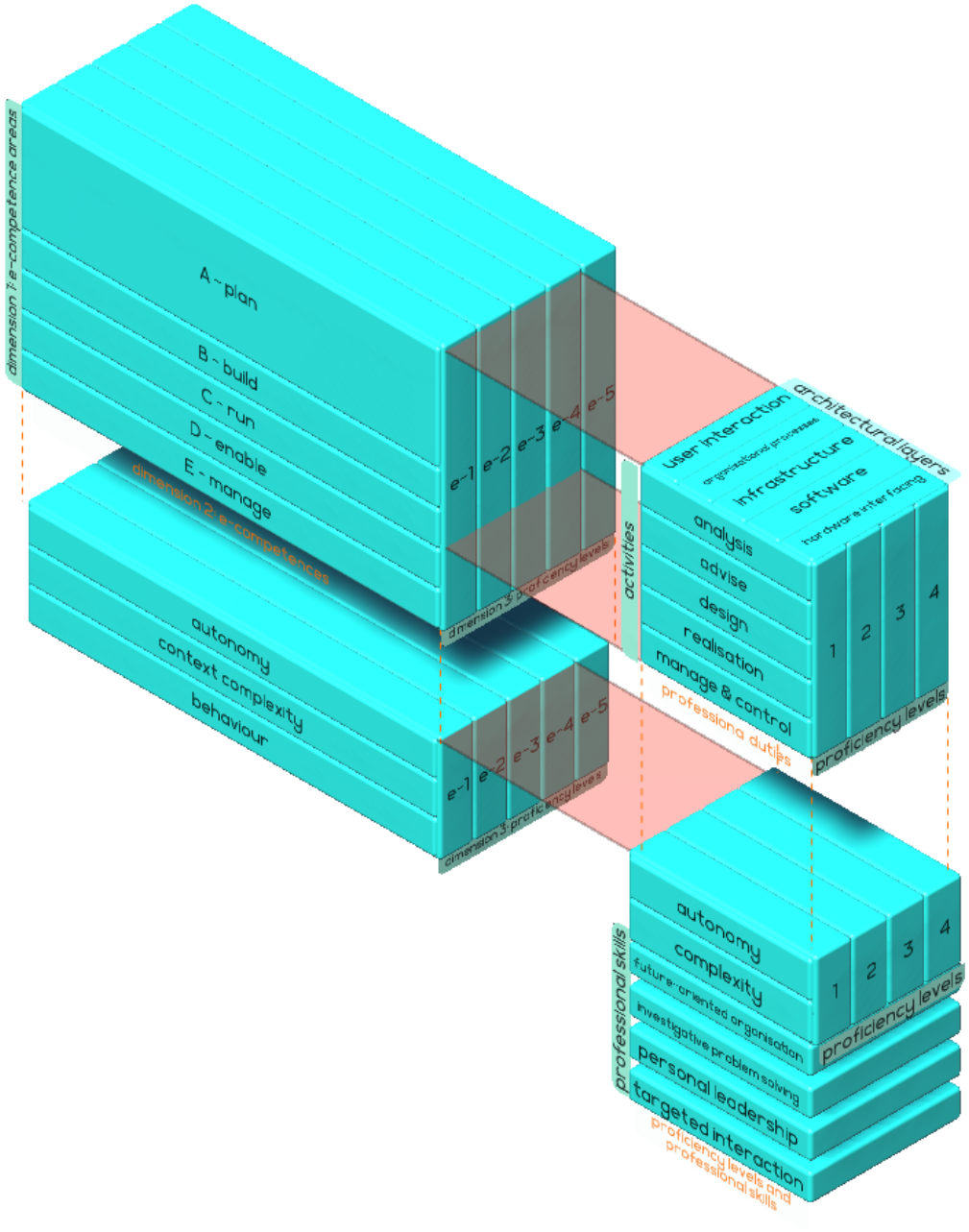
1. Autonomy: has a range from being able to ‘carry out instructions’ up to ‘can make personal choices’.
2. Behaviour: represents the perceivable results of a behaviour and has a range from ‘being able to make adjustments’ up to ‘being able to thoroughly understand’.
3. Context: has a range from able to handle ‘structured - predictable’ situations up to ‘unpredictable - unstructured’ situations.

