EUQuaSIT

European Qualification Strategies in Information and Communications Technology (ICT)

Recommendations on European ICT Qualifications

(Final Project Report 2004)

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Edited by: A. Willi Petersen, Carsten Wehmeyer
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Address:
biat - Berufsbildungsinstitut Arbeit und Technik, Universität Flensburg, Auf dem Campus 1, 24943 Flensburg

EUQuaSIT project partnership

The National Institute of Technical and Vocational Education
Weilova 1271/6, 102 00 Praha 10, Czech Republic
Phone: +42 (0)2-7865249, berny@nuov.cz
http://www.nuov.cz

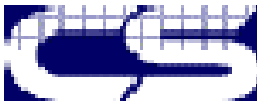
Berufsbildungsinstitut Arbeit und Technik,
University of Flensburg (project coordinator)
Auf dem Campus 1, 24943 Flensburg, Germany
Phone: +49 (0)461-805 2155 / 2158
awpetersen@biat.uni-flensburg.de
wehmeyer@biat.uni-flensburg.de
http://www.biat.uni-flensburg.de

Bundesinstitut für Berufsbildung
Hermann-Ehlers-Str. 10, 53043 Bonn, Germany
Phone: +49 (0)228-107 2626, weissmann@bibb.de
http://www.bibb.de

Kenteq International

Olympia 6-8, 1200 AB Hilversum, Netherlands
Phone: +31 35 7504356, international@kenteq.nl
http://www.kenteq.nl

Tecnoforma, S.A.
Praça Nuno Rodrigues dos Santos, 14 B,
1600-171 Lisboa, Portugal
Phone: +351-21-7200570, dirgeral@tecnoforma.pt
http://www.tecnoforma.pt



Central Systems s.r.l.
15 TIMISANA Street, Constantza – 8700, Romania
Phone: +40-(0)41-548775, epetac@univ-ovidius.ro
http://www.central-systems.ro

Danubius University
Portului str. 57-59, 6200 Galati, Romania
Phone: +40 (0)36 460106, variton@uni-danubius.galati.ro
http://www.uni-danubius.galati.ro

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Special warm thanks goes to the large number of ICT and non-ICT practitioners, teachers, trainers and trainees who concretely took part within the case studies and transferred a great deal of concrete expert work knowledge. It is hoped that the outcomes produced from these direct sources get the attention they deserve and that the documented practitioner information can adequately be transferred to the ongoing debate on the analyses and consideration of work and skill requirements as a vital basis for the processes of ICT qualifications and curriculum design as well as their implementation in vocational education and training practice.

Flensburg, August 2004

On behalf of the EUQuaSIT project team,

The authors

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1 Initial position, purpose, definitions and methods of EUQuaSIT

> *"Over the last decade growing attention has been paid at both national and European level to the transparency of qualifications and competences, for both academic and occupational purposes. Lack of transparency has often been regarded as an obstacle to mobility, for either educational or occupational purposes, and a constraint on developing the flexibility of labour markets in Europe; making qualifications and competences more transparent is essential to increase and improve mobility – between countries and regions, sectors and companies, as well as from learning to working in the perspective of lifelong learning."*[1]
>
> *"It is essential to assess the skills gap created by the mismatch between the skills and qualifications of the active population and the current and future needs of the labour market in skills and qualifications. Development is needed concerning the methodology of combining in a comparative way information on skills and educational attainment on the one hand and occupations and job needs on the other hand. Moreover, there is an additional mismatch at the local/enterprise level which needs to be addressed."*[2]

The quotations above underline the need of more transparency in the education and occupation systems in Europe as well as the corresponding need of investigations on current and future skills developments and requirements on the labour market. The purpose is a better match between the provisions of education and training systems and the emerging needs of the knowledge society in terms of level and quality of employment and lifelong learning (cf. CEC 2003). In this context the developments in the area of information and communications technologies (ICT) play a major role. Therefore, the EUQuaSIT project results on "European ICT qualifications" documented in this report contribute to the debate on increased European transparency and mutual strategies of prospectively improving vocational education and training structures and supply.

In recent years the spread and dynamic of ICT in all European countries have been steadily increasing. Today the high importance of ICT for the entire economies and all areas including business, services, domestic and leisure is obvious. Computer technology is present in a very large percentage of appliances, elements of process control equipment and appear on almost every professionals' desk across Europe as well as a multitude of smaller computerised devices in handbags or jacket pockets. Electronics, PCs with all types of standard and individual applications, communications networks and, last not least, the Internet, are very widespread and have had a profound impact on most industrial sectors. ICT developments have changed the society to an "information society" and new possibilities as well as challenges in all areas of work and life have been arisen, in particular, of course, in ICT business and work areas itself. New ICT technologies are creating fundamental changes within business and the world economy as a whole and success in this new, and digitally driven, economy will be critical to European competitiveness. However, in a structural view, e.g. occupational and qualifications classifications, the wide ICT penetration across sectors and occupations constitutes a big challenge for national and international comparative surveys like EUQuaSIT.

This final work report of the European Leonardo-da-Vinci-II project EUQuaSIT seeks to summarise the comprehensive quantitative, qualitative and especially comparative results on European ICT employment structures and practitioner numbers, the national and European demand of qualified ICT practitioners, the skill needs of ICT practitioners, the supply of ICT qualifications

[1] Proposal for a Decision of the European Parliament and the of the Council on a single framework for the transparency of qualifications and competences (Europass). COM(2003)796 final, Brussels, 17.12.2003, page 2 (CEC 2003)

[2] http://europa.eu.int/comm/education/programmes/leonardo/old/leonardoold/stat/trainingstatis/secondphase/workprog_en.html

and the implementation of ICT vocational education and training. In addition to the investigation of the ICT skill and practitioner needs of the ICT sector, the results equally cover the needs of the ICT user sectors and furthermore especially take into account the needs of small and medium ICT businesses.

In 2000 the ICT sector itself in the EU-15 employed app. 6 million people and represented about 3 % of all employment in the EU (cf. Garland 2003, p. 3). However, the ICT sector faces particular challenges in fulfilling its role in contributing to the success of the European Union's economy. These include keeping pace with the demands of rapid technological development, the constant innovation in products and services, and the emergence of new ÎCT markets such as complex telematic applications. Ensuring that there are sufficient numbers of ICT practitioners with the required skills[3] supporting the development of Europe's ICT sector will be a critical issue.

School, vocational, tertiary and higher education are key providers of adequately skilled ICT practitioners to the sector. Given the reported shortages with the required overall and specialist ICT skills, there was particular interest in promoting such provision, especially providing that the vocational education and training programmes offered do meet the skills and knowledge requirements of the sector. Businesses have also indicated that, in some cases, students lack the necessary generic or interpersonal (behavioural) skills and are, therefore, not ready for work after their studies. Clearly, there is a need for qualification programmes to ensure that adequate skills are developed, and that students and trainees are also able to apply these skills within the context of the workplace.

Providing international and in this case European reference material of and for vocational education and training (VET) is always a complex and multi-dimensional issue. National VET systems in Europe partly differ considerably, both in terms of their importance within the overall education system (education strategy) as well as concerning the conception and implementation of training, examination and certification, e.g. school based, dual system, on-the-job training. Different studies show difficulties of initial VET to meet the requirements of the changing work environments to more flexible and work process organisation (cf. Perez/Ortega 2003). This seems to be a specific problem in ICT work areas, since traditionally these have been occupied by academically qualified ICT practitioners. However, in such a dynamic area things are changing rapidly and we now see even work areas such as software applications development in which ICT practitioners at all levels are demanded.

Furthermore the coalescence of Europe and the constitution of international sectors result in a demand of more and clearer European occupations and qualification profiles. Examples are the aircraft- and automotive industry as well as the ICT field. For the coordination of these often divided processes a transparent European cooperation and information platform is needed.

It is imperative to set the context of the project in terms of recent political decisions within the European Union and the importance that education and training will play in their achievement. The European Council's strategic declaration of Lisbon stated in spring 2000 that by 2010 the European Union should become the most competitive and dynamic knowledge-based economy in the world and that the development of vocational training is a crucial and integral part of this strategy. The Copenhagen Declaration of 2002 correspondingly states:

"Investigating how transparency, comparability, transferability and recognition of competences and/or qualifications, between different countries and at different levels, could be pro-

[3] The term "skills" in this report is used as a broad term that comprises all other terms in this direction such as "competences, abilities, proficieny, knowledge" etc.

moted by developing reference levels, common principles for certification, and common measures, including a credit transfer system for vocational education and training."[4]

The actual relevance of a European VET credit transfer system was stressed recently by the Commission: "An important starting point would be to develop principles for credit transfer, which are applicable to both HE and VET. These principles are crucial in relation to ensuring compatibility between the systems, and in securing stakeholder acceptance."[5]

Against the background of these work, employment and qualification developments, this final EUQuaSIT project report tries to illuminate how the findings and conclusions can support European processes on mutually agreed VET strategies and concepts. Luckily, the considerable outcomes of the project could already partly be transferred to the actual European discussion and received vital attention, e.g. through the planned cooperation with the European Centre for the Development of Vocational Training (CEDEFOP).

1.1 Purpose and project activities of EUQuaSIT

EUQuaSIT aimed at contributing to more transparency of ICT employment and qualifications in Europe, both quantitatively (statistical data) and qualitatively. In the centre of attention the project produced tailored reference material on the supply and demand situation of qualified ICT practitioners[6] in Europe. The project gives recommendations for prospective strategic steps to be taken in order to guarantee more transparency of European ICT skills and VET developments, worked out from a professional qualifications' point of view. For this it is necessary to develop adequate occupational skills and qualification structures for the more reliable estimation of ICT skill needs and the ICT qualification supply. The project work has indicated that European countries as well as institutions such as the OECD and the European Commission and its bodies Eurostat and Cedefop are currently searching for adequate occupation and qualification structures that help reflecting and systematically describing the dynamic changes of ICT business, work and qualifications.

On this basis it was possible to construct European (reference) material on ICT qualifications reflecting both, corresponding ICT practitioner skill needs as well as the variety of qualification strategies and concepts in European countries (in the scope of the European principle of subsidiarity). In detail ICT skill needs and qualification structures and contents in Europe are described in order to define prospective priorities in this innovative and prosperous field of the knowledge-based society, economy and labour market. Initial position in this context is, that a comprehensive and sustainable knowledge of the skill needs of practitioners and how these can be systematically analysed and described is obligatory for the development of national and transnational ICT qualification concepts. And vice versa, adequate ICT qualifications have a major impact for the European labour market development and the supply of ICT practitioners. With this work the project is actively contributing to the development of innovative approaches

[4] The Copenhagen Declaration: Declaration of the European Ministers of Vocational Education and Training, and the European Commission, convened in Copenhagen on 29 and 30 November 2002, on enhanced European cooperation in vocational education and training, see http://europa.eu.int/comm/education/copenhagen/index_en.html

[5] IRISH PRESIDENCY: CONFERENCE ON COMMON THEMES AND APPROACHES ACROSS HE AND VET IN EUROPE, 8 MARCH 2004. Conclusions of N. van der Pas, DIRECTOR GENERAL DG EDUCATION AND CULTURE, EUROPEAN COMMISSION.

[6] "ICT practitioners are practitioners who work with their skills and competences at different skill levels in research, development and design, management, the production, consulting, marketing and sales, the integration, installation and administration, the maintenance, support and service of information and communications technology systems or who develop, integrate, support etc. and use ICT systems in a technical context and applications (e.g. multimedia or health informatics) in their occupational specialisation (ICT job practitioner)". The term generally covers all skill levels. For the delimitation to the workforce who use ICT systems and applications see EUQuaSIT Interim Report, chapter 1.3: "Common understandin of ICT for the project", p. 9 et seq.

with a special focus on linking the view of the business and working world to prospective strategies of (open) European VET systems. Corresponding networks have been envisaged.

The demand for ICT practitioner skills must be assessed both from a quantitative and qualitative viewpoint. The outcomes of different respectable studies throughout recent years (see exemplarily biat 2001, EUQuaSIT 2002; CEPIS 2002) have indicated that the supply of ICT qualification profiles and training programmes, especially in vocational education and training, may not sufficiently meet ICT practitioner skill needs on the labour market. And especially in ICT, rapid changes of systems and applications as well as ICT business and work processes lead to substantial changes of the practitioner skills required. Therefore, adequately skilled ICT practitioners are constantly in demand in all European countries and it is one of the major present and future challenges not only to react to this demand but also to provide a tailored European framework of ICT qualifications as a reference for European countries. In a European view and by considering national responsibilities for vocational education and training the conclusions and recommendations focus on reference material[7] as developed with the EUQuaSIT project.

For clarification of the complex context, it is necessary to identify and describe developments in the broad ICT business and work areas, against the background of different ICT market segments, and relate them to ICT practitioner skills and skill needs on the one hand, as well as ICT qualification profiles and programmes on the other. In fig. 1-1 this vital relationship is illustrated, showing that the skill needs of companies of the ICT sector and ICT user sectors are an important basis for the ICT qualification and training supply, both quantitatively and qualitatively at all skill levels, independent of each European education system. From a separate perspective, the ICT education and training supply has influence on ICT work and skills development, which means that education has an important role to play in supporting companies using developing technology and competences.

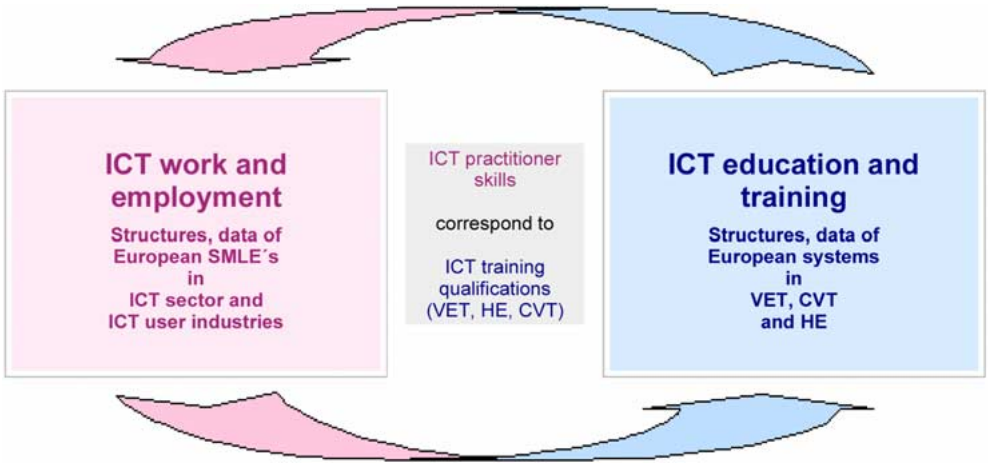


fig. 1-1: Survey approach of EUQuaSIT with the interaction of ICT work and employment and ICT education and training

With the EUQuaSIT project activities it was intended to get detailed information on skills requirements of ICT practitioners qualified at different levels. This covers the whole range of needed skills, from technical ICT skills to overall behavioural and personal skills. The initial aim of EUQuaSIT to identify, structure and classify overall and generic ICT work areas could be objectified based on the comprehensive and detailed investigations of concrete ICT business and work processes. The question in regard to the involved ICT practitioners (with their ICT job and qualification profiles) and their skills described in ICT work tasks within the processes play a

[7] see conclusions of N. van der Pas, Director General DG Education and Culture, European Commission, presented at IRISH PRESIDENCY: CONFERENCE ON COMMON THEMES AND APPROACHES ACROSS HE AND VET IN EUROPE, 8 MARCH 2004.

major role for the conclusions on prospective European ICT skills profiles and qualification programmes.

One major precondition for all surveys on ICT practitioner skill needs was a profound knowledge of existing sector-, business-, work- and qualification structures in the partner countries. Therefore overall and latest developments in ICT business and technologies were permanently investigated. Major task of the initial project activities, however, was to systematically describe, analyse and compare the structure, developments, demand and acceptance of ICT qualification profiles and programmes in the partner countries. The comprehensive and systematic documentation and interpretation of the existing ICT qualification profiles in the project internet database - including statistical data where available - functioned as an information platform for the partners and the project target groups. For the comparison, common references for training fields and levels relevant for ICT were used. Furthermore this work constituted a vital preparation for the empirical investigations in the European written examinations and case studies.

Altogether the project results ought to contribute to the European discussion on innovative procedures for the profound analysis, transfer and more reliable forecasts of qualification demands, especially in vocational education and training (VET). The development of modern and integrative VET solutions and curricula requires comprehensive knowledge about the work processes and needed skills and is therefore linked to the discussion on employment affairs and occupational objectives and contents.

The overall work programme of EUQuaSIT was subdivided into six work packages as shown and briefly described in the following table:

Work package I: National analysis of the development of ICT qualification possibilities and strategies within the national framework of initial and further vocational education and training in the field of Information and Communications Technology in European countries considering special initiatives and programmes for disadvantaged groups and women. Furthermore taking into account other ICT qualification and programmes (e.g. Higher Education).	6 months
Work package II: Empirical analysis of the practical implementation and acceptance of ICT qualification and programmes based on a written and online examination of companies and training institutions of different size and business also focusing on the demand of ICT practitioners and considering the great variety of ICT skill needs.	6 months
Work package III: International (European) comparison of collected national material on ICT qualification profiles and statistics of the VET and CVT system as well as the implementation of ICT training strategies and profiles in companies and training institutions. Transfer of the outcomes including recommendations with regard to common and innovative strategies in order to better meet the demand of ICT practitioners in Europe.	5 months
Work package IV: Case studies for the investigation of ICT business and work processes as well as the implementation of vocational training strategies in the field of information and communications technology. Undergoing of expert interviews with ICT practitioners and VET experts (teachers, trainers) in companies of different size and sectors as well as ICT training institutions.	8 months
Work package V: International and comparative analysis and evaluation of the company and training institution case studies with results of ICT practitioner work, skills and qualification considering the demand of ICT practitioners at different skill and qualification levels. Considering aspects like special initiatives for disadvantaged groups and females.	6 months
Work package VI: Final international co-ordination, dissemination and transfer of the project results. Organisation of a European workshop and final recommendations on mutual European and international strategies and initiatives such as the recognition of degrees and certificates in the field of ICT.	3 months

fig. 1-2: Overview of the work packages of the EUQuaSIT project

1.2 Analyses and methodological background and definitions

Major part of the first work packages - comprehensively described in the EUQuaSIT interim report - was the analysis and evaluation of current ICT qualification profiles and programmes including the supply of ICT practitioners at all levels in the project partner countries. The actual offer of ICT qualifications and training programmes were reflected against the background of each national education and training system. On the one hand, as primary material these comprehensive and profound material provide the target groups of the project with relevant information on actual ICT qualifications, training programmes and curricula in Europe. On the other hand, one needs to see that gathering and processing such information on European ICT qualifications is an ongoing process of up-dating, e.g. with new profiles or with those from other European countries. It was a matter of principle in the EUQuaSIT project that a profound thematic knowledge of the actual ICT qualification and training situation in the partner countries is obligatory for the detailed investigation of the work and skill needs of ICT practitioners in the companies as well as the practical implementation ICT training. However, before the approaches of the corresponding surveys will be described some clarifications on ICT work, employment and qualifications were needed from a methodological point of view, e.g. for a common understanding and use of terms and definitions.

1.2.1 ICT practitioner work, employment and technologies: the use of terms and classifications in Europe

Information and communications technology (ICT) plays a major role in the globalisation of the economy, and at the same time creates prospects for the development of future technology and the modernisation of products and services. The use of different types of ICT is one of the most significant features of today's business. ICT support tools are computers and data processing equipment, means for building computer systems, digital (tele)communications equipment, software products and (global) services connected with the delivery of software, communications products and services, selected forms of technology for the manufacture of electronic parts, multimedia products and related services. Furthermore, the Internet has already fundamentally changed the way today's businesses operate and will continue to do so in the future. ICT promotes prospects for economic growth and also results in the creation of jobs for highly skilled personnel.

Despite the high political and economical priority, the available data and information on the actual development of ICT in view of occupation, employment and qualifications structures indicate difficulties with regard to their transparency and consistency. But both criteria are a precondition for comparative European surveys and outcomes. Thus the clarification of terms and the project utilisation of relevant official classifications such as NACE, ISCO-88 (COM) and ISCED-97 is subject of the following initial chapters. The presented figures and descriptions summarise the complex project proceedings leading to these relevant results needed for a common understanding of what had to be investigated in the scope of our project, namely ICT qualifications and the nature of the processes corresponding to this innovative and complex field. As indicated earlier on especially with regard to the field of vocational education and training (VET) in Europe the EUQuaSIT project group became aware of the fact that a mutual European view on the significance of VET in the field of ICT certainly has not been developed yet.

In order to classify the material on the development of ICT practitioner skills and qualifications it was initially necessary to investigate and evaluate important categories and terms such as ICT practitioner and ICT qualification. Difficulties in a common understanding and usage of classifications as a reporting unit are considerably caused through an inconsistent use of terms, e.g. IT, ICT, e-business, computer experts or IT specialists (cf. OECD 2004, p. 2).

Within EUQuaSIT three groups were delimitated, namely ICT practitioners, ICT job practitioners as well as ICT users. The working definition of the comprehensive term and occupation group 'ICT practitioner' (as well as ICT job practitioner') is as follows:

> **"ICT practitioners are practitioners who work with their skills and competences at different skill levels in research, development and design, management, the production, consulting, marketing and sales, the integration, installation and administration, the maintenance, support and service of information and communications technology systems or who develop, integrate, support etc. and use ICT systems in a technical context and applications (e.g. multimedia or health informatics) in their occupational specialisation (ICT job practitioner)".**

The definition of 'ICT practitioners' and 'ICT job practitioners' is needed to describe the often blurring boundaries of today's ICT work and skills. It is realised that the skills of such practitioners become contextualised into the situation in which they are practiced and that sectors such as for example the ‘automotive industry’ will apply and evolve these skills to their own practices. The project sought to take this into account which is reflected in the consideration of all relevant ICT practitioner groups. However, it cannot completely be answered at this stage whether or not an automation engineer who performs PLC programming or a designer using computers (multimedia) are ICT practitioners. For the sake of their good knowledge in ICT, one may say that both above are ICT practitioners; however, each of them is first of all qualified in another domain, but they may fairly substantially develop, integrate and support ICT hardware and software in their jobs. For this the category of ICT job practitioners have been introduced in delimitation to ICT practitioners that are subject of the project from the viewpoint of the corresponding ICT qualifications supply.

Furthermore, the term 'ICT skills' is often utilised for the massively increasing ICT user group, for instance indicated by the European Computer Driving License (ECDL) initiative. In general ICT users do apply systems as tools in support of their own work. User skills cover the use of common and standard computer and communications applications and tools. Therefore it might be argued that already a secretary who uses technical office instruments (word processing or spreadsheet computer applications) is a kind of ICT practitioner. Even though ICT users are not subject of the EUQuaSIT project work, this group should at least be alluded at this initial point of the reporting.

Reaching to the point, we conclude that borders move from pure ICT practitioner skills via job specific ICT practitioner skills to ICT user skills as shown in the following picture.

fig. 1-3: Definition and delimitation of ICT practitioners, ICT specific jobs and ICT users

The second major challenge and precondition for the further EUQuaSIT work on ICT qualification strategies and concepts in Europe was to clarify in an occupational sense which groups need to covered as relevant ICT practitioner groups. Based on the definition given above an 'Occupational classification of ICT practitioners' was conducted in a European perspective of the surveys in orientation to the widely used occupational classification ISCO-88 (COM) (cf. ILO

1990; Elias 1997). Based on this occupational classification defined by skill levels and specialisations all ICT relevant 'unit groups' at the skill levels 2, 3 and 4 as well as the 'manager' skill level were considered as indicated in the table below. Even though some of the groups clearly subsume ICT practitioners, e.g. 'Computing professionals (ISCO 213)', there are others which need further interpretation such as for example 'Electronics and telecommunications engineers (ISCO 2144)'. Therefore a distinct nomination of ICT practitioners within the ISCO-88 structure is often difficult and sometimes almost impossible. For the project work, however, it was necessary for all partners to be aware of the fact that interpretations are inevitable, for instance in regard to the question which ICT qualifications needed to be considered within the initial EUQuaSIT surveys. Also for statistical purposes on the demand-supply comparisons and estimations in the European context this interpretation as summarised in the table had been vital.

Occupational classification of ICT practitioners
ISCO-88 (COM) occupation groups

Level	Major groups	Sub-Major groups	Minor groups	Unit groups
Skill level -	Legislators, senior officials and managers (ISCO 1)	Corporate managers (ISCO 12)	Other specialist managers (ISCO 123)	Sales and marketing managers (ISCO 1233)
				Computing services managers (ISCO 1236)
			Production and operations managers (ISCO 122)	Production and operations managers in ... communications (ISCO 1226)
		Managers of small enterprises (ISCO 13)	Managers of small enterprises (ISCO 131)	Managers of small enterprises in transport, storage and communications (ISCO 1316)
Skill level 4	Professionals (ISCO 2)	Physical, mathematical and engineering science professionals (ISCO 21)	Computing professionals (ISCO 213)	Computer systems designers, analysts and programmers (ISCO 2131)
				Computing professionals not elsewhere classified (ISCO 2139)
			Architects, engineers and related professionals (ISCO 214)	Electronics and telecommunications engineers (ISCO 2144)
Skill level 3	Technicians and associate professionals (ISCO 3)	Physical and engineering science associate professionals (ISCO 31)	Physical and engineering science technicians (ISCO 311)	Electronics and telecommunications engineering technicians (ISCO 3114)
			Computer associate professionals (ISCO 312)	Computer assistants (ISCO 3121)
				Computer equipment operators (ISCO 3122)
			Optical and electronic equipment operators (ISCO 313)	Broadcasting and telecommunications equipment operators (ISCO 3132)
Skill level 2	Clerks (ISCO 4)	Office clerks (ISCO 41)	Secretaries and keyboard-operating clerks (ISCO 411)	Data entry operators (ISCO 4113)
				Calculating-machine operators (ISCO 4114)
	Service workers and shop and market sales workers (ISCO 5)	Models, salespersons and demonstrators (ISCO 52)	Shop, stall and market salespersons and demonstrators (ISCO 522)	Salespersons for ICT (ISCO 5221) (CZ)
	Craft and related trades workers (ISCO 7)	Metal, machinery and related trades workers (ISCO 72)	Electrical and electronic equipment mechanics and fitters (ISCO 724)	Electronics mechanics, fitters and servicers (ISCO 7242)
				Telegraph and telephone installers and servicers (ISCO 7244)

fig. 1-4: Occupational structure of ICT practitioners of "International Standard Classification of Occupations ISCO-88 (COM)" used and named by EUQuaSIT

The comprehensively realised solution for the classification of ICT practitioners considers more than the often in other studies and surveys in a narrower view used IT minor groups 'Computing professionals (ISCO 213)' and 'Computer associate professionals (ISCO 312)', for instance in Eurostat statistics subsumed as 'Computer professionals' (see table below, cf. Ottens 2003, p. 59). Rather than just taking up this narrower skill level and specialisation ('computer or IT') view, the EUQuaSIT definition of ICT practitioners covers also IT managers (Computing services managers (ISCO 1236)) and other related occupational groups such as 'Electronics and telecommunications ...' (with the red colour background) as well ICT practitioners working in areas like management, marketing and sales (yellow backround). Two major messages can be transferred from these results, in line with the project objectives:

- ICT practitioners work and have skills at all levels of the ISCO-88 (COM) classification and
- the narrow view only on IT- or computer professionals does not reflect the comprehensive employment and work structures of ICT that equally cover communications practitioners as well as those in ICT management, marketing and sales.

Occupational classification of "Computer professionals"
ISCO-88 (COM) occupation groups

Level	Major groups	Sub-Major groups	Minor groups	Unit groups
Skill level 4	Professionals (ISCO 2)	Physical, mathematical and engineering science professionals (ISCO 21)	**Computing professionals (ISCO 213)**	Computer systems designers, analysts and programmers (ISCO 2131)
				Computing professionals not elsewhere classified (ISCO 2139)
Skill level 3	Technicians and associate professionals (ISCO 3)	Physical and engineering science associate professionals (ISCO 31)	**Computer associate professionals (ISCO 312)**	Computer assistants (ISCO 3121)
				Computer equipment operators (ISCO 3122)

fig. 1-5: Occupational structure of 'Computer professionals' of the "International Standard Classification of Occupations ISCO-88 (COM)"

Furthermore there are various international and national classifications for the description of social and economic activities, e.g. the "Statistical classification of economic activities in the European Community" (NACE), that is similar and currently being harmonised with the UN classification ISIC. A basic problem in this context is that it is often not sorted out very well whether 'ICT employment' means

- the employment in the ICT sector or
- the employment of ICT practitioners (in any sectors).

Based on the definition of ICT practitioners given above, as well as the assumption that their work and tasks are similar in the ICT sector and the ICT user sectors, no sector- or company-specific difference between ICT practitioners is made in the project. Independently of the sector and company type all ICT practitioners as well as those defined as ICT job practitioners are considered. In order to avoid any misconception in the project work, it was clearly differentiated between the 'employment of ICT practitioners' (in principle applying to all sectors) as well as 'ICT employment' which is defined as the total employment of the ICT sector and thus covers also 'non ICT practitioners', such as general managers, accountancies, mechanics etc. Correspondingly, and chiefly in view of ICT qualifications the term 'ICT employment' is not used in the project.

Economic activities classification of ICT sector and ICT user sectors
NACE Rev. 1.1

ICT sector
(ICT supplier industries)

ICT services IT services / CT services (NACE G 51, I 64, K 72, K 73)					
ICT manufacturing IT manufacturing / CT manufacturing (NACE DL 30, 31, 32, 33)					

ICT user sectors
(ICT user industries)

Manufacture of textiles and textile products (NACE DB)	Manufacture of pulp, paper and paper products; publishing and printing (NACE DE)	Manufacture of chemicals, chemical products and man-made fibres (NACE DG)	Manufacture of basic metals and fabricated metal products (NACE DJ)	Manufacture of electrical and optical equipment (NACE DL)	Manufacture of motor vehicles, trailers and semi-trailers (NACE DM 34)
Manufacture of other transport equipment (NACE DM 35)	Electricity, gas and water supply (NACE E)	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (NACE G)	Transport, storage and communications (NACE I)	Financial intermediation, except insurance and pension funding (NACE J 65)	Insurance and pension funding, except compulsory social security (NACE J 66)
Real estate, renting and business activities (NACE K)	Public administration and defence; compulsory social security (NACE L)	Education (NACE M)	Health and social work (NACE N)	Other community, social and personal service activities (NACE O)	others

fig. 1-6: Economic structure of the ICT sector and ICT user sectors of " Statistical Classification of Economic Activities in the European Community (NACE Rev. 1.1)" used by EUQuaSIT

In order to investigate the work of ICT practitioners it is in fact important to clarify in which sectors they work. In a comparative view the European NACE Rev. 1.1 was investigated in view of an Economic activities classification of the ICT sector and the variety of ICT user sectors.

Following the NACE structure of 'Section, Division, Groups and Classes' the ICT sector itself can be differentiated in the four areas 'IT services, CT services' and 'IT manufacturing, CT manufacturing'.

As for the ISCO-88 classification also a more detailed investigation of the NACE groups indicates that the mergence of the IT and CT industry to an ICT sector in a comprehensive work- and economical related view of the ICT area has not been realised yet. This is also true for national classifications and interpretations so that for the EUQuaSIT work a common European understanding of ICT practitioner work and skills had been a vital process. Furthermore and for all sectors a delimitation of ICT practitioners and the 'normal' users of ICT systems and applications was achieved.

Detailed classification of the ICT sector
NACE Rev. 1.1

Section	Division	Groups / Classes	ICT employment (ISCO level)				
			Skill level 1	Skill level 2	Skill level 3	Skill level 4	Skill level -
Manufacture of electrical and optical equipment (NACE DL)	Manufacture of office machinery and computers (NACE 30)	Manufacture of computers and other information processing equipment (NACE 30.02)					
	Manufacture of electrical machinery and apparatus n.e.c. (NACE 31)	Manufacture of insulated wire and cable (NACE 31.3)					
	Manufacture of radio, television and communication equipment and apparatus (NACE 32)	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy (NACE 32.2)					
	Manufacture of medical, precision and optical instruments, watches and clocks (NACE 33)	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment (NACE 33.2)					
		Manufacture of industrial process control equipment (NACE 33.3)					
Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (NACE G)	Wholesale trade and commission trade, except of motor vehicles and motorcycles (NACE 51)	Wholesale of computers, computer peripheral equipment and software (NACE 51.84)					
		Wholesale of other electronic parts and equipment (NACE 51.86)					
Transport, storage and communications (NACE I)	Post and telecommunications (NACE 64)	Telecommunications (NACE 64.2)					
Real estate, renting and business activities (NACE K)	Computer and related activities (NACE 72)	Hardware consultancy (NACE 72.1)					
		Software consultancy and supply (NACE 72.2)					
		Data processing (NACE 72.3)					
		Database activities (NACE 72.4)					
		Maintenance and repair of office, accounting and computing machinery (NACE 72.5)					
		Other computer related activities (NACE 72.6)					
	Research and development (NACE 73)	Research and experimental development on natural sciences and engineering (NSE) (NACE 73.1)					

fig. 1-7: Economic structure of the ICT sector of "Statistical Classification of Economic Activities in the European Community (NACE Rev. 1.1)" used and named by EUQuaSIT

In summary the following technological, economical and occupational definitions of ICT can eventually be stressed as being essential for the further work from a methodological point of view:

- ICT announce the mergence of “IT and CT”: “Information and Communications Technology”;
- ICT practitioner skills: The capabilities required for researching, developing and designing, managing, the producing, consulting, marketing and selling, the integrating, installing and administrating, the maintaining, supporting and service of ICT systems;
- ICT practitioners include e.g. “Computer professionals”;

- ICT practitioners work in the ICT sector and the ICT user sectors;
- ICT employment comprises the entire employment of the ICT sector (IT and CT service and manufacturing).

1.2.2 ICT qualifications in view of its correspondence to ICT practitioner work and skills

Based on the definition and classification of what is understood in the project by ICT practitioners, the methodological approach of the interaction of ICT work and skills on the one side as well as training and qualifications on the other, led to a definition and classification of ICT qualifications in the systems of vocational education and training (VET), higher education (HE) and continuing vocational training (CVT). As indicated in the figure below, a similar discussion as for the ICT practitioners took place in project in order to clarify the criteria for ICT 'practitioner' qualifications and as a basis for the national investigations and comparative analyses of relevant ICT qualification profiles and programmes. It is well known in the European debate especially on vocational education and training how different the national education and training systems are and therefore only a common and mutually agreed position, for instance in order to delimitate the relevant ICT qualification profiles and programmes from ICT user qualifications, would lead to comparative outcomes and prospective conclusions on ICT qualification strategies and concepts in Europe.

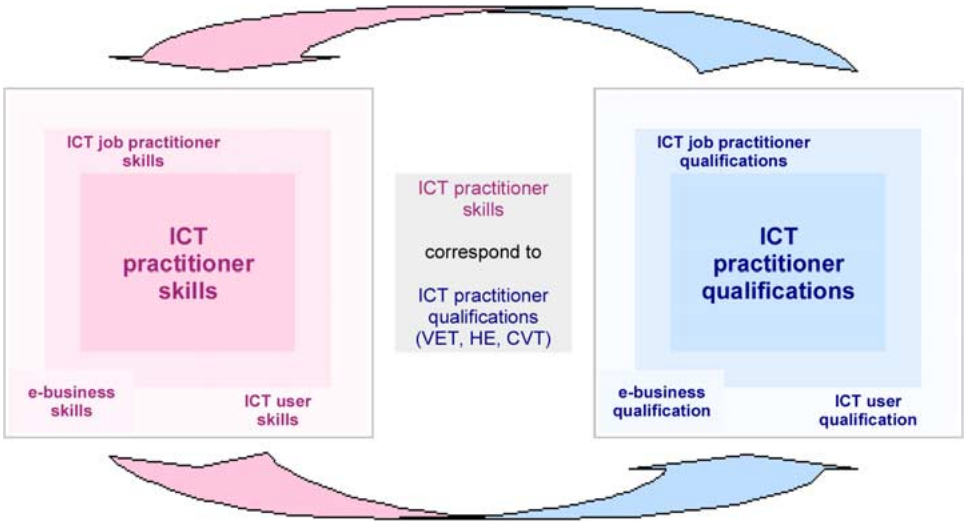


fig. 1-8: Definition and delimitation of ICT practitioner and ICT job practitioner qualifications to e-business and ICT user qualifications

As far as the delimitation of vocational education and training (VET) and continuing vocational education and training (CVT) is concerned, the EUQuaSIT project partners agreed on two main criteria. First of all, VET is defined as a qualification with which the participants reach a new level of vocational qualification, whereas CVT takes usually place on a certain level focussing on specific content. In accordance with this definition the group decided secondly that VET is also characterised by a certain period of time typically longer than 12 months. In addition, CVT courses were also only supposed to consider longer than 3 days of training.

The analysis of ICT qualification profiles and programmes requires a common structure which is not easy to agree on due to different existing VET systems in Europe (which is a well known barrier for a mutual European VET policy). However, in the methodological direction and orientation to existing and overall international and European classifications for education and training systems and programmes the complete "framework of ICT qualifications" is used in two major education and qualification categories, namely:

- the education and training (qualification) level and
- the education and qualification programme, subject and specialisation respectively.

The comparison of the international and European level frameworks used in this report is indicated in the table below. Based on the analysis the proposed and used ICT skills and qualification frameworks are each five-level structures with three 'skilled' / vocational education and training (VET) levels 2, 3 and 4 as well as two 'high skilled' / higher education (HE) levels 5B and 5M. The five qualification levels orient at existing international and national classifications as well as the new 'Bologna Process structure' with 'first and second cycle degrees“ (FCD; SCD) and Bachelor (BA) and Master (MA) respectively. Apart from Germany the EUQuaSIT partner countries have a national level classification for their vocational education and training programmes. The project group discussed these classifications and therefore a 'key' between each national and the EUQuaSIT level classification could be realised. For instance Dutch and Czech education and training profiles are based on the "old" European five levels framework as defined in Council Decision of 85/368/EEC (SEDOC). Even though not common in Germany, it was necessary to assign the ICT qualification profiles to this structure.Concretely, and already in view of final recommendations the defined VET and HE qualification levels should be nominated such as Bachelor (BA) und Master (MA). In terms of overall education and qualification levels expressed by ISCED 97, the table does not consider education level 1 and 2, since these levels do not cover relevant VET ICT qualifications.

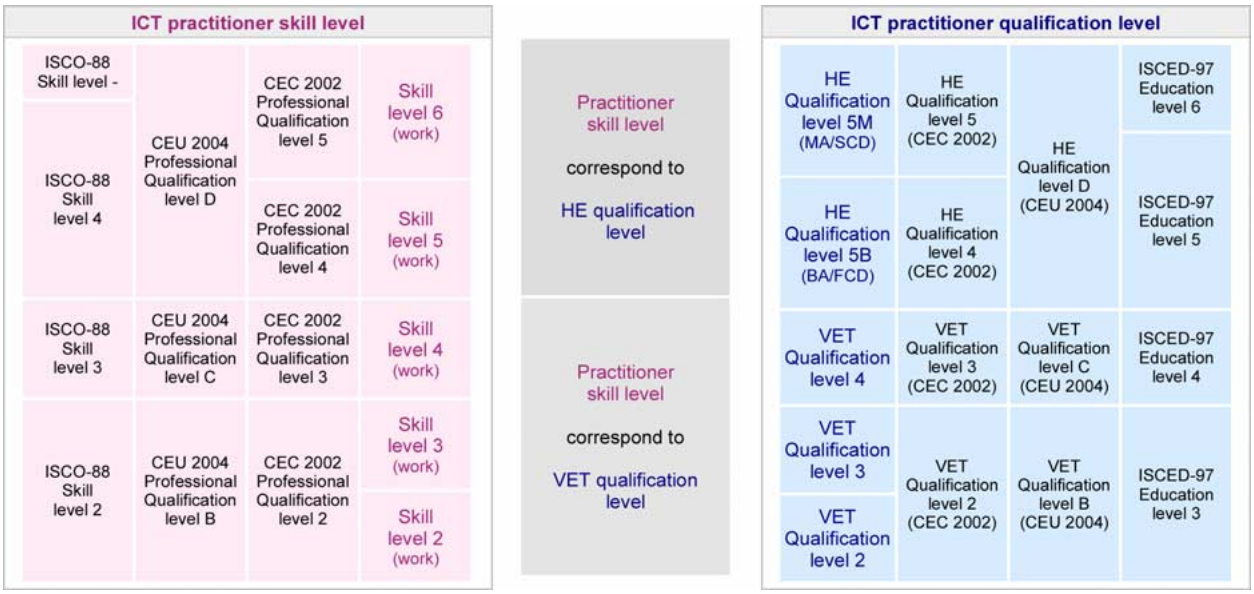


fig. 1-9: Correspondence of skills and qualification levels and the EUQuaSIT five VET and HE level solution

In correspondence of these relevant five ICT qualification levels to the employment system. the table furthermore indicates the nomination of five skill levels, too. This approach is in line with the specification of the ISCO-88 (COM) structure: "The International Standard Classification of Education (ISCED) was used to define the ISCO-88 skill levels" (Hoffmann 1999, p. 6). The defined structure of the five 'ICT practitioner qualification levels' on the one hand side, and the five 'ICT practitioner skill level' on the other, therefore does not only indicate a structural connection to the ISCED-97 levels as mentioned above, but also to the EU Directive on the recognition of professional qualifications at different levels (CEC COM 2002/0119 final - COD 2002/0061; amended in 2004) as well as based on this Commission proposal the latest 'Political agreement on the Council's common position' of May 2004 (CEU 9716/04 - ETS 42 CODEC 753). In view of the correspondence and interaction of the level structures for the employment and education and training system these level frameworks also allude to the international and European discussion on the problems and significance of harmonised frameworks.

Complete frameworks with qualification levels and ICT education and training fields

ICT qualifications need to address the specificity of the target domain. For the initial parts of the project, the EUQuaSIT team agreed on using an official European classification for training purposes. Since 1999 such a framework for vocational education and training is available as a supplement of the ISCED 97 classification for overall education aiming at classifying training programmes (cf. Cedefop / Eurostat 1999). In this framework a third 'digit' was created within the ISCED system which represents 'fields of training' (ibid., p. 7).

In the figure below the relevant '(ICT) fields of training' (from a total of 65 fields) with some exemplary main contents are presented in which the EUQuaSIT ICT qualification profiles and programmes have been classified. The colour of each field indicates its nature, as follows:

- ICT qualification and training programmes in audio-visual techniques and media production (blue colour),
- ICT qualification and training programmes in ICT related business and administration such as sales, marketing, management and administration (yellow colour),
- ICT qualification and training programmes profiles in computer science (blue colour),
- ICT qualification and training programmes profiles in electronics and automation (red colour).

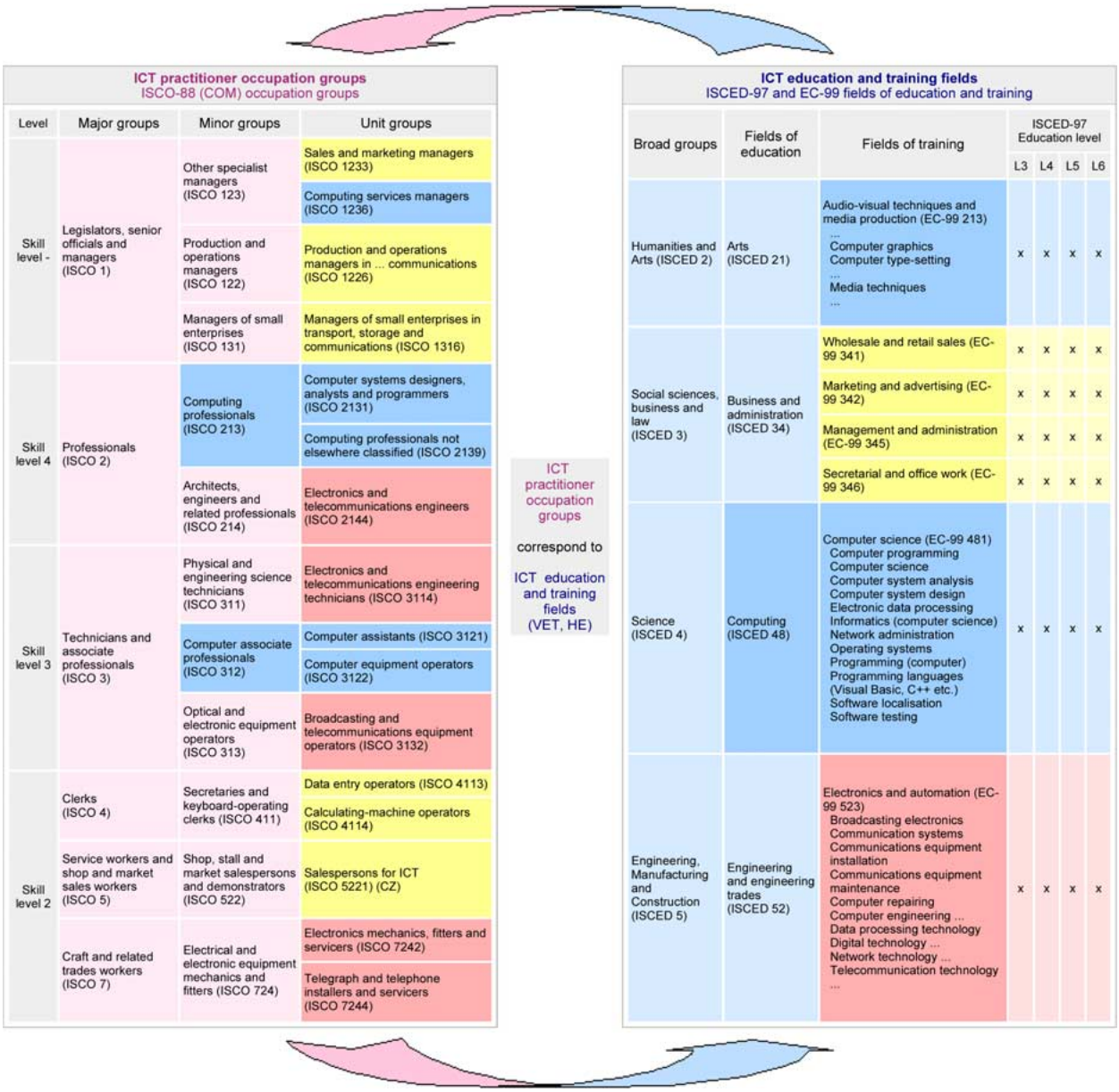
Further 'training field descriptions' are important for the classification of training programmes and to see which field best corresponds to the programme or the programme group that is to be classified (cf. Cedefop / Eurostat 1999, p. 13). For example the field 'computer science' is described as follows: "Computer science is the study of the design and development of computer systems and computing environments. It includes the study of the design, maintenance and integration of software applications" (Cedefop / Eurostat 1999, p. 18); and for 'electronics and automation': Electronics and automation (Engineering and engineering trades) is the study of planning, designing, developing maintaining and monitoring electronic equipment, machinery and systems. It includes designing computers and equipment for communication" (Cedefop / Eurostat 1999, p. 19).