Relevance to the HBO-i Domain description

The proficiency level of the Bachelor of ICT corresponds to dimension three of the e-CF. That is to say, the four proficiency levels of the domain description correspond with the proficiency levels e-1 through e-4 of dimension three of the e-CF. That is why at every level of the domain description, a fitting addition and/or broadening can take place with the help of the e-CF.

More information

- European e-Competence Framework – Tool
- NEN-EN 16234-1:2016 (and) - E-Competence Framework (e-CF) - A common European Framework for ICT Professionals in all industry sectors - Part 1: Framework


dimension 1: e-competence areas
A - plan
B - build
C - run
D - enable
E - manage
dimension 2: e-competences
autonomy
context complexity
behaviour
dimension 3: proficiency levels
e-1
e-2
e-3
e-4
e-5
activities
architectural layers
user interaction
organisational processes
infrastructure
software
hardware interfacing
analysis
advise
design
realisation
manage & control
professional duties
1
2
3
4
proficiency levels
professional skills
autonomy
complexity
future-oriented organisation
investigative problem solving
personal leadership
targeted interaction
proficiency levels and professional skills

5.1.6 Skills Framework for the Information Age (SFIA)

“SFIA – the Skills Framework for the Information Age – describes the skills that are required for professionals that have to do with information and communication technology.” This is how the Reference Guide of SFIA opens. The Reference Guide indicates that the framework has been adopted by organisations and individuals in nearly two hundred countries and works well for both large and small organisations. The framework describes skills and levels of responsibility. It is explicitly intended for, among others, educational institutions. The framework was first published in 2003 and has been available as version 6 (SFIA6) since 2015.

Structure

SFIA6 has the following main structure:

- Skills: Strategy and Architecture, Change and Transformation, Development and Implementation, Delivery and Operation, Skills and Quality, Relationship and Engagement
- Levels of responsibility: 1 Follow, 2 Assist, 3 Apply, 4 Enable, 5 Ensure, advise, 6 Initiate, influence, 7 Set strategy, inspire, mobilise
- Attributes: autonomy, influence, complexity, business skills

Relevance to the HBO-i domain description

As far as the professional duties are concerned, SFIA can be used for inspiration for those parts that the domain description does not address in terms of content. As far as the proficiency levels and professional skill are concerned, SFIA offers extra enrichment in regard to how matters should be interpreted and implemented.

To all of this applies that the proficiency levels one through three of the domain description correspond with the levels of responsibility one through three of SFIA. This makes it possible, if desired, and when using information from SFIA, to also select specific information at the required level. For proficiency level four of the domain description, it is a little more complicated. This is because the levels of proficiency four through seven of SFIA all concretely correspond with certain levels of proficiency of the e-CF. In this way, there is also a correlation to be found with level four of the domain description.

Sources

- SFIA Foundation (2015). *SFIA6 The complete reference guide.* London, United Kingdom: SFIA Foundation. Pages 8–9, 11–12.

More information

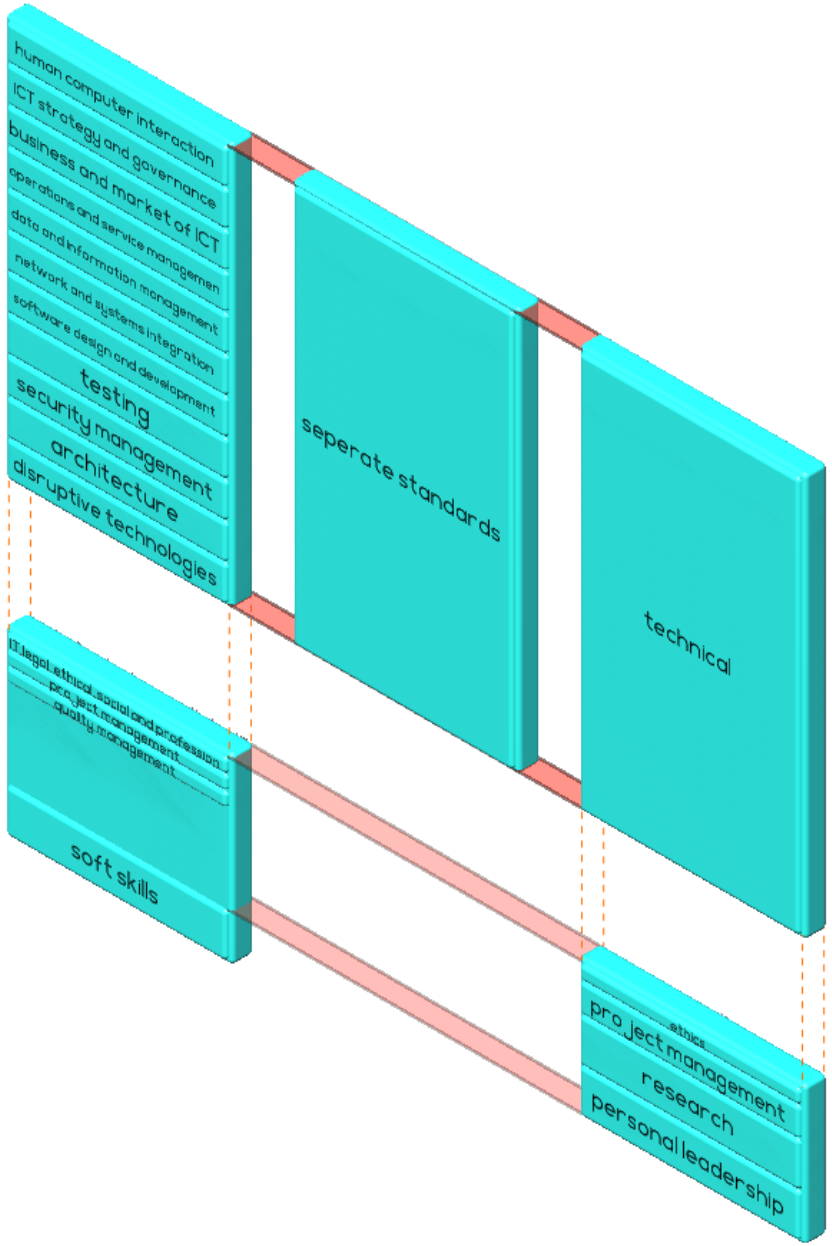
- SFIA Foundation – SFIA framework


categories
strategy and architecture
change and transformation
development and implementation
delivery and operation
skills and quality
relationship and engagement
skills
autonomy
complexity
business skills
influence
levels of responsibility
1 2 3 4 5 6 7
levels of responsibility
architectural layers
user interaction
organisational processes
infrastructure
software
hardware interfacing
activities
analysis
advise
design
realisation
manage & control
1 2 3 4
proficiency levels
professional duties
professional skills
autonomy
complexity
future-oriented organisation
investigative problem solving
personal leadership
targeted interaction
1 2 3 4
proficiency levels
proficiency levels and professional skills

5.2 Bodies of knowledge and skills (BOKS)

The content of the HBO-i domain description concerns the actual parts of the ICT professional domain for Dutch hbo programmes in the ICT domain. In the professional content details, an appropriate abstraction level was chosen by way of a sample collection of professional duties. The domain description is founded on a broad background of professional knowledge taken from the programmes concerned and sources used. To effectively use the domain description, this background information will be needed in practice. In order to achieve a broader and richer professional content on one hand, and to create clarity about the respective concepts and their content on the other hand. The prevailing bodies of knowledge (BOKS) in the field can provide for this. It usually concerns open standards that were created by a broad panel in a controlled process. To interpret and provide detail for the components of the domain description, they can offer the necessary background with a broad support base.