The framework below also indicates the level structure of ISCED 97 which has been an orientation for the adapted level framework used in EUQuaSIT (see above). The complete qualification framework with qualification levels and specialisations was supposed to allow the classification of each ICT qualification profile and programme of the partner countries. The illustration indicates that in each subject area relevant for ICT training, qualifications profiles can be structured at each level from ISCED level 3 onwards (upper secondary education).

The complete correspondence of relevant ICT practitioner occupation groups and ICT education and training fields based on ISCO-99 and the one side as well as ISCED 97 and EC-99 respectively on the other, is illustrated as a major result of the EUQuaSIT work on occupational and educational classifications. These two structures helped clarifying the common basis for the national analyses of ICT qualification possibilities and strategies in the partner countries as well as the evaluation and comparison of vocational training ICT qualifications.

The analysis of the two structures clearly indicates their different approaches. Within the ISCO-88 classification occupation groups are first of all split in five broad skill levels of which four skill levels are relevant for ICT practitioner groups. On the contrary the EC-99 training classification shows a subject-oriented structure that is initially characterised by the 'fields of training'. Thus classifying an occupational profile in ISCO-88 first of all requires a decision on the skill level the practitioner is working on, whereas corresponding training measures allow for each field of training different education levels, and therefore, for instance, 'computer science'

and related activities such as computer programming can be classified in the EC-99 structure at different qualification levels.



ICT practitioner occupation groups
ISCO-88 (COM) occupation groups

Level	Major groups	Minor groups	Unit groups
Skill level -	Legislators, senior officials and managers (ISCO 1)	Other specialist managers (ISCO 123)	Sales and marketing managers (ISCO 1233)
			Computing services managers (ISCO 1236)
		Production and operations managers (ISCO 122)	Production and operations managers in ... communications (ISCO 1226)
		Managers of small enterprises (ISCO 131)	Managers of small enterprises in transport, storage and communications (ISCO 1316)
Skill level 4	Professionals (ISCO 2)	Computing professionals (ISCO 213)	Computer systems designers, analysts and programmers (ISCO 2131)
			Computing professionals not elsewhere classified (ISCO 2139)
		Architects, engineers and related professionals (ISCO 214)	Electronics and telecommunications engineers (ISCO 2144)
Skill level 3	Technicians and associate professionals (ISCO 3)	Physical and engineering science technicians (ISCO 311)	Electronics and telecommunications engineering technicians (ISCO 3114)
		Computer associate professionals (ISCO 312)	Computer assistants (ISCO 3121)
			Computer equipment operators (ISCO 3122)
		Optical and electronic equipment operators (ISCO 313)	Broadcasting and telecommunications equipment operators (ISCO 3132)
Skill level 2	Clerks (ISCO 4)	Secretaries and keyboard-operating clerks (ISCO 411)	Data entry operators (ISCO 4113)
			Calculating-machine operators (ISCO 4114)
	Service workers and shop and market sales workers (ISCO 5)	Shop, stall and market salespersons and demonstrators (ISCO 522)	Salespersons for ICT (ISCO 5221) (CZ)
	Craft and related trades workers (ISCO 7)	Electrical and electronic equipment mechanics and fitters (ISCO 724)	Electronics mechanics, fitters and servicers (ISCO 7242)
			Telegraph and telephone installers and servicers (ISCO 7244)

ICT practitioner occupation groups correspond to ICT education and training fields (VET, HE)

ICT education and training fields
ISCED-97 and EC-99 fields of education and training

Broad groups	Fields of education	Fields of training	ISCED-97 Education level L3	L4	L5	L6
Humanities and Arts (ISCED 2)	Arts (ISCED 21)	Audio-visual techniques and media production (EC-99 213) ... Computer graphics Computer type-setting ... Media techniques ...	x	x	x	x
Social sciences, business and law (ISCED 3)	Business and administration (ISCED 34)	Wholesale and retail sales (EC-99 341)	x	x	x	x
		Marketing and advertising (EC-99 342)	x	x	x	x
		Management and administration (EC-99 345)	x	x	x	x
		Secretarial and office work (EC-99 346)	x	x	x	x
Science (ISCED 4)	Computing (ISCED 48)	Computer science (EC-99 481) Computer programming Computer science Computer system analysis Computer system design Electronic data processing Informatics (computer science) Network administration Operating systems Programming (computer) Programming languages (Visual Basic, C++ etc.) Software localisation Software testing	x	x	x	x
Engineering, Manufacturing and Construction (ISCED 5)	Engineering and engineering trades (ISCED 52)	Electronics and automation (EC-99 523) Broadcasting electronics Communication systems Communications equipment installation Communications equipment maintenance Computer repairing Computer engineering ... Data processing technology Digital technology ... Network technology ... Telecommunication technology ...	x	x	x	x

fig. 1-10: Relevant "ICT occupation groups" and "ICT training fields"

From a methodological point of view it is important for all investigations and comparisons within the EUQuaSIT project that these are carried out on a common and harmonised basis of the corresponding and interacting relevant 'ICT fields of training' and 'ICT occupation groups'.

1.2.3 The empirical analyses of EUQuaSIT

In order to further identify and clarify the firms' needs of ICT practitioner skills and to transfer them into interrelated conclusions on prospective ICT qualifications and training practices in Europe the following surveys and empirical analyses were carried out:

- Evaluation of the demand and supply and the gap and mismatch of ICT practitioner skills and ICT training solutions.
- Questioning and case studies (ICT practitioner interviews) in the small, medium and large companies of the ICT sector and ICT user sectors in the five EUQuaSIT partner countries.

- Questioning and case studies in ICT training institutions in the five EUQuaSIT partner countries.

The questionnaire surveys of companies and ICT training institutions within work package 2 aimed at empirical results on the demand of ICT practitioners and the acceptance and evaluation of the ICT qualification profiles and programmes in companies on the one hand, and the ICT training practice on the other. This work is needed for the initial international comparison of the European ICT qualification demand and supply in the partner countries within work package 3.

The concept of undergoing a written questionnaire survey requires the composition of adequate questionnaires following the requirements and realisation criteria of empirical social research instruments. Most important in this respect is the development of tailored questions in regard to the subject of the investigation as well as how the questions should be structured and, for instance, if the questions and answers should be provided in more closed or open way. Furthermore in and in relation to the subject area it is important to consider the preconditions of the group to be investigated. Therefore and depending on the part of the questionnaire, e.g. due to the great variety of existing ICT qualification profiles and programmes in the countries, sometimes additional hints may be needed in order to clarify the context and objective of the question.

However, in order to compare the results of both, the questionnaires of the companies and the training institutions were developed in a similar structure and content areas, for instance the demand and supply of ICT qualifications, European affairs or the views and experience of special initiatives for increasing the female proportion under ICT practitioners or the chances of disadvantaged groups in ICT work. The analysis of the project outcomes was undergone with statistical computer software like MS Excel and the corresponding presentation through diagrams.

fig. 1-11: Online examination of companies (ICT sector and ICT user sector) and VET, CVT and HE institutions

The questionnaires (mailed and online) were commonly developed in English and then translated by the partners in to their national language (see fig. 1-11) and send out with letters and the flyers describing the project objectives to the above mentioned numbers of companies and training institutions. The main topics and questions are provided in the corresponding chapters of the report.

1.2.4 Overall concept and approach of the case study investigations

The case study investigations of EUQuaSIT contribute to more transparency on ICT practitioner work structures, contents and skill needs on the one side, and the actual European situation on the development, supply and implementation of ICT education and training on the other ('demand-supply-approach'). From the perspective of the development of VET structures, goals and contents there are different approaches how skills and qualification needs can be analysed and the results transferred to prospective qualification strategies and concepts. With the case studies in companies it is possible to analyse and evaluate occupational work tasks and corresponding skill needs of ICT practitioners within the 'real' structure of ICT business and work processes. A profound understanding of both, the structure and contents of the ICT work processes as well as the overall and specific ICT skill needs is a precondition for innovative work oriented ICT qualifications and training contents and concepts. From a methodological point of view, work (or work process) orientation in developing and implementing vocational education and training (VET) in a specific area or sector requires a comprehensive and well structured picture of the work and skills of the practitioner groups concerned.

Consequently, the concepts for the case studies and expert interviews in companies and ICT training institutions were developed from a common understanding and perspective of ICT vocational education and training and is leading to a common view of conclusions and recommendations with regard to prospective European ICT qualification strategies (see fig. 1-12).

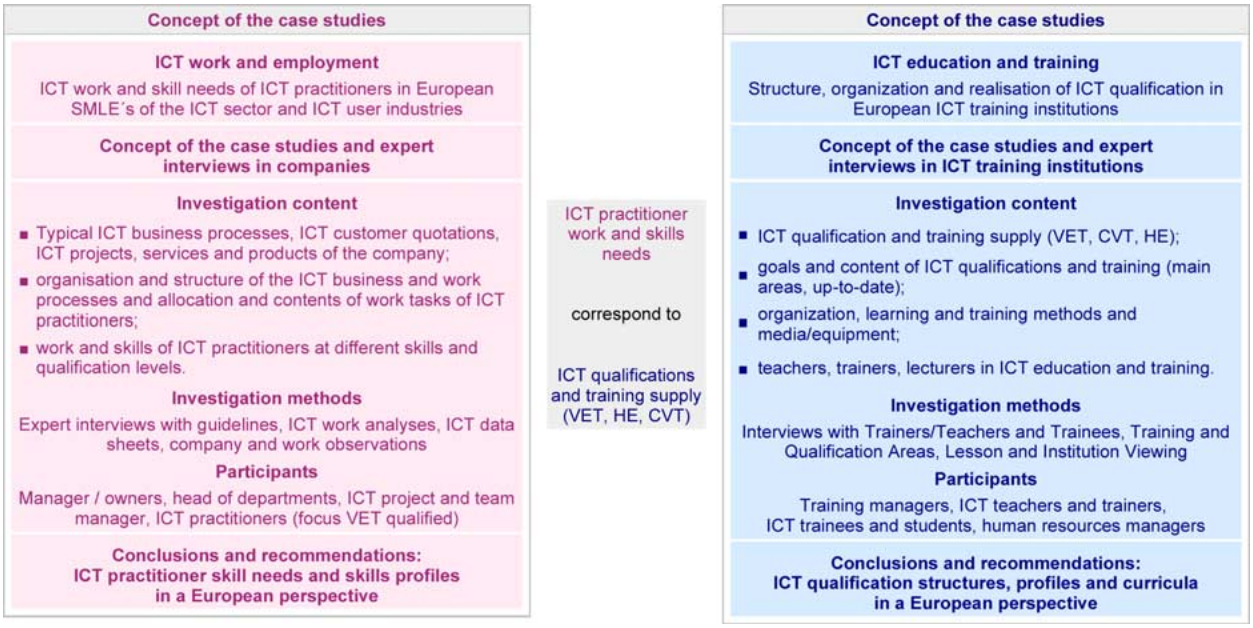


fig. 1-12: Overall approach for the case study investigations in European companies and ICT training institutions

In order to 'professionally' undergo a case study in a company complete and good information about the ICT business areas, projects and products is needed beforehand. If the company had already taken part in the questioning a lot of overall and empirical information were already available and could be completed with additional material sent by the company for preparation beforehand and through the internet. Ideally the case study is undergone by two people, one of which should have some professional skills in the ICT business and work area and must be able to make use of the developed analysis and data sheets, e.g. on ICT marketing or databases (see in the annex).

The outcomes of the case studies in companies support the development and provision of innovative work oriented concepts of professional ICT education and training in Europe. In order to reflect and evaluate the findings from the 'ICT business and working world' the second part of the investigations concerns the actual situation of ICT education and training in Europe and the

question how ICT training institutions have addressed the challenge of adequate ICT education and training provision as well as demanded ICT certifications.

The developed concept correspondingly consists of two related but specific parts for the case studies and expert interviews in companies and ICT training institutions. In the centre of the investigations the project partners did interviews with experts, namely ICT practitioners in companies and VET experts in ICT training institutions. These guided and dialogue based expert interviews give insights into the work of either side, which is a precondition for detailed conclusions on European ICT practitioner skill needs and prospective ICT education and training strategies. Today, experienced experts are a widely accepted source for investigations in certain field, one of which is the investigation of ICT skills needs at the work place and within real work processes of the practitioner group. In summary: the concrete knowledge on needed practitioner competences ('know how') in the business and work processes are an obligatory basis for the development of work oriented ICT qualifications, curricula and certifications. In addition to the experts often with many years of work and teaching experience, also trainees and students were interviewed.

The EUQuaSIT project implements innovative ways of systematically analysing and evaluating work and training practice. Even though the core activities of investigating overall and specific skill needs of ICT practitioners within small, medium and large European companies' ICT business and work process from the viewpoint of VET research are an enormous effort, the empirical outcomes surely offer prospective ways of designing tailored European ICT qualifications.

The new work and process oriented ICT skills framework was completed based on the ICT practitioner work and skills analyses as well as a comparison of existing occupational classifications (e.g. ISCO 88). In order to structure the identified ICT skill needs in the new framework, the project group investigated the skill needs of ICT practitioners (working in teams) and determined generic ICT skills (occupational) profiles at different levels and generic ICT work areas. Focussing on ICT practitioner skill needs at skilled worker level, concrete ICT work tasks were investigated and aggregated.

Corresponding to the specification of ICT skill levels, needs and profiles in the new (meta-) skills framework, ICT qualification levels and profiles were defined in a new framework of ICT qualifications and guidelines for the development of VET ICT curricula elaborated. The results contribute to new concepts of modular curriculum development and a European vocational education and training credit (transfer) system as well as international and ICT industry led initiatives regarding skills certification.

Based on these tailored occupation and (vocational) education structures new reference data for statistical purposes could be provided taking into account the entire range of ICT practitioner work and qualification. It is recommended from the comprehensive project findings to start new European initiatives to harmonise the national classifications on ICT occupations and qualifications in order to be able to quantify the whole range of ICT practitioners in Europe for which we need to find mutual ICT qualification strategies and concepts.

2 ICT work, employment and technology development: the situation of ICT Europe

After the Lisbon European Council in 2000, Europe had to star facing new set of challenges in what innovation concerns. The council provided indicators for tracking progress towards the EU's strategic goal of becoming the most competitive and dynamic knowledge-based economy in the world. Amongst the many sectors of activity involved, the ICT sector represents a vital element for the success or failure of these new policies and trends. According to the EU Commissioner for Enterprise and Information Society;

"Innovation is viewed as a multi-dimensional concept, which goes beyond technological innovation to encompass, for example, new means of distribution, marketing or design. Innovation is thus not only limited to high tech sectors of the economy, but rather an omnipresent driver for growth."

The first question to make is that of knowing if Europe is or is not reaching the targets settled in 2000 or, in other way, if the goals for 2010 are in danger or will be met. The EU Commission has frequently expressed concerns about the success of this strategy mainly because of the multidimensional nature of the innovation phenomenon which involves not only technologies and policies but all the society. As a matter of fact innovation can result from technology transfer or through the development of new business concepts, it can be of technological, organisational or presentational nature.

Due to the factors analysed such as the persistent inadequate performance of the Union, the implications of enlargement, the demographic trends and the large size of the public sector in EU economies it is vital that both at national and regional levels, the Member States and the Commission intensify their cooperation for the strengthening of innovation in the EU, including coordination and assessment mechanisms for mutual learning, as well as for tracking progress achieved.

In March 2003, EU Commission expressed these and other concerns to the Council, The European Parliament, the Economical and Social Committee and the Committee of The Regions. The objective was to update the Union's approach to the Lisbon Strategy and giving emphasis to the subsequent European Councils in particular Barcelona 2002.

2.1 Implications of innovation strategies in the ICT business area

Indicated as one of the most important sectors for achieving goals of innovation strategies, the information and communications technology (ICT) sector will play a major role in the next decade. Considering that according to the EU Commission the current challenges for EU innovation policy are:

1. Inadequate performance,
2. Enlargement,
3. Skills shortages,
4. Specific features of the Union's economic and social setting.

It should be of interest to say something further about each one of these aspects before analyzing the European trends on ICT and because all of these aspects represent considerable number of implications in the ICT policies and features in Europe.

Inadequate performance

This is the dominant challenge of the Union as a whole. The innovation performance of member states, candidate countries and certain other European states, and of the Union as a whole, is measured by the Commission's European innovation scoreboard. In spite of some encouraging features of Europe's innovation profile, it demonstrates the weaknesses in the Union's position relative to the United States and Japan.

Enlargement

The available evidence points to strong disparities in the innovation frameworks and performance of the recent admitted countries compared to the other Member States. On the one hand, people and companies in the new countries have shown a remarkable capacity to transform their economies. This also reflects a taste for innovation which will be beneficial for the enlarging EU. On the other hand, the existing obstacles to innovation in the New Countries must be directly addressed to raise the performance of the enlarged Union, making a further challenge to the open coordination method.

Innovation requires that entrepreneurship be encouraged in all the States, by policies that take into account the different patterns of entrepreneurship that are pertinent in different countries and regions.

Skills shortages

Real wealth – in terms of economic performance, industrial competitiveness and employment - comes not from the production of material goods alone, but from the production, transformation and exploitation of knowledge. The skills of their staff are fundamental to enterprises' capacity to obtain knowledge and to use it to innovate.

Therefore it is critical that training methods be addressed to continually update skills and knowledge and to ensure good cooperation between staff of different ages and generations. Demographic trends in Europe mean that enterprises will tend to have proportionally more older staff.

Specific features of the Union's economic and social setting

Several further specific features of the European Union have an important bearing on innovation policy developments, such as:

- The large size of the public sector in Member state economies must be involved to boost innovation;
- Most Europeans live in metropolitan areas. In regenerating our cities, we should build on their capacities in the provision of knowledge, skills, a highly qualified work force and geographical links to turn them into focus of innovation.
- European diversity brings with it different aspirations and attitudes to innovation that have to be respected.

2.2 Some trends for the innovation and the information society[8]

Innovation is more than a process leading from basic research to commercialisation. A more interactive model has emerged in recent years that recognises the importance of the environ-

[8] Source: Structural Policies and European Territories – Competitiveness, sustainable development and cohesion in Europe. From Lisbon to Gothenburg – Regional Policy Inforegio – Brussels - 2004

ment in which businesses, and particularly small and medium-sized businesses, operate. Today innovation is associated with concepts such as network formation, management, clustering and the way in which firms, universities, research institutes and public authorities work together, particularly at regional level. The capacity to innovate varies significantly from one region to another, both in quantitative and qualitative terms. Innovation, the information society, and research and technological development (RTD) can be determining factors in a region's success.

On the one hand, there is a strong concentration of these activities in the most advanced regions of the EU, where the top 10 regions account for around a third of all related expenditure in the Union. On the other hand, however, 17 of the 25 regions with the lowest RTD intensity are Objective 1 regions. Differences between regions are particularly significant in the cohesion countries. In Greece, for example, over half of all research expenditure is incurred in the capital region of Attiki, and in Spain over three quarters of the business RTD spending occurs in just three regions, with 30 % concentrated in the Madrid region alone.

Community policies on innovation, the information society and RTD promote the enhanced competitiveness of the European economy. They contribute to the development of a Europe of knowledge and know-how, with a world-class communications infrastructure and decreasing information costs. The Lisbon European Council reiterated the importance of research and development for economic growth, employment creation and social cohesion. It emphasised the need to move towards a European research area, an objective which now underpins the EU's sixth framework programme for research and technological development. As previously said this has been translated into targets such as increasing RTD spending with the aim of reaching 3 % of GDP by 2010 - from 1.9 % at present - and increasing the proportion financed by business to two thirds of that total.

Cohesion policy and funds are therefore focused on overcoming the technological and digital divide between rich and poor regions, between urban and rural regions, and even within regions. Networks of innovative businesses, university–business links and better access to communications services for citizens and enterprises are measures that receive increased Structural Fund support in the current period.

In 2001, the information and communications technology sector was worth EUR 643 billion, or 7.5 % of GDP, according to the European Information Technology Observatory.

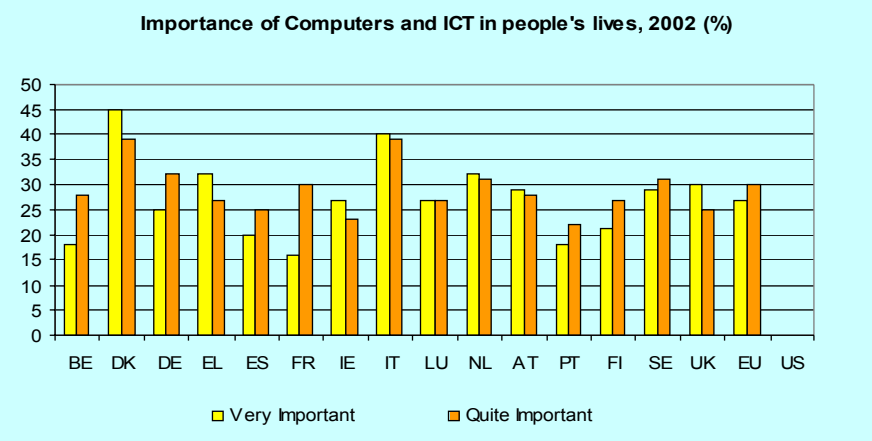
The EU's eEurope scheme seeks to create a digitally literate Europe and to ensure that the whole process is socially inclusive, builds consumer trust and narrows the gap between regions and between individuals in terms of the adoption of new technologies. Based on the Lisbon strategy, the 'eEurope action plan 2005', approved by EU leaders in Seville in June 2002, aims specifically at creating an inclusive information society. The Structural Funds have supported regional activities related to RTD and the information society, and the share of overall funding going to these sectors was increased to EUR 10 billion in the current period.

An instrument of the Structural Funds, which has been specifically targeted at fostering innovation in the period 2000–06, is the regional programmes of innovative actions. Under this instrument, 156 regions throughout the EU are eligible to apply directly to the Commission for a contribution of up to EUR 3 million towards a regional programme of no more than two years' duration. Three key themes have been selected under the European Regional Development Fund, which concern the issues of 'knowledge and technological innovation', 'the information society at the service of regional development' (e-EuropeRegio), and 'regional identity and sustainable development'. Since January 2001, 126 regional programmes of innovative actions and three specific network programmes have been approved. A prize for the most innovative project in each of the three priority themes will be awarded in April 2004.

The actual trends on ICT in Europe will be analysed and progresses in view of the EUQuaSIT project objectives comparing and completing the findings against information provided by Eurostat, for instance in its latest report "Statistics on the information society in Europe - edition 2003" (Ottens 2003). In some cases it is even possible to compare data with figures from US and Japan which determine EU's real trend for some specific aspects.

Computers and ICT – equipment in people's lives, 2002 (%)

The importance of computers and ICT equipment in people's life was responded as very important in Denmark by 45% of people while in France (16%), Belgium (18%) and Portugal (18%) less than 20% of people considered ICT as very important for their lives.



Internet development

The Internet is changing the world we live in. It seems a change no less significant than the Industrial revolution of the 18th and 19th centuries. Over the last two decades, information technologies and the Internet have been transforming the way companies do business, the way students learn, the way in which governments provide services to their citizens. Digital technologies have proved to be a powerful engine for economic growth and competitiveness.

In the 1990s, business and consumers in the United States were quick to take advantage of this "digital revolution". As a result, American business became much more competitive and the US economy enjoyed spectacular and unprecedented growth. The EU's success in achieving the 2000Lisbon goals will help determine the quality of life of its citizens, the working conditions of its workers and the overall competitiveness of its industries and services. Today, in the middle of 2004 we have already several indicators that enable us to be optimistic regarding the success of this new policy. Some of those are:

- More means of training and education for all ages in a word Investment in people;
- free markets and better research;
- starting the creation of a digitally literate Europe through the dissemination of the information society;
- easy and better access to Internet (broadband) and third generation mobile phones (UMTS);
- considerable developments in e-business, e-government, e-learning, e-health etc.

English is by far the most used language on the Internet, but its importance is declining as Internet access spreads around the world, notably in developing countries. The importance of the "Local Content" in the media is growing every day.

According to estimates by Global Research, in March 2003 only 35% of the world's on-line population was English speaking, down from 40% one year before. Other European languages (36% of the total) and Asian languages (30%) made up the remaining two-thirds of the total, both language groups gaining ground. Among the other European languages, the largest shares of the world's on-line population is accounted for by Spanish and which is spoken by a world-wide on-line population representing 8% of the total.

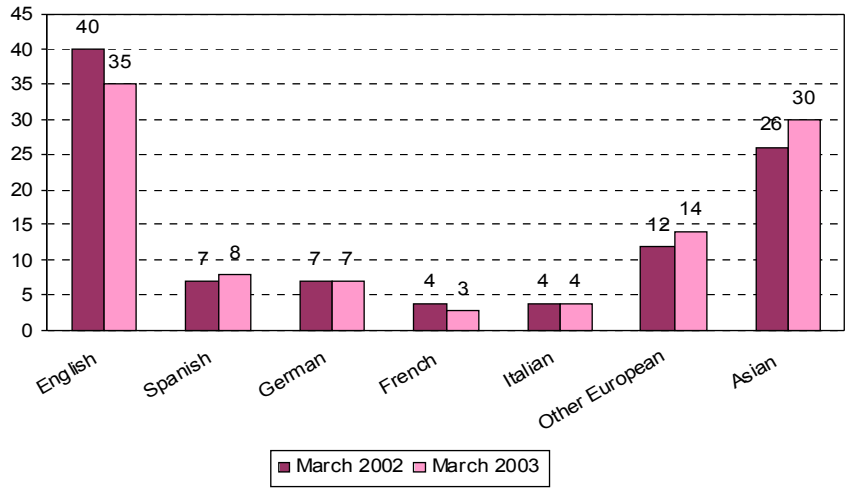


fig. 2-1: World's Online Population by Language (%)

General ICT education and training

While virtually all schools in the EU (15) had an Internet connections (93% in January 2002), only half had an internal PC network (53%) which usually means that the connection could not be shared among the various classes but restricted to individual access points or computer rooms. This is further evidenced by the number of computers in schools as a proportion of pupils.

There were on average only 11 PCs per 100 pupils in EU schools that used computers for educational purposes. Denmark was significantly above this level, with 31 PCs per 100 pupils, followed by Finland (16) and the United Kingdom (15). In contrast, schools in Germany and Italy (7 PCs per 100 pupils) reported the lowest equipment rate, below Greece and Portugal (both 8).

According to the September Eurobarometer, 49% of the active population in the EU using a computer for professional purposes had received computer training at the workplace. Levels of training were particularly high in the Nordic Member States (over 60%) and in Austria (58%). However, most countries reported a decline of workplace IT training compared to 2001.

Effects of ICT on the way of working

New technologies have been widely adopted by enterprises often with the objective of improving productivity. This was to be attained particularly by improving communications and information exchange and automating tasks. The majority (54%) of persons in employment in the EU in September 2002 agreed, saying that ICT has made their job easier. A majority (51%) however also noted that this has brought them a greater workload while a large minority (38%) indicated that ICT has increased the skills needed for their job. More contact with people was noted by (29%) of the inquired people.

3 European ICT qualifications and their analysis, documentation and evaluation

One of the major contributions of the transnational EUQuaSIT work is the comprehensive analysis, documentation, comparison and evaluation of national ICT qualification profiles and programmes at all VET and HE qualification levels in the European partner countries. In order to adequately structure and compare the great number, the profiles and programmes were classified in view of the level and (ICT) education and training field. For this classification different references were discussed and eventually led to a comprehensive picture of ICT qualifications in European countries. The enormous amount of information was collected and stored in the internet database on “ICT qualification profiles and programmes in European countries”. This approach guaranteed both, transparency for the project partners and beyond in terms of ICT qualification possibilities at VET, HE and CVT levels as well as a profound preparation for the evaluation of the ICT qualification supply in the partner countries.

Therefore and in the centre of attention, this chapter summarises the analytical and empirical results of the analyses as well as the questionnaire based evaluation of ICT qualifications in each country, namely regarding the (changing) needs and assessment of national specific ICT qualification profiles by the companies focusing at sub-degree VET levels as well as specific CVT demands. The evaluation of ICT qualifications from the viewpoint of the ICT business and work practice constitutes an important piece of work in terms of ICT practitioner skill needs and the work oriented development of ICT qualifications and curricula in a mutual European perspective.

Correspondingly, the methods, analyses and results presented in the following paragraphs, contribute to the actual European discussion on the ICT- and e-skills demand, gap and mismatch, respectively, and its implications for prospective ICT qualification strategies and mutually trusted solutions for a European framework of ICT qualifications.

3.1 Concept for the analysis of national ICT qualification profiles and programmes in European countries

EUQuaSIT project research revealed three aspects of the ICT education that future qualification strategies should explicitly deal with:

- ICT qualification aspect - characterising the extent of the education and the specialization detailed for the given ICT qualification as a training level.
- ICT profile aspect - characterising the specialisation of the ICT qualification, observing the demand of companies from ICT and non ICT sectors.
- ICT practitioner aspect - characterising the target domains / sectors, ICT business and work areas, ICT skill levels and specialisation in which an ICT practitioner acts.

In this chapter the ICT education and training supply and its analysis, documentation and evaluation in the EUQuaSIT partner countries is presented in a national and European comparative view. First of all and in addition to the initial methodological explanations the following paragraphs provide some more information about the concept of the curricular documentation and analyses of ICT qualification profiles and programmes.

For the first part of collecting and analysing relevant ICT qualification profiles and programmes in the partner countries the following table presents the corresponding occupation and

education structures of ISCO-88 (COM) and ISCED-97 / EC-99 respectively with relevant ICT groups and fields of training in a short form. As described in the previous chapters the initial work of the project was realised within the structure of the European 'education and training fields (cf. Cedefop / Eurostat 1999) but with 'adapted' EUQuaSIT skills and qualification levels.

ICT practitioner occupation groups
ISCO-88 (COM) occupation groups and EUQuaSIT skill level

EUQuaSIT skill level	Major groups	Sub-Major groups	Minor groups
Skill level 5/6	Legislators, senior officials and managers (ISCO 1)	Corporate managers (ISCO 12)	Other specialist managers (ISCO 123)
			Production and operations managers (ISCO 122)
		Managers of small enterprises (ISCO 13)	Managers of small enterprises (ISCO 131)
	Professionals (ISCO 2)	Physical, mathematical and engineering science professionals (ISCO 21)	Computing professionals (ISCO 213)
			Architects, engineers and related professionals (ISCO 214)
Skill level 4	Technicians and associate professionals (ISCO 3)	Physical and engineering science associate professionals (ISCO 31)	Physical and engineering science technicians (ISCO 311)
			Computer associate professionals (ISCO 312)
			Optical and electronic equipment operators (ISCO 313)
Skill level 2/3	Clerks (ISCO 4)	Office clerks (ISCO 41)	Secretaries and keyboard-operating clerks (ISCO 411)
	Service workers and shop and market sales workers (ISCO 5)	Models, salespersons and demonstrators (ISCO 52)	Shop, stall and market salespersons and demonstrators (ISCO 522)
	Craft and related trades workers (ISCO 7)	Metal, machinery and related trades workers (ISCO 72)	Electrical and electronic equipment mechanics and fitters (ISCO 724)

ICT practitioner occupation groups correspond to ICT education and training fields (VET, HE)

ICT education and training fields
ISCED-97 and EC-99 fields of training and EUQuaSIT qualification level

Broad groups	Fields of education	Fields of training	EUQuaSIT qualification level				
			L2	L3	L4	L5B	L5M
Humanities and Arts (ISCED 2)	Arts (ISCED 21)	Audio-visual techniques and media production (EC-99 213)	x	x	x	x	x
Social sciences, business and law (ISCED 3)	Business and administration (ISCED 34)	Wholesale and retail sales (EC-99 341)	x	x	x	x	x
		Marketing and advertising (EC-99 342)	x	x	x	x	x
		Management and administration (EC-99 345)	x	x	x	x	x
		Secretarial and office work (EC-99 346)	x	x	x	x	x
Science (ISCED 4)	Computing (ISCED 48)	Computer science (EC-99 481)	x	x	x	x	x
Engineering, Manufacturing and Construction (ISCED 5)	Engineering and engineering trades (ISCED 52)	Electronics and automation (EC-99 523)	x	x	x	x	x

fig. 3-1: Frameworks of all relevant "ICT occupation groups" and "ICT training fields"

In the scope of the project investigations and methods it can be summarised as a major result that the project eventually and after intensive discussions and debates agreed on a common structure of ICT fields of training that corresponds to ICT practitioner occupation groups.

The ‘legend’ of the level structures below (see fig. 3-2) furthermore reminds on the skill and qualification levels as they were compared based on actual structures and frameworks and eventually used in the five level structure the project group agreed on. All together, both, the structure of ICT fields of training as well as the project level structure was complete and could hence be systematically used for the national analyses and European comparisons of ICT qualification profiles and programmes. Based on this survey concept and structure the analyses first of all concentrated on the available ICT qualification profiles and programmes at VET and HE levels documented in the online database for the project group and were published in view of an information platform.

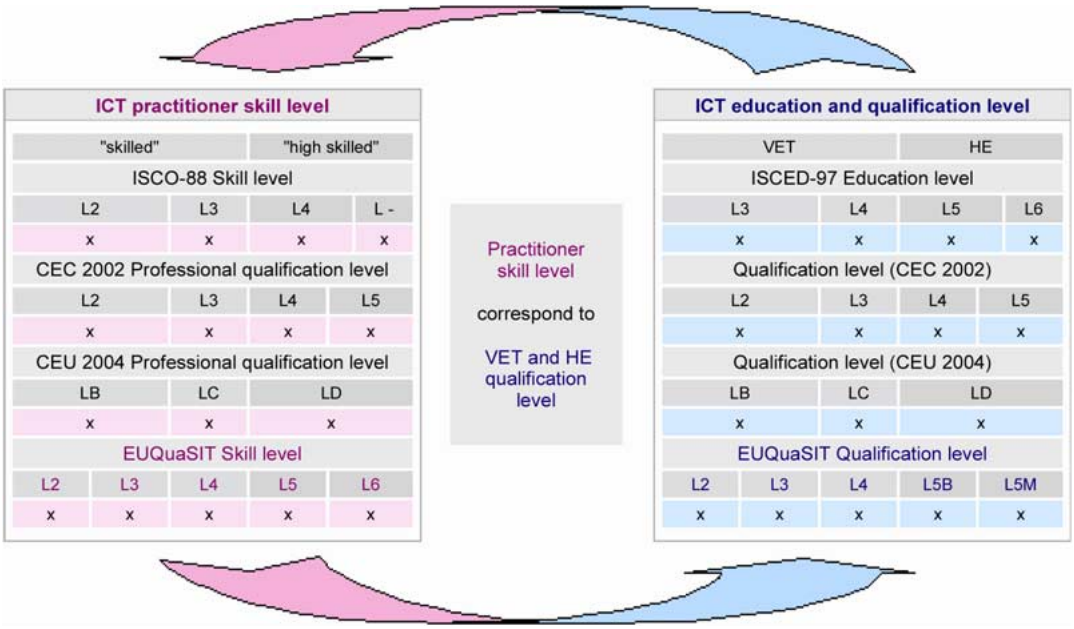


fig. 3-2: Correspondence of skills and qualification levels and the EUQuaSIT five level solution presented in a different direction (horizontal) as used for the project work

On the basis of this European approach the surveys of the initial work package focus on the national analyses of ICT education and training at the five VET and HE qualification levels. However, beside the analyses and questions of each national ICT qualification profiles and programmes to be structured and documented in the European ICT training fields, for each profile the curriculum details and statistical material was supposed to be analysed. Furthermore it was agreed that a representative picture of the supply of CVT courses for ICT practitioners should be provided.

Analysis fields of ICT qualification profiles and programmes in European countries
ISCED-97 and EC-99 fields of ICT training and EUQuaSIT qualification level

Field of education	Fields of training	Czech Republic					Germany					Netherlands					Portugal					Romania				
		L2	L3	L4	L5B	L5M	L2	L3	L4	L5B	L5M	L2	L3	L4	L5B	L5M	L2	L3	L4	L5B	L5M	L2	L3	L4	L5B	L5M
Arts (ISCED 21)	Audio-visual techniques and media production (EC-99 213)	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Business and administration (ISCED 34)	Wholesale and retail sales (EC-99 341)	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	Marketing and advertising (EC-99 342)																									
	Management and administration (EC-99 345)																									
	Secretarial and office work (EC-99 346)																									
Computing (ISCED 48)	Computer science (EC-99 481)	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Engineering and trades engineering (ISCED 52)	Electronics and automation (EC-99 523)	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

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fig. 3-3: Framework and analysis fields of ICT qualification profiles and programmes in European countries

Concretely the analysis and documentation of each ICT qualification profile and programme should look at the available information to the following curricular elements. The aim of such a comprehensive database was to have as much information as possible in view of the comparison and evaluation of collected national material on ICT qualification profiles and statistics as well as the implementation of ICT training strategies and qualification profiles in companies and ICT training institutions.

- Title / Occupation / Programme - name of the profile (country and English languages);
- Country - for the moment a certain EUQuaSIT partner country;
- Qualification - type of qualification, i.e. VET, HE or CVT;
- Level - the training level envisaged, i.e. VET level 2 - 4, HE level 5B - 5M, CVT level 2 - 5M ;
- Degree / Certificate obtained - how the qualification is officially recognized;
- Provider of Training - the type of training institution, with country and English names;
- Duration - in months;
- Launched or updated (year);
- Costs - in Euro (if available);
- Goals of Training / Learning / Study - in country and English languages;
- Contents of Training / Learning / Study - short presentation of curriculum or matters of training;
- Methods of Training / Learning / Study - regarding the scholastic, practical or new ways for knowledge transfer and acquisition;
- Media, Requisites and Equipment for Training - special needs for training;
- Target group;
- Preconditions of Trainees / Learners / Students;
- Teachers / Trainers / Lecturers - skill, level and special requirements;
- Number of trainees or students (new - first year of study, total and graduates).

ICT qualification may be obtained in various types of training institutions in the countries around Europe. With regard to the “Providers of training” the project partners agreed on a common list of ICT training providers presented in fig. 3-4, where the international (English) name (in the first column) refers to the national names of the training provider in the EUQuaSIT partner countries, and gives a general idea on ICT training institutions in Europe.

International	Czech Republic	Germany	Netherlands	Portugal	Romania
Public Vocational School / College	Střední odborná škola	Staatliche Berufsschule	(non existing)	Ensino Vocacional Público	De stat: 1. Liceu/Colegiu tehnologic (de specialitate/profil); 2. Şcoală de ucenici; 3. Şcoală Profesională;
Private Vocational School / College	Soukromá Střední odborná škola	Private Berufsschule	Particulier opleidingsinstituut (voor middelbaar beroepsonderwijs)	Ensino Vocacional Privado	Particulare: 1. Liceu/Colegiu tehnologic (de specialitate/profil); 2. Şcoală ucenici; 3. Şcoală Profesională;
Company and Vocational School / College	Střední odborne učiliště	Betrieb und Berufsschule	Bedrijf en regionaal opleidingscentrum (ROC)	Empresa/ Instituição e Ensino Vocacional	Şcoală de maiştri.
Public College / Institute for Further Vocational Education	Vyšší odborná škola	Staatliche Institution für berufliche Weiterbildung	Organisatie voor bijscholing	Escolas Públicas / Institutos Públicos de Ensino Vocacional Adicional	De stat: 1. Şcoală postliceală 2. Şcoală de maiştri.
Private College / Institute for Further Vocational Education	Soukromá vyšší odborná škola	Private Institution für berufliche Weiterbildung	Particuliere organisatie voor bijscholing	Escolas Privadas / Institutos Privados de Ensino Vocacional Adicional	Particulare: 1. Şcoală postliceală 2. Şcoală de maiştri.
Company	Spolecnost, Institut	Betrieb / Firma / Unternehmen	Bedrijf	Empresa / Instituição	Firma/Companie

Company and College for Higher Vocational Education	Akademie	Betrieb und Berufsakademie	Bedrijf en school voor hoger beroepsonderwijs	Empresa / Instituição e Escola de Ensino Vocacional Superior	Colegiu Universitar: 1. de stat; 2. particular
Public University of Applied Science / Higher Vocational Education	Vysoká škola	Staatliche Fachhochschule	School voor hoger beroepsonderwijs	Universidade Pública / Ensino Vocacional Superior	De stat: Universitate (tehnică)/Institut/ Academie
Private University of Applied Science / Higher Vocational Education	Soukromá vysoká škola	Private Fachhochschule	Particulier instituut voor hoger beroepsonderwijs	Universidade Privada / Ensino Vocacional Superior	Particulara: Universitate (tehnică)/Institut/Academie
Public University	Univerzita	Staatliche Universität	Universiteit	Universidade Pública	De stat: Universitate (tehnică) /Institut/Academie
Private University	Soukromá univerzita	Private Universität	(non existing)	Universidade Privada	Particulară: Universitate (tehnică) /Institut/Academie

fig. 3-4: Comparative list of “Provider of vocational and higher education and training”

From a methodological point of view the surveys base on the selection and secondary analysis of national information, literature sources, data material etc. Within the intensive accompanying debates and measures of the project group national differences as well as the processes and aspects of the development and changes in the field of ICT qualification had to be considered. For instance in one or the other partner new profiles have been set up since the beginning of the project so that the online database instrument was appreciated by the partners.

The examination and analysis within the equal opportunity themes in the field of ICT qualification as well as specific national ICT qualification programmes or initiatives for females were partly realised through specific and single enquiries and surveys on public and private offers.

Based on a comprehensive picture of the VET system of each partner country, these partly very detailed investigations of curricula were highly relevant, since the present knowledge basis, other studies and publications as well as economical, employment and educational international, European and national results and classifications often focus on sector-, occupation- or training-specific parts of the complex ICT area, e.g. only IT or CT or only higher education. Therefore, the ambitious claim on a comprehensive picture of information and communications technology (ICT) is also reflected in the overall methodological approach, e.g. the commonly used European frameworks, as well as the concrete and harmonised methods between the project partners, e.g. that the commonly worked questionnaires were translated from English into each mother tongue of the partners.

3.2 Documentation and analysis of national ICT qualifications

Major piece of the initial work of EUQuaSIT was to gather, structure and analyse the ICT qualification profiles and programmes of each partner country. The results were gathered and discussed based on the profile and curriculum data and information each partner provided in the online database of the project that were implemented in the internal work platform of the project. Even though some of the ICT qualification profiles and programmes led to discussions on where to classify it, e.g. with regard to the qualification level, field of training, in most cases, however, it was unproblematic to enter the profiles. The structure and fields of the data sheet were updated several times throughout the project and eventually contains all information and data

needed to classify and evaluate a qualification profile in the perspective of overall and curriculum information of interest within and beyond the project activities.

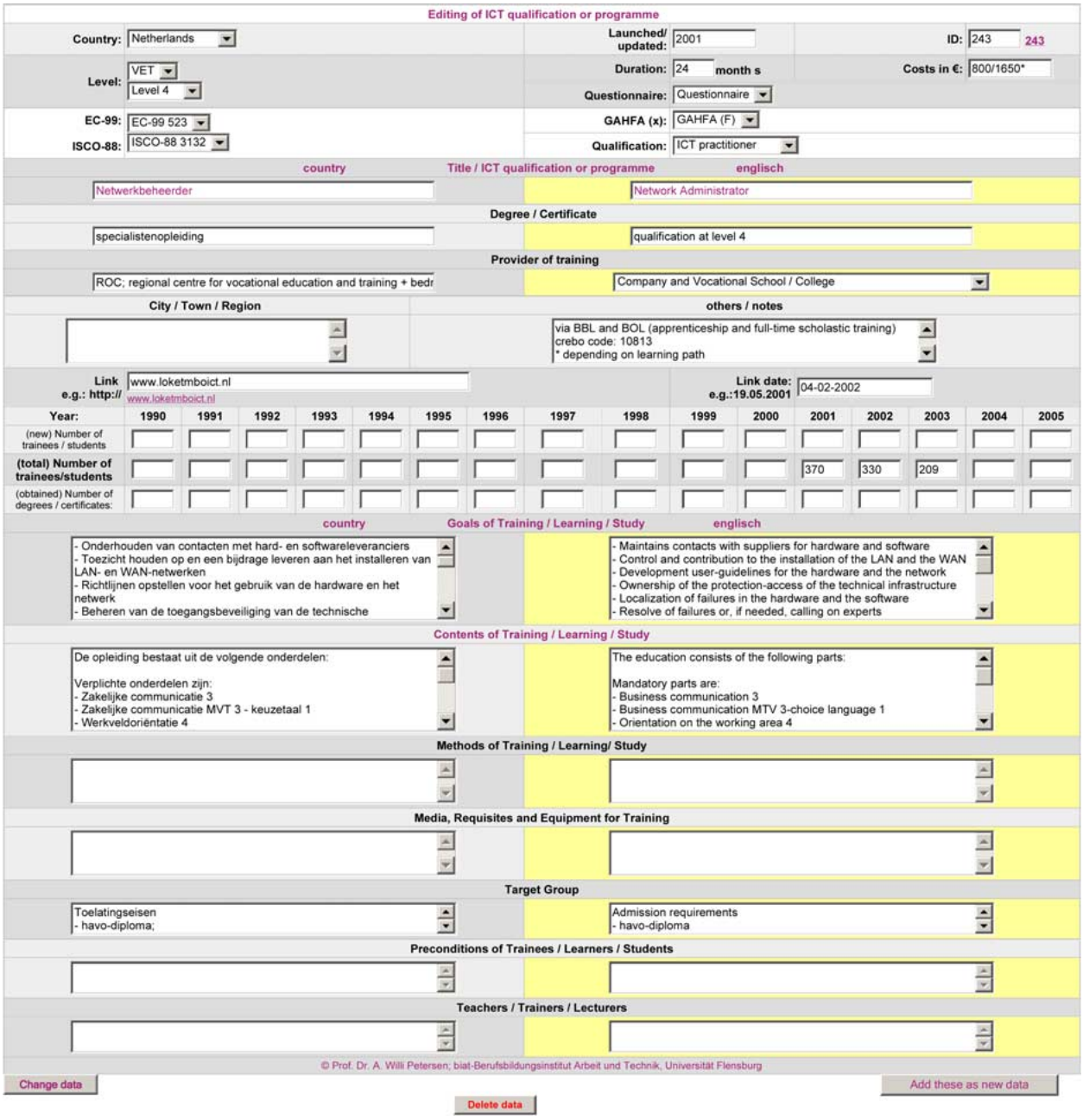

fig. 3-5: Enter and editing of ICT qualification profiles and programmes in the euquasit.net database (internal work platform)

In the result presented on the internet the database provides a corresponding search sheet at the beginning where a pre-selection for qualification, level and country can be made. Furthermore a special search term can be inserted to further precise the search. The information are presented in English and the corresponding partner country language and try to give a comprehensive picture about actual ICT qualification profiles and programmes (curricula) at all fields of training and levels in the project partner countries. Correspondingly, each data sheet contains information such as the qualification profile's title, certificate / diploma, goals and content of training and, if available in the statistics, the number and development of trainees / students undergoing the programme.

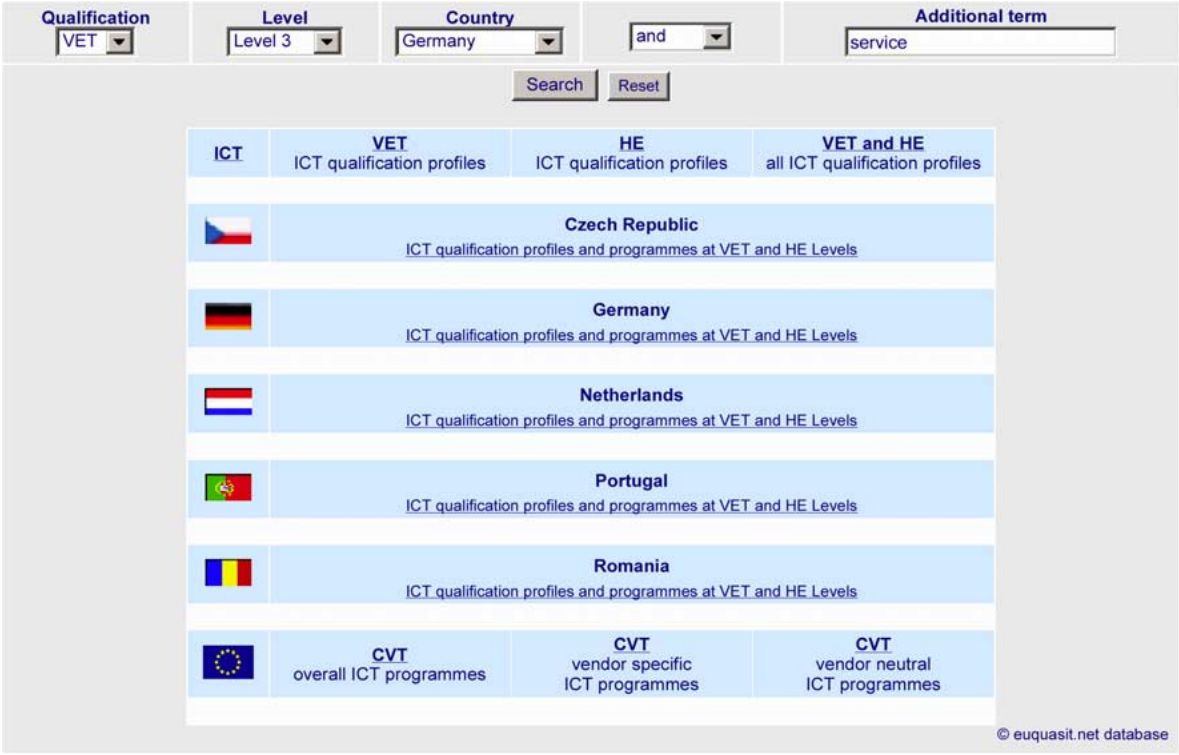

fig. 3-6: Search sheet for ICT qualification profiles in EUQuaSIT.net database

As far as the delimitation of vocational education and training (VET) and higher education (HE) to continuing vocational education and training (CVT) is concerned, the EUQuaSIT project partners agreed on two main criteria. First of all, VET and HE is defined as a qualification with which the participants reach a new level of vocational and professional qualification, whereas CVT takes usually place on a certain level focussing on specific content. In accordance with this definition the group decided secondly that VET and HE profiles are also characterised by a certain period of time typically longer than 12 months. In addition, CVT courses and certificates were also only supposed to consider longer than 3 days of training. Therefore for CVT only examples could be given that were differentiated between all ICT programmes the partners exemplarily gathered in the database, an exemplary and global list with vendor specific CVT programmes in ICT as well as, last but not least, some overall examples of vendor neutral CVT offers in ICT, e.g. CompTIA certificates.

Exemplarily the table below shows the list that is generated by pre-selecting the terms above.

ICT qualification profiles and programmes (found 5)
VET Level 3 Germany service

Levelsort	Titlesort	Countrysort	Country-Titlesort	Durationsort
VET Level 3	Communication Electronic Technician in Information Technology (m/f)	Germany	Kommunikationselektroniker/-in Fachrichtung Informationstechnik	42 months
VET Level 3	Information Technology Specialist (m/f) in System Integration	Germany	Fachinformatiker/-in Fachrichtung Systemintegration	36 months
VET Level 3	IT System Electronics (m/f)	Germany	IT-System-Elektroniker/-in	36 months
VET Level 3	Mathematical Technical Assistant (m/f)	Germany	Mathematisch-technische(r) Assistent/-in	30 months
VET Level 3	Micro Technologist (m/f)	Germany	Mikrotechnologe/-in	36 months

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fig. 3-7: Example of a search result for the criteria “VET Level 3 Germany service”

All VET and HE qualification profiles of the project database were systematically structured for each partner country in the European ‘fields of training’. The following results summarise this

vital part of the project that provides the important fundament for the comparison and evaluations. The table below is presented on the project internet platform and functions as a 'distribution centre' from where each national table presented below can be viewed. Furthermore the overview contains the numbers of ICT trainees / students in VET and HE of the partner countries, whereupon below the report will go into some more detail.

Furthermore and as indicated in fig. 3-8 above and further detailed in the following tables for each country, the numbers of students / trainees in vocational education and training (VET) and higher education (HE) programmes were investigated for each partner country. This important quantitative result of the EUQuaSIT project summarise the data for all identified ICT qualification profiles and programmes in each partner country and provide therefore a coherent quantitative picture for a certain domain (or 'sector'), in this case ICT. Beside the fact that these data have not been available in Europe yet, they are important in the comparative European view as described in the following chapter and for the forthcoming work on the demand and supply of ICT practitioners in Europe.

The following tables in detail indicate for each partner the variety of ICT qualification profiles and programmes in the structure of the European 'fields of training' (EC-99). The results show how different the supply can look like for the different qualification levels and fields. All together and without counting the additional sample of CVT offers in each partner country, more than 340 ICT qualification profiles and programmes have been documented and analysed in the project giving a comprehensive picture of 'national ICT practitioner qualifications frameworks'. Thus the outcomes of this qualifications and curriculum analyses provide a unique basis of European ICT qualifications and data in the VET and HE field (which together and as mentioned above is fairly unique anyway).

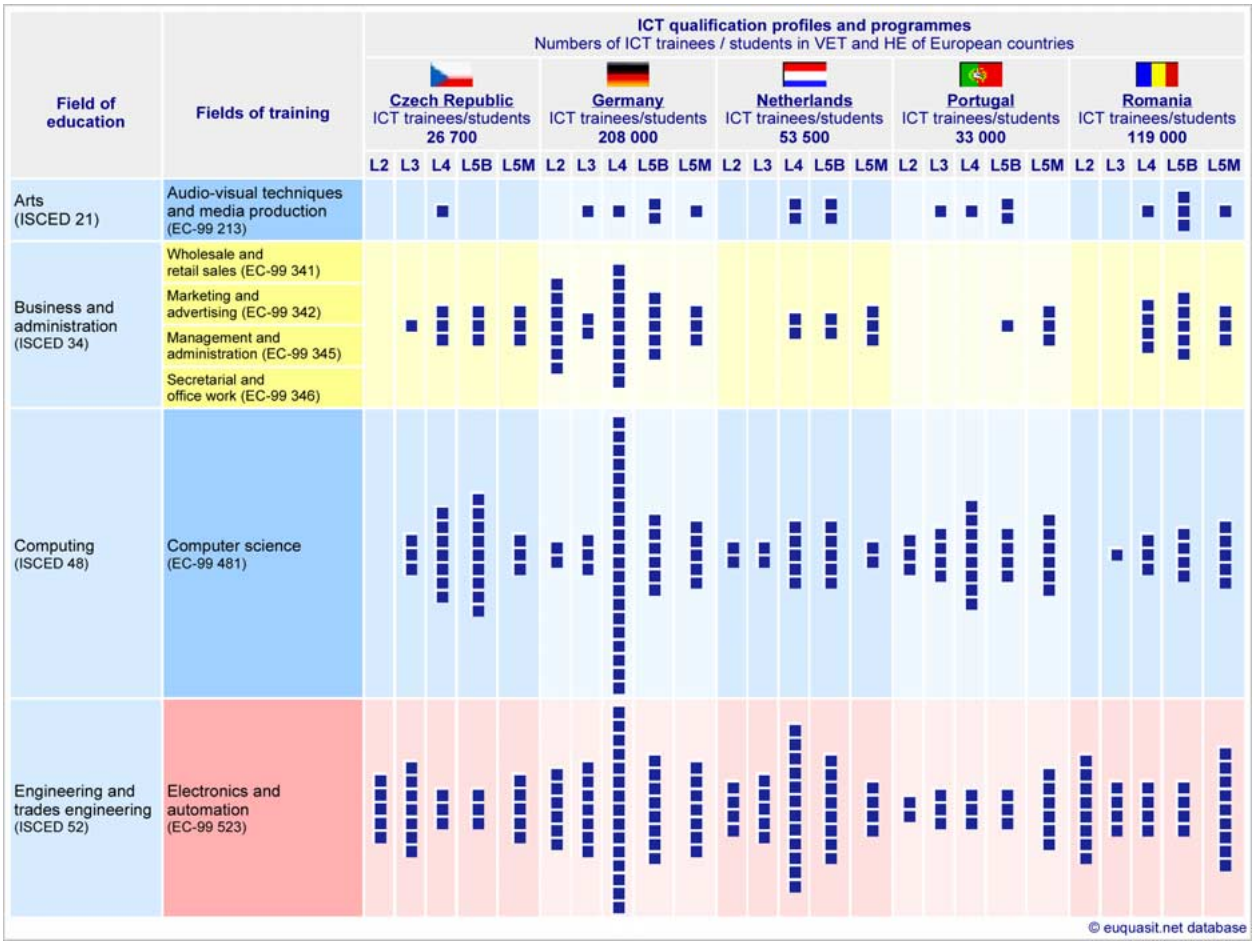

fig. 3-8: Collective structuring and curriculum results of national ICT qualification profiles and programmes in the European EC-99 Classification of Education and Training

Overview of ICT qualification profiles and programmes in the Czech Republic

Field of education	EC-99 Fields of training	Czech Republic Number of trainees/students: 26 700 (2000/2001) VET level 2 500 (2 %)	VET level 3 13 000 (49 %)	VET level 4 2 000 (7 %)	HE level 5B 2 200 (8 %)	HE level 5M 9 000 (34 %)
Arts (ISCED 21)	Audio-visual techniques and media production (EC-99 213)			Applications of Computer Graphics		
Business and administration (ISCED 34)	Wholesale and retail sales (EC-99 341)					
	Marketing and advertising (EC-99 342)			Computer processing of economic information	Economics of Informatics	Economics of Informatics
	Management and administration (EC-99 345)		Informatics in Economics	Computer support of control of company	Economics of Informatics	Informatics and Internet in business
	Secretarial and office work (EC-99 346)			Information management	Management of Informatics	Management of Informatics
Computing (ISCED 48)	Computer science (EC-99 481)		Information technology - application of personal computers Computer Technics Supervisor of information systems	Application of Computer Technics Computer Technics Computer Technology and Basic of Programming Computers systems Computers systems Informatics Systems Systems of Information	Application of Informatics Application of Informatics and Coordination Computer technics and Informatics Informatics Informatics and Computer Sciences Informatics Systems Informatics Technology Informatics Technology The science of application informatics	Informatics Informatics and Computer sciences Theoretical Informatics
Engineering and trades engineering (ISCED 52)	Electronics and automation (EC-99 523)	Mechanist electronic - automation engineering Mechanist of alarm and communication systems Mechanist Electronic - Digital and Control Technology Mechanist of telecommunication - communication networks Mechanist of telecommunication - coupler	Alarm and Communication Technology in Transport Automation engineering Computers electronics systems Computer graphics in electrotechnics Digital telecommunications technique Electronic computers systems Telecommunication mechanist	Automation and Informatics Computerized Systems Computerized Technics	Automatic Coordination and Informatics Engineering Informatics Informatics and Automation Technology	Automatic coordination and Engineering Informatics Cybernetics and control Technics, aplication sciences and Informatics Engineering Informatics Engineering Informatics and Automatisation System of Engineering

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fig. 3-9: Documented and analysed ICT qualification profiles and programmes in the Czech Republic

As already mentioned above the concrete analyses of the ICT qualification profiles provide detailed curricular results as well statistical information on each profiles as follows:

ICT qualification profile:
"Informatics in Economics"

Country:	**Czech Republic**	**VET:**	**Level 3**
Country Title:	Informatika v ekonomice	**Degree:**	Maturitni vysvedceni
Launched / updated:	2000		Leaving certificate
Provider:	Obchodni akademie	**Duration:**	48 month(s)
	Public Vocational School / College	**Costs:**	€
Others:			

Goals of Training / Learning / Study

Příprava pro práci kvalifikovaných odborníků v oblasti řešení ekonomických projektů s využitím prostředků informačních a komunikačních technologií.

Training for positions of qualified experts in business projects where information and communication technologies are to be widely used.

Contents of Training / Learning / Study

Studium oboru poskytuje potřebné technické a ekonomické znalosti a dovednosti z oblasti počítačového hardwaru a softwaru, počítačových sítí a technických prostředků přenosu dat, podnikové ekonomiky a účetnictví.

This study programme provides the technical and economic knowledge and skills from the area of computer hardware and software, computer networks and technical means of data transmission, business economy and accounting

Number of trainees / students

Year:	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of trainees or students:										0	31	62	235	545		

Overview of ICT qualification profiles and programmes in Germany

Field of education	EC-99 Fields of training	Germany Number of trainees/students 208 000 (2000/2001)				
		VET Level 2 13 000 (6 %)	VET Level 3 60 000 (29 %)	VET Level 4 10 000 (5 %)	HE Level 5B 60 000 (29 %)	HE Level 5M 65 000 (31 %)
Arts (ISCED 21)	Audio-visual techniques and media production (EC-99 213)		Designer of Digital and Print Media	Multimedia Developer	Computer Science Multimedia Multimedia	Computer Science Multimedia
Business and administration (ISCED 34)	Wholesale and retail sales (EC-99 341) Marketing and advertising (EC-99 342) Management and administration (EC-99 345) Secretarial and office work (EC-99 346)	Assistant for Business Informatics Business Assistant for Data Processing Business Assistant for Economy and Data Processing Business Assistant for Information Technology Commercial Assistant for Information Processing Information Technology Assistant for Business Technical Assistant for Business Information Technology	Information Technology Officer IT System Support Specialist	Business Manager in Business Informatics Business Manager in Data Processing and Organisation Business Systems Administrator Business Systems Adviser IT Key Accounter Knowledge Management System Developer Technical Writer Specialist for Data Processing - Business Information Technology (IHK) Specialist for Data Processing - Information Organizer (IHK)	Computer Science Economy and Business Computer Science Economy and Business (Berufsakademie) IT Manager IT Commercial IT Consultant	Computer Science Economy and Business Computer Science Economy and Business IT Business Engineer
Computing (ISCED 48)	Computer science (EC-99 481)	Technical Assistant for Data Processing Technical Assistant for Informatics	Information Technology Specialist in Application Development Information Technology Specialist in System Integration Mathematical Technical Assistant	Database Developer Device Developer E Logistic Developer E Marketing Developer ICT Process Manager IT Configuration Coordinator IT Product Coordinator IT Project Coordinator IT Security Coordinator Network Developer Quality Management Coordinator Software Developer Specialist for Data Processing - Mathematical Technical Information Technology (IHK) Specialist for Data Processing - Organisational Programming (IHK) Specialist for Data Processing - Software Developer (IHK) State Certified Informatics User Interface Developer IT Test Coordinator Database Administrator Web Administrator IT Trainer	Bio Informatics Computer Science (general) Informatics Geo Informatics International Female Studies Computer Science Medical Informatics IT Engineer	Computer Science (general) / Informatics Bio Informatics Geo Informatics Medical Informatics IT System Engineer

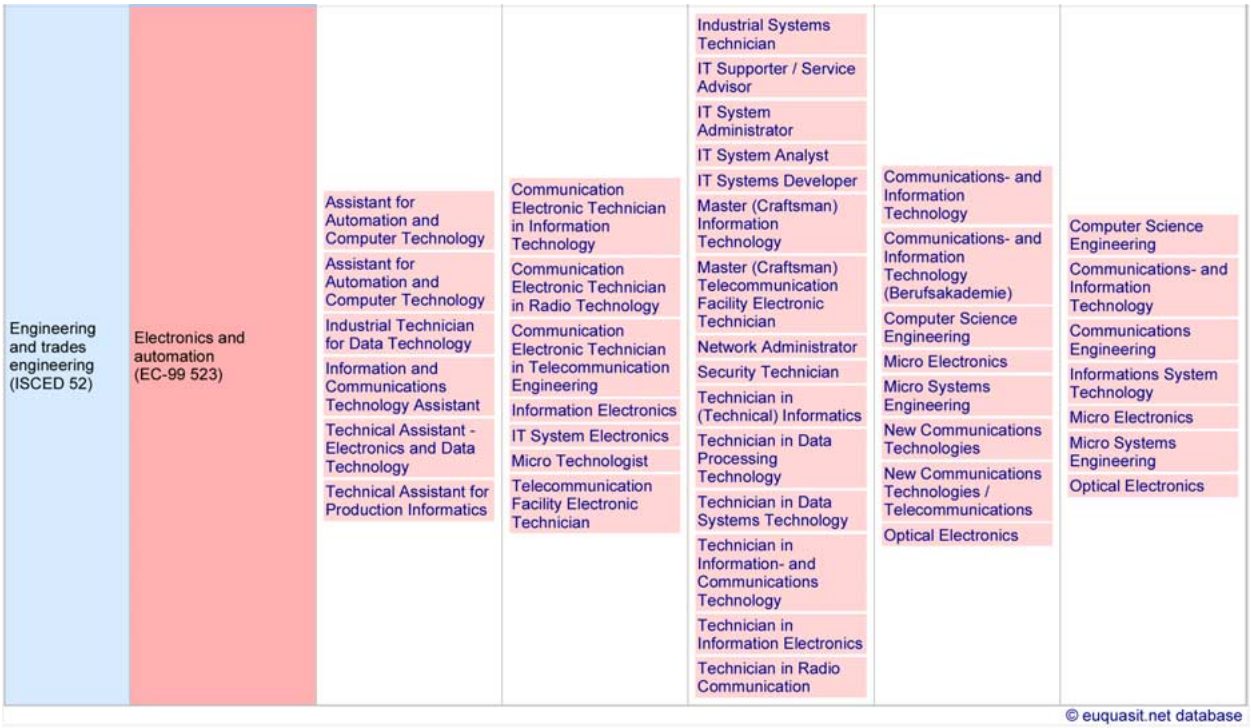

fig. 3-10: Documented and analysed ICT qualification profiles and programmes in the Germany

Overview of ICT qualification profiles and programmes in the Netherlands

Field of education	EC-99 Fields of training	Netherlands Number of trainees/students: 53 500 (2000/2001)				
		VET level 2 6 000 (11 %)	VET level 3 8 500 (16 %)	VET level 4 15 000 (28 %)	HE level 5B 18 000 (34 %)	HE level 5M 6 000 (11 %)
Arts (ISCED 21)	Audio-visual techniques and media production (EC-99 213)			Middle Management Employee IT Media Production Middle Management Employee Multimedia designer	Communication and multimedia design Graphic media technology	
Business and administration (ISCED 34)	Wholesale and retail sales (EC-99 341) Marketing and advertising (EC-99 342) Management and administration (EC-99 345) Secretarial and office work (EC-99 346)			Middle Management Employee Office Automation Engineering [expired per 2001] Short HBO course business administration informatics	Business administration informatics Business administration informatics	Business Information Technology Business Mathematics and Informatics (expired per 2000) Informatics and Economics
Computing (ISCED 48)	Computer science (EC-99 481)	ICT service worker ICT worker [expired per 2001]	Assistant Administrator ICT Assistant information systems administration [expired per 2001]	Developer Software Applications Administrator Software Applications Middle Management Employee Telematics [expired per 2002] Short HBO course informatics Middle Management Employee Administrator ICT Administrator ICT [expired per 2001]	Computer Techniques Higher education software engineer Higher informatics Informatics Informatics and information knowledge	Informatics Information Science
Engineering and trades engineering (ISCED 52)	Electronics and automation (EC-99 523)	Craftsman Communications Networks Craftsman Communications-Installations Craftsman Consumer Electronics Craftsman Industrial Electronics	First Craftsman Communications Networks First Craftsman Communications-Installations First Craftsman Consumer Electronics First Craftsman Electrics and Instrumentation First Craftsman Industrial Electronics	Middle Management Employee Administrator technical infrastructure [expired per 2001] Middle Management Employee Automation Electronics Middle Management Employee Automation Energy Engineering Middle Management Employee Computer Interface Engineering Middle Management Production Automation Engineering [expired per 2001] Network Administrator System administrator SME [expired per 2001] Technician Communications Systems Technician Consumer Electronics Technician Electrical Industrial Plants Telecommunications and ICT engineer	Communications systems Electrical engineering Electrical engineering Electrical engineering Electronics engineering Higher education system engineer Higher electronics expert Technical informatics / computer techniques	Communication and Information Science Electrical engineering Technical Informatics Telematics

fig. 3-11: Documented and analysed ICT qualification profiles and programmes in the Netherlands

Overview of ICT qualification profiles and programmes in Portugal

Field of education	EC-99 Fields of training	Portugal Number of trainees/students: 33 000 (2000/2001)				
		VET level 2 (Assistant) 2 000 (6 %)	VET level 3 (Technician) 5 000 (15 %)	VET level 4 (Specialist) 5 000 (15 %)	HE level 5B (Bachelor) 9 000 (27 %)	HE level 5M (Master) 12 000 (36 %)
Arts (ISCED 21)	Audio-visual techniques and media production (EC-99 213)		Multimedia Systems Programmer	Multimedia Applications Operator	Graphic Computer Sciences Multimedia Design	
Business and administration (ISCED 34)	Wholesale and retail sales (EC-99 341) Marketing and advertising (EC-99 342) Management and administration (EC-99 345) Secretarial and office work (EC-99 346)				Information Technology for Management	Informatics for Business Administration Information and Management Statistics & Information Management
Computing (ISCED 48)	Computer science (EC-99 481)	Data Processing Assistant Informatics Assistant Technician Informatics Operator	Database Management - Micro Systems Informatics Technician Advanced Applications Operator Data Processing Technician	Software Analyst Data Analyst Data Processing Management Database manager Database Management - Main Frame Informatics Applications Analyst Informatics Applications Programmer Main Frame Applications Programmer	Informatics Informatics / Computer Sciences Informatics Systems Information Technologies	Informatics Informatics / Computer Sciences Computer Applied Mathematics Informatics Engineer Computer Systems Engineer Informatics Systems Engineer
Engineering and trades engineering (ISCED 52)	Electronics and automation (EC-99 523)	Assistant Technicians of Equipment Maintenance Network (PC's) Maintenance Technicians	Network Maintenance Technician Hardware Technician CAD Operator	Maintenance Applications Technician Micro Network Management and Installation Technician Industrial Design CAD 3D Specialist	Electronics and Telecommunications Communications Design Electronics and Computers	Electronics and Computer Engineering Automation Systems Engineer New Communication Technologies Telecommunications and Informatics Engineering Telematics Engineering Engineer of Electronics and Telecommunications

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fig. 3-12: Documented and analysed ICT qualification profiles and programmes in Portugal

Overview of ICT qualification profiles and programmes in Romania

Field of education	EC-99 Fields of training	Romania Number of trainees/students 119 000 (2000/2001) VET level 2 28 000 (24 %)	VET level 3 20 000 (17 %)	VET level 4 4 000 (4 %)	HE level 5B 12 000 (10 %)	HE level 5M 55 000 (45 %)
Arts (ISCED 21)	Audio-visual techniques and media production (EC-99 213)			Multimedia developer	Audio-video, multimedia Multimedia, Sound, Setting Photo-Video and Image Computer-Processing	Audio-visual Communication
Business and administration (ISCED 34)	Wholesale and retail sales (EC-99 341) Marketing and advertising (EC-99 342) Management and administration (EC-99 345) Secretarial and office work (EC-99 346)			e-marketing Consultant Information technology advisor IT Business specialist Shift operator chief in computer centre or computer office	Cybernetics and Economical forecast Computer Processing of economical data Informatics in Book-Keeping and Management Information technology in Book-Keeping and Administration Office IT	Accounting and Management IT Economic Informatics Economical Engineering for Electronics and Communications
Computing (ISCED 48)	Computer science (EC-99 481)		Assistant analyst-programmer	IT system engineer Database administrator Webmaster	Computing Technique Informatics Informatics (also in Hungarian and German) Information Technology	Applied Informatics Bioinformatics and health-care management Computer Science Mathematics-Informatics System and Computer Science
Engineering and trades engineering (ISCED 52)	Electronics and automation (EC-99 523)	Computer systems electric troubleshooting technician Computer systems electronic troubleshooting technician Electro-mechanic networks and lines Electro-mechanic telegraph Junctions technician Lines technician Mounting, tuning and testing technician for telecommunication, alarm, centralising and blocking installations Telecommunication electronics technician	Computer and networking technician Computer and networking operator Computer Maintenance Technician Technician- operator to industrial robots	Foreman-operator to industrial robots Industry IT specialist Maintenance engineer Network administrator	Communication and Post Office Exploitation Electronics Technical Informatics Technologies Assisted by Computers	Applied Electronics Communications Automation and Industrial Informatics Communications Control Systems and Equipment in the army Electrical Engineering and Computer Science Electronics and Telecommunications Industrial Robots Mechatronics Microelectronics

fig. 3-13: Documented and analysed ICT qualification profiles and programmes in Romania

It is worth mentioning that during the project development the qualification policy evolved in EUQuaSIT partner countries, and new ICT qualifications appeared. However, as it will be mentioned further, old and new qualifications in ICT yet do not cover the job market needs, many of them overlap regarding the fields and training goals – see comparison below. The Data Base is up-dated periodically and it becomes means for study of ICT qualifications in Europe, also information means for those interested in the field.

3.3 Special ICT qualification programmes of VET, HE and CVT in European countries

The European Commission states that 'special interventions may be needed to promote the skills and mobility of those who are at a disadvantage in the labour market' (CEC 2002c, p. 8). Beside handicapped people, foreign workers and ethnic minorities this discussion still also concerns gender aspects, since females are significantly underrepresented, for instance in ICT

training and work practice. The empirical results from the EUQuaSIT survey display an average female proportion in European ICT training of approximately 20 % and an even lower figure for ICT practitioners in companies. In the more economic and technically oriented ICT qualification profiles, the proportion of females is higher than in more technical informatics and communications oriented profiles. It is interesting that many European companies see a good proportion of males and females as important in the ICT business.

In some EUQuaSIT partner countries throughout recent years governments and other bodies in charge have launched special ICT qualification programmes and measures within equal opportunity themes. Concrete examples for the promotion of higher female proportion in ICT qualifications are in the Czech Republic the government decision No. 456 from 9th May 2001, in which the Minister of Education undertakes to support access of women to those jobs where information and communication technologies (ICT) are used, especially by increasing their involvement in the relevant training and education. Even though this does not directly aim at ICT practitioner qualifications is indicates an attempt of attracting more females to the ICT areas.

Below some other examples of special courses for women in order to promote and increase the share of women in ICT training are described. In further chapters the question of their effectiveness and success will be dealt with, since this was part of the questionnaire surveys in companies and ICT training institutions as well as the European comparisons of the outcomes.

The proportion of young women in ICT is still less dynamic than expected and hoped in many European countries. In Germany the proportion is almost steady at 14% on average, e.g. in the more technical orientated ICT qualifications between 5-10% and in the more business orientated ones between 25-30% (cf. Petersen/Wehmeyer 2001, p. 174 ff.).

There are some initiatives that try to get to higher female rates in ICT occupations in Germany one of which is entitled “idee-it” (see www.idee-it.de). It is promoted by the Ministry for youth and a common governmental / economy programme called “initiative d21”. Describing the existing and innovative chances of ICT occupations the platform also presents advice for the application, a database of companies providing places for an apprenticeship, useful links etc.

Other broad initiatives for young females looking for a tailored training have been launched throughout the last years, one of which was started by the Federal Labour Office entitled “was werden” (see http://www.was-werden.de).

Furthermore there is one special initiative commissioned by the Federal Ministry of Education and Research (BMBF) that wants to promote further training for trainers especially for women with a vocational education and training in the field of ICT (see http://www.it-ausbilderinnen.de).

At the University of Applied Sciences of Bremen in 2000 they established the Women Division "Computer Science" that is the youngest division in the Department of Economics. It has been the first opportunity in Germany to study computer science in a single-gender environment. Based on education principles followed by womens' colleges in the United States it aims to provide an excellent technical education for women. The Division offers a single-gender education to increase the number of women in computer science and to promote careers of women in science in Germany. Due to the practical focus of the education the number of students is kept small, each year 30 students.

Less favoured groups

There are actually not many initiatives concerning ICT qualification of disadvantaged or disabled people in the EUQuaSIT partner countries. Young people with low or even very low school leaving exams have very little chances to get a training place on the free training market like in Germany.

Another chance for such low level school leavers to have a “regular” training place in the dual system is to start with a school based ICT training (Berufsfachschule) at qualification level 2. In order to improve training for disadvantaged young people, the programme "Promoting Skills - Vocational Qualification for Target Groups Requiring Special Support", which was launched in 2001 by the Federal Ministry of Education and Research, will be used to develop the necessary instruments, in order to prevent youth unemployment and lower existing youth unemployment (see http://www.berufsbildungsbericht.info/_htdocs/bbb2002/teil1_en/inhalt/teil1_kapitel1.htm).

Especially for disabled people there are little results available for their integration into the ICT qualification and labour market in Germany. One initiative for disabled people is especially for those with hearing defects. The outcomes of this project indicate that there possibilities to integrate such handicapped young people into the “normal” training and work within the ICT sector (see http://www.best-news.de/?it_azubis).

Another initiative in regard to the development of concepts for the training of disabled people started in September 1999 in the Annedore-Leber-Berufsbildungswerk. Objective of the initiative is to offer vocational training for young disabled people in ICT qualifications such as IT-System-Elektroniker/-in and Informatikkaufmann/-frau at VET level 3. During the courses the trainees are supported by special pedagogical measures that focus on multimedia- and communication skills as well as key competencies like self-learning and self-organised information management. The training method is chiefly characterised by real working tasks and customer orientated training (cf. BMBF, Berufsbildungsbericht 2002, S. 369).

3.4 European comparison of national ICT qualification profiles and programmes

Of great interest in the present comparison is the distribution of ICT profiles for each country and for each level in each field of training. Those numbers indicate the relative difference between European countries regarding the existing ICT profiles in the given fields and the discrepancy between existing ICT profiles. The comparison of ICT qualification profiles by country and qualification level (VET, HE levels) uses the information from the EUQuaSIT analysis of ICT qualification profiles and programmes collected from the partner countries and stored in internet database. It reflects the quantitative and the qualitative situations existing now in Europe in the field of ICT qualifications such as informatics and computer science, economics informatics, electronics and telecommunication, bioinformatics etc., as well as electronics and automation, microelectronics, cybernetics.

Because there is this vital interaction of work and skill needs on the one side and ICT education and training on the other the countries demand and supply of ICT qualifications differs partly considerably. For instance at skill level 4 there are ICT qualifications available in all countries ranging from software analysis and development to administration. There is also a wide range of ICT qualification profiles in these work areas at skill level 3 and 2 in Germany and Portugal, but little in the Netherlands.

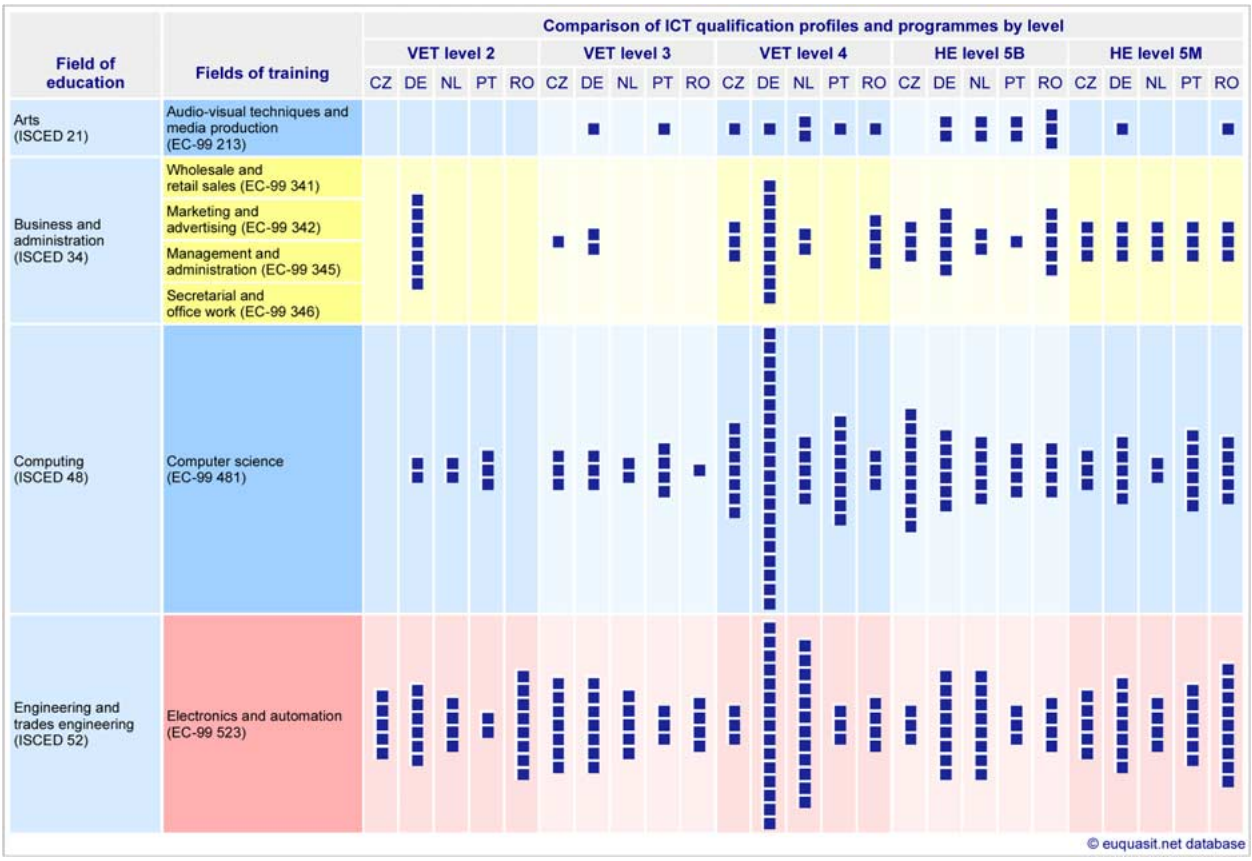

fig. 3-14: Comparison of ICT qualification profiles and programmes in the EUQuaSIT partner countries by level

While the total numbers on HE ICT qualification profiles is similar in the investigated countries there exist distinct differences in the number of ICT qualifications in the fields of training and at the different levels. Moreover, the titles of the ICT profile and the content are partly very different. Similar numbers do not indicate similarities in ICT profiles, hence the comparison is conducted on the analysis of the profiles depending on the fields of training they belong to. On the other hand, the number of specializations do not always indicates a diversity of profiles; for example, the offer of HE profiles for ICT in Romania is large but its diversity is actually small, while some specialization overlap. The forms of HE are chiefly based on university and university of applied science studies, with some differences regarding the lengths of studies (see Fachochschule and Berufsakademie in Germany), also regarding private versus state institutions (very well developed private sector in Netherlands, in a significant growth in Portugal and Romania, weak in Germany and Czech Republic).

Many ICT qualification profiles and programmes exist in the training field ‘Electronics and automation (EC-99 523)’ and in the field ‘Computer science’, especially at VET level 4 and here chiefly in Germany (within the new advanced IT training system). It is obvious that using new design tools in the software development lower level qualifications are less involved in that process. At VET levels the widest range of ICT qualifications exists in Germany, but the other countries such as Portugal and the Czech Republic developed VET ICT profiles oriented to the job market needs. Portugal and Romania exhibit a growth of the number of pupils enrolled in VET, even companies yet mostly require HE graduates for job in ICT field.

So, while for HE (level 5M and 5B) almost all countries have the same view on the duration of the study, for VET (levels 4 to 2) the diversity is surprising. Only looking to the training duration it becomes obvious that a common European policy is necessary to assure the compatibility of ICT qualifications in Europe. The analysis of the training durations for VET in ICT leads to the idea that such a diversity will hinder a common European strategy without observing some gen-

eral directions in this respect. In this respect, EUQuaSIT project comes with a framework of generic specializations for each level, which should be used as a minimal set of qualifications for VET in Europe, then each country should decide how many derived qualifications it considers, observing specific needs of the own economy or specific intentions in the qualification policy.

In summary the number of existing ICT qualification profiles is estimated as being sufficient by the vast majority of companies. However, in the Netherlands up to one fourth of the companies state that new or other profiles are needed, e.g. at HE level 5M or VET level 2. In Germany and the Czech Republic we find similar proportions at VET level 2 and up to 10% of the companies seeing a demand of more profiles at the other qualification levels. Seeing no such estimation in Portugal or Romania we can conclude that from a quantitative point of view the number of ICT qualifications profiles and programmes is sufficient. On the contrary, if the number of ICT qualifications is very high, as for instance at VET level 4 in Germany, especially many smaller companies criticize that too many highly specialised profiles would not meet their ICT practitioner skills demand.

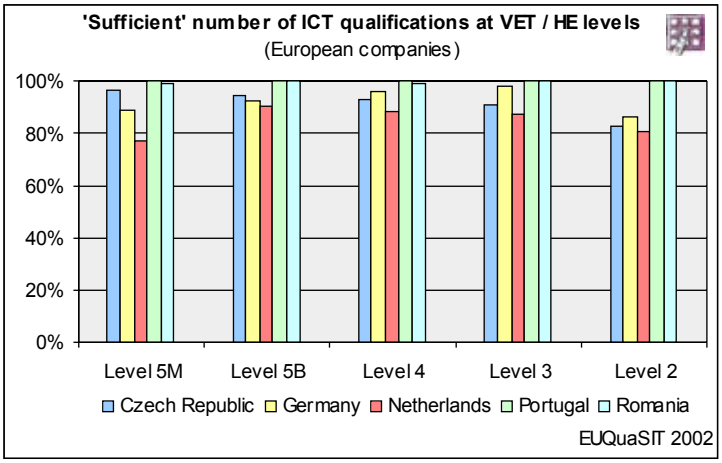

fig. 3-15: Companies' estimation on the number of ICT qualification profiles and programmes in each country

3.4.1 Demand and knowledge of ICT qualification profiles and programmes

The questionnaire survey of the companies provides comprehensive and detailed results on the demand, knowledge as well as the curricular evaluation for each of the analysed ICT qualification profiles and programmes of the partner countries at all qualification levels.

The evaluation results on companies' needs and the necessity of revision indicate for instance a large need but also little revision of profiles like "Administrator Software Applications" at level 4 in the Netherlands or "Information Technology Specialist in Application Development" at level 3 in Germany. For instance at skill level 4 there are four ICT qualifications available in Germany and the Netherlands focusing on technical aspects like more informatics, more telecommunications or specific problems like computer interfaces. There are two ICT qualification profiles each at skill level 3 and 2 in these countries, whereas in Portugal the number of profiles is less.

In summary the results can be briefly summarised conformed by some exemplary figures from the survey as follows[9]: For some of the ICT qualification profiles and programmes in the partner countries there is rather little and for others a fairly distinctive demand in the companies. The demand for specific ICT qualification profiles and programmes differentiated by companies of the ICT sector and those of the ICT user sectors (non ICT sector) differs partly considerably for some profiles, but is also more or less comparable for others.

For level 2 ICT profiles the average demand is low. In Czech Republic the only branches under the group “Electrical engineering, telecommunication and computer technology” are those dealing with communication and security technology in the transportation, communications and telecommunications, which also hire highly acknowledge graduates in the branch. For the Germany and Netherlands and Portugal it is obvious that companies have a little demand for qualifications of level 2.

In Romania, companies need ICT (level 2) working power for practical activities but they use higher education graduates; such well trained personnel could do any other job, if required, from hardware configuration to software configuration and programming. The overqualified ICT practitioners means also high costs spent for the university education (supported by state or individuals), but this policy of companies gives an opportunity for university graduates to find jobs – in Romanian transition economy. Lack of narrow specialization – hence lower productivity, and also wages of the overqualified personnel in ICT are hidden costs of Romanian companies they are not (yet) aware.

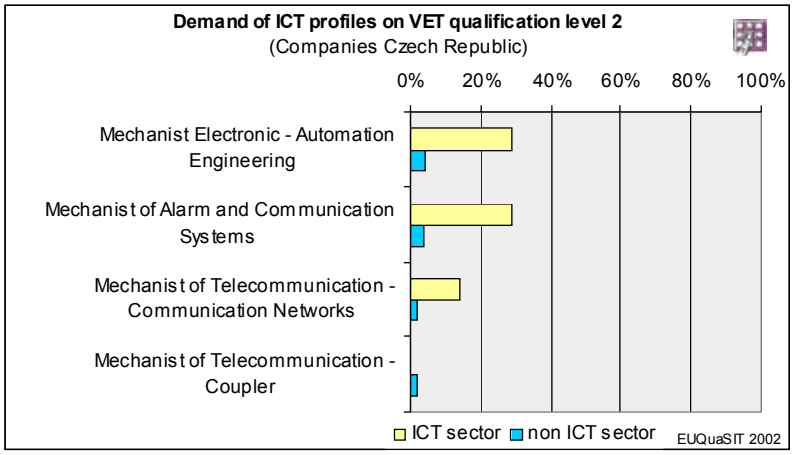

fig. 3-16: Companies’ demand of ICT practitioners with qualification profiles at VET qualification level 2 in the Czech Republic

For VET level 3 ICT qualification profiles and programmes, Czech Republic experience indicates a relatively high demand (comparing to other countries), but their spectrum does not cover the most required activities the companies envisage. So, “Telecommunication Mechanist”, “Telecommunication Techniques” and “Device of Communications” are met only in communication companies. Similar demand shows Germany where – on the contrary, the spectrum of level 3 profiles is large and obviously fitted (hence required) by the companies. In Portugal the profile "Network Maintenance Technician" at VET level 3 is often required. For Portugal and Romania and, the other moderate demand of VET level 3 ICT profiles is explained by the belief of most companies that tasks corresponding to level 3 may be performed by ICT practitioners from similar profiles situated on VET levels 4 or even HE level 5 of training. In the Netherlands, companies only have a significant demand for the qualification Assistant Administrator ICT. The other qualifications are specific qualifications in the field of communications that mostly only occur in the communications sector.