The overview of the bodies of knowledge is not exhaustive. But, we have included the most customary. The ‘BOK’ phenomenon has been summarised in detail for those sub-domains where a (more formalised) BOK is needed, such as in the area of ethics. The status of this overview in the context of this domain description, is largely informative. Some of the various independent bodies of knowledge and skills from this overview have been named in the various components of the domain description.


human computer interaction
ICT strategy and governance
business and market of ICT
operations and service management
data and information management
network and systems integration
software design and development
testing
security management
architecture
disruptive technologies
seperate standards
technical
IT,legal,ethical,social and profession
project management
quality management
soft skills
ethics
project management
research
personal leadership

5.2.1 European Foundational ICT BOK

The European Foundational ICT Body of Knowledge is intended as a European reference point for ICT knowledge (European Commission, 2015, p. 5). The European Foundational ICT Body of Knowledge version 1, was published by the order of the European Commission in 2015.

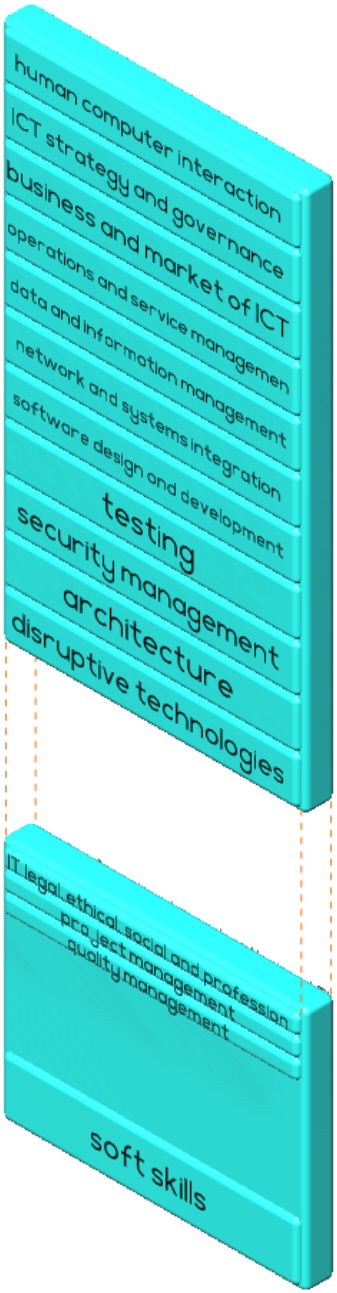
Structure

This BOK is comprised of the following parts:

- Not cross-cutting knowledge areas
  - ICT strategy and governance
  - Business and market of ICT
  - Project management
  - Quality management
  - Security management
  - Architecture
  - Data and information management
  - Network and systems integration
  - Software design and development
  - Human computer interaction
  - Testing
  - Operations and service management
- Cross-cutting knowledge areas
  Complementary base-level knowledge that can be referred to in relation to all knowledge areas
  - Soft skills
  - IT legal, ethical, social and professional practices
  - Emerging/disruptive technologies

Sources

- European Commission (2015) 


human computer interaction
ICT strategy and governance
business and market of ICT
operations and service managemen
data and information management
network and systems integration
software design and development
testing
security management
architecture
disruptive technologies
IT, legal, ethical, social and profession
project management
quality management
soft skills

5.2.2 ISO/NEN/IEC/IEEE standards

Various standards bodies establish ICT standards according to open processes. Such standards usually form the underpinning for certain parts of the field. They define, for example, certain concepts and processes. A couple of the most well-known include the SWEBOK and the life cycle process software.