[9] All detailed results are available on the internet at http://www.euquasit.net

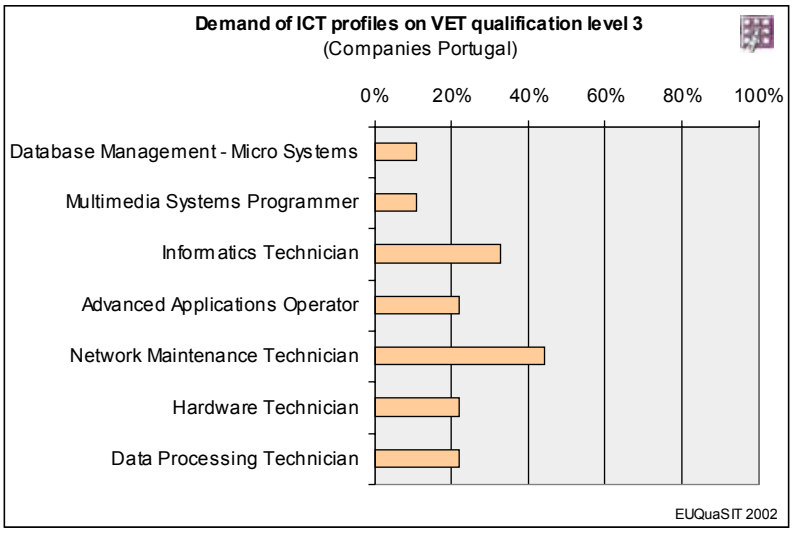

fig. 3-17: Companies' demand of ICT practitioners with qualification profiles at VET qualification level 3 in Portugal

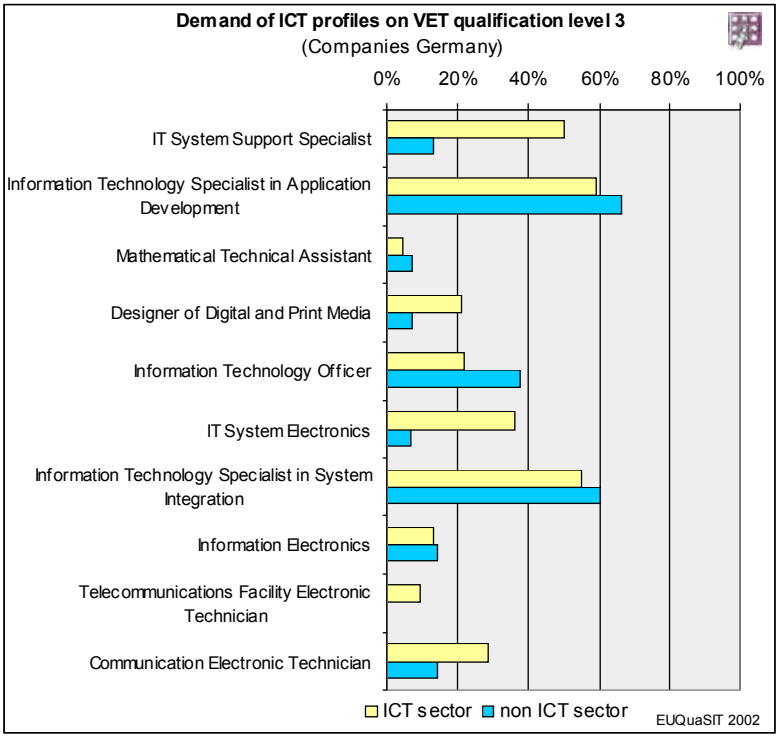

fig. 3-18: Companies' demand of ICT practitioners with qualification profiles at VET qualification level 3 in Germany

Especially companies from the Netherlands and Romania have a high demand of ICT practitioners at VET level 4. The evaluation results indicate for instance a large need but also the necessity of revision of profiles like "Network Administrator" at level 4 in the Netherlands. In the Netherlands, companies from the ICT sector believe that ICT-personnel at level 4 is definitely required in the near future, while they also believe that the work currently done by ICT practitioner with HE level 5B qualifications can be done by level 4 personnel or that current activities performed by level 4 ICT practitioners might grow. In Romania, despite the demand of the level 4 ICT profiles, the existing ones are not adequate to the current needs of the companies (they are either too old or too general).

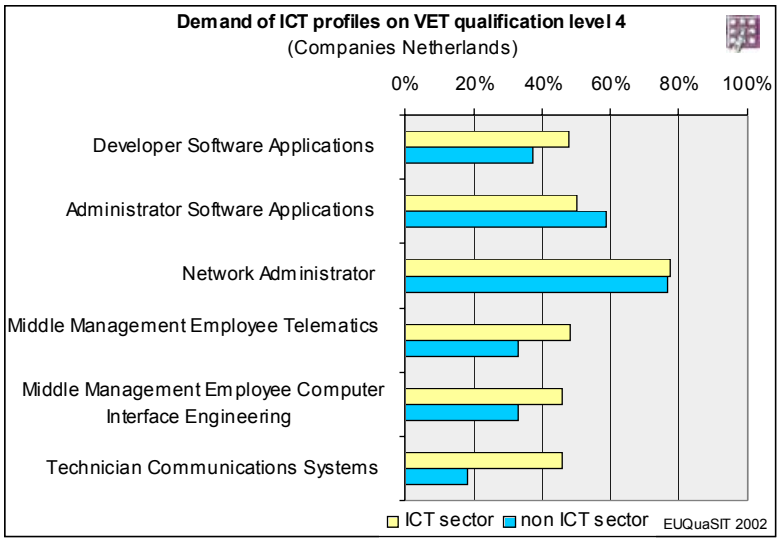

fig. 3-19: Companies' demand of ICT practitioners with qualification profiles at VET qualification level 4 in the Netherlands

Most of the ICT qualification profiles and programmes are known by the majority of the companies but there are also other profiles that are not very well known by many companies.

Regarding the demand of ICT practitioners at higher education levels it may be stressed that companies have a continuing need. For example, in Romania the peak is represented by Computers Science profile, (around 77 %), as specialization that is well known by companies and hence demanded; at the opposite pole are „Mechatronics" and „Industrial Robots" as profiles, for which companies do not see a big demand emerging in the near future. That is the case of "Medical Informatics", "Geo Informatics" and "Bio Informatics" in Germany, too. However, the low demand for such ICT profiles comes from the narrow specialization and the dedicated needs that these 'ICT job practitioners' should meet, so the demand should be considered in a nuanced way when a conclusion in envisaged. In Netherlands the demand for personnel with a level 5M qualification will stay the same. On the whole, it is encountered an increased demand from companies for level 5M technical and economic specializations, and a greater diversification of profiles for specific jobs of the Information Society.

In Czech Republic minimal demands go to theoretical branches in level 5B (Informatics Systems and Informatics and Automatics). On the other side demands about applied branches (Applied Informatics and Control, Engineering Informatics, Managerial Informatics, Information Technology - Programming Languages and Graphic Systems) are approximately identical about 50%. Demands of ICT and non-ICT sector are very different – in ICT sectors predominate demand of level 5B in all branches. We can explain this predomination of ICT sector by better work categorization profiles of level 5B in ICT company than in ICT departments in big non ICT companies – which play a significant role for the demand on ICT practitioner in level 5B.

Netherlands faces an important demand on ICT qualification profiles and programmes at HE level 5B, while companies have better knowledge on level 5B ICT qualifications than on level 5M. The results also clearly states that the content of level 5B qualifications is better then of level 5M qualifications, and the demand for ICT qualification profiles is all together clearly higher for level 5B than 5M.

In Romania it is obvious that the demand for 5B level ICT profiles is moderate, while they tend to hire ICT practitioners with HE level 5M. One explanation seems to be the common belief of those responsible with human resources that ICT is a high technology domain and requires highest education graduates.

Again, disregarding the diversity encountered, the comparison reveals common trends in the European countries. So, the demand of ICT qualification profiles and programmes obtained through higher education is bigger than those for levels 2 and 3. Level 4 ICT profiles are, on the average, most demanded comparing to the others. That trend shows mainly that SMEs require skilled ICT practitioners at level 4, able to initiate and manage ICT activities, or to develop independently ICT work in the target area.

3.4.2 Curricular evaluation of ICT qualification profiles and programmes

The European evaluation of ICT qualification profiles and programmes in companies entails the discussion of the content of the curricula. Therefore, the ICT curricula have been highly important under aspects of the needs and revision. The results indicate, especially under revision aspects, a mismatch in regard to the ICT training goals and contents. Beside using these results to find out the needs and a prospective curriculum structure of ICT qualification profiles and programmes, the evaluation results can be in the same context further interpreted as a mismatch to a certain extent and findings of the current ICT curricula e.g. in terms of curriculum examples of "good or bad practice".

The evaluation of curricula at sub-degree and VET levels indicate differences in European countries with regard to profile skill levels, the number of ICT qualification profiles at each level and the main subjects of ICT qualification. There are differences in individual curricula, as shown in detail by the project results, e.g. in regard to the goals, contents, method or duration of the ICT training, as the curriculum elements focus on the profiles and skill levels structures.

In this sense and in relation of the current curricula of ICT qualification profiles the evaluation results can be summarised as follows:

- The curricula of "modern" ICT qualification profiles, launched or updated in the last years, are often relevant as curriculum examples of "good practice". To a high percentage they meet the skill needs and contents presented by the generic work area orientated ICT skills profiles, e.g. in Germany the four new ICT qualification profiles at level 3 and new work process orientated further ICT specialist profiles at level 4 or in the Netherlands the new BCP ICT qualification profiles or also in Portugal the new professional ICT qualification profiles at vocational levels.

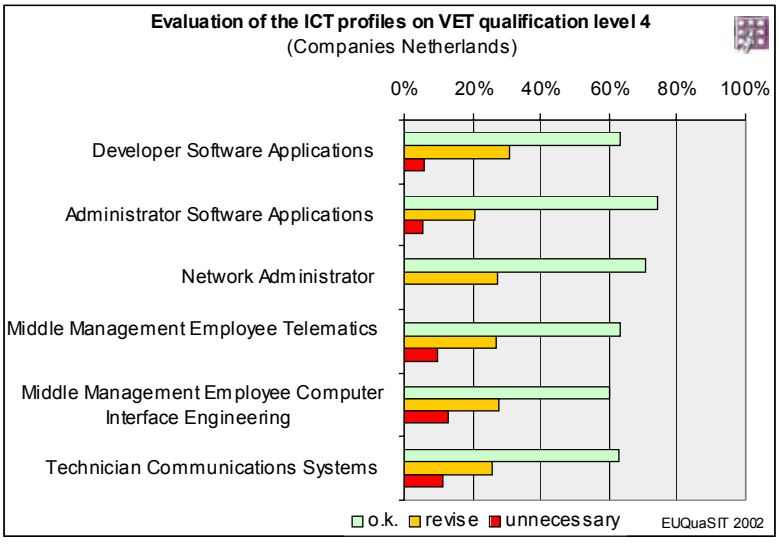

fig. 3-20: Companies' evaluation of the ICT qualification profiles and programmes at VET qualification level 4 in the Netherlands

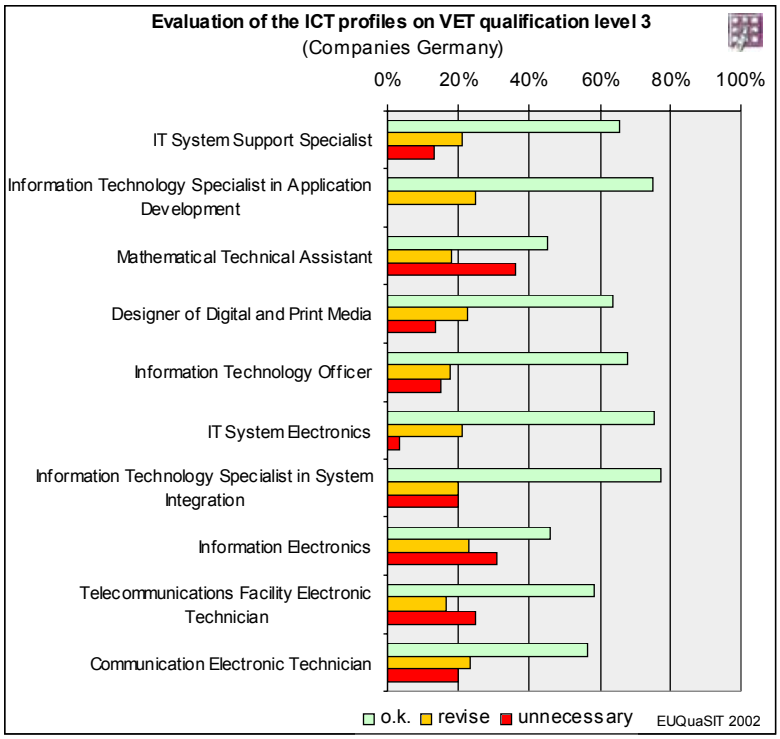

fig. 3-21: Companies' evaluation of the ICT qualification profiles and programmes at VET qualification level 3 in Germany

- Beside the curricula of "modern" ICT qualification profiles the problems are that often the "old" ICT qualification profiles further and parallel exist and in this context the corresponding ICT curricula and training profiles partly overlap significantly in skills and contents, but, however, this result partly applies to some new ICT qualification profiles as well.
- The curricula of ICT qualification profiles that meet the skill needs and contents only to a lower degree, still often split and separate the ICT skills and contents for instance in IT and CT, especially current ICT qualification profiles at VET level 2 and 3, e.g. in Germany "Telecommunication Facility Electronic Technician" and "Mathematical Technical Assistant" or in Netherlands "Craftsman Communications Networks".
- The curricula which still partially but strongly split and separate ICT business, informatics (software) and electronics (hardware) skills and contents do not meet companies' skill needs. These curricula are mostly strong subject or scientific discipline orientated without enough or none integrated or combined structure and contents, e.g. in Germany "Technician in Radio Communication" or in the Czech Republic "Computer Technology and Basic of Programming".
- Other curricula with a mismatch in general hardly consider any work area orientated skills and contents or cross section and basic work skills. These curricula also mostly strong subject or scientific discipline orientated and hardly include for instance business, customer and application orientated contents, work process and quality management contents or overall subject contents, and finally other curricula with a mismatch often stress too much the basic skills with predominantly scientific base and engineering theory contents like computer and technology science and mathematics orientated contents and, at the same time, too little basic skills with work, customer and application orientated contents.

The following table summarises some of the findings for each qualification level:

Level	Demand is due to	Change is required for
Level 5M	• specialized profile in certain application area • knowledge and skill on matters in the application area • knowledge and skill on usage of instruments use specific to area • experience on low to high level tasks in the application area • practice in team working and human communication • knowledge and skills on work planning and team co-ordination • creativity and knowledge on meta level techniques	• less ICT oriented but more application area oriented • less ICT theoretical but more working area oriented • more practice on up-to date technology in industry • more practice and projects but few lectures and theory • less individual but more group oriented education • fewer pure ICT but more work management matters • less technical education but more research and design
Level 5B	• basic and intensive knowledge on application area • practical abilities and on techniques in application area • abilities in work planning and team co-ordination	• less encyclopedic but more application oriented matters • less theoretical but more area oriented education • less individual activities but more team working
Level 4	• knowledge and skills on up to date technology and tools • knowledge on economic and management activities • orientation on actual and technical context of problems • knowledge and skills in work organization and coordination • knowledge and skills on concrete production/service	• less theoretical but more working oriented matters • more economic and management matters • few technical but more strategic matters in the area • less individual but more group and organizing tasks • less research or design but more production/service tasks
Level 3	• specialization on specific activities of the application area • practical skills in working tasks specific of the application area • team work and communication abilities	• less encyclopedic but more activity oriented in the area • more working and less scholastic tasks • less individual but more group oriented education
Level 2	• basic knowledge on specific matters in the application area • practical abilities in specific tasks of the application area	• less ICT general but more application oriented matters • less theoretical but more working oriented in the area

fig. 3-1: Assessment on curricula features that lead to demand and change of ICT profiles.

3.4.3 Strategy, demand and assessment of continuing vocational training (CVT) in the field of ICT

Beside the profound analysis and documentation of ICT qualification profiles and programmes of the vocational education and training (VET) and higher education (HE) systems in the partner countries, also the companies' strategies, demand and assessment of continuing vocational training (CVT) in the field of ICT was investigated in the second part of the questionnaire survey.

Based on a mix of reasons and concepts of continuing vocational education and training (CVT) for their ICT practitioners (e.g. human resources strategy, new products or concrete problems or the commitment of the practitioners), an average of about 70 % of the companies see a concrete CVT demand.

As indicated in fig. 3-22 the demand exists for ICT practitioners at all skill levels, only at level 2 the demand is significantly lower, and furthermore varies for the partner countries. The highest short- and medium term demand is indicated by companies from the Czech Republic, namely for ICT practitioners at all skill levels apart from level 2. As in the Czech Republic, the companies in Germany see the biggest demand for the ICT practitioners at level 3 as well as skill level 5. In the Netherlands the demand of CVT at level 6 is clearly lower than for the other levels as well as in comparison to the other countries. The Dutch companies see a specific CVT demand

for ICT practitioners with VET qualifications at level 4, whereas the Romanian companies equally at all skills and qualification levels.

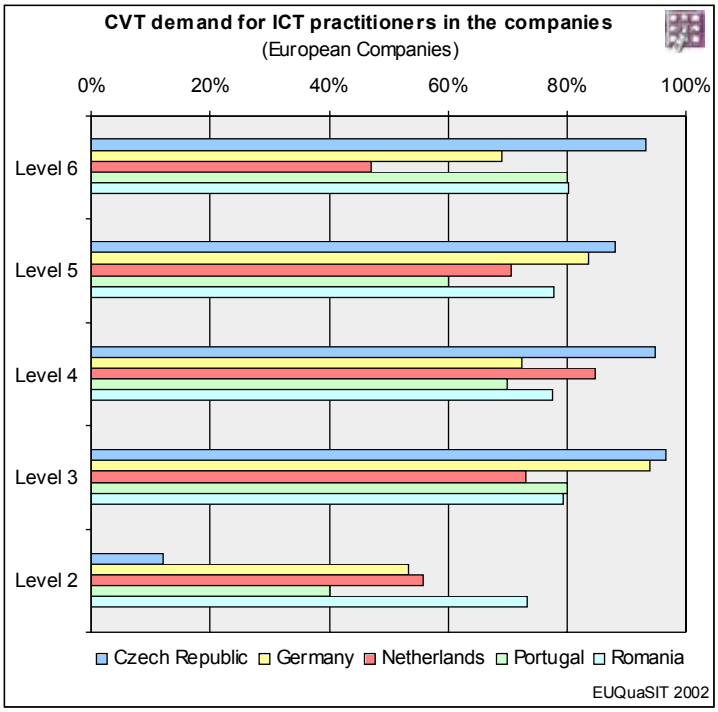

fig. 3-22: CVT demand for ICT practitioners in European companies

The detailed analysis indicates a range of contents and ICT work areas in which companies see the CVT demand for their ICT practitioners. A great demand, for instance, is indicated in the work area 'ICT systems and application development' (e.g. Germany, Portugal; but not so much in the Czech Republic), ICT systems installation (all the countries apart from Romania) and ICT service and administration (e.g. Czech Republic and Germany). In more business and commerce orientated fields like ICT marketing and ICT sales and consulting especially a lot of German companies see a fairly big demand. Analysed by skill level there are partly significant differences in the ICT work areas. For instance in ICT management there is more a CVT demand for ICT practitioners with higher education qualifications at skill level 6 and 5 whereas CVT contents such as ‘ICT systems installation’ and ‘ICT service and administration’ are more required for ICT practitioners with VET qualifications corresponding to skill levels 3 and 4.

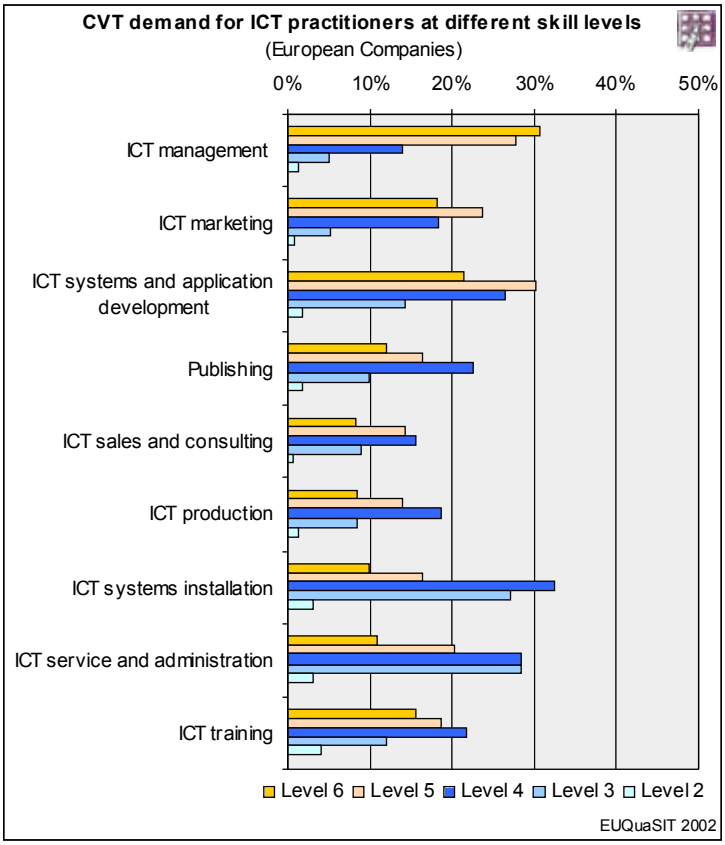

fig. 3-23: CVT demand for ICT practitioners at different skill levels

In addition to the CVT demand in the concrete ICT work and qualification areas the companies confirm the importance of integrating “key competences” within continuing ICT training courses. According to the survey results a high proportion of companies state that competences such as language skills (mainly English), team- and communication skills, user- and customer care etc. are of crucial importance in CVT courses.

The most important providers of CVT courses today are those with vendor- and product specific offers. Also and in correspondence to this, the greatest success and the preferred further training methods are company-, work- and product-related CVT courses for ICT practitioners. Even though companies already have certain experience with computer- and web-based training, many companies are not as convinced of their success as of the other concepts mentioned.

According to about 40 % of the companies the regional supply of CVT courses for ICT practitioners is inadequate and does not fit their needs in regard to the curricula and contents. Beside the inadequate supply and a lack of contents quality especially the competences of the trainers is often disapproved by the companies.

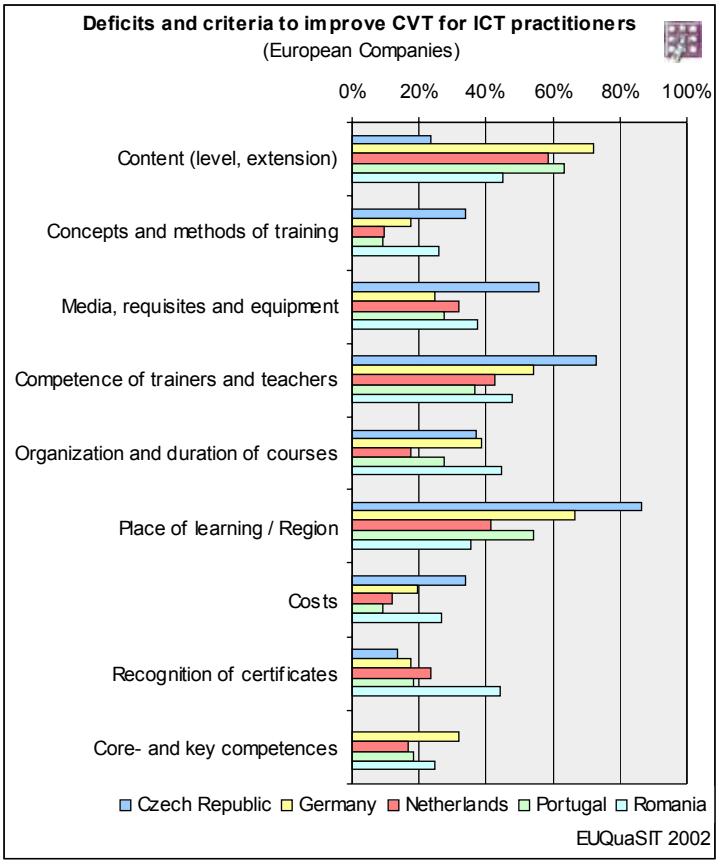

fig. 3-24: Deficits and criteria for the improvement of CVT courses for ICT practitioners

The costs or the recognition of certificates of CVT courses for ICT practitioners are rarely seen as a problem for the companies. On the average the companies calculate annual costs between 2 000 and 4 000 EUR for CVT per ICT practitioner and a duration of the courses of eight days on average.

3.5 Empirical analysis of the demand of ICT practitioners and the evaluation of ICT qualification and programmes in Europe

Based on the outcomes of the systematic analysis and documentation of ICT qualification profiles and programmes in the EUQuaSIT partner countries, the next part of the project within work package 2 was aiming at empirical results on the demand of ICT practitioners as well as the acceptance and evaluation of the ICT qualification profiles and programmes in companies. This work is needed for the initial international comparison of the European ICT qualification demand and supply in the partner countries and beyond as well as first proposals on how to fit industries' ICT practitioner skills needs.

It is clear that the training in a narrow specialization is made mostly at the working place and/or through CVT. However, VET and HE training have to keep pace with the dynamic changes of ICT qualification requirements that come from companies and job market needs of the time. It is therefore of great help for the stakeholders in charge for up-dating qualification profiles and curricula as well as ICT training institutions to know, or at least to have an idea, on the real features ICT qualifications should have to fit the skill needs of ICT practitioners.

3.5.1 Concept and questionnaire

Based on the outcomes of the systematic analysis and documentation of ICT qualification profiles and programmes in the EUQuaSIT partner countries, the next part of the project within work package 2 was aiming at empirical results on the demand of ICT practitioners as well as the acceptance and evaluation of the ICT qualification profiles and programmes in companies. This work is needed for the initial international comparison of the European ICT qualification demand and supply in the partner countries.

In the questionnaire first of all overall information of the companies were gathered, e.g. sector (ICT sector or ICT user sector to be nominated), company size, region as well as contact data for further enquiries. Furthermore a short information about the current situation of ICT qualification profiles and programmes for each country was given as indicated in the previous chapter.

The questionnaire for the companies is characterised by two main parts. The first part (A) focuses in its main part on information about the current employment of ICT practitioners and the expected demand as well as the evaluation of the ICT qualification profiles and programmes at VET and HE levels. This also comprises questions on actual female rates and initiatives in the field, a European standardization of ICT qualifications and certificates, the integration of disabled and disadvantaged people etc.

A1:	How many ICT practitioners are employed in your company how is the allocation of ICT practitioners according to the ICT qualification groups (levels)?
A2:	How do you expect a change in demand in short and mid term view of ICT practitioners and according to the ICT qualification groups (levels)?
A3:	What is the actual female rate under the ICT practitioners in your company all together?
A4/A8:	Demand, assessment and knowledge of ICT qualification profiles at the different levels.

Czech Republic					Germany					Netherlands					Portugal					Romania				
L2	L3	L4	L5B	L5M	L2	L3	L4	L5B	L5M	L2	L3	L4	L5B	L5M	L2	L3	L4	L5B	L5M	L2	L3	L4	L5B	L5M

A4/A8:	Are the ICT qualification profiles at the different levels sufficient for the ICT work and tasks in your company?
A9:	When you look for new staff, how important is the exact ICT qualification profile and the qualification level?
A10:	What do you think about a European standardization of ICT qualification profiles and degrees (certificates)?
A11:	How do you assess the supply of ICT practitioners in order to meet companies' demand in a short and mid term view?
A12:	Which statement would you agree with concerning the companies' short and mid term demand of ICT practitioners?
A13:	How important is for your company a sensible proportion of males and females (diversity) in the ICT working processes?
A14:	What do you think about existing training and employment initiatives in order to increase females proportion under ICT practitioners?
A15:	How do assess the integration of disabled and disadvantaged people into companies' ICT working fields?
B1:	Please choose your companies' further qualification demand in the ICT field according to the ICT practitioners groups (levels) in a short and medium term view?
B2:	Participation and selection of participants of continuing training in the ICT field is (mainly) based or depends on ...
B3:	Need and demand of your company regarding further ICT qualification and training in the different ICT working areas.
B3:	Need and demand of your company regarding further ICT qualification and training in the different ICT working areas and on the different qualification levels.
B4:	Which of the following key competencies are of crucial importance within further ICT courses?
B5:	Is there a sufficient and tailored offer of further ICT courses in the region?
B6:	Which qualification concepts and methods in further ICT vocational training are practiced? Are they suitable as far as the learning success is concerned?
B7:	Which are the most important external training providers for your companies? How do you assess the success of the training?
B8:	Where are the main problems and which are the main criteria to improve further ICT training?
B9:	How should further ICT courses preferably be organized from the companies' point of view? How many days could ICT practitioners stay on courses (average)?
B10:	What is the budget the company calculates for further training of ICT practitioners a year?

fig. 3-25: Overview of the questions asked to the companies in the European questionnaire survey of EUQuaSIT

The second part (B) is concerned with the demand and assessment of the situation of continuing vocational training (CVT) in ICT. The answers of both parts could mainly be chosen from

a variety of given answers and the persons asked could always give open statements at the end of each question.

3.5.2 Companies' stock and demand of ICT practitioners and corresponding ICT qualification profiles and programmes

The following paragraphs try to summarise the comprehensive results of the questionnaire survey of companies, namely in view of answers on the European stock and demand of ICT practitioners as well as the demand and evaluation of the ICT qualification profiles and programmes from the viewpoint of companies and their ICT practitioner skill needs.

The first question on the number of ICT practitioners is a relevant labour market parameter, e.g. concerning the question how many ICT practitioners are employed in the ICT sector itself and how many in all other 'ICT user sectors'. The EUQuaSIT results reveal a proportion of up to 50 % of ICT practitioners in companies of the ICT sector itself and between 2 % and 10 % in the ICT user sectors. Especially the Czech partner investigated some companies of financial and insurance services where the proportion of ICT practitioners seems significantly higher than for instance in public administration or most industry sectors.

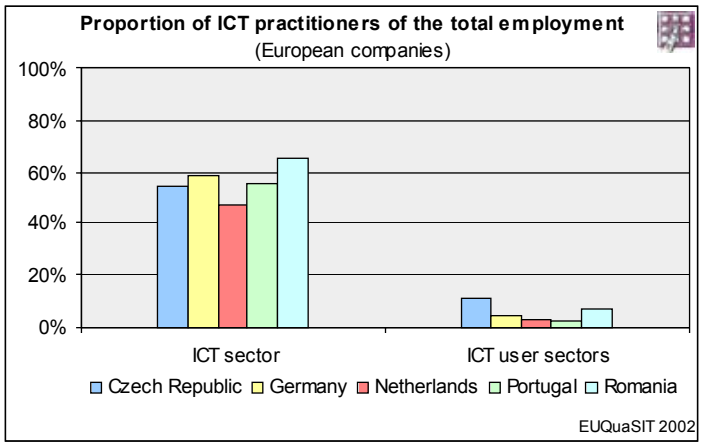

fig. 3-26: Proportion of ICT practitioner workforce of the total employment in the investigated companies of the ICT sector and ICT user sectors

The allocation of ICT practitioners (among themselves) is indicated in the following figure divided by the skill respectively qualification level and country. The results indicate that about 45 % of the ICT practitioners in the investigated companies have a higher education (HE) qualification level and the other about 55 % have a vocational education and training (VET) qualification level. Whereas the HE proportions are almost the same, the largest VET proportion can be seen at VET level 3 with almost 25 % of all ICT practitioners. The proportion of ICT practitioners at with a VET qualification at level 2 is 15 %, after all.

Especially at VET levels the allocation differs considerably by country. Whereas in the Netherlands the proportion is higher at VET level 4 and level 2, in Germany and Romania the by far largest proportion is indicated at VET level 3. In Portugal these proportions are almost the same.

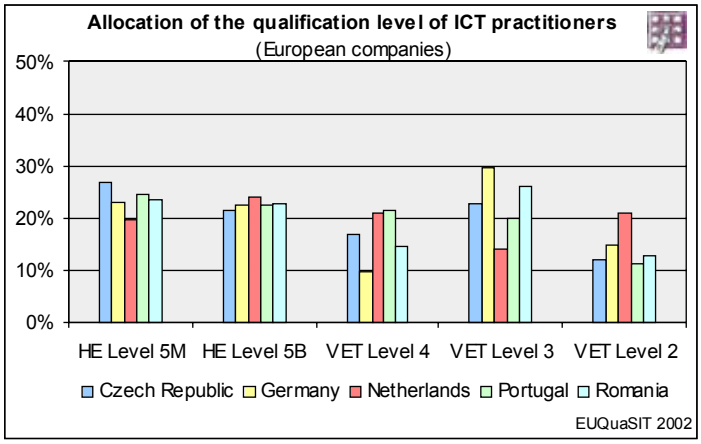

fig. 3-27: Allocation of the qualification level of ICT practitioners in the EUQuaSIT partner countries

The actual female proportion amongst ICT practitioners in the companies is expectably low even though and according to the companies numbers in Romania and Portugal it is summarized for all levels about 20 % of the ICT practitioner workforce. For the other countries the percentage is only around 10 %. Divided by skill and qualification levels the results indicate significant differences in the partner countries especially for the skill levels 6 and 3. Especially at level 3 there is a significant higher number of females in Germany and also in Romania, whereas at skill level 6 the number of females in Portugal is significantly higher.

In addition to the actual proportion of females amongst the ICT practitioner workforce the companies were asked about their assumption of the short- and medium term change. The result is basically that about 30 % of the companies state they want to increase the female proportion. In the Netherlands almost half of the companies say they suppose the female proportion will be higher than at the moment.

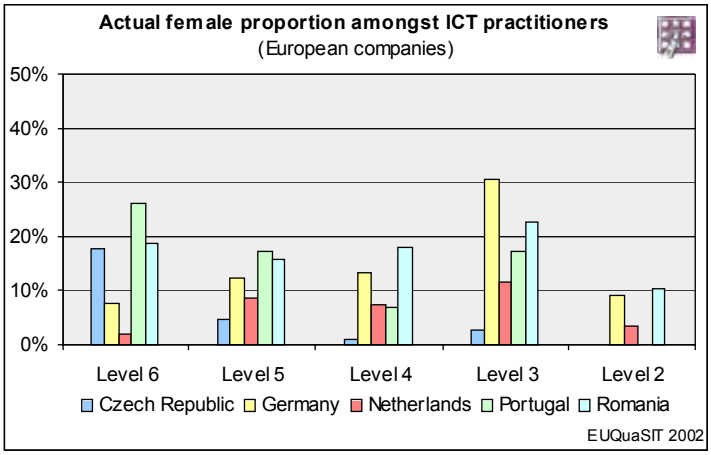

fig. 3-28: Actual female proportion amongst ICT practitioners divided by level and country

Many companies indicate that a good proportion of males and females is important in their daily ICT business and work processes and support initiatives to increase the female rate amongst ICT practitioners. However, the success of such initiatives is evaluated differently, but about 50% of the companies in Portugal and Romania, where the proportions of females are the highest, believe that such initiatives can be successful.

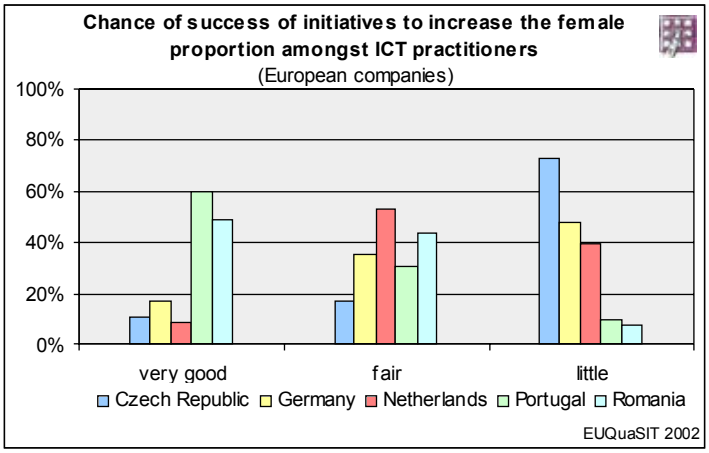

fig. 3-29: Chance of success of initiatives to increase the female proportion amongst ICT practitioners

For most of the companies the integration of disadvantaged and handicapped ICT practitioners is no problem or at partly no problem. However also 15 % of the companies of the ICT sector indicate that this is problematic.

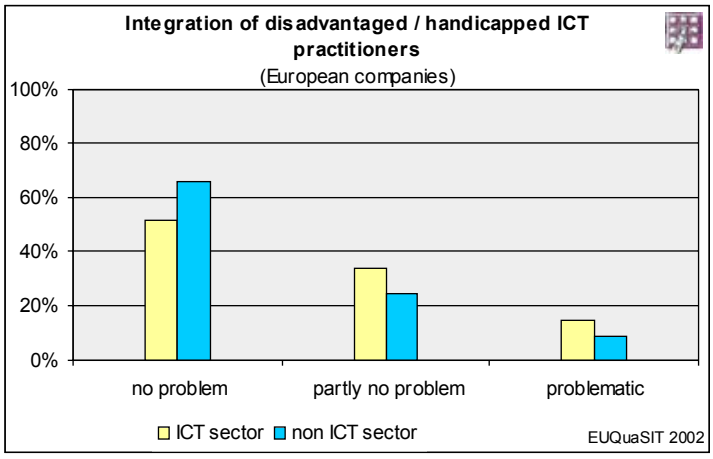

fig. 3-30: Assessment of the companies on the integration of disadvantaged and handicapped ICT practitioners

One of the most debated questions with regard to labour and employment market in Europe concerns the supply and demand of ICT practitioners. A lot of surveys have been referring to a huge gap of highly qualified practitioners in this domain The EUQuaSIT questionnaire survey also looked at companies' demand of ICT practitioners. The results indicate

Differences can also be recognised between the countries at the different skill levels. The expectations of the companies indicate an increasing and higher demand of ICT practitioners especially for level 5B. Apart from the companies in Romania and especially Portugal almost 40 % of the companies say the demand will increase at this level. About one third of the companies expect an increasing demand of ICT practitioners at level 5M, and here especially in Romania and Portugal and at level 4, and here especially in the Czech Republic and the Netherlands. For level 3 it is still an average of 30 % of the companies that indicate an expectation of a higher demand, and here especially in Germany.

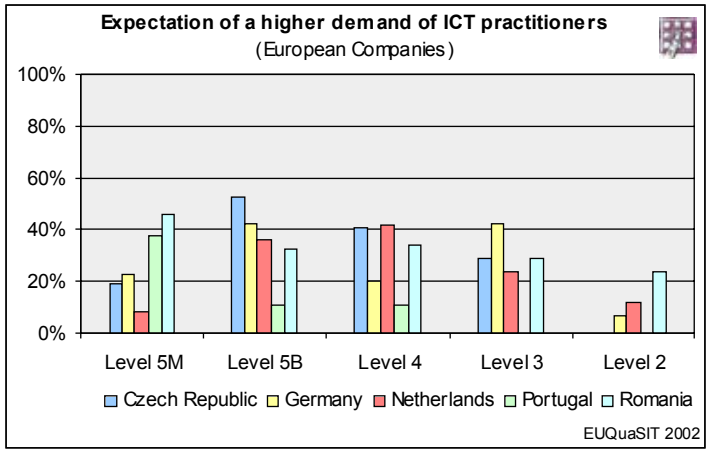

fig. 3-31: Companies' indicating a higher demand of ICT practitioners in the short- and medium term view

In short- and medium term view a slightly (relative) higher demand of ICT practitioners at all levels is indicated by the companies of the ICT sector compared to those of the ICT user sectors. The same small differences can be recognized for smaller companies compared to the large ones.

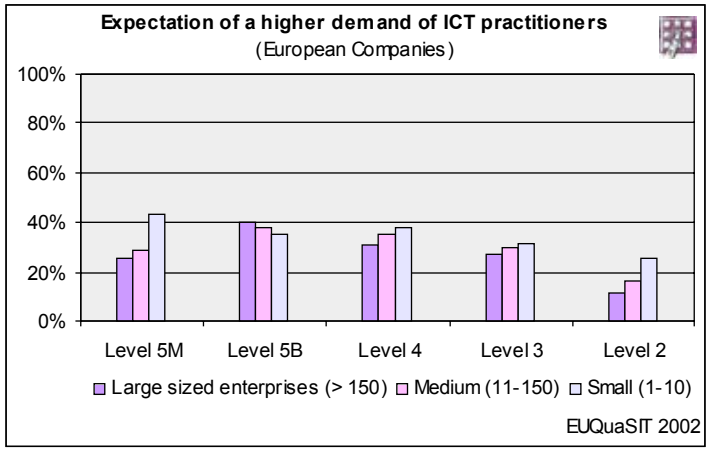

fig. 3-32: Expectation of a higher demand of ICT practitioners differentiated by company size

Regarding the supply of qualified ICT practitioners available on the labour market in order to meet companies' demand in a short- and medium term view the situation does not seem ideal in any of the investigated countries. In the Czech Republic, Germany and Portugal only between 20 % and 25 % of the companies say the supply of ICT practitioners is 'very good'. The best situation is indicated in the Netherlands and Romania where almost 50 % of the companies assess the supply of qualified ICT practitioners as being ‘very good’. While the majority of Czech companies would assess the situation as being 'fair', it is more than one third of the companies in Germany and Portugal that say the supply of ICT practitioners was rather 'bad'. In summary just under 20 % of the companies evaluate the supply as being ‘bad’.

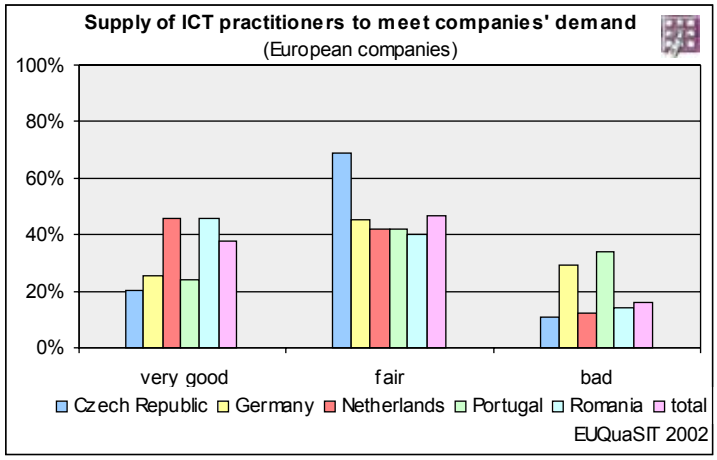

fig. 3-33: Companies' assessment of the supply of ICT practitioners

In the context of the ICT practitioner demand for instance when looking for new staff, the right skills and qualification profile and level is of essential importance for most of the companies, whereas the level is not as significant as the right profile of new ICT practitioners itself. In the Czech Republic, Germany and Portugal the proportion of companies who stress the significance of 'the right' ICT qualification profile of new ICT practitioners is between 80 and 85 %. In the Netherlands and Romania the percentage is significantly lower.

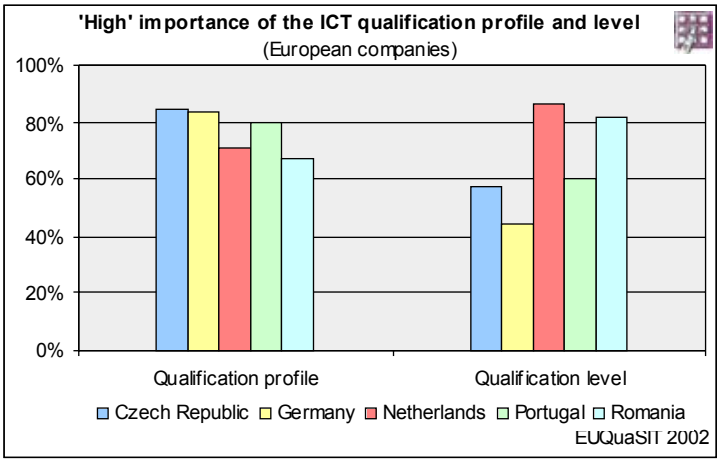

fig. 3-34: Companies indicating a 'high' importance of the ICT qualification profile and level of new hires

On the contrary in the Netherlands the level of qualification is more significant, which is, for instance, not the case in German companies.

4 European comparison of the demand of ICT practitioners and supply ICT trainees / students

The complexity and dynamics of ICT technologies (hardware, software, systems, communications, contents and user applications) and the corresponding breadth of needed ICT practitioner (and user) skills are currently challenging traditional ways of analysing and forecasting to describe the ICT practitioner workforce and its demand and supply. The results of the EUQuaSIT questionnaire survey of European companies provide an empirical basis for estimations in regard to the ICT practitioner demand. In medium-term perspective every other company stated a higher demand of ICT practitioners. The results furthermore indicate differences by country and skill levels.

However, in order to concretely quantify gathered information the use of existing statistics and classifications is obligatory in order to get some numbers at all. But it needs to be stressed at this point that estimations are needed to draw a coherent picture. The comprehensive analyses of EUQuaSIT indicated that the usability of the "official" ICT workforce numbers for instance of the national statistics offices and their merged results presented in the ISCO-88 structure used by Eurostat is rather limited due to a lack of a common European classification coherency.

4.1 ICT practitioner work, employment and technology development: comparative statistical analysis of ICT Europe

With the recent enlargement the Union's population has suffered a dramatic increase from approximately 380 million inhabitants in 2003 to 460 million inhabitants today. This represents around 20% of increase which is a considerable change in the demographic aspect. The average household size in EU before the enlargement was around 2.5 and has is now of 2.7. These figures represent a change in the line of population growth of EU which was in the last ten years of 3.4 % only.

In 2002, 169 million were in employment in the EU, more than two-thirds of whom were working in services (67.8 %). Industry (including construction) accounted for 28.2 % of employment and agriculture for only 4.0 %. This pattern was rather similar in all Member States, with the exception of Greece and Portugal, were a larger share of people work in agriculture and a smaller share in services.

The common characteristic of the new countries and the candidate countries in comparison with the EU is the much lower importance of services in the national economies, as they generally accounted for less than 60% of the workforce, down as low as 32.7 % in Romania. Agriculture was also relatively more important in Romania (36.8 %), Poland (19.3 %) and Lithuania (18.2 %), although Hungary (6.0 %, Cyprus (5.4 %) and the EUQuaSIT partner country Czech Republic (4.8 %) were closer to the EU average.

	BE	DK	DE	EL	ES	FR	IE	IT	LU	NL	AT	PT	FI	SE	UK	EU-15	US	JP
									Total Employment (Thousands)									
2002	4 189	2 776	38 626	3 914	16 303	24 924	1 767	23 345	194	8 336	4 061	5 027	2 344	4 347	27 659	168 653		
									Annual average growth rate of employment (%)									
2002	-0.2	-0.6	-0.6	-0.2	1.3	0.8	1.4	1.3	2.1	0.8	-0.4	0.1	0.4	0.2	-2.4	0.4		
1997-2002	1.2	0.6	0.8	0.7	2.9	1.7	4.7	1.4	2.4	2.0	0.7	1.7	1.7	1.6	0.5	1.4		
									Harmonised unemployment rate, total (%) (1)									
2000	6.9	4.4	7.8	11.0	11.3	9.3	4.3	10.4	2.3	2.8	3.7	4.1	9.8	5.6	5.4	7.8		
2001	6.7	4.3	7.8	10.4	10.6	8.5.	3.9	9.4	2.1	2.4	3.6	4.1	9.1	4.9	5.0	7.4	4.8	5.0
2002	7.3	4.5	8.6	10.0	11.3	8.7	4.4	9.0	2.8	2.7	4.3	5.1	9.1	4.9	5.1	7.7		
	IS	NO	CH	BG	CY	CZ	EE	HU	LV	LT	MT	PL	RO	SK	SL	TR		
									Total Employment (Thousands)									
2002	140	2 318		2 992	305	4 796	588	3 871	1 065	1 399	137	13 782	7 819	902	2 127	21 779		
									Annual average growth rate of employment (%)									
2002	-0.7	0.1		0.8	0.3	1.0	1.4	0.7	2.7	-8.1	-0.7	-3.0	-8.7	-0.1	0.2	0.2		
1997-2002	1.7	0.9		-1.1	1.4	-0.6	-1.1	1.4	0.5	-3.5	0.4	-1.9	-2.8	2.1	-0.6			
									Harmonised unemployment rate, total (%) (1)									
2000		3.4		16.4	5.2	8.7	12.5	6.3	13.7	15.7	7.0	16.4	6.8	18.7	6.6	6.6		
2001		3.6		19.2	4.4	8.0	11.8	5.6	12.8	16.1	6.7	18.5	6.6	19.4	5.8	8.5		
2002		3.9		18.1	3.8	7.3	9.1	5.6	12.8	13.1	7.4	19.9	7.0	18.6	6.0	10.4		
(1) According to ILO definitions: persons aged 15 to 74 years.																		

fig. 4-1: Employment numbers for European countries

The complexity and dynamics of ICT technologies (hardware, software, systems, communications, contents and user applications) and the corresponding breadth of needed ICT practitioner (and user) skills are currently challenging traditional ways of analysing and forecasting to describe the ICT practitioner workforce and its demand and supply. The results of the EUQuaSIT questionnaire survey of European companies provide an empirical basis for estimations in regard to the ICT practitioner demand. In medium-term perspective every other company stated a higher demand of ICT practitioners. The results furthermore indicate differences by country and skill levels.

However, in order to concretely quantify gathered information the use of existing statistics and classifications is obligatory in order to get some numbers at all. But it needs to be stressed at this point that estimations are needed to draw a coherent picture. The comprehensive analyses of EUQuaSIT indicated that the usability of the "official" ICT workforce numbers for instance of the national statistics offices and their merged results presented in the ISCO-88 structure used by Eurostat is rather limited due to a lack of a common European classification coherency.

4.1.1 ICT practitioner workforce in Europe compared in occupation classifications (ISCO-88 COM)

Under the headline "ICT Labour Force", Eurostat presents in its "Statistics on the information society in Europe" the numbers and proportions on "Computer professionals" in Europe. This number is estimated with some 1.5 % of the total EU-15 labour force in the year 2000. A major initial problem was that this number was accounted only for ISCO-88 minor group "213 Computing professionals". After consultations with Eurostat the situation was clarified, so that the published numbers for "computer professionals" cover the ISCO-88 (COM) minor groups 213 Computing professionals and 312 Computer associate professionals (see table below). The author of the Eurostat report comments the data as follows: "The highest proportion of computer professionals (more than 2 %) was recorded in the countries where the use of ICT was also highest, namely Denmark Finland, the United Kingdom, and in particular, the Netherlands and Sweden (more than 3 % of the workforce were computer professionals). Among the candidate countries, the share of computer professionals in total employment was usually lower than the EU average; the Czech Republic (1.8 %) was the only candidate country to report a higher proportion of computer professionals. Computer professionals are often a highly mobile and flexible workforce, willing to travel to take-up a new post" (Ottens 2003, p. 59).

	BE	CZ	DK	DE	EL	ES	FR	IE	IT	LU	NL	AT	PT	RO	FI	SE	UK	EU-15	EU-15
1995*	1.2	:	1.3	1.0	0.3	0.5	1.3	:	0.6	1.0	2.0	0.8	0.7	:	1.3	2.2	1.1	**1.1**	**1 727 000**
1998	1.4	1.2	1.9	1.2	0.4	0.9	1.3	:	0.7	1.5	2.6	1.3	0.5	:	1.7	2.2	1.4	**:**	
1999	1.6	1.4	2.0	1.3	0.3	1.0	1.6	1.2	0.9	1.8	2.8	1.4	0.7	:	2.1	2.5	1.7	**1.4**	**2 296 000**
2000	1.5	1.5	2.3	1.5	0.4	1.0	1.6	1.2	0.9	1.5	3.2	1.5	0.6	1**	2.0	3.3	1.8	**1.5**	**2 500 000**
2001	1.7	1.7	2.2	1.7	0.4	1.1	1.8	1.3	1.1	2.0	3.2	1.7	0.8	:	2.2	3.4	2.3	**1.8**	**3 050 000**
2002	1.9	1.8	2.4	1.6	0.5	1.1	1.8	1.5	1.2	1.7	3.1	1.9	0.9	:	2.4	3.3	2.2	**1.7**	**2 890 000**

fig. 4-2: National and European workforce share of "Computer professionals" (1995 - 2002); Eurostat, Labour Force Survey (LFS): "Computer professionals (ISCO-88 213, 312) as a share of total employment (%)" (cf. Ottens, 2003, p. 59; * OECD 2001, p. 69; ** Estimation)

As shown in the tables this proportion of 1.5 % equals a number of app. 2 500 000 ICT practitioners in EU-15 countries, which covers the data on ISCO-88 213 and 312 and no data at skill level 2. But national statistics indicate a considerable stock and number of ICT practitioners in several unit groups, especially for instance in the ISCO-88 group 7244 which is a group where all practitioner can be considered as ICT practitioners. We conclude at this point, that the numbers of the "ICT labour force" in Europe is mostly presented in a narrow view of "Computer professionals", i. e. neither ICT business or computer marketing and sales staff or electronics and communications engineers, communications installers nor or relevant skill levels.

Based on this statistical practice two options remain for the national statistics services when they report their LFS numbers to Eurostat:

1. European countries do not report any ICT practitioners at ISCO-88 skill level 2 simply due to the fact that the limited (ICT) LFS does not consider any such groups and therefore a considerable number of ICT practitioners is not presented in official statistics of the ICT labour force in Europe;
2. European countries may report ICT (computer) practitioners in the ISCO-88 group 312 (ISCO skill level 3) who would normally belong to ISCO-88 skill level 2 (which is exemplarily indicated for Germany below, where ICT practitioners with an ICT apprenticeship training belong to skill level 2 but may be reported for ISCO-88 group 312).

Therefore, the numbers of Eurostat are both, limited in the sense of the definition of ICT practitioners as well as show differences to the national statistics to be further described below, especially regarding the allocation between ISCO-88 groups at skill levels 3 and 2.

National and European workforce numbers of "Computer professionals" (2000)

Level	Minor groups	Unit groups	CZ	DE	NL	PT	RO	UK	FI	CS/IBM*	EU-15
			70 000 1.5 %	580 000 1.5 %	260 000 3.2 %	30 000 0.6 %	80 000* 1 %	515 000 1.8 %	46 000 2 %	3 191 000	**2 500 000** 1.5 %
Skill level 4	Computing professionals (ISCO 213)	Computer systems designers, analysts and programmers (ISCO 2131)	30 000	280 000	130 000	5 000	50 000*	200 000	34 000	1 306 000	**1 200 000**
		Computing professionals not elsewhere classified (ISCO 2139)									
Skill level 3	Computer associate professionals (ISCO 312)	Computer assistants (ISCO 3121)	40 000	300 000	130 000	25 000	30 000*	315 000	12 000	1 885 000	**1 300 000**
		Computer equipment operators (ISCO 3122)									

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fig. 4-3: Comparison of the national and European numbers of Computer professionals in the structure of ISCO-88 (COM) (Ottens, 2003, p. 59; Proportions of ISCO 213 and 312 estimated based on CEPIS 2002, p. 38; * Career Space (ICEL) 2001, p. 18 mapped by EUQuaSIT)

In detail the comparison of the numbers of ICT practitioners in the partner countries was possible based on the national results gathered and analysed by the EUQuaSIT project partners. These comprehensive results are summarised in the table below. The sources indicate that some national data from the statistics offices are partly available for all relevant ICT practitioner

groups in the ISCO-88 structure due to the direct use of this classification for national purposes, e.g. in the Czech Republic and Portugal. The German numbers were elaborated and transferred from data of the national statistics office (StBA) and the federal labour office (BA). For the ISCO-88 groups 213 and 312 the German numbers of Eurostat's holdings of the Labour Force Survey (LFS) are displayed in brackets below the EUQuaSIT calculations (CEPIS 2002, p. 38). Especially the number of "only" 75 000 ICT practitioners for ISCO 312 shows a big difference to the LFS number of 256 000. The reason is that the used StBA/BA numbers indicate an allocation of the corresponding national occupational group "774 Datenverarbeitungsfachleute, Informatiker" with a sizeable number at skill level 2 estimated 181 000. However, since there is no such "computer ..." group at skill level 2 only the indication that these ICT practitioner belong to that level. In addition there are some more 140 000 ICT practitioners at skill level 2, chiefly in the unit groups ISCO 7242 and 7244. The results for the Netherlands were calculated in the same way. The Romanian numbers are completely estimated by the project partners.

National and European workforce numbers of ICT practitioners (2000/2001)
ICT sector and ICT user sectors

			Country Inhabitants Total employment Total ICT practitioners Proportion of employment	CZ 10.2 Mio. 4.7 Mio. 94 785 2 %	DE 82.1 Mio. 38.7 Mio. 800 000* 2.1 %	NL 15.8 Mio. 8.1 Mio. 280 000* 3.5 %	PT 10.2 Mio. 5 Mio. 70 000 1.5 %	RO 22.4 Mio. 8.6 Mio. 150 000* 1.7 %	**EU-15** 377 Mio. 167 Mio. **3 700 000***** 2.2 %
Level	Major groups	Minor groups	Unit groups	ISCO/CZ	StBA/BA	CBS/LFS	CNP/PT	COR/RO	LFS/EU
Skill level -	Legislators, senior officials and managers (ISCO 1)	Other specialist managers (ISCO 123)	Sales and marketing managers (ISCO 1233)	3 748	24 000*	10 000*	2 379	80 000*	**200 000***
			Computing services managers (ISCO 1236)	1 537			2 640		
		Production and operations managers (ISCO 122)	Production and operations managers in ... communications (ISCO 1226)	9 123	16 000*		6 544		
		Managers of small enterprises (ISCO 131)	Managers of small enterprises in transport, storage and communications (ISCO 1316)						
Skill level 4	Professionals (ISCO 2)	Computing professionals (ISCO 213)	Computer systems designers, analysts and programmers (ISCO 2131)	6 418	280 000*	130 000**	4 020		**1 200 000****
			Computing professionals not elsewhere classified (ISCO 2139)	7 198			2 967		
		Architects, engineers and related professionals (ISCO 214)	Electronics and telecommunications engineers (ISCO 2144)	2 789	40 000*		4 299		**200 000***
Skill level 3	Technicians and associate professionals (ISCO 3)	Physical and engineering science technicians (ISCO 311)	Electronics and telecommunications engineering technicians (ISCO 3114)	12 252	33 000*	65 000* + L2 65 000* (130 000**)	3 000*	25 000*	**200 000***
		Computer associate professionals (ISCO 312)	Computer assistants (ISCO 3121)	5 650	75 000* + L2 225 000* (300 000**)		12 414		**600 000***
			Computer equipment operators (ISCO 3122)	21 411			8 256		
		Optical and electronic equipment operators (ISCO 313)	Broadcasting and telecommunications equipment operators (ISCO 3132)	3 202	12 000*		1 500*		**100 000***
Skill level 2	Clerks (ISCO 4)	Secretaries and keyboard-operating clerks (ISCO 411)	Data entry operators (ISCO 4113)	2 436	35 000*	10 000*	3 000*	45 000*	**1 200 000***
			Calculating-machine operators (ISCO 4114)	896					
	Service workers and shop and market sales workers (ISCO 5)	Shop, stall and market salespersons and demonstrators (ISCO 522)	Salespersons for ICT (ISCO 5221) (CZ)	2 746	9 000*		4 197		
	Craft and related trades workers (ISCO 7)	Electrical and electronic equipment mechanics and fitters (ISCO 724)	Electronics mechanics, fitters and servicers (ISCO 7242)	10 634	45 000		8 168		
			Telegraph and telephone installers and servicers (ISCO 7244)	4 745	50 000		7 135		
			Country	CZ	DE	NL	PT	RO	**EU-15**

fig. 4-4: Numbers of all ICT practitioners in the structure of ISCO-88 (COM)[10]

[10] (EUQuaSIT national results (ISCO-CZ; StBA/BA; CNP/PT; CBS/LFS-NL) and * other data estimated and partly based on Eurostat Labour Force Survey (LFS) data 2000/2001; ** Eurostat Labour Force Survey (LFS) data in Ottens, 2003, p. 59 and CEPIS 2002, p. 38; *** estimated number based on the comparable national numbers and proportions between the numbers of

Correspondingly, the estimation of EU-15 numbers is based on the composition of the national figures as well as the available data of Eurostat's holdings of the national labour force surveys (LFS). The number of 3 700 000 ICT practitioners in Europe includes among others the specific proportion of "Computing professionals" (213) and "Computer associate professionals" (312) (cf. Ottens 2003, p. 59).

In summary the table below compares the total numbers of ICT practitioners for each ISCO-88 skill level (level 4 and the open level - are summarised) taking into account two more European countries, namely the UK and Finland. This comprehensive comparison covers all relevant occupation groups and skill levels of ISCO-88 (COM). This leads to remarkable numbers in those groups usually not covered by Eurostat publications about the ICT labour market. For instance at ISCO-88 skill level 2 a total number of more than 1 million European ICT practitioners is concluded.

National and European workforce numbers of ICT practitioners (2000/2001)
ICT sector and ICT user sectors

Level	Unit groups	CZ	DE	NL	PT	RO	UK***	FI	CS/IBM**	EU-15
		94 785 2 %	800 000* 2.1 %	280 000* 3.5 %	70 000 1.5 %	150 000* 1.7 %	905 000 3.1 %	85 000 3.7 %	6 489 000*	**3 700 000** 2.2 %
Skill level -	Sales and marketing managers (ISCO 1233)	30 813	360 000 (LFS 213 280 000)*	140 000 (LFS 213 130 000)*	23 000 (LFS 213 5 000)*	80 000	380 000 LFS UK SOC 90 126, 214	50 000 (LFS 213 34 000)*	3 123 000 CS/IBM SOC 90 126, 214	**1 600 000** (LFS 213 1 200 000)*
	Computing services managers (ISCO 1236)									
	Production and operations managers in ... communications (ISCO 1226)									
	Managers of small enterprises in transport, storage and communications (ISCO 1316)									
Skill level 4	Computer systems designers, analysts and programmers (ISCO 2131)									
	Computing professionals not elsewhere classified (ISCO 2139)									
	Electronics and telecommunications engineers (ISCO 2144)									
Skill level 3	Electronics and telecommunications engineering technicians (ISCO 3114)	42 515	120 000 (LFS 312 300 000)*	65 000 (LFS 312 130 000)*	25 000 (LFS 312 25 000)*	25 000	315 000 LFS UK SOC 90 320	20 000 (LFS 312 12 000)*	1 885 000 CS/IBM SOC 90 320	**900 000** (LFS 312 1 300 000)*
	Computer assistants (ISCO 3121)									
	Computer equipment operators (ISCO 3122)									
	Broadcasting and telecommunications equipment operators (ISCO 3132)									
Skill level 2	Data entry operators (ISCO 4113)	21 457	320 000	75 000	22 000	45 000	210 000 LFS UK SOC 90 490, 528	15 000	1 044 000 CS/IBM SOC 90 490, 528	**1 200 000***
	Calculating-machine operators (ISCO 4114)									
	Salespersons for ICT (ISCO 5221) (CZ)									
	Electronics mechanics, fitters and servicers (ISCO 7242)									
	Telegraph and telephone installers and servicers (ISCO 7244)									

fig. 4-5: Numbers of all ICT practitioners in the structure of ISCO-88 (COM)[11]

The table contains a comparison of the EUQuaSIT total European numbers to those of a Career Space study on the demand for ICT skills in Europe (Career Space (ICEL) 2001). Whereas the EUQuaSIT number of ICT practitioners at skill level 2 complies with findings of the Career Space / IBM study, great differences occur for skill level 3 and especially for skill level 4 / -. Dif-

ICT practitioners at the skill levels by using the European data and its proportion for ISCO 213 and 312 computer professionals as well as the supplementation of this "IT" data with all other ICT practitioners numbers)

[11] (EUQuaSIT national results (ISCO-CZ; StBA/BA; CNP/PT; CBS/LFS-NL) and *other data estimated and partly based on Eurostat Labour Force Survey (LFS) data 2000/2001 (Ottens, 2003, p. 59; proportions of ISCO 213 and 312 estimated based on CEPIS 2002, p. 38); ; ** Career Space (ICEL) 2001, p. 18 mapped by EUQuaSIT ; ***CEPIS 2002, p. 53, 54, 109

ferent estimations for occupation groups in which not all practitioners are ICT practitioners, for instance "Electronics and telecommunications engineers (ISCO 2144)", may be the cause here.

It can also again be recognised that the mapping of national and European occupation groups (here UK SOC-90 and ISCO-88) leads to differences. For example below the SOC group 490 was mapped to ISCO-88 411 and the SOC group 520 to ISCO-88 724. In summary the report estimates “6 333 000 ICT jobs in Western Europe” with 3.9 per cent of total employment. The big differences of more than 2.6 Mio. is not easy to explain and shows for instance in the proportion to Germany the following problem. By using the 3.9 per cent of total employment Germany would have had in the year 2000 1 509 300 ICT practitioners. But based on the detailed own analyses of the German official occupation statistic (Statistisches Bundesamt StBA) the result is 800 000 ICT practitioners.

For the calculation and forecasts of the demand of ICT practitioners the development of the ICT market is an important indicator. After the massive increase at the end of 1990s the growth of ICT market in Western Europe has been decreasing between 2000 and 2002 with a growth of 4.2 % and 2.6 % in 2001 and 2002 respectively in telecommunications (equipment and carrier services) and even a decrease of -3.4 % in information technology (computer hardware and software) (EITO 2004). However, according to the EITO estimations the economy is currently recovering which is also leading to higher ICT investments and an estimated growth of app. 3 % in 2004 and more than 4 % in 2005. In the global comparison the European trend is similar to the USA and the growth even higher than Japan. The development estimations in the past showed, however, that difficulties occur in regard to both, appraisements on the employment and economic development within the ICT and user sectors.

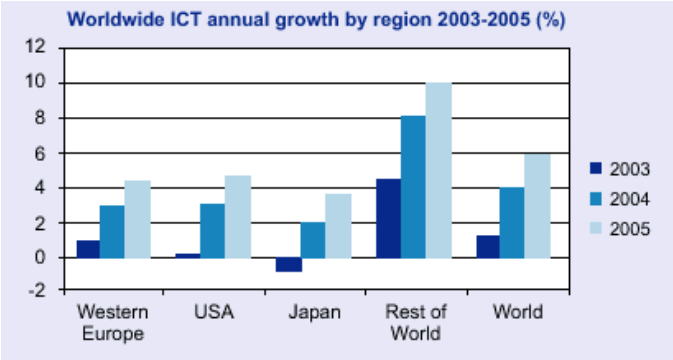


fig. 4-6: Estimated annual growth of the ICT market in a global and European comparison (Source: EITO (2004): European Information Technology Observatory 2004. www.eito.com)

Concerning the interaction of the employment and education system especially questions and data on the actual and future demand of ICT practitioners are important. Based upon recent developments of the ICT business and labour market described above careful forecasts and different scenarios about the future demand of ICT practitioners are possible. Very helpful are also the questionnaire results on the expected change of the number of ICT practitioners in European companies. These results show in a short and medium-term perspective a demand of ICT practitioner in app. 35 % of the evaluated companies of the ICT and user sectors in Europe.

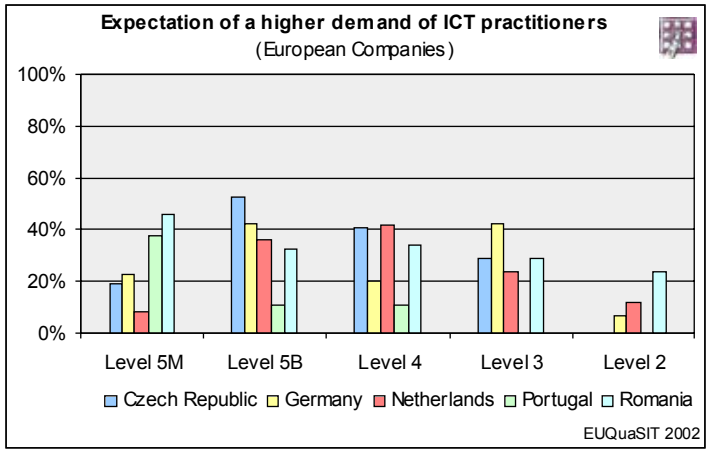


fig. 4-7: Expected change of the number ICT practitioners in European companies for the different skill levels

The results differentiated by level and country partly show significant differences to be further considered in estimations on the future demand and in the supply-demand-perspective of ICT practitioners. Furthermore the survey results indicate a slightly higher demand of companies of the ICT sector.

Europe (EU-15)
ICT practitioner workforce
Numbers and proportions (2000/2001)

Minor group (occupation area)	Workforce 3 700 000	Demand / year 230 000 (3.5 % + 2.5 %)
Information and Communications Technology (ICT) ICT sector and ICT user sectors	ISCO-88 skill level 4 / -	
	1 843 000 50 %	115 000 50 %
	ISCO-88 skill level 3	
	800 000 21 %	50 000 22 %
	ISCO-88 skill level 2	
	1 057 000 29 %	65 000 28 %
Minor group (occupation area)	Workforce	Demand / year

Scenario of 5 % annual growth

Scenario of 2 % annual growth

Europe (EU-15)
ICT practitioner workforce
Numbers and proportions (2000/2001)

Minor group (occupation area)	Workforce 3 700 000	Demand / year 280 000 (5 % + 2.5 %)
Information and Communications Technology (ICT) ICT sector and ICT user sectors	ISCO-88 skill level 4 / -	
	1 843 000 50 %	140 000 50 %
	ISCO-88 skill level 3	
	800 000 21 %	61 000 22 %
	ISCO-88 skill level 2	
	1 057 000 29 %	79 000 28 %
Minor group (occupation area)	Workforce	Demand / year

Europe (EU-15)
ICT practitioner workforce
Numbers and proportions (2000/2001)

Minor group (occupation area)	Workforce 3 700 000	Demand / year 170 000 (2 % + 2.5 %)
Information and Communications Technology (ICT) ICT sector and ICT user sectors	ISCO-88 skill level 4 / -	
	1 843 000 50 %	85 000 50 %
	ISCO-88 skill level 3	
	800 000 21 %	37 000 22 %
	ISCO-88 skill level 2	
	1 057 000 29 %	48 000 28 %
Minor group (occupation area)	Workforce	Demand / year

fig. 4-8: European workforce of ICT practitioner and annual demand based on 3.5 % and 5 % / 2 % growth

Based upon recent developments and these assumptions as well as considering different scenarios of the ICT employment growth between the years 2000 to 2010 the annual increase can be calculated from 2 % to 5 %, with an estimated average of 3.5 % p.a. That means the appraisement of the concrete total demand of ICT practitioners in Europe - including the 3.5 % growth and in addition a 2.5 % replacement demand - can be roughly estimated with some 230 000 ICT practitioners per year. In consideration of these annual needs and a corresponding development until the year 2010 for Europe a total employment of estimated 5 100 000 ICT practitioners seems a realistic and reasonable estimation. On the other hand, therefore less realistic today are the "old" numbers of a huge quantitative shortage of ICT practitioners in Europe, e.g. the predicted 1.6 million shortage by 2004 (IDC 2001, quoted in CSC/Cedefop 2001a, p. 5). A shortage of ICT practitioners is understood as an insufficient number of skilled people in the ICT labour market.

Three ICT labour market growth scenarios with the corresponding demand of ICT practitioners in Europe are presented below: the predicted 3.5 % growth, an 'upper limit' 5 % scenario as well as a 'lower limit' scenario of 2 % annual growth of ICT practitioners in Europe.

4.1.2 ICT employment and ICT practitioner workforce in Europe compared in employment classifications (NACE)

From an employment perspective the total number of 3 700 000 ICT practitioners can be divided in the ICT sector with an estimated 1 700 000 and in the ICT user sectors with app. 2 000 000 ICT practitioners (own estimates based on the LFS). The proportions of the employment of ICT practitioners in the 'ICT sector' and 'ICT user sectors' can therefore be summarised for Europe as follows:

- 45% of ICT practitioners are employed by the ICT sector and
- 55% of ICT practitioners are employed by ICT user sectors

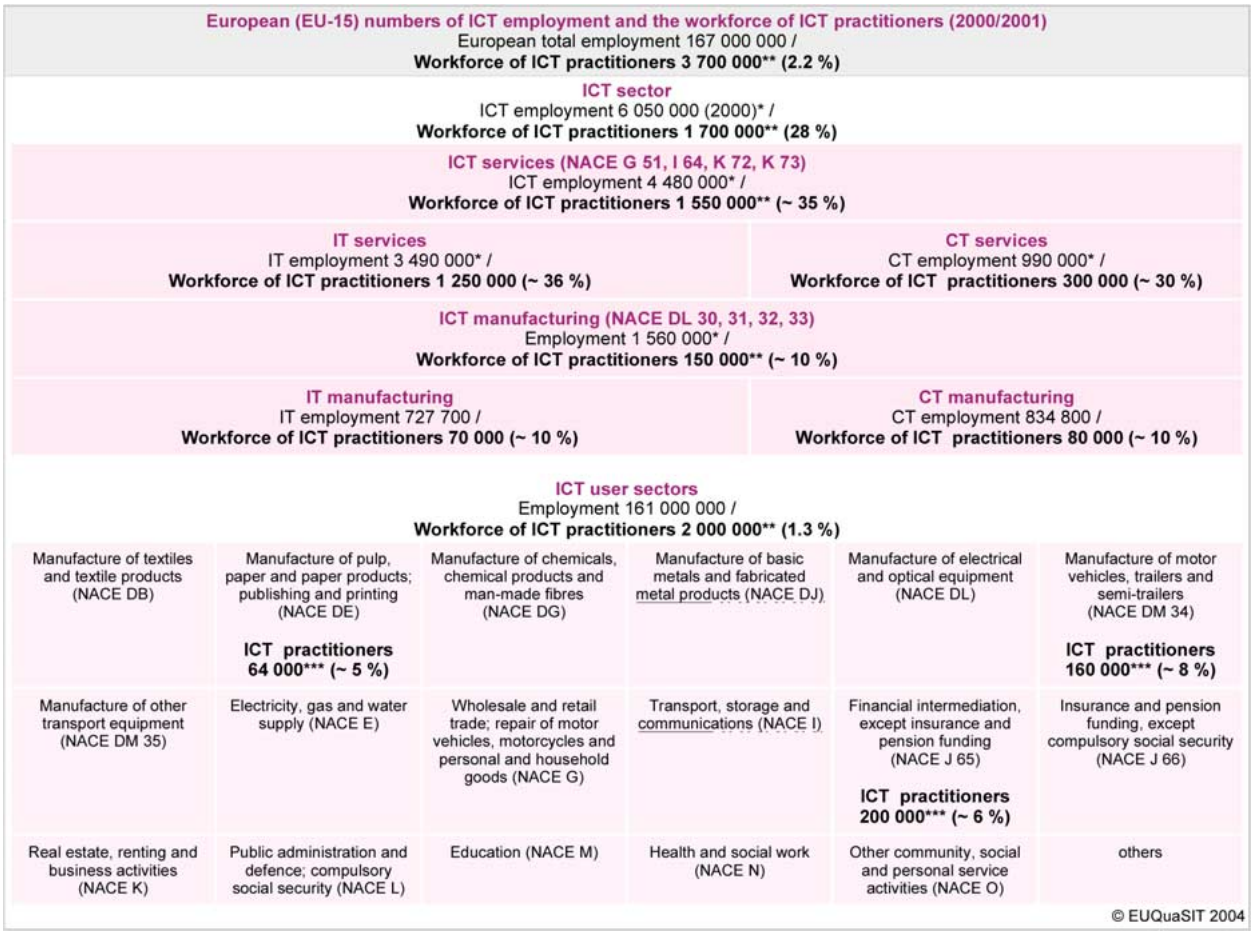


fig. 4-9: Numbers of ICT employment and the workforce of ICT practitioners of the ICT sector and ICT user sectors in the structure of NACE Rev. 1.1[12]

In some economic and labour market contexts the total employment in the ICT sector is interesting and also the proportion of ICT practitioners in regard to the total employment. Overall statistics for Europe show the total employment in the entire ICT service sector is 4 480 000 and in the ICT manufacturing 1 560 000 (cf. Garland, ES 2003, page 3). The concrete workforce of ICT practitioners of the ICT service sector is estimated with some 1 550 000 and thus an ICT practitioner proportion of 35 %. Compared to this result, the ICT manufacturing sector has an ICT practitioner proportion of 'only' 10 %. Therefore the average proportion of the 1 700 000 ICT practitioners in the ICT service and manufacturing sector in regard to the total employment of 6 million in the sector is about 28 %. The reason for the difference of these proportions is that the ICT manufacturing sector covers the production of computers, wire and cable, consumer electronics etc. with a lower proportion of ICT practitioners, for example comparable to other manufacturing sectors. The proportion of the ICT practitioners in the ICT user industries in regard to the employment indicates results between 2 and 10 % (see questionnaire results). Breaking down the ICT practitioners employed by specific ICT user sectors indicates that app. 160 000 are employed in the sector "Manufacture of motor vehicles, trailers and semi-trailers (NACE DM 34)", app. 200 000 in "Financial intermediation, except insurance and pension funding (NACE J 65)" and app. 64 000 in the "Manufacture of pulp, paper and paper products; publishing and printing (NACE DE)". These three ICT user sectors therefore employ app. 20 % of the ICT practitioners of all ICT user sectors (see table above) (cf. Petersen et al, 2004).

In detail for the ICT sector and the countries of the EUQuaSIT project a comparison of the 'ICT employment' and the numbers of ICT practitioners is presented in the table below. Mainly

[12] (* Garland Eurostat, 2003, p. 3; ** Eurostat (2001) Labour Force Survey (LFS) data 2000, EUQuaSIT national results and estimated data 2000/2001; *** Petersen et al, 2004; **** Deiss, Eurostat 2002, p. 3;)

based on Eurostat numbers and partly estimated for own purposes, the figures indicate some national differences of ICT employment in the differentiated categories, namely especially in ICT manufacturing where the economical structure and industry activities as well as the "relative specialisation of ICT manufacturing" (Ottens 2003, p. 13) of European countries is reflected.

ICT sector
National and European numbers of ICT employment and workforce of ICT practitioners

Section	Division	Groups / Classes	CZ**	DE	NL	PT	RO**	EU-15
		Sector ICT employment	151 192	1 122 870	345 700*	94 400*	143 819	6 050 000*
		/ Sector workforce of ICT practitioners	/ 35 500	/ 300 000	/ 110 000	/ 26 000	/ 39 500	/ 1 700 000
		Proportion of employment	24 %	27 %	32 %	28 %	27 %	28 %
IT services			CZ	DE	NL	PT	RO	EU-15
Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (NACE G)	Wholesale trade and commission trade, except of motor vehicles and motorcycles (NACE 51)	Wholesale of computers, computer peripheral equipment and software (NACE 51.84)						
Real estate, renting and business activities (NACE K)	Computer and related activities (NACE 72)	Hardware consultancy (NACE 72.1)						
		Software consultancy and supply (NACE 72.2)						
		Data processing (NACE 72.3)	65 000 / 23 000 35 %	579 200* / 210 000 36 %	217 600* / 83 000 38 %	52 500* / 18 000 35 %	40 000 / 15 000 37 %	3 490 000* / 1 250 000 36 %
		Database activities (NACE 72.4)						
		Maintenance and repair of office, accounting and computing machinery (NACE 72.5)						
		Other computer related activities (NACE 72.6)						
	Research and development (NACE 73)	Research and experimental development on natural sciences and engineering (NSE) (NACE 73.1)						
CT services			CZ	DE	NL	PT	RO	EU-15
Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (NACE G)	Wholesale trade and commission trade, except of motor vehicles and motorcycles (NACE 51)	Wholesale of other electronic parts and equipment (NACE 51.86)						
Transport, storage and communications (NACE I)	Post and telecommunications (NACE 64)	Telecommunications (NACE 64.2)	28 000 / 7 000 25 %	171 400* / 52 500 31 %	62 000* / 20 000 32 %	20 200* / 6 000 30 %	70 000 / 21 000 30 %	990 000* / 300 000 30 %
Real estate, renting and business activities (NACE K)	Research and development (NACE 73)	Research and experimental development on natural sciences and engineering (NSE) (NACE 73.1)						
IT manufacturing			CZ	DE	NL	PT	RO**	EU-15
Manufacture of electrical and optical equipment (NACE DL)	Manufacture of office machinery and computers (NACE 30)	Manufacture of office machinery (NACE 30.01)						
		Manufacture of computers and other information processing equipment (NACE 30.02)						
	Manufacture of electrical machinery and apparatus n.e.c. (NACE 31)	Manufacture of insulated wire and cable (NACE 31.3)	27 437 / 2 500 9 %	201 699 / 20 000 10 %	23 505 / 2 500 11 %	5 140 / 500 10 %	20 000 / 2 000 10 %	727 700 / 70 000 10 %
	Manufacture of medical, precision and optical instruments, watches and clocks (NACE 33)	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment (NACE 33.2)						
		Manufacture of industrial process control equipment (NACE 33.3)						
CT manufacturing			CZ	DE	NL	PT	RO	EU-15
Manufacture of electrical and optical equipment (NACE DL)	Manufacture of radio, television and communication equipment and apparatus (NACE 32)	(NACE 32.1)						
		Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy (NACE 32.2)	30 755 / 3 000 10 %	170 571 / 17 500 10 %	42 518 / 4 500 11 %	16 578 / 1 500 9 %	13 819 / 1 500 11 %	834 800 / 80 000 10 %
		(NACE 32.3)						

fig. 4-10: Numbers of ICT employment and workforce of ICT practitioners of the ICT sector in the structure of NACE Rev. 1.1[13]

[13] (Ottens, 2003, p. 59, *Garland ES, 2003, p. 3, partly from 1999; **EUQuaSIT national results and estimated data 2000/2001; all other data estimated and partly based on Eurostat Labour Force Survey (LFS) data and EUQuaSIT national results (see figure workforce numbers of ICT practitioners above)

4.2 EUQuaSIT's comparative view on numbers of ICT practitioners and ICT trainees / students in Europe

In order to better meet the demand of ICT practitioners in Europe and to prospectively avoid further shortages in certain work areas, for instance as for ICT practitioners at the beginning of this century, the balance of the ICT practitioner workforce and the number of ICT trainees and students at the different skill levels is vital labour market process. But the previous chapters have indicated that the European comparison and nomination of the demand of ICT practitioners from the available information and official statistics still means an enormous challenge and effort.

At European and often even at national and regional levels it is a difficult undertaking to get tailored numbers, both on the ICT practitioner workforce as well as the educational supply. Based on comprehensive analyses and definitions of what is supposed to be covered as the European ICT practitioner workforce the EUQuaSIT results allow to more exactly specify in which occupational areas and at which skill levels the workforce of ICT practitioners is employed and needed in European countries. In correspondence the comparative approach of the project seeks to reflect the supply of ICT practitioners especially from the viewpoint of vocational education and training (VET).

4.2.1 Comparison of the ICT practitioner workforce and ICT trainees / students in Europe

Based on comprehensive analyses and definitions of what is supposed to be covered as the European ICT practitioner workforce the EUQuaSIT results allow to more exactly specify in which occupational areas and at which skill levels the workforce of ICT practitioners is employed and needed in European countries. In correspondence the comparative approach of the project seeks to reflect the supply of ICT practitioners from the viewpoint of ICT qualification profiles and programmes, especially from the vocational education and training (VET) system.

The reference table below summarises the results and provides the numbers of the ICT practitioner workforce and ICT trainees and students for the years 2000/2001 in comparative way. Based on these figures and taking into account an average duration of four years training and studying respectively and a drop out rate, about 220 000 newly qualified ICT practitioner would be available per year on the European labour market. The demand of ICT practitioners is calculated to some 230 000 in Europe, based on 3.5 % growth and a 2.5 % replacement demand, and in correspondence to this demand the estimated number of European ICT students and trainees today is close to meet the demand, quantitatively. But a certain shortage of ICT practitioners is recognisable at specific skill levels as indicated in the table below. For Europe we recognise a shortage of ICT practitioners at skill levels 4 and 5/6, but on the other hand a slight oversupply at skill level 2/3.

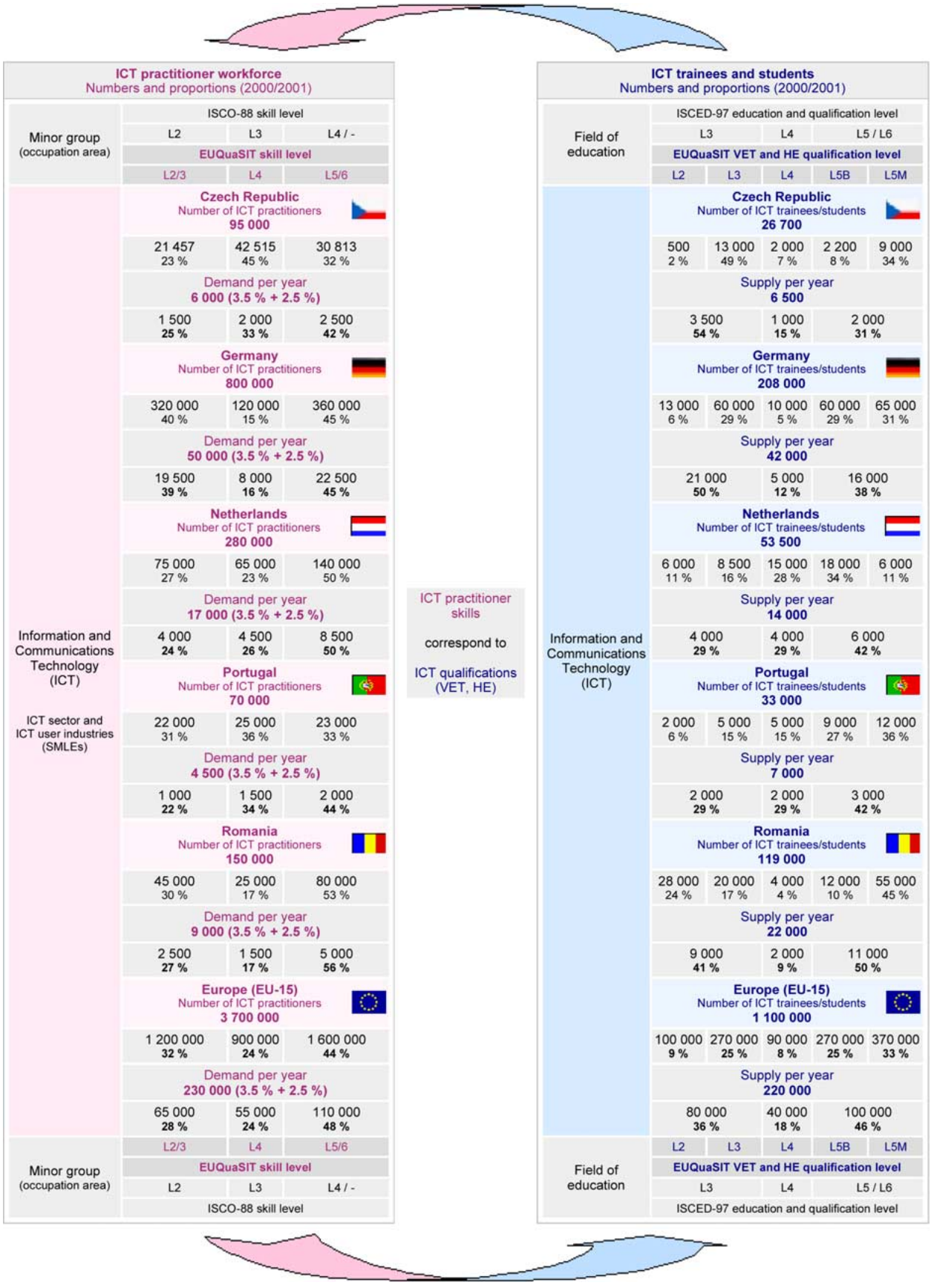


fig. 4-11: Comparison of the ICT practitioner workforce and ICT trainees / students in Europe

The comparison of the numbers of ICT trainees and students in the EUQuaSIT partner countries provide some concrete and level oriented transparency. Of course depending on the vocational education and training (VET) systems of the countries both the numbers of ICT qualifica-

tion profiles as well as the number of trainees and students differ by level. For instance the Czech Republic and Germany have high proportions of almost 50 and 30 % respectively at VET level 3. The Netherlands also have a high proportion of VET trainees, but more at level 4. On the contrary Portugal has less than 30 % of ICT trainees and students at all three VET levels and Romania even less than 20 %. In these two countries the higher education ICT studies are currently much more occupied than VET programmes.

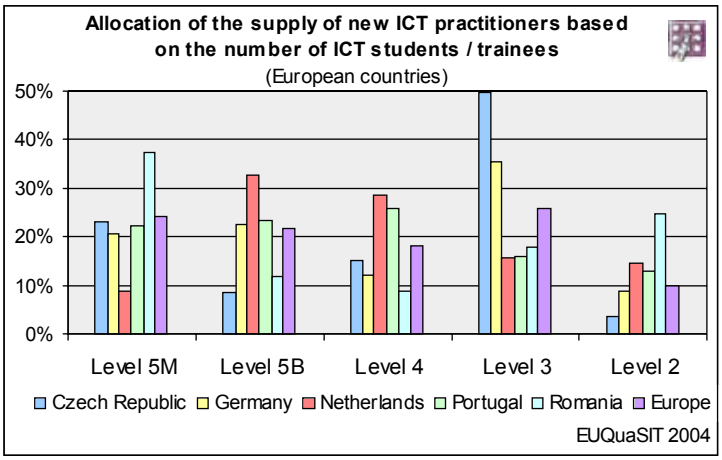


fig. 4-12: Supply of new ICT practitioners based on the number of ICT students / trainees at different levels

The quantitative results of the EUQuaSIT investigations support the indicated developments in supply and demand of ICT practitioners in European countries.

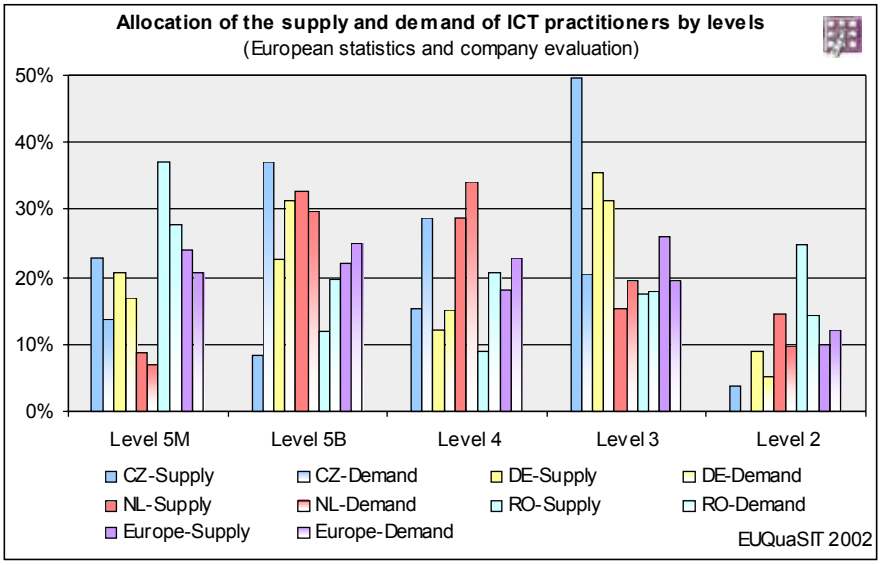


fig. 4-13: Allocation of the supply and demand of ICT practitioners by levels

In summary the EUQuaSIT ICT practitioner workforce and qualifications estimations indicate that the total demand is quantitatively almost being met by the supply, which was also recognised by in the questionnaire survey with a high percentage of companies stating the supply of ICT practitioners was either 'very good' or 'fair'. However, the demand for ICT practitioners needs to be assessed particularly from a qualitative viewpoint, namely that the supply of ICT programmes and training profiles may not sufficiently meet the ICT practitioner and skill needs expressed by companies.

Questions on potential mismatches between the ICT qualification profiles and programmes and the ICT skill needs of the employers - arising from profiles/course/curricula misalignment - were investigated in the case study investigations in companies and ICT training institutions.

And it is always true that the rapid changes in ICT applications and ICT business and work processes leads to substantial changes of the practitioner skills required. Therefore, adequately skilled ICT practitioners are constantly in demand in all European countries and it is one of the major present and future challenges not only to react to this demand but also to provide a tailored frameworks of ICT practitioner skills and qualifications at all different levels.

The following tables summarise the results for Europe and Germany based on the expected demand of ICT practitioners (3.5 % (new) + 2.5 % (replacement)) as well as a further 'scenario' of an annual 5 % increase of the ICT practitioner workforce in Europe.