- IEEE 1012-2016 - IEEE Standard for System, Software and Hardware Verification and Validation
- IEEE 1016-2009 - IEEE Standard for Information Technology--Systems Design--Software Design Descriptions
- IEEE 1028-2008 - IEEE Standard for Software Reviews and Audits
- IEEE 1320.1-1998 - IEEE Standard for Functional Modeling Language - Syntax and Semantics for IDEF0
- IEEE 1320.2-1998 - IEEE Standard for Conceptual Modeling Language - Syntax and Semantics for IDEF1X97 (IDEFobject)
- ISO 9241-151:2008 - Ergonomics of human-system interaction -- Part 151 Guidance on World Wide Web user interfaces
- ISO/IEC 12207:2017 - Systems and software engineering -- Software life cycle processes
- ISO/IEC/IEEE 15288:2015 - Systems and software engineering -- System life cycle processes
- ISO 15704:2000 - Industrial automation systems -- Requirements for enterprise-reference architectures and methodologies
- ISO/IEC TR 19759:2015 - Software Engineering -- Guide to the software engineering body of knowledge (SWEBOK)
- ISO/IEC 19770
  - ISO/IEC 19770-1:2017 - Information technology -- Software asset management -- Part 1: Processes and tiered assessment of conformance
  - ISO/IEC 19770-2:2015 - Information technology -- Software asset management -- Part 2: Software identification tag
  - ISO/IEC 19770-3:2016 - Information technology -- IT asset management -- Part 3: Entitlement schema
  - ISO/IEC 19770-4:2017 - Information technology -- IT asset management -- Part 4: Resource utilization measurement
  - ISO/IEC 19770-5:2015 - Information technology -- IT asset management -- Part 5: Overview and vocabulary
- ISO/IEC/IEEE 24748-3-2012 - IEEE Guide:--Adoption of ISO/IEC TR 24748-3:2011, Systems and software engineering-Life cycle management-Part 3: Guide to the application of ISO/IEC 12207 (Software life cycle processes)
- ISO/IEC/IEEE 24765:2017 - Systems and software engineering -- Vocabulary
- ISO/IEC 25000 - Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE)
  - ISO/IEC 25000:2014 - Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- Guide to SQuaRE
  - ISO/IEC 25001:2014 - Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- Planning and management
  - ISO/IEC 25010:2011 - Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- System and software quality models
  - ISO/IEC 25012:2008 - Software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- Data quality model
  - ISO/IEC 25020:2007 - Software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- Measurement reference model and guide
  - ISO/IEC 25021:2012 - Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- Quality measure elements
  - ISO/IEC 25030:2007 - Software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- Quality requirements
  - ISO/IEC 25040:2011 - Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- Evaluation process

    - ISO/IEC 25041:2012 - Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- Evaluation guide for developers, acquirers and independent evaluators
    - ISO/IEC 25045:2010 - Systems and software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- Evaluation module for recoverability
    - ISO/IEC 25051:2014 - Software engineering -- Systems and software Quality Requirements and Evaluation (SQuaRE) -- Requirements for quality of Ready to Use Software Product (RUSP) and instructions for testing
    - ISO/IEC TR 25060:2010 - Systems and software engineering -- Systems and software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: General framework for usability-related information
    - ISO/IEC 25062:2006 - Software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability test reports
    - ISO/IEC 25063:2014 - Systems and software engineering -- Systems and software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: Context of use description
    - ISO/IEC 25064:2013 - Systems and software engineering -- Software product Quality Requirements and Evaluation (SQuaRE) -- Common Industry Format (CIF) for usability: User needs report
- ISO/IEC/IEEE FDIS 26511 - Systems and software engineering -- Requirements for managers of information for users of systems, software, and services
- ISO/IEC/IEEE FDIS 26515 - Systems and software engineering -- Developing information for users in an agile environment
- ISO/IEC/IEEE 29119 Software Testing
    - ISO/IEC/IEEE 29119-1:2013 - Software and systems engineering -- Software testing -- Part 1: Concepts and definitions
    - ISO/IEC/IEEE 29119-2:2013 - Software and systems engineering -- Software testing -- Part 2: Test processes
    - ISO/IEC/IEEE 29119-3:2013 - Software and systems engineering -- Software testing -- Part 3: Test documentation
    - ISO/IEC/IEEE 29119-4:2015 - Software and systems engineering -- Software testing -- Part 4: Test techniques
    - ISO/IEC/IEEE 29119-5:2016 - Software and systems engineering -- Software testing -- Part 5: Keyword-driven testing
- ISO/IEC/IEEE 29148:2011 - Systems and software engineering -- Life cycle processes -- Requirements engineering
- ISO/IEC/IEEE 31320-2:2012 - Information technology -- Modeling Languages -- Part 2: Syntax and Semantics for IDEF1X97 (IDEFobject)
- ISO/IEC/IEEE 42010-2011 - Systems and software engineering -- Architecture description
- ISO 55000:2014 - Asset management -- Overview, principles and terminology