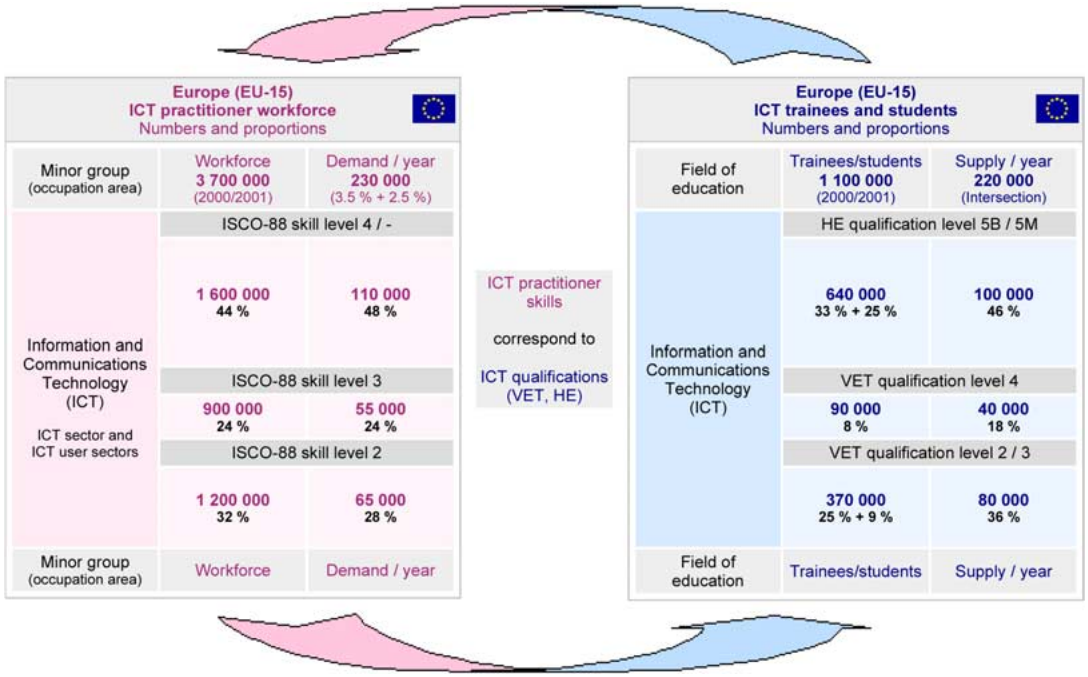


fig. 4-14: European correspondence of the ICT practitioner workforce stock and annual demand on the one side and supply of ICT trainees and students on the other in a quantitative view

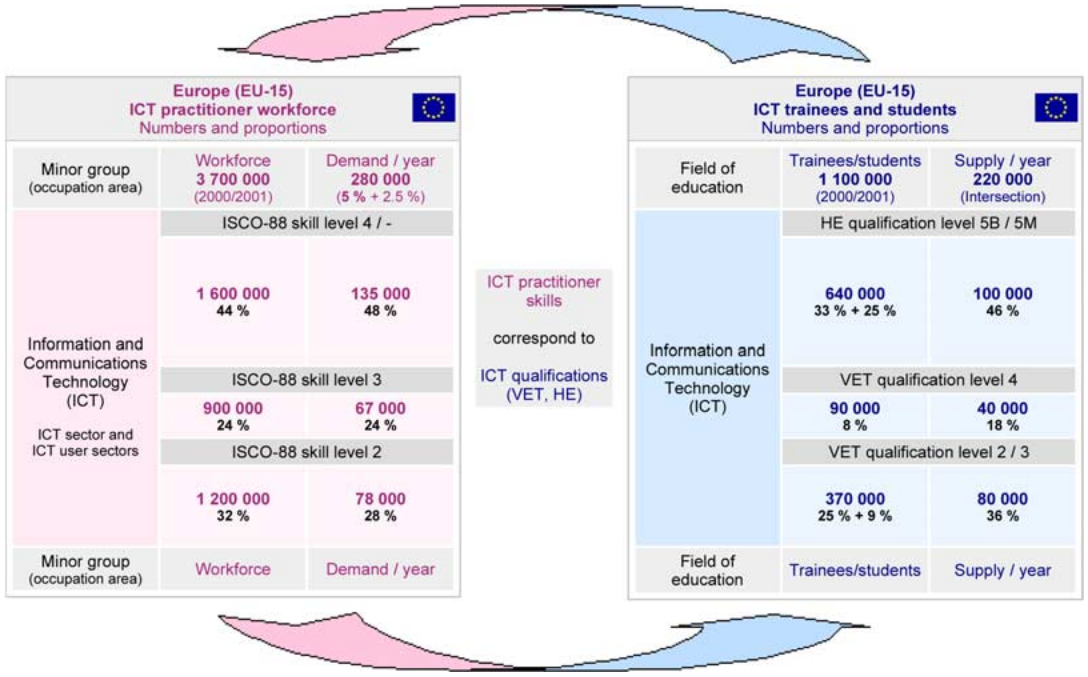


fig. 4-15: European correspondence of the ICT practitioner workforce stock and annual demand on the one side and supply of ICT trainees and students on the other in a quantitative view - 5 % scenario

5 ICT training situation and training institutions in Europe - evaluation and international comparison

Qualifying ICT practitioners certainly confronts us with most of the challenges currently discussed in terms of the relationship between education and the labour market, i.e. skills demand, gap and mismatch by work areas and level. Major challenge especially for the Western European countries is the need for highly qualified ICT practitioners that can compete on the European and global market within the economical circumstances and under significant cost pressure. The role and perspectives of vocational education and training (VET) for instance in ICT systems and software applications production is still not well known, e.g. compared to higher education with a longer tradition in informatics and computer studies.

One of the major objectives of the EUQuaSIT project was to investigate and compare how European education and training institutions deal with the challenge of keeping up-to-date their ICT qualification programmes. Depending on the education and training system these comprehensive surveys in all partner countries indicated the implementation of the analysed ICT qualification profiles and curricula at different levels and fields of training and thus allow conclusions on the quality of the profiles from the viewpoint of the training practice. Of course in this context new qualification strategies, e.g. the challenges and chances of more work oriented ICT qualifications or the European dimension, could be discussed with the training experts. Other important aspects of the investigations concerned specific teaching concepts, the ICT infrastructure and equipment (media) as well as how the training institutions guarantee adequately qualified teaching staff.

The results could be directly reflected against current ICT work and skills requirements of companies investigated in the parallel empirical surveys. One important aspect in this context was how ICT training institutions determine and up-date the goals and contents of ICT education and training and whether they directly collect information for instance through "qualification requirement analyses" like case studies, work analyses and expert interviews in companies.

The synthesis of these questionnaire and case study surveys in the following paragraphs is a comparative piece of work. It tries to stress relevant differences but also indicates good practice suitable to contribute to recommendations on innovative European qualification strategies and frameworks in the field of ICT. However, it is accepted that there is no single European way of qualifying ICT practitioners in terms of training concepts and its implementation, but the results are supposed to contribute to a concrete and mutually trusted European action plan for ICT skills, qualifications and mobility as agreed at the Barcelona European Council in 2002.

The new EU member state Czech Republic as well as the EU acceding country Romania got special attention within these empirical EUQuaSIT investigations. The previous chapters have indicated especially for Romania that ICT qualifications, training concepts and its implementation with an equal significance of vocational education and training (VET) and higher education (HE) strategies do certainly not exist yet.

Based on the case study surveys each project partner has provided a national report available for download on then project website, being the basis of this synthesis.

5.1 Objectives, concept and sample of the surveys in European ICT training institutions

Based on the outcomes of the systematic analysis and documentation as one of the first phases of the project the next part was aiming at empirical results of the acceptance and im-

plementation of ICT vocational training and qualification in training institutions in the partner-countries. This work was needed for a first international comparison of various "European Qualification Strategies in Information and Communications Technology". Concrete objectives were as follows:

- Analysis and survey of the practical implementation of qualification and training profiles (curricula) and ICT qualification strategies in VET, HE and CVT training institutions.
- Analysis of typical challenges and problems of ICT training institutions when providing ICT qualifications in VET, HE or CVT.
- Acceptance and success of special programmes and individual initiatives in ICT training and qualification for females and disabled and disadvantaged groups.

Based on the quantitative research criteria 'size', 'region' and 'ICT qualification profiles available', the delimitation and representative limiting of the sample survey of institutions were chosen. The field of study covers:

- VET, HE and CVT training institutions, colleges and vocational schools (gross sample size about 50 training institutions per partner-country)

and is based on

- common methods and techniques for the data collection and analysis of the questionnaire and case study investigations.

In order to investigate the acceptance and practical implementation of ICT qualification profiles in VET, HE and CVT training institutions the first step to be taken was the use of a questionnaire. The empirical technique was a mailed and online examination. The questionnaire was commonly developed in English and then translated by the project-partners into their national language and sent out with letters and project flyers to the above mentioned number of training institutions, colleges and vocational schools. The online version was available on the project's website www.euquasit.net.

However, in order to compare the results of both, the questionnaires of the companies and the training institutions were developed in a similar structure and content areas, for instance the demand and supply of ICT qualifications, European affairs or the views and experience of special initiatives for increasing the female proportion under ICT practitioners or the chances of disadvantaged groups in ICT work. The analysis of the project outcomes was undergone with statistical computer software like MS Excel and the corresponding presentation through diagrams.

Objectives and concept of the case studies in training institutions

Within the EUQuaSIT case studies in ICT training institutions the practical implementation of ICT qualifications was analysed and evaluated by interviewing people in charge of personnel, management, training and teaching as well as ICT trainees. In addition to the European wide written and online questionnaire, the aim of these more detailed empirical analyses was to obtain comparative results on common and popular ICT teaching- and training concepts. Primary question is how ICT training institutions try to ensure that their concepts, goals and contents at a certain level meet the increasingly complex ICT practitioner skill needs in ICT business and work processes. This does not only cover primary ICT skills in narrow subject sense but also the broad and deep ICT skills requirements in work practice, i.e. including key competences such as language skills (mainly English), team- and communication skills, responsibility, problem solving, creativity etc.

Another objective was to determine if the education and work universe are in balance considering the company survey results on ICT business and work processes and ICT practitioner

skills requirements on the one side, and the ICT qualifications supply, didactic concepts and methodologies as well as learning equipment of training institutions, on the other side. Based on the comprehensive picture to be drawn from the results some conclusions can eventually be made with regard to the planning and optimisation of ICT learning and teaching offers, concepts and practice in a European perspective.

It has always been a major challenge for vocational education training institutions and higher education institutions to be up-to-date in regard to the objectives and contents of their training programmes. Considering the fact - especially in ICT - that expertise and special knowledge in the domain arise rapidly, training institutions permanently face the challenge to implement tailored and prospective didactic solutions in their qualifications. Therefore focus of these studies lies on the question how ICT training institutions make sure they are up-to-date and innovative with their ICT training. The following steps of the concept can be summarised and will be further described and illustrated in the next paragraphs:

A	**>>**	**Overall information of the ICT training institution and number of ICT teachers / trainers and trainees / students**
B	**>>**	**Supply of ICT qualification profiles and programmes (VET, HE, CVT) and planned changes in a short- and medium-term view**
C	**>>**	**Goals and contents of ICT education and training**
D	**>>**	**Organization, learning and media/equipment concepts of ICT education and training**
E	**>>**	**Assessment, examination and certification (own and external) of ICT education and training**
F	**>>**	**Teachers, trainers and lecturers in ICT education and training**
G	**>>**	**Special aspects like female initiatives, integration of disabled and disadvantaged people, European initiatives of ICT education and training etc.**
H	**>>**	**Investigation of specific "good practice" of ICT training and education in the institution**

For a better understanding and classification within the EUQuaSIT project five different qualification levels were defined and used for the investigations. Referring to the ICT qualifications in each country the following definitions were used:

Level	Czech Republic	Germany	Netherlands	Portugal	Romania
VET L2	Secondary vocational training (Střední odborné vzdělávání)	School based ICT qualification (ICT Assistant Profile)	Basic vocational training (kwalificatie basisberoepsopleiding)	Secondary school (Curso Geral de Informática) Ensino Recorrente ICT Assistant	High-school – technological or informatics; training school (Curs liceal – tehnologic sau de informatică; Şcoală profesională)
VET L3	Upper secondary vocational training (Úplné střední odborné vzdělání)	ICT apprenticeship qualification within the dual system (e.g. IT System Electronics)	Professional training (kwalificatie vakopleiding)	Upper secondary vocational training. (Curso Técnico de Informática) ICT or Electronics	Post-high school, improving (training) courses (Curs postliceal, curs de perfecţionare)
VET L4	Post secondary vocational training (Vyšší odborné vzdělání)	Higher vocational ICT qualifications (e.g. Meister, State recognised Technician, ICT Specialists)	Middle management and specialist qualification (kwalificatie middenkaderfunctionaris, specialist)	Post secondary vocational training. (Certificate of Qualification) ICT or Electronics technician.	Continuous training / chief operators schools – with / without other university studies (formare continuă / şcoli de maiştri – cu / fără studii superioare în alte domenii)
HE L5B	First and shorter higher education (HE) qualification at the university (Bachelor studies) (Počáteční a kratší vysokoškolské vzdělání - bakalářské programy)	First and shorter higher education (HE) qualification at the university of applied science (e.g. FH/BA)	Qualification of higher professional education (kwalificatie hoger beroepsonderwijs of Bachelor kwalificatie)	Bachelor in ICT (Faculdade ou Instituto Politécnico) Access to Master degrees	Short term University studies – Higher Education (HE) (Studii universitare de scurtă durată- Invatamant superior)
HE L5M	Higher education (HE) qualification at university level - Master studies (Vysokoškolské vzdělání) (magisterské programy)	Higher education (HE) qualification at university level (e.g. Uni/MA)	Higher education qualification at university level (universitaire kwalificatie of Master kwalificatie)	Higher education qualification at university level; minimum 5 year studies (master degree) (Doctorate + 1 or 2 years)	Long term university studies – Higher education (HE), with or without master degree (studii universitare de lungă durată -Invatamant superior, cu sau fără masterat

fig. 5-1: Definitions of ICT qualifications at different levels in the partner countries used in the EUQuaSIT project

Sample of the questionnaire survey and case studies

In all the partner countries more than 150 ICT training institutions took part in the survey, mainly VET and CVT providers, but also universities and other higher education institutions. This number allowed reliable trend statements on the subject matter as well as in preparation of the case studies. Taking into account the comprehensive questionnaire as well as the European background the sample can be estimated as success.

In the partner countries the case studies described in the following paragraphs were completed seventeen VET training institutions and in six institutes of higher education. Accordingly a number of VET and HE experts in these institutions have been interviewed. These core case studies could be completed by some interviews of CVT providers and companies (offering ICT training in a dual approach). During the case studies a total of about 100 ICT teachers and trainers as well as trainees and students could be interviewed on their specific domains of ICT teaching and learning. The investigated institutions are shown in the structure of their main focus as VET, HE and CVT institutions in the following tables:

Overview of the case studies in VET institutions:

Provider of training	Data / Information	ICT training supply	Code
Public vocational school	5 ICT teachers 420 ICT students	- Digital telecommunication technology (level 3) - Telecommunication mechanician (level 3) - Communication technician (level 2)	CS-TI-CZ-01
Company and vocational school / college	6 ICT teachers 160 ICT students	- Information technology – PC applications (level 3) - Courses for unemployed o Re-training courses in the area of ICT - Courses for teachers of primary and secondary schools o Internet to schools	CS-TI-CZ-02
Public vocational school	12 teachers 560 ICT students	- Automation technics (level 3) - Computer technology applications (level 4) - Courses for teachers of elementary schools, secondary schools and grammar schools o Training of teacher within SIPVZ/P1 – level Z o Training of teacher within SIPVZ/P1 – level P	CS-TI-CZ-03
Public vocational school	18 ICT teachers 660 ICT students	- Electronic computer systems (level 3) - Automation technology (level 3) - Mechanical engineering (level 4) - CVT course CNA (Cisco)	CS-TI-CZ-04
Public vocational school	7 ICT teachers 240 ICT students	- Information technologies – computer applications (level 3) - Courses for teachers of elementary schools, secondary schools and grammar schools o Training of teacher within SIPVZ/P1 – level Z o Training of teacher within SIPVZ/P1 – level P - Course o Internet centre – National programme of computer literacy	CS-TI-CZ-07
Public vocational school	85 ICT teachers 500 ICT apprentices (Part-time) (in Germany this is a large vocational school due to centralisation)	- State Certified Technician in Informatics (Level 4), with integrated entrance qualification for university of applied science (Fachhochschulreife) - Five dual ICT qualifications (Level 3): - IT System Support Specialist - Information Technology Specialist - Information Technology Officer - IT System Electronics - Information Electronics (new offer 2003) - Full-time vocational school in Informatics (1 Year and preparation for dual system VET at level 3) - Technical Secondary School Informatics (following dual system training and entrance qualification for university of applied science)	CS-TI-DE-01
Public vocational school / Private vocational college	7 ICT teachers 50 ICT apprentices 25 master (craftsman) students	- Master (Craftsman) Information Technology (Level 4) - Dual ICT occupation Information Electronics (Level 3)	CS-TI-DE-02
Public vocational school	6 ICT teachers (2 only economical ICT) 20 ICT apprentices	- Dual ICT qualification Information Technology Specialist (Level 3)	CS-TI-DE-04
Private vocational school	10 ICT teachers	- Associate Engineer (Level 3) in - Information and Communications - Information Systems and Economy - Communication Systems - Technical Assistant for Informatics (Level 2)	CS-TI-DE-05
Company	ICT sector Large enterprise (global player in document management) 5 (full-time) ICT trainers + department mentors 70 ICT apprentices	- Dual ICT qualifications (Level 3): - IT System Support Specialist - Information Technology Specialist - IT System Electronics - Parallel dual HE studies for “IT System Support Specialist” (Level 5B) - precondition university entrance qualification)	CS-TI-DE-06
Company	ICT sector Medium enterprise 6 ICT apprentices	- Dual ICT qualifications (Level 3): - IT System Support Specialist - Information Technology Specialist - Information Technology Officer	CS-TI-DE-07

Public / private vocational school	15 ICT teachers 300 ICT students	- Middle Management Employee Administrator ICT (level 4) - Middle Management Employee Computer Interface Engineering (level 4) - Middle Management Employee Office Automation Engineering (level 4) - Assistant Administrator ICT (level 3) - Network Administrator (level 4) - Application Developer (level 4) - Administrator Software Applications (level 4) - Middle Management Employee IT Media Production (level 4)	CS-TI-NL-01
Public / private vocational school	24 ICT teachers 610 ICT students	- Middle Management Employee Administrator ICT (level 4) - Assistant Administrator ICT (level 3) - Network Administrator (level 4) - Application Developer (level 4) - Administrator Software Applications (level 4) - ICT Service worker (level 2)	CS-TI-NL-02
Public / private vocational school	40 ICT teachers 650 ICT students	- Middle Management Employee Administrator ICT (level 4) - Assistant Administrator ICT (level 3) - ICT Service worker (level 2)	CS-TI-NL-03
Private vocational school	35 ICT teachers 254 ICT trainees + variable number of ICT students in non regular part-time courses	- Electronics and Communication Specialist (VET, level 3) - Database Management Specialist (VET, level 4) - Automation Robotics and Industrial Control Specialist (CVT)	CS-TI-PT-03
Private vocational school	35 ICT trainers 350 ICT trainees in full time courses plus a variable number in part-time non regular courses	- CAD/GIS Specialist (VET, level 3) - Microsoft System Engineer (CVT, level 4)	CS-TI-PT-04
Technological high school, post – secondary school education, apprentice school	11 ICT teachers 950 students	- Calculus techniques operator technician (level 2) - Automatic controls technician (level 2) - Electrotechnics technician (level 2) - Electric Installations technician (level 2) - Mechatronics technician (level 2) - Automatic controls technician (Post-Secondary School) (level 3) - 2 years - Electrotechnics specialist (Apprentice School) – level 2-3 years	CS-TI-RO-03
Technological high school, post high school, foremen school, art and vocational school	6 ICT teachers 1420 students	- Automation and Computer Techniques (level 3) - Electro-techniques Technician (level 2) - Electrician Power stations and Electric supply networks (level 4) - Electro-energetic Technician (level 3)	CS-TI-RO-04

Overview of the case studies in HE institutions

Provider of training	Data / Information	ICT Training Supply	Code
Public university of applied science / higher vocational education	35 ICT teachers 880 ICT students	- Applied informatics (level 5B) - Information management (level 5M)	CS-TI-CZ-05
Private university of applied science / higher vocational education	45 ICT teachers 160 ICT students	- Tele-informatics, telecommunication and information technology (level 5B and 5M)	CS-TI-CZ-08
University of applied science / higher professional education	60 ICT teachers 1100 ICT students	- Higher Informatics (level 5B) - Technical Informatics (level 5B) - Informatics (level 5B) - Information Engineering (level 5B) - Media Technology (level 5B)	CS-TI-NL-04

Public university of applied science / higher vocational education	65 ICT teachers 840 ICT students	- Informatics Engineering (Level 5M) - Architectures and Operative Systems (Level 5M) - Multimedia and Graphic Computation (Level 5M) - Artificial Intelligence (Level 5M) - Programming Technology and Methodology (Level 5M) - Information Systems (Level 5M) - Professional Specialization in Informatics Engineering (CVT, Level 4) - Informatics Projects Management (CVT, Level 4) - Development of Information Systems (CVT, Level 4)	CS-TI-PT-01
Higher education institution	8 ICT teachers 500 students	- Economic Informatics (level 5M) - Accounting and Management Informatics (level 5B)	CS-TI-RO-02
Higher education institution	9 ICT teachers 170 Students	- Informatics (level 5B) - Information Technology (level 5B) - Informatics Working for Economics Data (level 5B)	CS-TI-RO-07

Overview of the case studies in CVT insititutions

Provider of training	Data / Information	ICT Training Supply	Code
Public college / institute for further vocational education	11 ICT teachers 840 ICT students	- Computer graphics in electrical engineering (level 4) - Courses for teachers of elementary schools, secondary schools and grammar schools o Training of teacher within SIPVZ/P1 – level Z o Training of teacher within SIPVZ/P1 – level P - Course for primary school pupils o Planeta internet	CS-TI-CZ-06
Private college for continuing vocational training	2 full-time and 15 part-time ICT lecturers 4 classes ICT occupations	- Dual ICT occupation Information Technology Specialist (Level 3) (Full-time re-training, 2 years) - CVT courses in ICT, for instance new courses in Linux	CS-TI-DE-03
Private vocational school	Variable number of ICT teachers (200 in database) 330 ICT apprentices	- Database Manager (CVT) - Network - Installation and Management Specialist (CVT) - Programming Specialist (CVT) - JAVA Server Pages Programming JSP Specialist (CVT) - CAD 3D Operator (VET, level 3) - Applications Certificates (VET, level 3)	CS-TI-PT-02
Technological high school (electronics and telecommunications high school)	28 ICT teachers 990 students	- Electronics technician (level 2) - Telecommunications technician (level 2) - Electrotechnics technician (level 2) - Mathematics-Informatics (level 2)	CS-TI-RO-01
Public vocational school		- CCNA (level 4) - Fundamentals of Unix (level 3)	CS-TI-RO-05
Private vocational school and continuous vocational training institutions	13 ICT teachers 600 Students	- PC operator (level 2) - Network administrator (level 4) - Web Designer (level 4)	CS-TI-RO-06
Private continuous vocational training institution	9 ICT teachers 1100 Students	- Matra/ Nortel Networks/ EADS Telecom (Level 3) - Structured Cabling (Level 3) - Oracle training (Level 4) - PC and ERP applications use (Level 2)	CS-TI-RO-08
Private continuous training institutions	5 ICT Teachers 250 Students	- Computer Network operator and Computer operator (level 2) - Internet and e-mail user (level 2) - Web design (level 2) - Bookkeeping informatics (level 2)	CS-TI-RO-09

5.2 Results and international comparison of the supply and practical implementation of ICT qualification profiles and programmes in European ICT training institutions

The questionnaire and the case study investigations in ICT training institutions focused on the practical implementation of ICT training in the partner countries. This includes an exemplary analysis and evaluation of the demands of teachers and trainers and of the requirements with regard to learning methods, training requisites and media that are being used. In addition, the investigations looked at exceptional didactic features and good practice experience of vocational ICT training in order to have concrete indicators for mutual European qualification approaches.

Supply of vocational education and training (VET) and higher education (HE) in the field of ICT

In addition to the ICT qualification profiles in which the training institutions currently offer vocational education and training, the training institutions were asked whether or not new ICT vocational education and training profiles are to be offered in the near future. The answers show that about half of the training providers plan such action, with the highest percentage in Germany and the lowest of about 30 in Romania. The focus of new profiles is on business and management areas of ICT as well as in new application orientated ICT qualification profiles. In Germany for instance some of the training institutions plan to offer new ICT specialist qualification profiles at level 4 like IT Key Account Manager, IT Trainer etc. In the Netherlands the qualification structure is currently changing under the influence of the development towards a competence oriented qualification structure introducing updated and new qualifications which stimulates training institutions to offer these new and updated profiles.

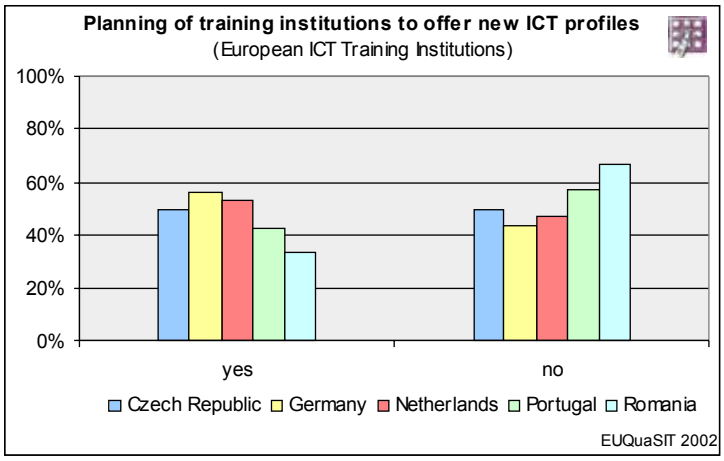


fig. 5-2: Planning of training institutions to offer new ICT profiles

Czech training institution in VET plan to change their offers of ICT trainings mostly because of technical innovation. Also because of practical problems like insufficient classrooms VET training institutions in the Czech Republic change their offer of training. Dutch training institutions have other reasons when they change the offer of trainings. They do this when there is a lack of students and therefore classes get too small. Also if they have information that absolvents with different qualifications are needed by companies and they estimate that enough students can be found to fill a class they introduce new profiles. And if it concerns an apprenticeship training route, when there is a lack of practical training places in companies, which momentarily happens because of the worse getting economic situation, the training institutions will stop offering

the training via the apprenticeship training route and only offer the training via the school-based training route.

Several Dutch VET training institutions experiment with training programmes that have a better link with higher education. Close contacts exist between VET and HE training institutions. In future these experiments of smooth cross-over of VET to HE training need to be institutionalized. At HE training institutions in the Netherlands new training routes in the form of apprenticeship are being introduced.

VET training institutions in the Netherlands all indicate that ICT qualifications cannot exist at level 1 and sometimes there is doubt about the usefulness of ICT qualifications at level 2. They say that many ICT work tasks seem too complex and complicated to be done by a person that only has a level 1 or level 2 qualification. In the countries covered by the EUQuaSIT project HE qualifications in ICT have there place in one of the following four areas: mathematical, technical, economical and graphical/media. In Romania the trend is to reduce the number of HE qualifications through standardization at national level. Regarding content HE in Romania is rather conservative. Curricula are hardly updated to new software instruments and methods. There is little attention for practical works and experiments to be in tune with practical matters and available products on the market. Also the studies at HE levels 5B and 5M, which are currently strictly separated, will be combined like in the Bachelor-Master structure. In Germany, the Netherlands and in the Czech Republic universities of applied science and universities already started to introduce or already have introduced the Bachelor-Master structure.

Supply of continuing vocational training (CVT) in the field of ICT

The results regarding the supply of continuing vocational training (CVT) for ICT practitioners illustrate that CVT courses in the Czech Republic provided also in institutions for VET. In this view Czech training institutions have a close co-operation with the state employment offices as well as with the Internet Centre; an organisation that organises courses aimed at increasing the computer literacy of the general public. In the Netherlands VET as well as HE training institutions have daughter organisations with an own legal status for CVT training to make sure funds from the government do not mix with income from CVT. In Romania VET training institutions can provide CVT courses although not many of them do. In Germany CVT courses in ICT are offered by large private providers. The case study of such a provider in Germany has clearly indicated their market driven and individual approach for instance in difference to the regulated training of vocational schools. However, some vocational schools also try offer some CVT courses, e.g. as a local Cisco academy, but chiefly concentrate on VET offers. Also vocational school teachers and company trainers of course take CVT courses of private providers.

Expectations as regards additional schooling in ICT Systems and Application Development become apparent while the expected number of candidates for additional schooling is notably low in Romania.

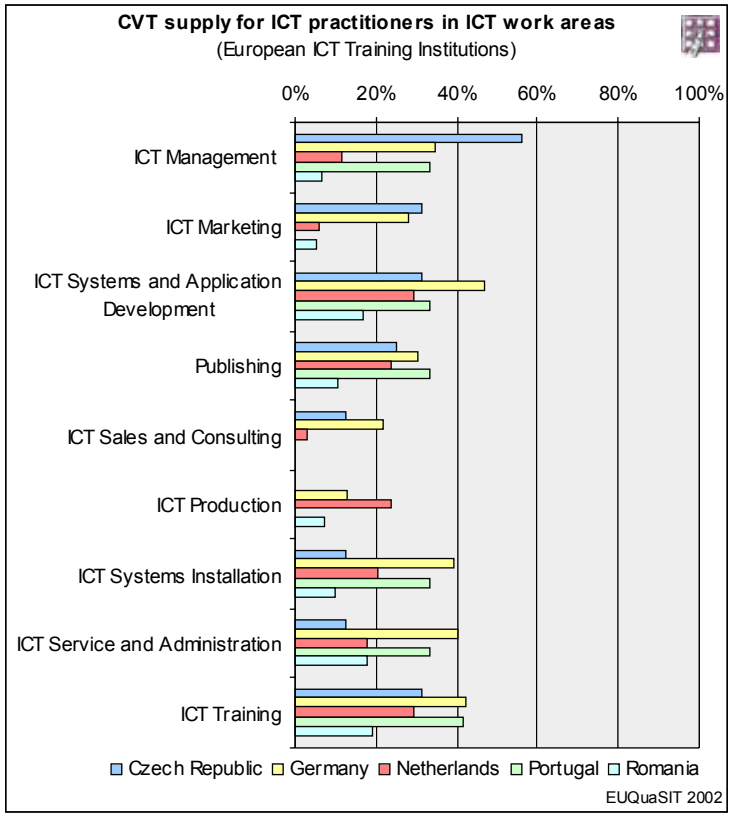


fig. 5-1: CVT supply (absolute) for ICT practitioners in selected ICT work areas

VET and HE training institutions in Germany and the Netherlands integrate into the regular ICT training programme (parts of) curricula of ICT vendor certificates such as Microsoft, CISCO or other ICT players but also provide this training as an extra-curricular subject. Mostly though to receive the adjoining certificate an examination at an external institute needs to be performed because many of the ICT training institutions are not accredited to perform the examination and award these certificates, yet. In Romania and in the Czech Republic HE training institutions also start with the providing of vendor certificates.

5.3 Goals and contents of the ICT qualifications and training

The following results look at the practical implementation of ICT qualification profiles and curricula in VET, CVT and HE in the training institutions as far as the goals and content are concerned. To obtain information on these crucial aspects within the EUQuaSIT project the questionnaire contained two questions on goals and content of ICT training. Also in the case studies these two items were considered in a main block of the interview guidelines.

Keeping up to date with ICT developments

Especially in the field of information and communications technology it is of interest to know, how training providers keep up to date with the rapid development which is taking place on technical aspects.

According to the empirical results of the investigation most training institutions, of whatever type in all partner-countries, use reference books in the specific area of ICT training (see fig. 5-2). Interviews in the Netherlands give us the information that budget for buying reference books is available and adequate. Reference books are still found to be more important than the use of product information and product teaching materials of ICT companies, of which the latter

can be characterised as close a connection with the ICT business market you can have. Reference books, publications in the subject area, internet (newsgroups), specialist journals etc. do not provide any ICT work oriented view which would be an important precondition for the purposeful selection of “tailored” contents.

Especially in Romania the use of material provided by ICT companies as well as the participation of trainers and lecturers at ICT seminars etc. is of little significance. Case studies indicate that in Romania there is no budget for teachers and lecturers to participate at these seminars and that budget for reference books is too low. Whenever teachers or lecturers do participate, they do this on their own expenses. Only university teachers tend to participate because of this. A Portuguese university of science told they find vendor's teaching material especially important, as a base for developing course material.

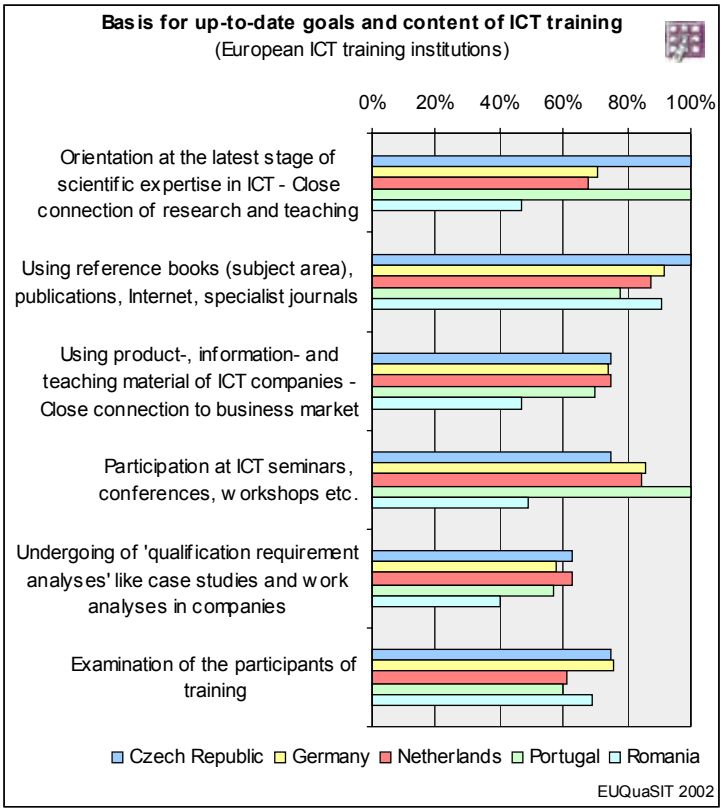


fig. 5-2: Basis for being up to date with the goals and content of ICT training

Although not more than 70 % of the Dutch training institutions say they have a 'connection to the business market' for keeping goals and content of ICT training up to date, the training institutions that participated in the case studies all had contacts with the business market, however not all through the same canals and for the same purpose. Some Dutch training institutions have discussion groups with representatives to improve the training programme and others have closer contact in regard to the practical company training. Although the ICT training institutions itself do not see these contacts mainly for keeping the goals and content of the training up to date the suggestion can be made that their contact to the business market, without knowing, helps them to perform this task. In higher education in the Netherlands the next to last semester is not part of the official curriculum - as in the new Bachelor-Master guidelines - and students can study subjects that they are interested in. Therefore there will be no problems with keeping up to date with this part of the curriculum.

The Czech training institutions that have been interviewed say they have no official partnerships with the business market. Contacts with the business market only occur through personal contacts. These personal contacts however help them to keep the content and goal of the ICT

training up to date looking at the 75% of the Czech training institutions from the questionnaire that said they use the 'connection to the business market' as means for keeping up to date the goals and content of their ICT training.

Goals and content of some of the dual VET courses in Portugal are very close to the needs of companies since these courses have been designed and developed according to viewpoints and concepts of a multinational company which coordinates and manages the training institution that offers them. The curricula of the new ICT qualifications for the Portuguese vocational schools, like all new qualifications within the dual system, are based on so-called learning fields that describe comprehensible learning goals and contents.

In Germany as primary part of the dual training system the results of the case studies clearly indicate that the company ICT training part guarantees a close link to the work reality. Apart from sporadic phases in training departments the ICT qualification in companies is integrated into ICT business and work processes. Goals and content of qualification almost automatically - but of course still depending on the progress of the trainees - fit with the current work tasks. However, this of course nor answer the question of whether the work requirements meet the occupational profiles neither how the contents can best be delivered to “novice” apprentices. In vocational schools as a dual partner or the institutions that offer full-time school based training the link to the business and work reality still is a big challenge. Even though new syllabi require a closer work-activity orientation, VET teachers are confronted with organisational, didactical and practical problems of guaranteeing this link. This lack of work process orientation concerns the goals, contents as well as methods and tools of ICT training. A comprehensive cooperation between training companies and vocational schools is needed at all organisational levels.

Students of Portuguese public schools indicate that because there are little partnership agreements of the school with technological companies the curricula currently being used is not market oriented. However, this discrepancy should be solved with a new curriculum to be implemented in the school year of 2004/2005 which includes on the job training components and project design for students of ICT courses, VET – Level 3 under the national education system.

In Portugal many of the private institutions are based on partnerships with producing companies (hardware and software). This could be one of the reasons that they indicate less problems in keeping up to date the content and goals of their training than public schools and institutions which do not have relations to the business market do.

Furthermore half of the training institutions in the partner-countries undergo qualification requirement analysis like case studies, working analyses and expert interviews in companies. Especially Czech higher education training institutions analyse qualification requirements through interviews with experts in companies or through case studies. Case studies in the Netherlands have not encountered training institutions, neither in VET nor in HE, that question the market or do other research for qualification requirements.

In the case studies Czech higher education institutes pointed out that survey among participants of training aiming at the evaluation of the quality of teaching is quite common. Students make regular, anonymous evaluations of the teaching process and the teachers by completing questionnaires. No alumni are surveyed though. In a private German training institution these evaluations takes place in the same way. None of the interviewed Dutch training institutions have structured contact with students and alumni to review training programmes. Information gathering on the quality of training only occurs in some training institutions occasionally. This happens also occasionally at an interviewed VET training institution in Germany. Here they do not have systematic approaches concerning the questioning of ex-students on quality of training. One reason for this is that time fails them to organize it. Occasionally though they meet quite a lot of ex-students and they often talk about the training they were offered.

In Portugal in higher education it is a common practice do perform case studies, work analysis and expert interviews in companies so that experiences, work process and new methodologies become acknowledged and implemented in the education and training process. However, in VET these means for updating training programmes are still rather rare.

The transfer of information through participation in seminars and conferences as well as the maintenance of the latest scientific knowledge on ICT obtains a very high score in Portugal. From the graph it can be seen that it differs per country if the training institution keeps a close connection to research and development. However from the interviews we know that VET institutions have much less contact with R&D than HE institutions. Czech HE institutions are stimulated to participation in research projects of the Czech Ministry of Education, Fund of Development of Higher Education (FRVŠ) and the Czech Grant Agency (GAČR).

Specific difficulties in keeping up to date with ICT developments

With regard to the difficulties in keeping up to date goals and content of training for ICT practitioners the international comparison points out that problems more often occur for training institutions in Romania than for those in other countries. One of the reasons for this could be that in Romania close contacts between training institutions and ICT companies are rare. In case studies it was also mentioned that qualifications and curricula in Romania are not in close connection with the latest stage of scientific expertise in ICT because – so the interviewees said: 'The Ministry of Education, Research and Youth (MECT) in case of VET, and the National Commission for Academic Evaluation and Accreditation (CNEAA) for HE are involved in the development and do not take into consideration the innovations in ICT'. Case study interviews point out that in Romania HE is less innovative than CVT and VET in the view of innovation of training programmes and qualifications. Curricula have not changed for years and are not updated to new software and hardware and teaching methods.

With regard to ICT business and work orientation German vocational schools clearly have difficulties to ensure tailored goals and contents of ICT qualification and to keep pace with ICT skills requirements. In general the contents are chiefly oriented to the technical basics of ICT rather then to ICT business and work processes. One major cause is a lack of competences of the teachers on real ICT business and work processes. Trainees interviewed stress this aspect as a major cause for their disaffection. This is a fundamental reason why some German vocational schools today also try to attract some experienced ICT practitioners in addition to the vocational school teachers.

From the graph it catches the eye that in the case of the Netherlands and Portugal only minor problems are expected with the adaptations in the general area (see fig. 5-3). Looking in more detail, it appears that the biggest problems are in commercial and business content like ICT Marketing, ICT Sales and Consulting, e-Commerce etc. This goes especially for the majority of Portuguese training institutions. In the Czech Republic, Germany and the Netherlands ‘only’ about one third of the providers see any major difficulties in being up to date with ICT business contents, although a German manager of a training institution stated: 'I am not a tradesman, that is why I am in a training institution and not in a company. Offering marketing and sales subjects is therefore very difficult.' All interviewed Dutch training institutions stated that they will increase the 'economic technical' oriented subjects in the near future: 'Because ICT practitioners need this in working life more and more'. Also for Portuguese training institutions is a major problem to realize the combination of technical and economic oriented contents. Simply due to the fact that content such as ICT marketing, consulting and sales can certainly best be professionally generated from a work oriented perspective, especially vocational schools have difficulties to link the economic oriented contents to ICT subjects. The same was found for ICT project management. A Portuguese university of applied science stated that surely more attention is

needed for ICT marketing, consulting, sales etc, but that in their project oriented learning the focus will be on the technical solution and afterwards on the business / marketing aspects.

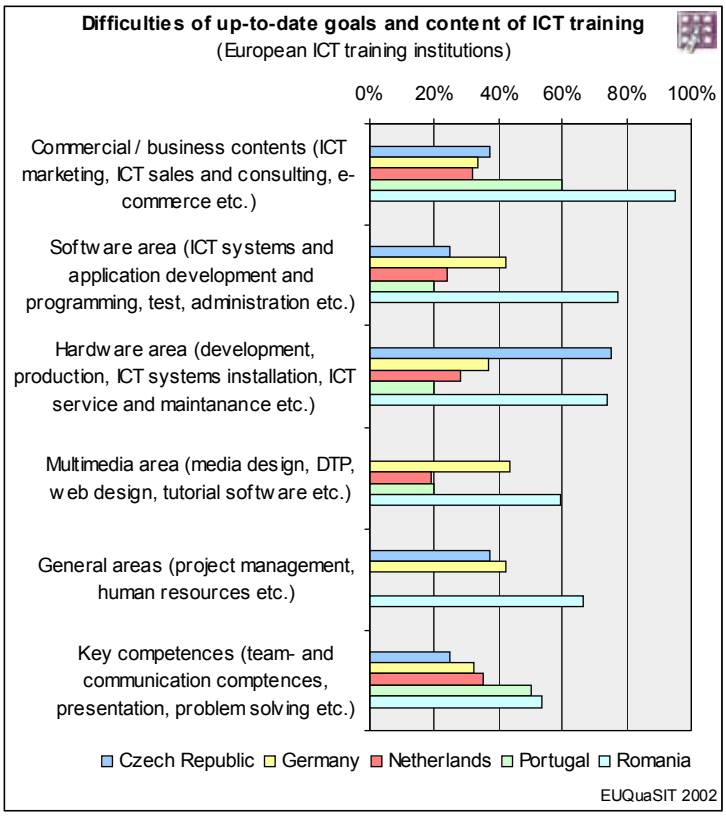


fig. 5-3: Difficulties of keeping up to date goals and content of ICT training

Czech and Romanian training institutions especially see difficulties in keeping up to date with hardware equipment. They do not have the budget to realize up to date hardware and therefore also have trouble keeping the content of the hardware area up to date. For the same reason of a too low budget there is a low penetration of computers in the Czech and Romanian training institutions compared to the other partner-countries.

5.4 Organization, learning and media/equipment concepts of ICT education and training (HE, VET, CVT)

This chapter deals with the concepts of organisation, methodology and requisites for ICT education and training. As for the goals and concepts special attention was given to the fact that these aspects play a major role in the development of the ICT training institutions as well as their didactic and methodological approaches. The tailored implementation of new curricula, that were worked out in recent years, challenges all training companies and ICT training institutions. However, it was acknowledged in the case studies and their analyses that different organisational approaches can be successful depending on the general and specific conditions, advising the acceptance of a methodological diversity.

Organisation of ICT education and training

The structure and organisation of ICT education and training is quite different with some of the EUQuaSIT partner-countries. Before you see the graph it is important to note that several answers could have been given in the questionnaire. It is quite visible that most of the education

and training is organised on an internal basis in the Netherlands, Portugal and Romania (see fig. 5-4).

In the Netherlands the training providers very often have ICT training taking place inside the institution including the acquisition of practical work experience, yet they also combine the efforts of the institution and an outside company in a systematic dual concept of vocational training. This is practised in half of the training institutions in Germany as well. A private continuous training institution in Portugal that has a partnership with a branch of the Siemens company in Portugal, indicates that is provides training 'according to the German system of Training of Alternation'.

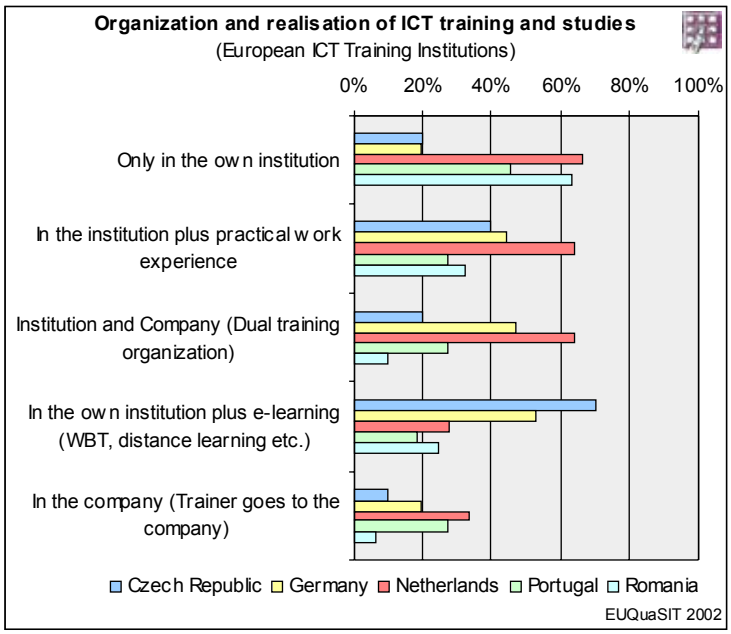


fig. 5-4: Organization of ICT training and qualification concepts

Concepts focusing on training in the institution along with e-learning like WBT, tele-learning, long distance learning etc. are mainly practised in the Czech Republic and Germany. A Portuguese university of applied science told that their major change and innovation was the implementation of several courses available online. In the Netherlands in general it looks as if the organisation varies a lot, whereas in Romania organisation is almost always limited to ‘the own organisation’ sometimes combined with practical work experience.

The majority of the Romanian training institutions organized training as classroom teaching or lectures followed by practical works on the items taught. Some of the subjects come with additional learning items, e.g. projects, short individual presentations. Students perform all project tasks alone; team work is not really encouraged. Changes in the Romanian learning methods were started after introducing open and distance learning – partly as experiments, partly as the new education form encouraged to replace previous evening classes as form of education.

From the 90's in the Czech Republic the percentage of practical experience within the training programme was cut to 20 – 25 %. Instead of more compulsory practical experience an extended teaching of general subjects was introduced which had a negative impact on the (still needed) manual skills of the trainees. Also the number of qualifications got reduced down to two qualifications in ICT on level 2. In total 91 public and private training institutions in the Czech Republic train pupils for qualifications on the levels 2, 3 and 4. Level 3 qualifications are mostly hardware oriented; the graduates can work in the area of computer installation and servicing. Level 4 qualifications are more software oriented; aiming at programming. Typical for training for level 4 qualifications is the length of the practical training in a company that can range from two to six

months; however the quality of this training varies. At level 2 and 3 training the practical training in companies is much less or not practiced at all.

In the Czech Republic school-training is organized as classroom training or lectures, project learning, CBT or WBT. There is a growing tendency of self-study supported by technical literature, specialised press and internet as well as various forms of e-learning. Within the Portuguese dual system of initial VET the training was done using concepts of alternate training in class rooms with training in workshops and on job training. Due to the more project-oriented methodology used in private training institutions that are coordinated and managed by industry associations, private institutes and ICT training dedicated companies, the number of trainees here is growing where this is not the fact on public training institutions. Although the project-oriented approach seems to work some of the interviewees have mentioned the difficulty of developing projects for training that are close to the world of work. The case studies and questionnaire analyses show that daily teaching in Portuguese vocational schools is still dominated by class room teaching and a teacher centred approach.

The Dutch VET system knows two training routes; one is the apprenticeship and the other comprises training in school combined with a practical period in a company. In the Netherlands students in VET and HE are obligated to do a practical training or apprenticeship in an accredited training company. Although it sounds strange some VET training institutions have within the school an accredited training company and can therefore supply practical training places for some of their own students within the institution itself.

In the Netherlands almost all school-training for ICT qualifications is provided in the form of project-oriented learning. Individual study and team-work is being stimulated. All Dutch VET Training Institutions have so-called 'open-learning centres' by which students are stimulated to do self-study. Training usually has some classroom training in the beginning of the course (first six months to first year) to teach some basic knowledge. After this practically all the rest of the training is practiced as project-oriented learning. With project-oriented learning there comes a different role for the teacher. The role of a teacher in project-oriented learning is that of a coach or tutor that guides students. In this way of training often portfolios are being used at assessment.

In Germany the results on organisational structures of ICT qualification vary considerably depending on the place of learning, i.e. company, public vocational school or private training suppliers. Especially the company organisation furthermore depends on the size. In small enterprises the apprentices are directly involved in the ICT work, with more or less complex work tasks, whereas large companies still have training departments, which actually change to more training organisers (in the sense of human resources development), that only organise the ICT training and the allocation of the apprentices and students to the different teams and departments.

In the company surveys in Germany the trainees stressed the advantages of being integrated into the work of the ICT teams. On the other hand there are also more critical comments on the concept, e.g.: „A big problem is that some of the projects are not suitable for me, so that I do not have the technical background needed to carry out the tasks“, a trainee said.

In continuing vocational education and training (CVT) a large percentage of training providers in the Czech Republic have regular evening and weekend courses. This happens far less in the other countries. The results show however that several training institutions in the partner-countries do have experience in offering evening and weekend continuous vocational training courses.

Didactic concepts and ICT training methods

All didactic concepts and methodologies for training and teaching are used to a more or lesser extent. The frequent use of WBT and CBT in the Czech Republic is notable. Classroom teaching – direct and teacher oriented - happens nearly equally often in all countries. Training at a special training company appears least of all. See the results shown in fig. 5-5.

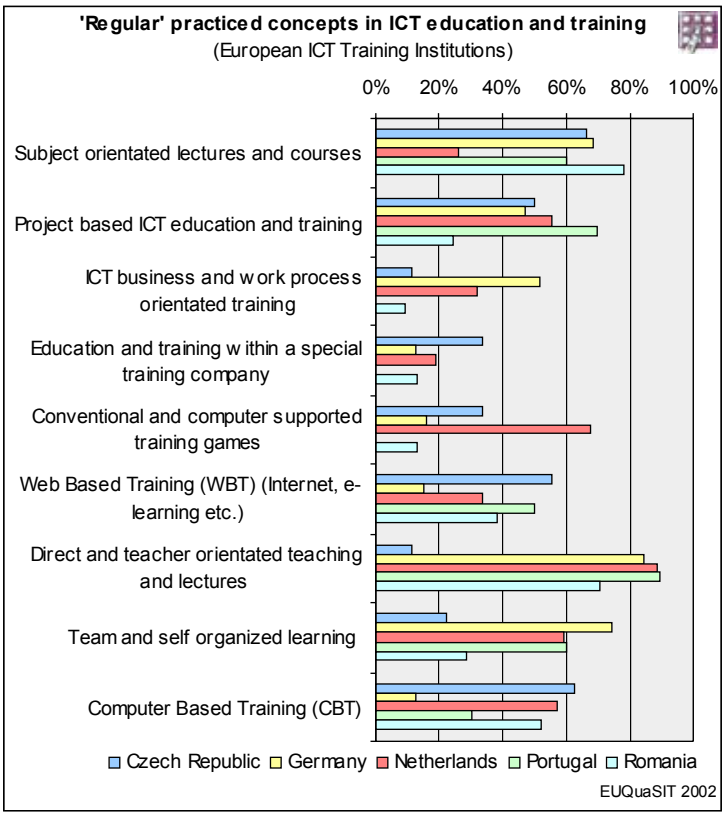


fig. 5-5: Practiced didactical concepts in ICT education and training

In the Czech Republic fluency in foreign languages, predominantly English, is mainly taught in an integrated way. All countries prefer to offer the subjects of the organisation of work and the solution of problems in an integrated manner. From the case studies it is clear that training institutions have not yet found the best solution on how to teach and train the different types of key competences. Many of the training institutions interviewed are not sure what the best didactical way is to offer instruction and training of the different key competences.

Learning and training equipment in ICT

The last question in this part of the questionnaire concerns learning and training equipment in ICT. It is highly relevant to have the right equipment in order to ensure a high quality in practice orientated teaching and training. The training institutions were therefore asked in which areas of media and requisites they see problems and challenges concerning aspects like cost, procuring, administration, and maintenance of equipment. The international comparison indicates that the biggest problems with regard to the actual ICT training equipment exist in the Czech Republic and Romania (see fig. 5-6). Interviewed VET training institutions in the Czech Republic say they finance the purchase of new hardware funded through the budget of the institute's founder, from financial reserves and for an important part from sponsor donations. Also all kind of extra efforts are undertaken to create the required budget for updating software, mainly through state subsidies, projects, sponsoring or own commercial activities (courses and trainings). In Czech HE grants are the most important source of funding for updating hardware and software. In the Netherlands Software is being bought using the low-cost school-licences. In the last years a

large investment was done by the Portuguese government to provide schools and universities with the appropriate equipment if not in number at least in quality. The problem however is that equipment is rapidly becoming obsolete and the financial capacity for replacement is not ensured in all cases.

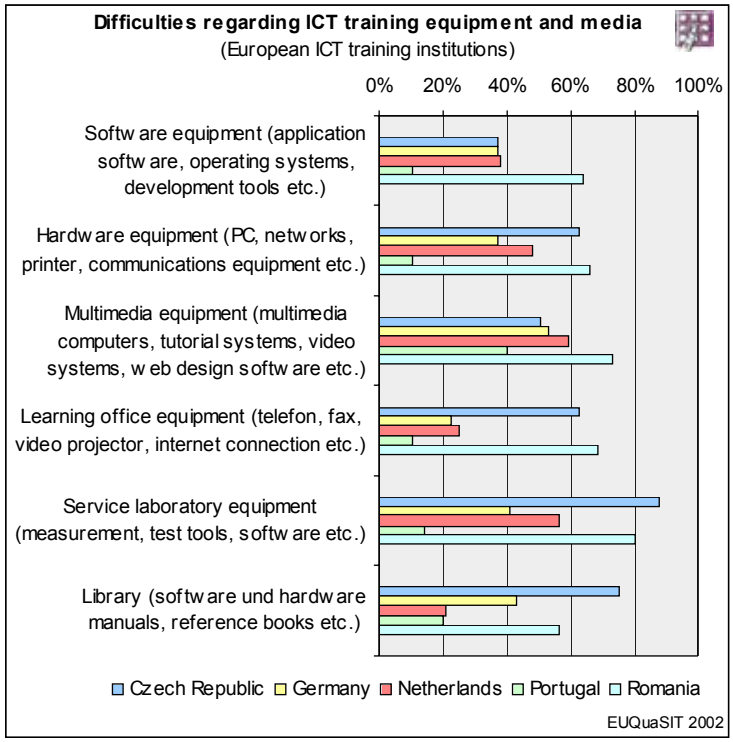


fig. 5-6: Difficulties of keeping up to date with ICT training equipment

Interesting to know is that training institutions might have indicated that they have problems keeping up to date for example hardware equipment (about 45% in the Netherlands), but that they might not see this as a problem in keeping the education and training on a high quality standard. A Dutch manager of ICT training department states on this: 'I have to write off my pc-s in 4 years instead of the regular 3 years. This means that they break down more often and have to be upgraded more in between. This however is no problem concerning the training.'

In the Czech Republic public training institutions that train on level 3 have more lack of funds and also teaching equipment is less sufficient compared to private training institutions. Private schools charge a tuition fee which gives them the necessary financial resources to stay up-to-date with both hardware and software. This creates a clear difference in quality of training between public and private training institutions.

Internet access in Romania is offered via RoEduNet (Romanian Education Network) to about 460 (mainly training) institutions. Although some training institutions might have contracted other providers this indicates that not all institutions have a good internet connection. All VET Training institutions in the Netherlands are connected to the internet via Kennisnet (the internet organisation of and by the educational field) and all HE Training institutions are connected via SURFnet (the national computer network for higher education and research in the Netherlands). The results of the questionnaire indicate therefore only little problems for Dutch VET and HE Training institutions and big problems for Romanian institutions.

ICT training institutions, especially in Germany and in Portugal, indicated that administration and maintenance of the ICT systems, e.g. networks, servers, databases is a huge problem. Normally there are no extra human resources available so that teachers themselves often take over these tasks as well. They have to do back-ups etc. in weekends.

5.5 Assessment and examination

At all forms of training, Romanian examination proceeds as written and practical works (programmes or project applications). Evaluation is made by the teacher or for the final examination by a commission that comprises teachers of more subjects. Practical work weights 50% or 60% in the final mark.

Dutch examinations are mostly in the form of continuous assessment through project work, presentations and task-review. Traditional written en practical tests have practically disappeared although sometimes they are being practiced at level 2 trainings. Also in Dutch higher education examination is mostly done not anymore through tests (whether theory or practise) but with continuous judgement using portfolios, project presentation and assessment of proven competence.

In the Czech Republic for the final evaluation of VET students a combination of at least two of the following forms is used: oral exam, written exam, practical exam. In higher education the final evaluation is usually based on the oral exam and quality of a thesis. One of the most common CVT certificates is the ECDL certificate.

What is especially in Portugal important is to adopt as soon as possible a practical view on examination orienting to the occupational competencies instead of academic views. Several students and trainers have mentioned this aspect and everything seems consensual for those solutions to be implemented in the future.

One of the “most explosive” topics in all German case studies was the assessment and examination of ICT qualifications. Especially within the dual system the apprentices massively complain about the examinations and the corresponding preparation. Primary problem are the written exams that often do not adequately examine the complexity of occupational competences. This confirms that it is a major challenge to create exams that focus on the specific tasks of each ICT occupation.

On the contrary the concept of examination projects as a final part of the company training is much more popular with German trainees. However, it is not always easy for the companies to find adequate projects for the trainees to do their final examination on.

5.6 Teachers, trainers and lecturers in ICT education and training (HE, VET, CVT)

In addition to the questions concerning ICT teaching concepts, media and equipment one of the major categories in ICT vocational education and training is ‘teachers, trainers and lecturers’. The outcome is presented in this part of the report.

Employment of ICT trainers, teachers and lecturers

In Romania all teachers are required to have a graduation in the field they want to teach. Czech teachers in theory teaching, whether in HE or in VET, need a university degree in a relevant area, for teaching laboratory training they need a level 4 qualification in a relevant area. A smaller percentage of them are secondary school graduates (who mostly attend a university and plan to get a degree) or are graduates of a university of applied science. Most of the Czech teachers in HE are assistant professor or participant in a doctoral programme. Dutch teachers need a teacher-training on level 5B before they can teach in VET. To be able to teach in HE they need a teacher-training on level 5M. All Dutch teachers in the interviewed training institutions have the obligated qualification.

In Romania, as a proof of knowledge and skill, teachers in universities have to issue the courses they teach as books. In interviews Czech teachers in VET as well as HE said further study at universities, training organised by other providers of ICT training, participation at trainings about products of ICT companies and participation at organised training of teachers are the most important ways of keeping up-to-date their qualification of ICT teacher. The most effective way to update knowledge for VET teachers is involvement into the practical experience and relevant ICT processes in companies or self-study. For HE teachers the most efficient way to update their knowledge are research groups, use of e-learning, involvement in the practical experience and relevant ICT processes in companies.

Because most of the Dutch training institutions provide training in project-oriented training they need a new kind of teachers. For traditional teachers it is difficult to perform the new tasks that come with this way of training. Training institutions in VET have problems finding good 'new' teachers, although all of them have the obligated qualification. An interviewed Dutch VET training institution explains that with special attention and training for the teachers this problem of finding good 'new' teachers can be overcome. In a German training institution for VET training in the 'Handwerk' sector another problem is indicated. The difficulty there is that practical trainers in the companies are mostly older persons that have problems staying up-to-date in modern technology, so training ICT students is difficult. Younger workers don't want to train students because in the 'Handwerk' sector companies are mostly small and younger persons want first to ensure the stability of their company before focussing on training.

Dutch teachers in VET have sometimes problems with staying in touch with practical and job-related ICT knowledge and skills. Sometimes they keep in touch with the real practice through the guidance of students at their practical training in companies. In HE experiments are undergone for short trainee periods for teachers within companies. A German training institution stated that they do see the use of going into companies to keep up-to-date but don’t do it anyway. On the other hand an external teacher from a private VET and CVT training institution says a practice period of a teacher / trainer in a company is not so useful. It would be better to organize, with help of a company, practice-oriented projects for teachers / trainers within the training institution.

It is of interest to know what type of ICT trainers, teachers and lecturers the training providers employ. From the surveys it can be seen that the average share of own and temporary ICT trainers employed by the training institutions is about 50/50. This percentage also accounts for the Czech Republic and the Netherlands. In the Netherlands also occasionally guest speakers from a company are invited to the training institution. In Romania and Portugal the majority of ICT training staff is still company related, whereas in Germany the number of temporary external ICT trainers chiefly in CVT is significantly higher than the own training workforce.

Keeping up to date subject orientated and didactic qualifications

The important question concerning the ICT trainers is how they keep their subject orientated and didactic qualifications up to date. The ways in which teachers keep their knowledge up to the mark or increase it are manifold. It is striking that in the Czech Republic they do not participate in product training by ICT companies, whereas they do make use of ICT training possibilities to an extent of 90%. A German VET training institution does not participate in product training of ICT companies because: 'We don't get invited for this' - being a training institution and not a company. In the case studies Portuguese teachers of lower level training have also mentioned the difficulty to reach product contents of ICT companies in special the big ones who specify things as confidential or “secret”.

Teachers in Romania mostly depend on themselves for keeping up-to-date with ICT knowledge. In state institutions there are limited funds granted for teachers’ participation to work-

shops and training, and in private institutions there are almost no funds for this. Czech teachers only have limited possibilities to participate at seminars, conferences, ICT trade fairs or exhibitions. On higher education level there are wider possibilities to participate. Dutch VET Teachers stay up-to-date mostly by visiting seminars, congresses etc. HE teachers can subscribe for courses and go to conferences on their own initiative, however the participation of teachers should be higher, a Dutch HE training institution stated, but teachers mostly don't find the time. In the Netherlands participation in teacher training is nearly 100%.

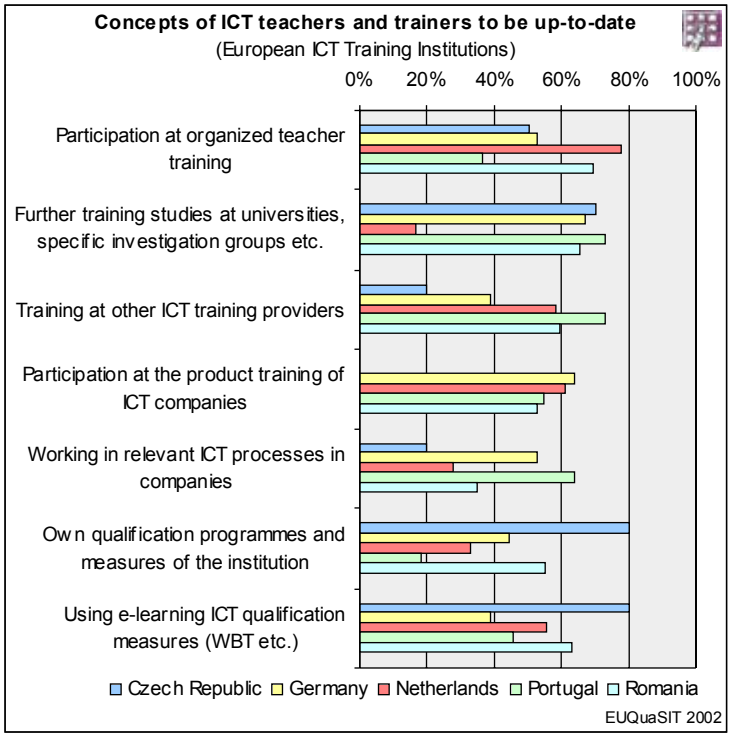


fig. 5-7: Concepts of ICT trainers to be up to date in subject and didactics

The results point out significant differences between the EUQuaSIT partner countries again, as illustrated in fig. 5-7.

For Portugal it is important that schools, universities and ICT training institutions promote new relationships with ICT and non ICT companies allowing teacher's observation and investigation of methods, work processes and projects and transmit that experience to the students and trainees. This could also encourage many of them to create more project-oriented teaching.

5.7 Female participation and special initiatives

This next part of the report concerns itself with the actual rate of female ICT trainees. Also special courses for women and the effectiveness thereof as well as special initiative to promote and increase the share of women in ICT training is dealt with.

Providers of training as well as companies were asked about the proportion of females in ICT courses and in their company. The results as illustrated in fig. 5-8 indicate that the presence of women in ICT courses (HE, VET and CVT) is highest in Romania with almost 50%. In accordance with this, their share in companies is higher than in the other partner countries as well, although the difference here is smaller. In Portugal also the share of women in companies is bigger than in the other partner-countries. It is clear that the number of women among ICT prac-

titioners in companies is lower than in ICT courses. This effect is most clearly visible for the Czech Republic and Germany.

The interviewed Czech training institutions told from experience that the female share in vocational education differs per study area. For example in VET in telecommunications the percentage of women is around 18%, in the area of information technologies it is about 10% and in electrical branches the percentage of women is approximately 3%. In HE in the area of teleinformatics, telecommunications and information technology the percentage of women is very low while in study areas such as applied information science or information management women represent between one third and one half of all students. At Portuguese university level, the number of female students is surprisingly enough even higher than the number of males.

At a case study in a Dutch university of applies science it was told that for the full-time studies only 3% of the students are female. At this institution however surprisingly different is the situation for the part-time studies, where about 20% of the students are female.

Comparison of female proportions in ICT

	Companies	VET, HE	CVT
Czech Republic	9%	36%	16%
Germany	8%	18%	26%
The Netherlands	10%	11%	21%
Portugal	20%	36%	22%
Romania	25%	47%	52%

fig. 5-8: Comparison of the share of women in companies and in ICT courses
(from the investigated institutions and companies)

However in all training institutions in the partner-countries, special ICT initiatives, programmes and projects in order to promote and increase the female proportion in the ICT field are very rare. In Portugal they do not have special initiatives – so they stated at the interviewed training institutions - because of their already high percentage of female students in ICT.

In Germany up to 20% of the training providers offer ICT qualifications for women only or directed specially at women, or have special ICT qualifications with women as teachers and trainers. The continuing schooling in Portugal has only been adapted as regards didactics and methodology, while in the Netherlands an adaptation has taken place on the base of the content of the course. Women teachers are active in this country as well (see fig. 5-9). The percentage of women teachers is higher than the percentage of female students.

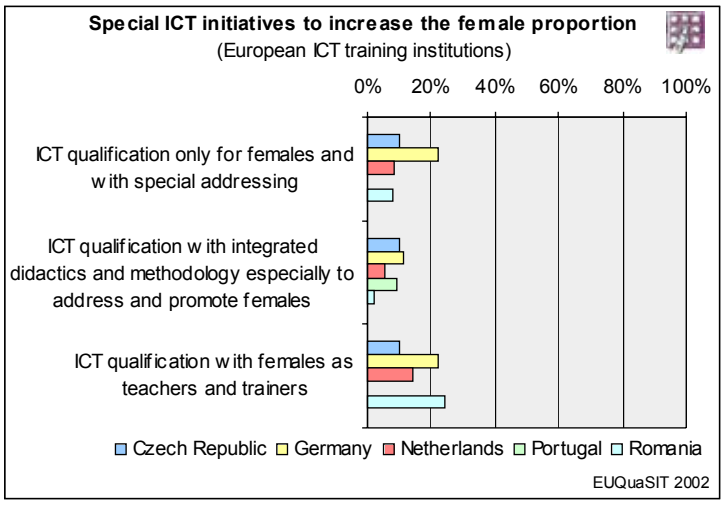


fig. 5-9: Special initiatives in order to increase the female proportion

When asked about the chance of success of initiatives to promote and increase the presence of women in ICT courses, especially a big number of training institutions in Portugal and Romania are optimistic (see fig. 5-10). This result certainly correlates with relatively high proportions of females, both in companies and ICT education and training (see again in table above). In Germany about half of the companies state that ICT qualification for women only or special ICT qualification with women as teachers and trainers have a good change of success, whereas integrated didactics and teaching methods especially directed at women seem less attractive to training institutions in Germany. In the Czech Republic and the Netherlands less than 20% of the training providers think that this kind of special initiatives will be a success.

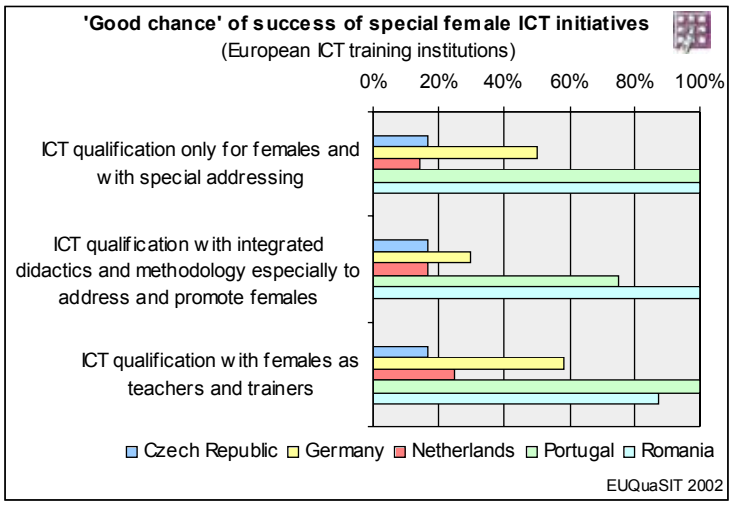


fig. 5-10: Good chance of success as special female ICT initiatives

Integration of disabled and disadvantaged people

With regard to the experience with ICT education and training with a focus on the integration of disadvantaged and handicapped people, it is mainly the training institutions in the Czech Republic and Romania which do not see any problems (see fig. 5-11). However, just a little number of about 20% of the training providers for example in Germany and the Netherlands think this is problematic. Solutions are found in the adaptation of the building and/or the working place: a lift is built, for example.

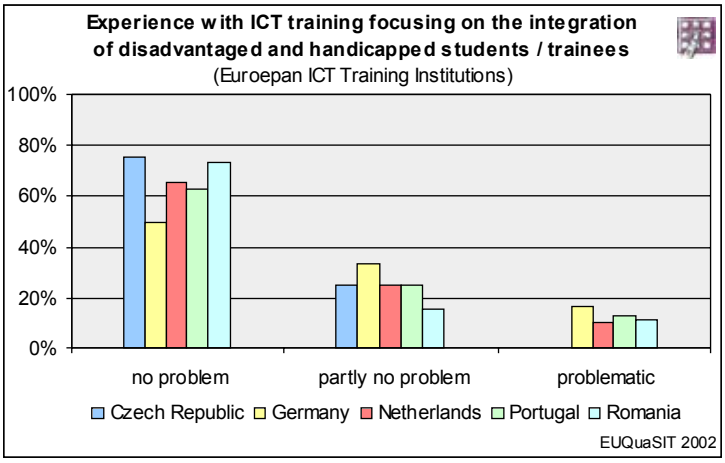


fig. 5-11: Experience with ICT training focussing on the integration of disadvantaged and handicapped people

Only a small number of interviewed persons in Czech VET training institutions have experience with integration of disabled or disadvantaged people in their school. Adaptations will be made if necessary but: 'A full integration of the disabled or disadvantaged is the best solution.'

so an interviewed manager of a Czech VET institutions said. Interviewed persons in Czech HE stated this as well but added that after graduation disabled or disadvantaged people often stay unemployed. In Romania, if special care is required for disabled of disadvantaged people, this is the full responsibility of the teacher giving him or her less time to do the regular work.

Interviewed training institutions In the Netherlands say problems are not big but one stated that autistic students can be a problem. Adaptations in buildings are mostly not necessary and special equipment needed will be purchased. In some cases special 'counselling groups' are present to give extra attention to disabled and/or disadvantaged students. The investigated ICT training institutions in Germany do not see bigger problems in this context. However, specific experience in this field didn't exist at the interviewed training institutions.

5.8 ICT qualification profiles and harmonisation in a European perspective

This last part reports on European standardisation of ICT education and training on various levels.

Training institutions were asked for their opinion about a European standardisation of ICT education and training profiles and curricula on the various qualification levels. As shown in fig. 5-12 there is a huge majority of training institutions in all partner countries that say that such a standardisation is very necessary. The higher the level of qualification is, the higher the percentage is getting. This is exactly the same trend as was found in the examination of companies.

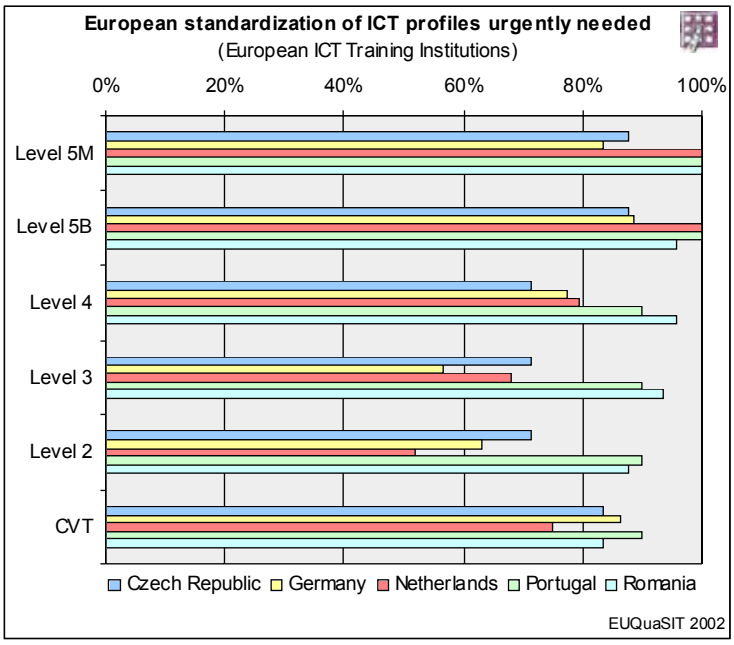


fig. 5-12: European standardization of ICT qualification profiles and programmes is urgently necessary

Dutch training institutions say they see vendor certificates as MSCE and ECDL as the starting point for European standardisation of profiles. Furthermore a drastic renewal of secondary vocational education and training is underway in the Netherlands, namely the introduction of a professional competences directed qualification structure. This will promote a transparent qualification structure as occupational competence profiles in ICT are compared with each other, as well as with occupational competence profiles from other sectors. Also the content of the profiles is

compared on different levels and, if necessary, joined into one or a number of qualification profiles.

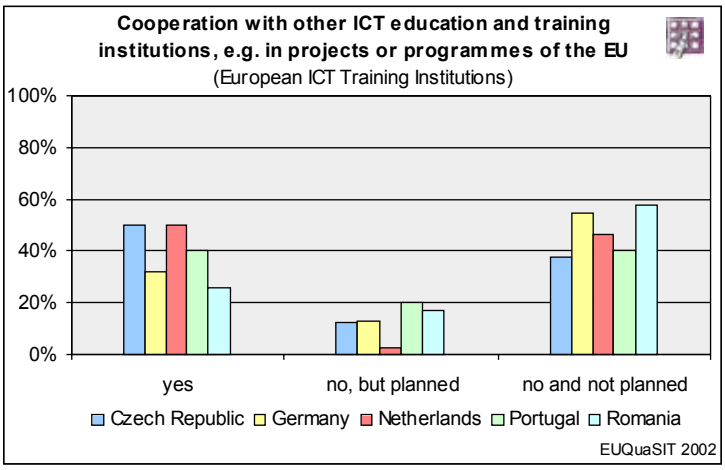


fig. 5-13: Cooperation with other ICT education and training institutions, e.g. in projects of programmes of the EU

In the context of the necessity of a European standardisation of ICT profiles and curricula on the different qualification levels and the CVT area it is of interest to know whether the ICT training providers co-operate with other ICT education and training institutions in, for example, EU projects or programmes. It shows that about half of the training institutions in the Czech Republic, Netherlands and Portugal work together with other providers in Europe. As is the case, Dutch training institutions co-operate with schools in England, Spain and Finland. Particularly in Germany and Romania the percentage is significantly lower; about 60% of the training institutions say that nothing in this direction is actually planned and between 15% and 20% say they have no actual co-operation but are planning to (see fig. 5-13).

5.9 Summary and conclusions

In addition to the analysis and evaluation of ICT qualification profiles and programmes, the questionnaire and case study surveys of ICT training institutions in the partner countries provide detailed results on the ICT training practice. The results are an important contribution in view of prospective European ICT qualification and training concepts and strategies. The role and perspective of vocational education and training (VET), for instance in delimitation to ICT higher education offers, is a complex subject to deal with. The following paragraphs summarise and compare the major findings on the ICT qualification supply and concepts of ICT training institutions in the partner countries of EUQuaSIT. Empirical results of the acceptance and implementation of ICT qualification profiles and programmes at all qualification levels (VET, HE and CVT) in training institutions such as (public and private) vocational schools, colleges, companies, universities etc., have been gained.

As well known at the level of education and training systems, these results also reveal some country specific and significant differences in terms of the goals, contents and teachers as well as didactical categories and the equipment for ICT training.

ICT practitioner training and study supply

The results clearly indicate that ICT training institutions try to focus on the relevant business and work areas of ICT and on new applications in ICT when they introduce new ICT qualification profiles, programmes or concepts. VET training institutions mostly introduce new profiles due to changing of supply of the national organisation responsible for development of qualifica-

tions and / or training programmes, but sometimes also because of a specific demand from the ICT market. Training institutions clearly think, for their own ideas but also from sayings from the ICT market, that the ICT market needs far more ICT practitioners at skill level 3 and 4 than on level 2. Some even doubt if on VET level 2 ICT qualifications should be offered.

For a better continuation of study some good initiatives of co-operation between Dutch VET and HE training institutions make it for students easier to continue their study on HE level 5B after having completed a level 4 training. This co-operation means that more transparency and adaptation to both training programmes give less problems and even provide some exemptions when the student starts at level 5B training.

Within higher education in all partner-countries the bachelor-master will be introduced or has been introduced already. This makes the whole of the higher education more transparent all across Europe, although this does not say anything about the match of ICT profiles with the demand of the ICT market. At VET training institutions ICT vendor certificates are often integrated into VET trainings, e.g. Cisco Systems certificates for networks subjects and contents.

ICT practitioner training goals and contents

Reference books and participation of teachers at seminars and conferences are still the most used way to update content and goals of profiles. Reference books, publications in the subject area, internet (newsgroups), specialist journals etc. however do not provide any ICT work oriented view which would be an important precondition for the purposeful selection of “tailored” contents. Training institutions do not make use of the right means to keep the content and goals of their training up to date with the ICT business market. Training institutions should be more in contact with the market and should make more use of product information and product teaching materials of ICT companies to make sure their training has the content and goal the ICT market needs. Results from private training institutions in Portugal proof that contacts with the business market helps to keep the profiles up to date. In Romania, where training institutions have fewer contacts with the ICT market than in the other partner-countries, training institutions have more problems in keeping content and goal up to date.

Difficulties of keeping up-to-date the goals and contents of ICT training offers vary slightly for the different areas in the partner countries and mainly in Romania many institutions report problems, but also partly half of the German institutions, e.g. in regard to soft- and hardware contents. In further comments given in the questionnaire, the vocational schools and also universities stress the need to increase contacts to companies, e.g. to improve economic-technical training and keeping the content of that training area up-to-date. Company training is not confronted with the problem of ensuring up-dated work and training contents rather then ensuring a systematic competence acquirement of the trainees (work oriented and integrated learning almost naturally holds this risk). Therefore a good and well coordinated cooperation with vocational schools is important companies committed in VET.

ICT training concepts and methods

On a regular basis, a lot of investigated European ICT training institutions perform subject-oriented lectures and courses, with a significantly lower proportion in the Netherlands. But also project-based training is regularly practiced in ICT education and training with the highest proportion in Portugal. Teachers in charge stress in this context that it is important that the projects have a reasonable link to the occupational work practice, but only a smaller proportion of the ICT training institutions practices ICT business and work process orientated training, mostly in Germany and the Netherlands. However, this requires that teachers and trainers know ICT business and work processes, which is of course directly guaranteed in companies, as well as work oriented teaching and information material needs to be available. E-learning and CBT is

also practised very much today, and most significant in the Czech Republic and less in Germany. In summary the results indicate a 'mix' of teaching and training concepts and methods in all European countries.

ICT training equipment and media

In the partner-countries problems concerning the ICT training equipment are not too big. Only the Czech Republic and Romania indicate bigger problems in this area. Internet access is available at most of the training institutions, although there can be doubts on the speed and quality of these connections. A big problem at training institutions in vocational education and training is the administration and maintenance of the ICT systems. There are not always human resources available to perform backups of data and repairs on the network. It would be an improvement and relieve of teachers and trainers if there was a specialist available for instance to maintain and administer the ICT systems and application in the training institutions.

ICT examination and teachers and trainers

Traditional written, oral and practical tests are being practised most of the time with the exception of the Netherlands where often examination is being practised in the form of continuous assessment through project work, presentations and task-review. In Germany project based assessment was introduced to the final ICT apprenticeship exams leading to good results. The traditional forms of examination are knowledge based most of the time whereas the business market asks the ICT practitioners for competences. Competences can better be tested as continuous assessment.

The most effective way to update knowledge of ICT teachers, trainers and lecturers is involvement into practical experience and relevant ICT processes in companies. Also product trainings and organised teacher trainings are effective in this. Contradictory to this teaching staff very little update their knowledge in these ways. They use reference books most of the time. When budget was to be available teaching staff could participate more easily to all kinds of trainings that are provided.

Female proportions and special initiatives in ICT training institutions

There are significant differences how the investigated ICT training institutions evaluate the chance of special initiatives in order to increase the female proportions. Especially in Portugal and Romania (and partly in Germany) the chance that such initiatives succeed is seen much more positive than in the other countries. This result corresponds to the opinion of the companies in these countries, where actually the proportion of female ICT practitioner is also higher. And it is furthermore interesting in this context that the participation of females in ICT practitioner training in general is higher than in companies. Therefore the recruitment practice of companies can be seen as a major key to higher female proportions amongst ICT practitioners.

There are not too big problems with the integration of disabled and disadvantaged students in the partner countries. If necessary, adaptation to the school-building or training programme can be made. According to the vast majority of training institutions, more European transparency of ICT qualifications is definitely necessary. The higher the level of qualification the bigger the wish for standardisation is. Although they say European standardisation is necessary, training institutions do not have that much European co-operation with training institutions abroad.

CVT demand and supply for ICT practitioners

A final vital result is shown in the following figure, namely the comparison of the national results on (relative allocation of the) demand of CVT courses (announced by the companies in the questionnaire survey) as well as the supply by ICT training providers for selected ICT work ar-

eas. Overall, both can be recognised in the comparison, a good balance in some ICT work areas, e.g. ICT systems and application development and ICT service and administration (apart from the Czech Republic), as well as a rather poor balance in other areas such as ICT marketing, publishing or ICT systems installation. However there are partly significant national differences that indicate, that despite a more and more global ICT market with corresponding CVT courses and certificates mostly offered by the vendors still imbalances exist in very different ICT work areas. So the problem may be appointed at global and European level but needs to be tackled still at national level.

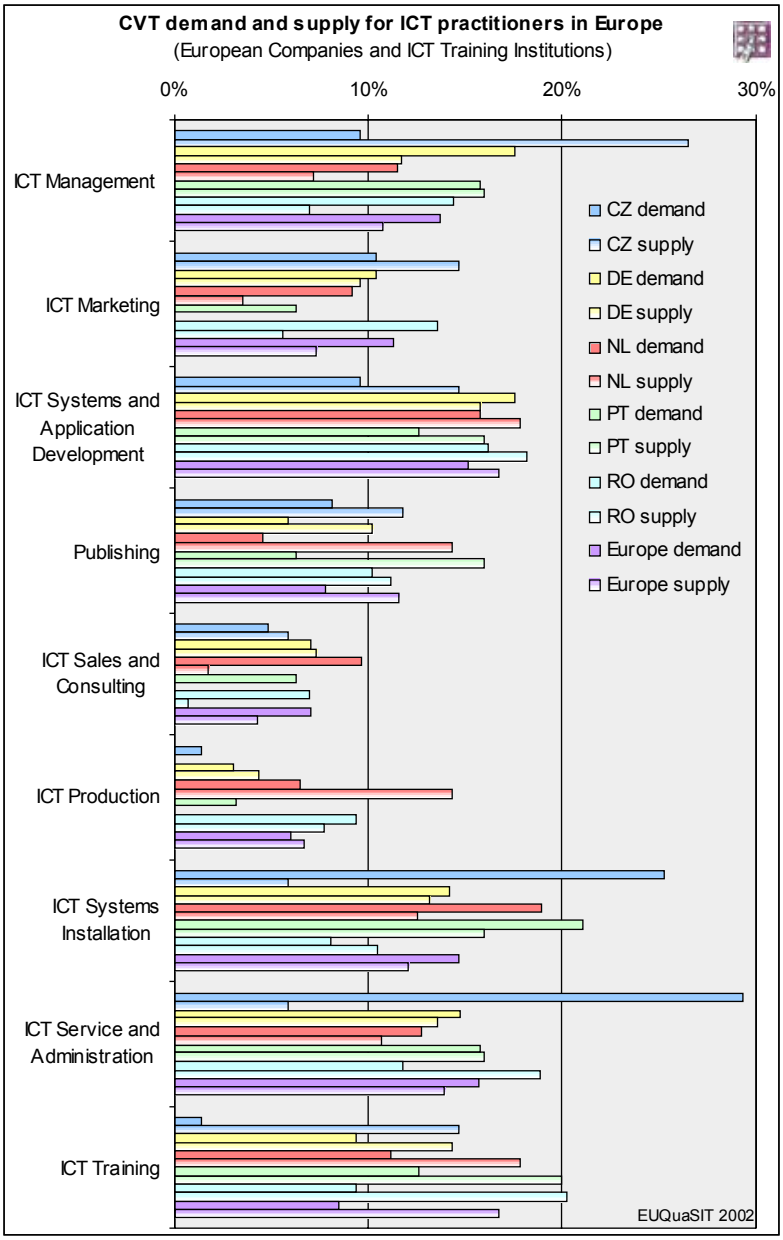


fig. 5-3: Empirical results and comparison of CVT demand and supply for ICT practitioners in Europe

6 ICT work and skill needs - concept and results of case studies in companies

The planning, realisation and analysis of case studies in companies were the biggest part of the EUQuaSIT project. The main purpose of this project part was to investigate in detail actual work and skill needs of ICT practitioners within typical ICT business and work processes of the companies and to transfer the findings to a proposal of European (reference) framework of ICT skills and prospective ICT skills profiles. The comprehensive case studies were undergone in large, medium and small sized companies in various areas of business and trade (ICT sector and ICT user industries) and various regions in each partner country.

The ICT skills profiles are developed as a 'tool' that links the world of work with the world of training. Neither experts from the sphere of education nor experts from the sphere of work can develop them alone. Both types of experts must participate in their development. That is why surroundings of field groups are just suitable for the development of such profiles. The applicability of the detailed case study surveys on skill needs of ICT practitioners, with a focus on skilled worker levels and complementary to the evaluation of national ICT qualification profiles and programmes, should lead to the revision and development of ICT qualification profiles.

6.1 Objectives and concept for the case studies and expert interviews in European companies

For the concrete and detailed analysis of ICT business and work processes and ICT practitioner work tasks and skills needs specific interview guidelines were developed. The following steps of the concept can be summarised and will be further described and illustrated in the next paragraphs.

A	>>	Overall information of the company and qualification structure of ICT practitioners
B	>>	Typical ICT business processes (projects, products, services, customer etc.) and organisational structure of the company
C	>>	Exemplary choice of one typical ICT business process of the company: Detailed investigation of a concrete example (project title and description, involved ICT practitioners, ICT work processes)
D	>>	Structure and content of each ICT work process: definition and description of the phases of activity and ICT work tasks and the cooperation and responsibility of involved ICT practitioners
E	>>	Detailed analysis of some exemplary ICT work tasks of all detected ICT work tasks of the work processes and phases of activity (especially relevant for the ICT practitioners with VET qualification at level 2-4!)

A >> Overall information of the company and qualification structure of ICT practitioners

The initial part of the interview guidelines gathers overall information of the company such as sector and size (numbers of employees). Based on information about the (ICT) products and services a short 'company portrait' is provided. Furthermore it is important to analyse the number and proportion of employed ICT practitioners, namely in the developed five level structure of the project, as well as whether the company provide ICT vocational training and if so, in which ICT qualification profiles.

B >> Typical ICT business processes (projects, products, services, customer etc.) and organisational structure of the company

The first objective of each case study is to find out and analyse the "core ICT business area" of the company. This is possible by identifying and nominating some typical and concrete ICT business processes (e.g. actual projects). The result is a list of different typical ICT business processes (app. 5 to 6), which show for instance the specialisation and the ICT core field(s) of the company, beside other factors. Furthermore it is important for the understanding of ICT business structures to illustrate the organisational structure of the company in which the ICT business processes take place, e.g. different departments, project teams, product or customer related organisation).

Based on the overview of the company (ICT business area and organisational structure) it is possible to choose one typical and exemplary ICT business process to be further analysed as described in the following steps. Please note that for the profound analysis of this one typical process example it is necessary that all the ICT practitioner(s) - who were/are involved in this process and especially with VET qualification - need to take part in the interview (as a group or sometimes better individually) and work observations.

C >> Exemplary choice of one typical ICT business process of the company: Detailed investigation of a concrete example (project title and description, involved ICT practitioners, ICT work processes)

The "right" choice of one typical ICT business process (project) of the company is an important decision for a profound analysis of the work and skills of ICT practitioners. This also depends on the interview participants and the corresponding information available on the process. Together with the interview participants the interviewer(s) must decide on a good and typical example, always taking into account that ICT practitioners with VET qualification were/are involved.

The concept of investigating one typical ICT business process of the company is based on the common model structure of ICT business and work processes.

Following the model structure, each ICT business process can be described in its work flow by distinguishable ICT work processes (see "Broad Structure" below). The contents and structure of the ICT work processes vary depending on criteria like the company organisation. The table below gives some examples that indicate how different "real" ICT business processes (projects) can look like in its structure of work processes. Nevertheless, however, there are similarities in most ICT business processes, e.g. that each process normally starts with a more economic technical oriented work process like marketing, sales and consulting.

The experiences and first results with regard to the structure and contents of ICT business processes (work flow) have been leading to the assumption that ICT business processes can in general consist of distinguishable types of ICT work processes as follows:

- ICT work processes with more economic technical oriented phases of activity and work tasks (in model structure yellow colour) like ICT marketing, sales etc.,
- ICT work processes with more informatics technical oriented phases of activity and work tasks (in model structure blue colour) like ICT system development, soft- and hardware development, administration etc.,
- ICT work processes with more technical informatics oriented phases of activity and work tasks (in model structure red colour) like ICT system integration, installation etc. and
- ICT work processes with more ICT service oriented phases of activity and work tasks (in model structure green colour) like ICT service, troubleshooting, maintenance etc.