Sources

- IEC – International Electrotechnical Commission
- IEEE – Institute of Electrical and Electronics Engineers
- INCITS – InterNational Committee for Information Technology Standards
- ISO – International Organization for Standardization

5.2.3 Other bodies of knowledge and skills

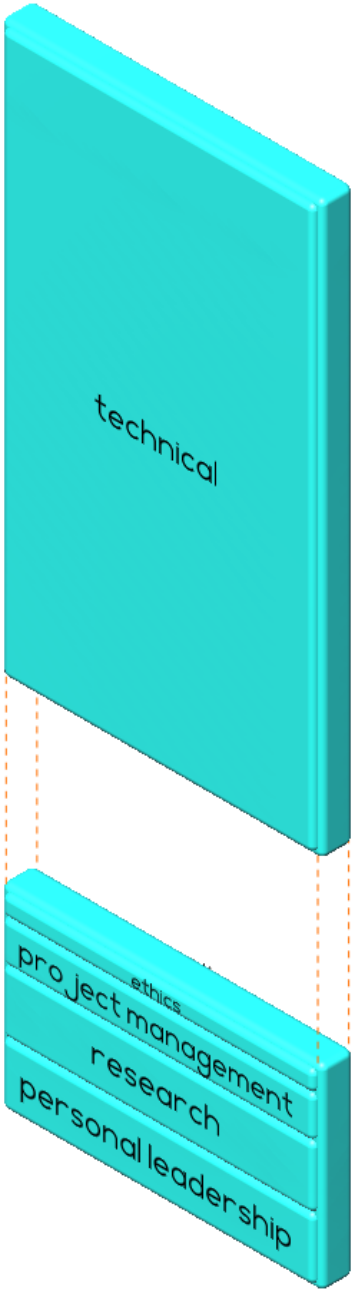
- Babok Guide
- ASL – Application Services Library
- BiSL – Business Information Services Library
- BPMN – Business Process Model and Notation
- CGEIT – Certified in the Governance of Enterprise IT
- CISSP – Certified Information Systems Security Professional
- CSSLP – Certified Secure Software Lifecycle Professional
- CMMI-DEV – Capability Maturity Model for Development
- CMMI-SVC – Capability Maturity Model for Services
- COBIT – Control Objectives for Information and related Technology
- CPRE – Certified Professional for Requirements Engineering
- DMBOK – Data Management Body of Knowledge
- EABOK – Enterprise Architecture Body of Knowledge
- GERAM – Generalised Enterprise Reference Architecture and Methodology
- Zachman Framework for Enterprise Architecture
- EITBOK – Enterprise Information Technology Body of Knowledge
- SEBOK – Systems Engineering Body of Knowledge
- ITIL – Information Technology Infrastructure Library
- FSM-procesmodel
- ISM-framework
- RESILIA
- SABOK – System Administration Body of Knowledge
- SCRUM
- SEVOCAB – Software and Systems Engineering Vocabulary
- TMap – Test Management Approach
- TOGAF – The Open Group Architecture Framework
- UML –Unified Modeling Language
- UXPA – Usability Body of Knowledge
- HHS – Usabilty Guidelines
- IBM Ease of Use
- IEEE – WEBOK – Wireless Engineering Body of Knowledge
- ISA – A guide to the automation body of knowledge

- ACM/IEEE-CS Software Engineering Code of Ethics and Professional Practice
- ACM Code of Ethics and Professional Conduct
- Gedragscode Nederland ICT
- IEEE Code of Ethics
- (ISC)2 Code of Ethics
- Ten Commandments of Computer Ethics

- APM Body of Knowledge 6th edition
- PRINCE2
- M_o_R – Management of Risk
- MSP – Managing Succesful Programmes
- MoP – Management of Portfolios
- P3M3 – Portfolio, Programme, and Project Management Maturity Model
- P3O – Portfolio, Programme and Project Offices
- PMBOK – Project Management Body of Knowledge

- HBO-i – ICT research methods

- The seven habits of highly effective people


technical
ethics
project management
research
personal leadership