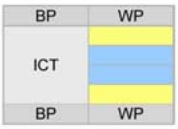
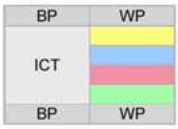
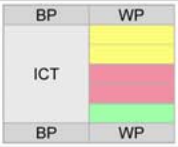
Broad structure	Example 1	Example 2	Example 3	Example 4
Normally in the first investigation step the ICT business process can be described by 3, 4, 5 or more distinguishable ICT work processes.	In this case the ICT business process covers all types of Work Processes. E.g. when a complete ICT solution including applications and ICT infrastructure is delivered (... marketing and sales, development, integration, infrastructure and service processes).	In this case the ICT business process covers only "economic technical oriented" and "informatics technical oriented" work processes (e.g. software development or adaptation) finishing with e.g. billing.	Rather similar as example 1 but there is only one "informatics technical oriented" process. ICT service is also one ICT work process of this ICT business process.	This ICT business process does not include any "informatics technical oriented" (blue) process, like an extra software development or adaptation. The kind of process could be the delivery of a telecommunications system or a printing systems.
				
Description: BP: ICT business process; WP: ICT work processes				

fig. 6-1: Exemplary structures of ICT work processes

Furthermore it is important which kind and number of ICT practitioners are involved in the ICT business process and therefore in all work processes. For the overview nominate all involved and responsible ICT practitioners with their ICT job and training profiles.

D >> Structure and content of each ICT work process: definition and description of the phases of activity and ICT work tasks and the cooperation and responsibility of involved ICT practitioners

In the next step the above nominated ICT work processes of the (chosen) typical ICT business process are further investigated and described in more detail and with regard to the ICT skills and skill needs of involved ICT practitioners. For this each work process must be divided in 2, 3, 4 or more distinguishable phases of activity. And normally we can further divide each phase of activity in 2, 3, 4 or more distinguishable ICT work tasks - concretely carried out by e.g. one or two ICT practitioners (see model structure below). For example an ICT work process "application development" may have phases of activity like design, conception, programming, testing etc. and for instance to the phase of activity "design" 2, 3 or more work tasks can be nominated and described.

The table below shows how different the numbers of phases of activity and ICT work tasks of the ICT work processes can look like. For each ICT work process the number of the phases and within each phase the number of ICT work tasks can vary depending on the conditions of the organisation and content of the ICT work. For example "Testing" could be a separate phase of activity and therefore cover several ICT work tasks within the ICT work process "systems development", but could also be only an ICT work task as an integrated part of a phase of activity "programming". Therefore it depends on the real project and process structure and contents which and therefore how many phases of activity and ICT work tasks can be differentiated.

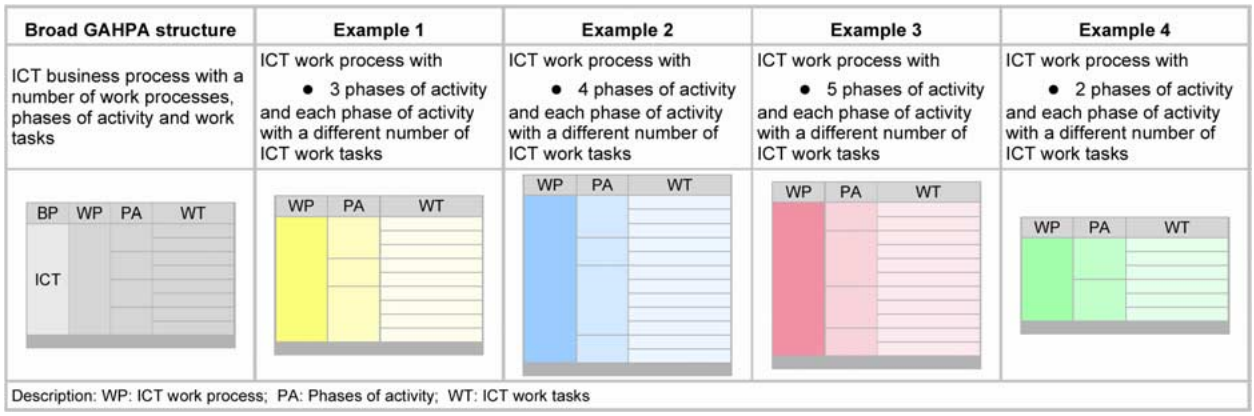


fig. 6-2: Exemplary structures of ICT work processes, phases of activity and work tasks

Furthermore and as indicated in the overall structure it is of crucial importance to analyse which ICT practitioners (ICT Job / Qualification) are involved and responsible in each phase of activity and the ICT work tasks respectively.

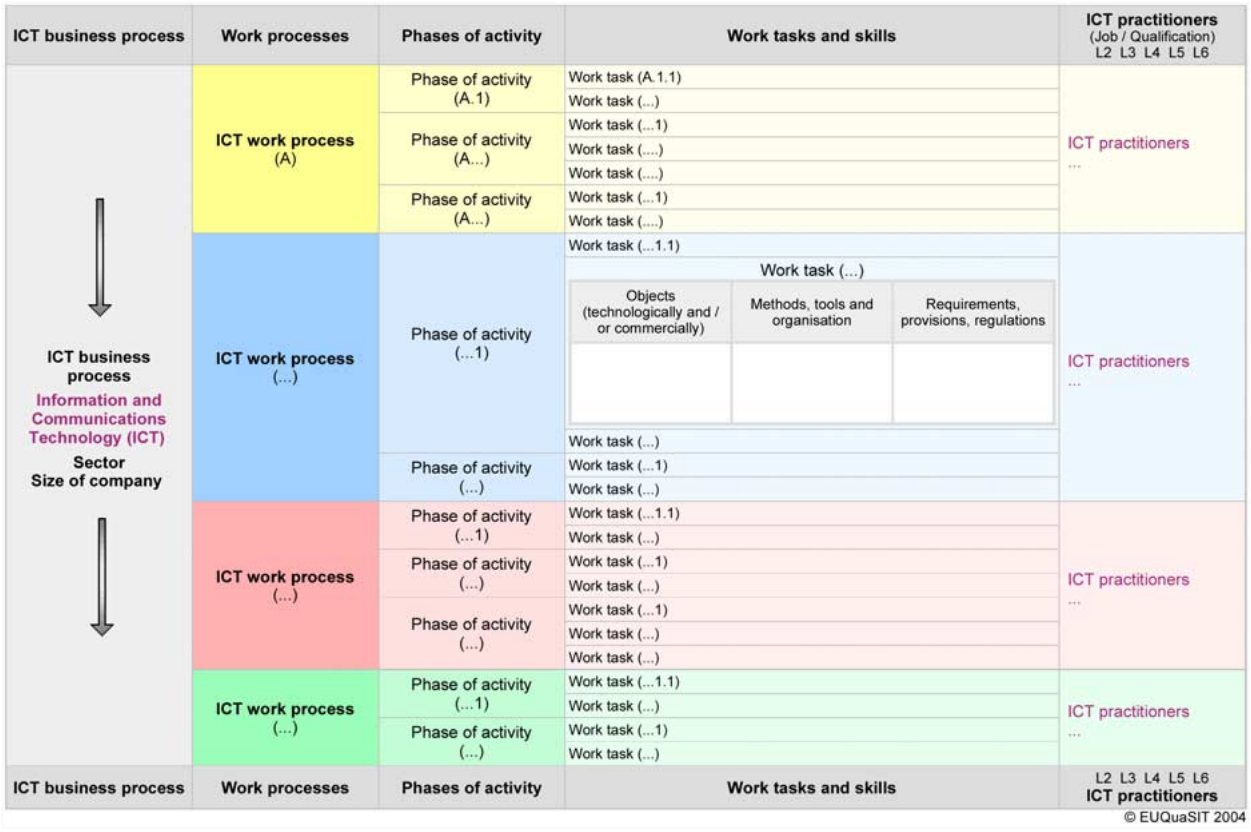


fig. 6-3: GAHPA common model structure for the ICT business process and workflow analysis with "Work processes", "Phases of activities" and "Work tasks" and the job / qualification of ICT practitioners

E >> Detailed analysis of some exemplary ICT work tasks of all detected ICT work tasks of the work processes and phases of activity (especially relevant for the ICT practitioners with VET qualification at level 2-4!)

In order to have profound results on ICT work and skill requirements of ICT practitioners the ICT work tasks need to be investigated in detail. For this analysis and because we surely cannot investigate in detail all identified work tasks of all work processes and phases of activity, some relevant and exemplary ICT work tasks must be chosen. But very important is that the exemplary ICT work tasks - as a kind of occupational "core tasks" - is especially relevant and carried out by ICT practitioners with skills and qualifications at levels 2-4!

(...)	**ICT work process**
(...)	**Phase of activity**
(...)	**Work task**

ICT practitioner(s) carrying out the work task (ICT job / qualification (level))

Objects of ICT work task (technologically and / or commercially)	Methods, tools and organisation of ICT work task	Requirements, provisions, regulations (company, society, individual) of ICT work task

fig. 6-4: Three dimensions for analysing the work tasks of ICT practitioners

To support the analysis and description of the ICT work tasks and contents a structure of three work and qualification dimensions (Objects ... , Methods ..., Requirements ...) is provided for this part as indicated in the table below. Please do not forget to write the name of the ICT work process and phase of activity in which the task is carried out in order to ensure the work context in the process view.

In the European perspective and baring in mind the EUQuaSIT project objectives and results, the analyses of the ICT work tasks give answers with regard to occupational (profile, level) features and criteria of how ICT work and skill needs can be differentiated and eventually utilised for tailored and more work area oriented ICT training and curriculum solutions. In this perspective, also aspects like crucial changes throughout the last years and the future developments of ICT work should be considered and therefore discussed with the "ICT experts" of the companies.

Sector-specific sample criteria for the choice of companies and case studies in the ICT sector and ICT user sectors

It has already been mentioned in the previous chapter that the criteria for the choice of the companies were the company size, sector, region and the ICT products, services and business and work areas. Beside a good balance of large, medium and small companies the sector aspect is highly significant in order to ensure that breadth of economic activities is considered. Therefore the project were agreed to ensure a good balance of companies in regard to the sector as ii was of relevance for the entire project and is again indicated below.

Basis and sample criteria of the case studies in the ICT sector and ICT user sectors
NACE Rev. 1.1

ICT sector
(ICT supplier industries)

ICT services IT services / CT services (NACE G 51, I 64, K 72, K 73)		
Small enterprises	Medium enterprises	Large enterprises
ICT manufacturing IT manufacturing / CT manufacturing (NACE DL 30, 31, 32, 33)		
Small enterprises	Medium enterprises	Large enterprises

ICT user sectors
(ICT user industries)

Manufacture of textiles and textile products (NACE DB)	Manufacture of pulp, paper and paper products; publishing and printing (NACE DE)	Manufacture of chemicals, chemical products and man-made fibres (NACE DG)	Manufacture of basic metals and fabricated metal products (NACE DJ)	Manufacture of electrical and optical equipment (NACE DL)	Manufacture of motor vehicles, trailers and semi-trailers (NACE DM 34)
Manufacture of other transport equipment (NACE DM 35)	Electricity, gas and water supply (NACE E)	Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (NACE G)	Transport, storage and communications (NACE I)	Financial intermediation, except insurance and pension funding (NACE J 65)	Insurance and pension funding, except compulsory social security (NACE J 66)
Real estate, renting and business activities (NACE K)	Public administration and defence; compulsory social security (NACE L)	Education (NACE M)	Health and social work (NACE N)	Other community, social and personal service activities (NACE O)	others

fig. 6-5: Basis and sample criteria of the case studies in the ICT sector and ICT user sectors

6.2 The investigated companies and the qualification structure of employed ICT practitioners

The planning, realisation and analysis of case studies in companies were the biggest part of the EUQuaSIT project. The main objective of this project part was to investigate in some detail actual work and skill needs of ICT practitioners within typical ICT business and work processes of the companies. The comprehensive case studies were undergone in large, medium and small sized companies in various areas of business and trade (ICT sector and ICT user industries) and various regions in each partner country. Since small companies of the ICT user sectors usually do not have own ICT practitioner workforce no case studies were realised there.

The case studies, which were signed with a project specific code, are structured by company size and delimitated in those case studies undergone in the ICT sector and the ICT user sectors. For each of the comprehensive case studies the following table provides a short "company portrait" in order to support a well directed choice. Each short description tries to summarise the main business areas of the company as well as giving a direction towards the more detailed results of the ICT practitioner work and skills investigations within a typical ICT business and work process of the company, which is also linked at the bottom of each company description.

Results and companies of the case studies
ICT sector
Link: Case study-Company-Country code-Number

Small enterprises	Medium enterprises	Large enterprises

CS-CO-RO-08

Company portrait of case study:

The company is involved in computer selling, computer maintenance (most of all for the equipment at clients) and software development. The main project now is the development of an e-learning platform (called PIED) that is already in tests at "Dunarea de Jos" University from Galati - ODL Dept.

The company was founded in 1995 and has a small growth in the first years. However, the company competed for projects started in the region, won and participated to one project for educational software and training of regular computer users from SMEs.

The company pays attention to the quality of services, hence to the employees' skills and communication abilities. In this respect most of employees participate to training courses organized by the Council of SMEs in the region and also to international experience exchange; so, the General Manager participated to some study and know-how exchange in Western Europe and South-East Asia countries. The PROMPT company is a member of the Technological Software Park first created in Romania by the City and County Council with the support of the Romanian Ministry of ICT.

ICT business process:

- Computers and computer parts sales

CS-CO-RO-05

Company portrait of case study:

The company is involved in offshore and outsourcing projects in telecommunication - main beneficiaries in France. It also is involved R&D projects with governmental funds and in networking projects for companies in Romania.

The company was established by two female professors from "Dunarea de Jos" University of Galati, and the entire staff comes from that university - graduates or students yet. The staff consists of 6 permanent employee and 8 temporarily employee, 5 of them undergraduates (students at Information Technology or Computer Science at mentioned university.

Up to now, the company contracts envisaged research and development of special software products, in the frame of grants and outsourcing projects from abroad and from IST funds granted by the Romanian government. Future prospective are the issue of own software products in networking and e-learning. The company is planed to take part of the "Software Park" founded by Romanian ICT Minister and the local administration.

ICT business process:

- Management and configuration programming for networking equipment

CS-CO-NL-08

Company portrait of case study:

This small-sized company offers internet-services to all kinds of companies and organisations. The focus lies on system administration for several national branch-organisations, design, building and promoting of websites. The last year the company has grown from three till twelve persons.

ICT business process:

- Installation and configuration of workstation PCs

CS-CO-NL-06

Company portrait of case study:

This small-sized ICT company only works on development of standard and tailor-made software packages. It has four fulltime employees and a few free-lance workers.

ICT business process:

- Made-to-measure software development

CS-CO-NL-01

Company portrait of case study:

This small-sized company can take care of all that has to do with computers and computer networks. For many of their customers they are responsible for the whole automation system. But also parts of the automation system of a customer can be taken care of; for example system administration or call-centre software.

The company only works for companies / organisations (not for private persons) and has about 1000 customers throughout the whole of the Netherlands. Customers can be small companies / organisations or big multi-national companies. At big and multi-national companies only own developed software is supplied.

ICT business process:

- Further development of existing standard software packages

CS-CO-NL-02

Company portrait of case study:

This medium-sized company with about 50 employees offers internet services to private persons and companies. From origin this company is a company delivering cable-television via a glass-fibre network. Their offers have been extended with telephone, and internet services via antenna cable, telephone, ADSL and Wifi. The company covers an area as big as a province in the Netherlands.

Other services are webhosting, webdesign, system administration and e-business.

ICT business process:

- 2nd Line helpdesk for Internet connections

CS-CO-RO-01

Company portrait of case study:

This company was from the beginning (early 90-ies) an important actor for ICT development in Galati region. The company has now a distinct division "Computers" involved in ICT, that comprises 39 employees. The ICT division evolve somehow separated from mother company, and now it is an Internet Service Provider, computer and parts seller, computer maintenance and troubleshooting, training institution for specific products, computer solutions adviser.

The company tend to become a computer integrated solutions provider. So, in addition to the well founded hardware sector it will develop a software sector, suited for distributed applications design and implementation. For now, the software group comprises three level 5M ICT practitioners specialized in (network) operating systems. The target group is to be changed from individual customers and small companies to medium and big companies. The company is already in extension from applications in economic sector to industrial one.

ICT business process:

- Networking project - design, installation and test of networking equipment and cabling

CS-CO-RO-04

Company portrait of case study:

Founded in 1991 the company's activities in the ICT field range from assembling PCs to consulting and building up networks. For instance experience in networking dates back to 1992, when the network for a commercial bank was made operational. After that, it's experience in structured networks was extended by making operational some over 100 hosts, networks, including WAN connectivity.

The warranty for structured cabling made by the company is based on the yearly certification obtained from BICC Brand Rex (a world acknowledged company for structured cabling) through training and periodical examinations. The company is also a certified "Hewlett Packard Business Reseller", "HP Supplies Sales Professional", "Microsoft Certified Dealer" and "Symantec Certified Reseller".

ICT business process:

- Computer systems design (PC assembly, installation, and configuration)

CS-CO-DE-01

Company portrait of case study:

This medium-sized company with app. 60 employees and app. 40 ICT practitioners offers a wide spectrum of products and services in the ICT business areas company-specific software development, ERP software and information technology consultancy e.g. for data processing departments of large banks in Germany. Founded in 1985 by three informatics graduates the company has established its major product, a sales information and controlling system for the optimisation customer relations (CRM) chiefly for beverage industry on the market The company today also offers SAP consulting and solutions.

ICT business process:

- Development of a client-server based software for the data administration of German wide high voltage power supply system

CS-CO-DE-02

Company portrait of case study:

This medium sized system company founded in 1989 with 25 employees offers as main business a sector-specific software system for funeral parlours. This solution consists of an order processing software and a sector-specific accountancy application. The company offers the complete delivery of the ICT hard- and software infrastructure for the customers including the assembly and integration into a network.

CS-CO-CZ-01

Company portrait of case study:

This medium-sized company was founded before 10 years. From the beginning of its existence it has been active in the wholesale, delivering computer technology to its dealers and end clients. The distribution company concentrating on components, peripherals and locally manufactured personal computers. It has a network of 2000 active dealers in the whole territory of the Czech Republic. For the sale of computers it has a network of authorized vendors and authorized service centres that take care of computer service and deliveries countrywide (more than 100 sale points). Besides the Czech Republic the company has clients in the whole Central and Eastern Europe.

ICT business process:

- Delivery of complete ICT solution for a smaller company of local importance

CS-CO-DE-05

Company portrait of case study:

This large-sized telecommunications carrier founded in 1997 has established a closed regional fibre glass network on which fundament it offers fixed line telephony (Analogue, ISDN) and Internet services mainly based on DSL services. For business customers the company offers complete services, from call centre services, leased lines, premium services like 0800-, 0180-, 0190- numbers, hosting and housing as well as specific e-commerce offers.

ICT business process:

- Planning and construction of a main distribution station (MDS)

CS-CO-DE-06

Company portrait of case study:

Major overall business area of the company is the after sales service and repair of mobile phones. In this business area the company is specialised on one vendor to which a close connection have been existing for more than ten years now. In a wider sense the repair service also includes specific ICT tasks but only focussing on mobile phone repair.

As an internal service provider the ICT department supports the other business areas and users of the company (ICT systems and network infrastructure, web services / e-shops, ERP system etc.) and plans and installs new ICT infrastructure and solutions often in cooperation with external local ICT firms.

ICT business process:

- Connection and integration of the external network of a sister company into the company ICT infrastructure and ERP system

CS-CO-CZ-02

Company portrait of case study:

This big-sized company with about 550 employees with two basic business paths : Computer Services and Business Solutions. Computer Services: commercial and service network reaching the whole territory of the Czech Republic. This company network has gained a reputation for being a reliable partner for deliveries of computer technology and related services to a wide spectre of clients. Business Solutions: Deliveries of integrated information systems to large corporate clients and state administration. Internally, it is further subdivided into divisions specialised in specific areas of deliveries of information systems.

ICT business process:

- Migration of IS from Windows NT 4.0 to Windows 2000

CS-CO-NL-07*

Company portrait of case study:

This big multi-national company produces consumer electronics and business electronics products. It has sites in many countries all over the world.

The case study was held at a factory in the Netherlands. The ICT-department of this factory functions as a support department for the office automation as well as the production process.

ICT business process:

- ICT projects: Upgrade network structure

CS-CO-NL-09*

Company portrait of case study:

This big multi-national company produces consumer electronics and business electronics products. It has sites in many countries all over the world.

The case study was held at a factory in the Netherlands. The ICT-department of this factory functions as a support department for the office automation as well as the production process.

ICT business process:

- Configuration and license management

CS-CO-CZ-08

Company portrait of case study:

The company provides internet-services to all kinds of companies and organisations. The focus lies design, building and promoting of websites.

ICT business process:

- Planning and realisation of an Internet solution for a medium sized company

CS-CO-DE-09

Company portrait of case study:

As a partner of major suppliers like Sun Microsystems, Cisco Systems, Oracle und Veritas this small enterprise is a Unix specialist in the areas Consulting, Sales, Installation and Support. It sells midrange IT systems like:

- Reseller Sun Microsystems: Server, Workstations, Storage, Workshops & Support
- Reseller Cisco Systems: Router, Switches, Firewalls, Networks technology
- Reseller Oracle: Consulting & Planning, Analysis & Tuning, Internet connection
- Clustering: FsFo Cluster (FailSave FailOver), SunCluster 3.0, Sun Cluster 2.x.

With these products the company offers solutions like Migration, High Availability + Clustering, Hierarchical Storage Management, Storage Area Network, Database, Networking, Consolidation.

ICT business process:

- Planning, installation and integration of a high-availability Midframe Server solution on Sun Solaris basis including cluster and storage systems

CS-CO-RO-02

Company portrait of case study:

Established in September 2002, the company is the newborn brother of a bigger ICT consulting business (11 years of activity), aimed at splitting software and hardware business between the two. For its Romanian customers, the company is capable to offer a complete IT solution: starting with business analysis, IT requirements, structured cabling of both computer LANs, and telephony, PC assembly, installation, and configuration, and up to database design, software implementation, administration, maintenance, web and e-mail solutions, and personnel training.

For the foreign ones, they are mainly providing IT and business consultancy, as well as off-shore designing and writing software, from firmware for image processing and communication processors, middleware (be it between portable terminals and databases, or between video surveillance equipment and PC LANs), multimedia applications (for video surveillance), and up to data analysis, mining, and migration tools of legacy COBOL applications and hierarchical VSAM data, to relational engines (IBM DB/2, MS SQL Server, Oracle, and Access) and modern object-oriented Cobol (Merant Microfocus), or Java web enabling.

ICT business process:

- Database design, software implementation and database maintenance

CS-CO-NL-05

Company portrait of case study:

This small-sized ICT company with four ICT-specialists focuses on networks installation and service.

ICT business process:

- System and network administration

ICT business process:

- Supply of companies' sector-specific software application including consulting, hard- and software adaptation and delivery

CS-CO-DE-08

Company portrait of case study:

Since its foundation in 1984 the company offers individual solutions in ICT consulting, software development and ICT infrastructure management services. The work is based on high quality requirements to the practitioners, the offer of reliable and flexible services as well as fair prises for the customers. The real challenge for the teams is the task to analyse and fulfil the concrete demand of the customers in order to sustainable contribute to their success.

ICT business process:

- Reengineering of ICT mainframe applications for the direct selling of federal securities of a financial service authority to end customers

CS-CO-NL-04

Company portrait of case study:

This medium-sized company focuses on development of sector specific software (mainly office automation) installation and service, printing systems, e-commerce development and administration, automation systems.

It also works outside the ICT sector; namely as a consultancy company for all kinds of projects and organisations.

ICT business process:

- Installation and administration of ICT training and simulations software

CS-CO-PT-03

Company portrait of case study:

This medium sized company develops ERP software solutions (ERP - Enter-prise Resource Planning) and provides consulting services in this field. It is a growing business and intends to reach new work markets. The investigated software development and adaptation process is typical in terms of the proc-ess organisation and contents and well comparable with other projects investi-gated within EUQuaSIT case studies.

ICT business process:

- Management of camping parks

CS-CO-DE-03

Company portrait of case study:

This medium-sized company with 60 employees founded in 1992 today has a structure with different ICT business areas and departments. As an independent service provider It offers support in internet systems and solutions, e.g. Internet Service Providing (ISP), Consulting. Furthermore the company offers networks and security solutions, data processing retail and applications development for internet and intranet solutions.

The portfolio in the business area ISP covers fixed connections with and without managed firewall and virus scanning, dial-up solutions, e-mail solutions, web and domain hosting (see example) as well web and server housing. The 7x24 hours operating offers monitoring for the customer systems and the data processing center.

ICT business process:

- Planning and implementation of a complex Domain-Name-Server (DNS)

CS-CO-CZ-06

Company portrait of case study:

It is Czech subsidiary of the second of the biggest software company in the world. The company offer internet platform, tools and internet application with support, education and consultation. The Czech subsidiary was founded in 1994. Upwards of 100 experts help to solve Czech companies complex problem with the processing of important information for the control of companies.

ICT business process:

- Marketing, adaptation and hosting of the Web-based learning management solution (LMS) based on Oracle's iLearning

CS-CO-RO-06

Company portrait of case study:

Since 1992 the companies printing and publishing solutions has been helping companies output and manage their business documents. As a business equipment sales/service company it is a full-service, value-added dealer of digital imaging systems, including multifunctional devices (copy, print, fax and scan) and storage and retrieval solutions, typically connected between network and users' desktops. Correspondingly, the company is structured in three departments commercial, service and administration.

ICT business process:

- Office equipment service

CS-CO-DE-11

Company portrait of case study:

This global ICT corporation produces and distributes a wide range of hardware, software und provides corresponding services. It is one of the leading companies in the field of e-business and e-commerce solutions respectively. In Germany the company employs 25 000 people in more than 40 branches. Specific activities in Germany cover marketing, sales, production and services as well as certain development tasks in the scope of the global organisation.

The investigated ICT business area "roll out" is an service partner for the development, planning and realisation of complex ICT infrastructure and systems. This covers all types of ICT systems offered by the corporation, e.g. server systems, notebooks, mobile and fixed networks, cash register systems.

ICT business process:

- Development, roll-out and support (helpdesk) of an automotive diagnosis system on the basis of a PC standard product (notebook) for the service garages of the automotive producer

CS-CO-DE-12*

Company portrait of case study:

This large enterprise produces and distributes facilities, systems and equipment of industrial process control equipment. The company is a good example for the explaining the close connection between electronics, automation and ICT products. Correspondingly in manufacturing there work ICT practitioners in industrial electronics design, development and integration.

The ICT department is an internal service department with a range of activities, e.g. standard PC support, planning and support of complex client-server systems, production and process planning and integration and support of business process software such as SAP or Baan.

ICT business process:

- Development of VBA applications for the preparation of business letters and fax forms in the scope of company's office automation activities

Results and companies of the case studies
ICT user sectors

Large enterprises

CS-CO-DE-04

Company portrait of case study:

This large-sized company produces all different types of wallpapers. The annual production capacity is 30 million rolls. Within the scope of the initial public offer in form of „Management Buy-Out (MBO)" the management took over the majority of the stock.

In the case study the data processing department was investigated. It employs six ICT practitioners and offers apprenticeship placement for one or two trainees in ICT occupations. The department is in charge for all internal ICT processes except the design of wall papers.

ICT business process:

- Planning, installation and implementation of a computer-controlled fully automated high rack storage area for wallpaper rolls

CS-CO-RO-03

Company portrait of case study:

Iron and steel complex ISPAT-SIDEX uses and integrated flow for steel products, starting from high furnaces and ending with commodities as steel plates, tubes and profiles, covered with antioxidant material or not.

The ICT domain of the company is involved in production (process control), management of production and survey on distribution of energy and of various kind of fluids along the industrial platform, management of materials, management of supply and sales, management of accounting, management of human resources.

ICT business process:

- Application development and implementation

CS-CO-DE-12*

Company portrait of case study:

This large enterprise produces and distributes facilities, systems and equipment of industrial process control equipment. The company is a good example for the explaining the close connection between electronics, automation and ICT products. Correspondingly in manufacturing there work ICT practitioners in industrial electronics design, development and integration.

The ICT department is an internal service department with a range of activities, e.g. standard PC support, planning and support of complex client-server systems, production and process planning and integration and support of business process software such as SAP or Baan.

ICT business process:

- Development of VBA applications for the preparation of business letters and fax forms in the scope of company's office automation activities

CS-CO-NL-07*

Company portrait of case study:

This big multi-national company produces consumer electronics and business electronics products. It has sites in many countries all over the world.

The case study was held at a factory in the Netherlands. The ICT-department of this factory functions as a support department for the office automation as well as the production process.

ICT business process:

- ICT projects: Upgrade network structure

CS-CO-NL-09*

Company portrait of case study:

This big multi-national company produces consumer electronics and business electronics products. It has sites in many countries all over the world.

The case study was held at a factory in the Netherlands. The ICT-department of this factory functions as a support department for the office automation as well as the production process.

ICT business process:

- Configuration and license management

CS-CO-CZ-07

Company portrait of case study:

Purchase, production, distribution and sale of electricity and heat, including the provision of services connected with the supply, consumption or use of electricity and heat.

ICT business process:

- Implementation of the backup disc storage site and the related development of the SUN architecture

CS-CO-PT-02

Company portrait of case study:

This large enterprise is a postal operator offering complete and integrated communication solutions to deliver messages, items and services. The ICT department with about 200 ICT practitioners runs the entire ICT service from applications development, networks administration to PC maintenance.

ICT business process:

- Development of an Intranet Services Platform

CS-CO-CZ-03

Company portrait of case study:

The company with about 11 000 employees. It is the largest bank for retail clients in the Czech Republic. It provides services to more than five million customers. The company is primarily a bank for retail clients, SME's, and towns and municipalities. In addition, it plays an indispensable role in the financing of large companies and corporations. The accumulation of services for clients, accumulation of clients do not correspond dimensions of IT department. So big company as this company has small number of ICT professional especially experts for networks.

ICT business process:

- Development, implementation and administration of a new, multi-channel platform for Internet banking

CS-CO-NL-03

Company portrait of case study:

The company with about 500 employees is responsible (from the Ministry of education) for several task within vocational education. It is responsible for development of qualifications and professional profiles, quality improvement of practical training and approval of companies for practical training. Also examinations are developed and standard and tailor-made further training courses are provided and it publishes education material as books and multimedia.

The ICT-department of this company functions as a support department for the office automation of their main office, regional offices and consultants (that have their office at their private home).

ICT business process:

- Transition of network facilities

CS-CO-CZ-04

Company portrait of case study:

The multimedia company offering the best entertainment to the widest range of people. The company has some subsidiaries for all Czech republic. It has also film ateliers. Focuses on dubbing of movies and construction electronic titles of movies.

ICT business process:

- Development and construction of the complex e-shop solution Bontonland.cz

CS-CO-CZ-05

Company portrait of case study:

1993 the company returned to Czech Republic after 50 years as commerce representation. The company has a major partner in Austria. The company is divided to 52 regional offices, 64 agent offices and 6 regional main offices. The general headquarters is divided to 18 departments. One of them is small ICT department (9 + 35 external part - time employees)

ICT business process:

- Project SAP – transition to new accounting system

CS-CO-PT-01

Company portrait of case study:

This large enterprise provides services in the field of internet data processing such as telephone numbers, contact ad-dress, SMS service etc. The ICT department is in charge for the entire ICT infrastructure, databases and develops and coordinates with external providers specific applications.

ICT business process:

- ICT projects in big service company of the non ICT sector

Medium enterprises

CS-CO-DE-07

Company portrait of case study:

The overall corporate group is one of leading producers of computer hardware, telecommunications hardware, electronics etc. For the world wide employed people the corporation has merged its further training in the field business learning, e.g. for administrative staff.

In the overall learning department all further training activities are integrated. The offers are available via a virtual campus in the intranet. The investigated ICT department supports the overall learning department with ICT systems infrastructure and specific applications, e.g. the investigated Livelink-Portal.

ICT business process:

- Development of a Livelink-Portal for a big company learning institution

CS-CO-DE-10

Company portrait of case study:

The company offers the complete (payroll) accountancy service with integrated online services. The ICT team chiefly has two teams:

- Administration and service of the internal systems and
- Development and support of the accountancy service software from order processing to printing and delivery to the customer.

ICT business process:

- Development of a Java based software system for the complete accountancy process

fig. 6-6: Results and companies of the case studies in the ICT sector and ICT user sectors

Based on the approach and interview guidelines described above, the results of the case studies allow in addition to the statistical analyses to extract some more conclusions on the sectors, employment numbers as well as the allocation of ICT practitioners by qualification level. Complementary to the statistics the outcomes roughly confirm the estimated distribution of ICT practitioners by their qualification level. Typical for most of the investigated companies is a balance of ICT practitioners at all skill and qualification levels respectively, with a little predominance of those with higher education qualifications (HE level 5B and level 5M). All together we can conclude that app. 50 % of employed ICT practitioners in the investigated companies have a higher education degree. The other half of ICT practitioners have VET qualifications, with level 3 being the largest VET qualified ICT practitioner group. This result underlines the good sample of investigated companies, namely in terms of the qualifications of ICT practitioners. All together the investigated companies have a qualification structure of employed ICT practitioners as follows:

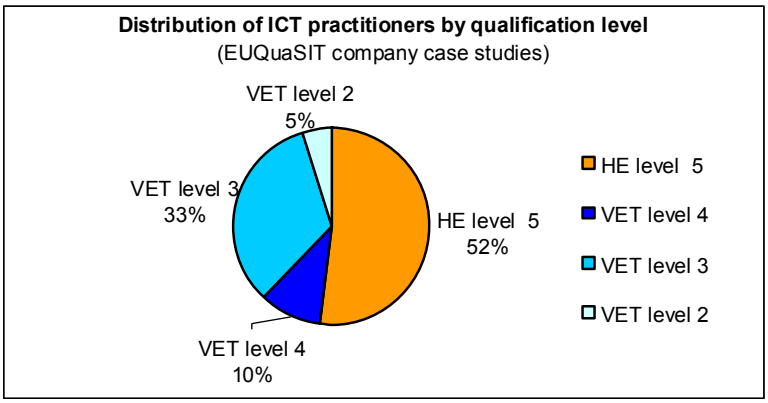


fig. 6-7: Allocation of ICT practitioners by qualification level of the investigated companies

Structure and content of the investigated companies and ICT business processes of the European ICT sector and ICT user industries

Based on the overall information analysed in the case studies the companies can be allocated in the economic structure on NACE (Rev 1.1). The table divides case studies undergone in the ICT sector as well as those in the ICT user sectors. In summary, the list indicates a well balanced sample with regard to the 'major' economic activity and (ICT) business of each company respectively. It was possible to cover the entire range of ICT sectors of the NACE structure as well as a selection of companies of ICT user sectors, e.g. manufacturing, financial and insurance services or from the education sector.

In line with its economic significance within the ICT sector (cf. Garland 2003, p. 2) the work of ICT practitioners in the 'ICT service sector' was of highest significance. The most important division investigated was 'Computer and related activities (NACE 72)', which is also in line with its economic power within the 'ICT service sector' (ibid.), and within this division the group 'Software consultancy and supply (NACE 72.2)'. Typical for the ICT sector is the significant number of small and medium enterprises (SMEs) which were comprehensively considered in the case studies.

Results and companies of the case studies
in the structure of NACE Rev. 1.1

ICT sector
(ICT supplier industries)

Section	Division	Groups / Classes	Link: Case study-Company-Country code-Number		
			Small enterprises	Medium enterprises	Large enterprises
Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods (NACE G)	Wholesale trade and commission trade, except of motor vehicles and motorcycles (NACE 51)	Wholesale of computers, computer peripheral equipment and software (NACE 51.84)	■ CS-CO-RO-08		■ CS-CO-CZ-01*
Transport, storage and communications (NACE I)	Post and telecommunications (NACE 64)	Telecommunications (NACE 64.2)	■ CS-CO-RO-05	■ CS-CO-NL-02 ■ CS-CO-RO-01	■ CS-CO-DE-05 ■ CS-CO-DE-06
Real estate, renting and business activities (NACE K)	Computer and related activities (NACE 72)	Hardware consultancy (NACE 72.1)	■ CS-CO-NL-08	■ CS-CO-RO-04	■ CS-CO-DE-11
		Software consultancy and supply (NACE 72.2)	■ CS-CO-CZ-08 ■ CS-CO-NL-01 ■ CS-CO-NL-06	■ CS-CO-DE-01 ■ CS-CO-DE-02 ■ CS-CO-DE-08 ■ CS-CO-NL-04 ■ CS-CO-PT-03	
		Data processing (NACE 72.3)	■ CS-CO-DE-09	■ CS-CO-DE-03	
		Database activities (NACE 72.4)	■ CS-CO-RO-02	■ CS-CO-CZ-06	
		Maintenance and repair of office, accounting and computing machinery (NACE 72.5)	■ CS-CO-NL-05	■ CS-CO-RO-06	
		Other computer related activities (NACE 72.6)			■ CS-CO-CZ-02
Manufacture of electrical and optical equipment (NACE DL)	Manufacture of office machinery and computers (NACE 30)	Manufacture of computers and other information processing equipment (NACE 30.02)			■ CS-CO-CZ-01*
	Manufacture of radio, television and communication equipment and apparatus (NACE 32)	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy (NACE 32.2)			■ CS-CO-NL-07* ■ CS-CO-NL-09*
	Manufacture of medical, precision and optical instruments, watches and clocks (NACE 33)	Manufacture of industrial process control equipment (NACE 33.3)			■ CS-CO-DE-12*

ICT user sectors
(ICT user industries)

Manufacture of pulp, paper and paper products; publishing and printing (NACE DE) ■ CS-CO-DE-04	Manufacture of basic metals and fabricated metal products (NACE DJ) ■ CS-CO-RO-03	Manufacture of electrical and optical equipment (NACE DL) ■ CS-CO-DE-12* ■ CS-CO-NL-07* ■ CS-CO-NL-09*	Electricity, gas and water supply (NACE E) ■ CS-CO-CZ-07	Transport, storage and communications (NACE I) ■ CS-CO-PT-02
Financial intermediation, except insurance and pension funding (NACE J 65) ■ CS-CO-CZ-03	Insurance and pension funding, except compulsory social security (NACE J 66) ■ CS-CO-CZ-05	Real estate, renting and business activities (NACE K) ■ CS-CO-DE-10	Education (NACE M) ■ CS-CO-DE-07 ■ CS-CO-NL-03	Other community, social and personal service activities (NACE O) ■ CS-CO-CZ-04 ■ CS-CO-PT-01

fig. 6-8: Results and companies of the case studies in the NACE structure

Based on the sample, one of the major goals of the EUQuaSIT project, namely to investigate the ICT skill needs of small and medium enterprises could be realised and therefore detailed results on the "development of skills within SMEs" (see LEONARDO - Thematic monitoring, Theme 2) could be produced. These fairly unique and concrete results on ICT practitioner skill needs in SMEs complement usually existing outcomes on ICT practitioner work and skill needs of large enterprises (vendors) of the ICT sector (see for example Career Space / Cedefop 2001). Provided in detail in further chapters, it can already be mentioned at this stage of the presentation that the way ICT business and work processes - from the organisational and content perspective as well as in view of the ICT practitioner work and skill needs - are realised in small companies differ from those in large firms and their department or business area teams, but also indicate some significant similarities. This is also the case for the companies of the ICT user sector for which the results provide a good basis for some conclusions in the qualitative and comparative perspective of the EUQuaSIT studies.

6.3 Proposal for European (reference) ICT skills framework and generic ICT skills profiles

There is consensus that common European (reference) frameworks for the recognition of skills and qualifications can efficiently support transparency and mobility on the labour markets in European countries. A lot of current vocational education and training (VET) activities in Europe stress the importance (but also challenge) of creating mutual recognised frameworks of skills and qualifications as well as certificates. The most relevant overall example is the initiative to create and implement a single framework document, called new Europass (see European e-skill newsletter, p. 13). A precondition, however, for all such common European qualification activities is a clear picture of skill needs summarised in a comprehensive skills framework, both in terms of relevant skill levels as well as skills profiles comprehending and differentiating a set of characteristic occupational skills needs and contents in a clearly defined employment and business segment.

The comprehensive investigations of the case studies in European companies allow a purposeful international and comparative analysis and evaluation of ICT practitioner work, skills and qualifications considering the demand of ICT practitioners at different skill and qualification levels. Furthermore, the case studies in ICT training institution reflecting the supply of ICT qualifications provide references on the actual ICT training practice and difficulties and therefore provide further important insights with regard to the mismatch of ICT skill needs and training supply in Europe. Based on the qualitative nature of the case study surveys they are of course limited to a selection, but allow to describe and 'operationalise' a concrete feedback from the ICT work and training practice.

Aggregation of ICT business process to a generic ICT business area

The approach of EUQuaSIT surveys is based on the assumption that the empirical analysis of a variety of "ICT business and work processes" in small, medium and large sized enterprises of the ICT sector and ICT user sectors as well as in different countries supports the mutually recognised development of a European occupation and qualifications structure. The first step focused on the structure and content of the investigated ICT business processes within the case studies in small, medium and large European enterprises. All together the case studies in involved companies detected almost 200 ICT business processes in different level of detail, namely 140 in companies of the ICT sector and 60 in companies of the ICT user sectors.

The table below shows the more concretely investigated ICT business processes in companies in the structure of the company size as well as divided into those of the ICT sector and ICT user sectors. A glance at this list indicates the variety of the investigated ICT business and work processes which is abstracted in more detail in the following paragraphs.

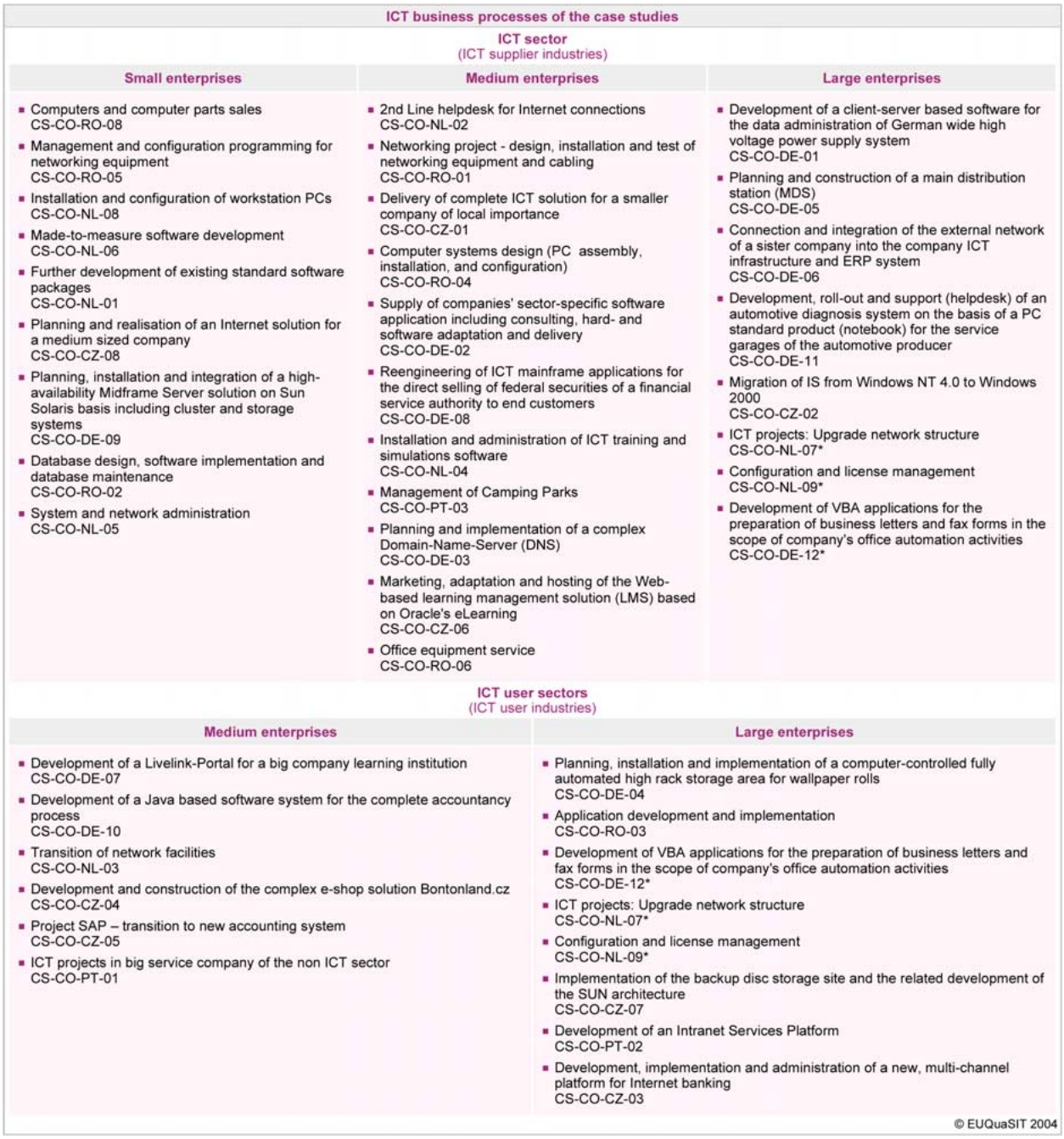


fig. 6-9: Structure and content of the investigated ICT business processes in the European ICT sector and ICT user sectors

Nevertheless and despite the enormous breadth of the ICT field the case study investigations first of all allow by comparing the structures and contents of the ICT business processes in the SMLEs and the ICT sector and ICT user sectors the aggregation of relevant ICT business (and technology) areas. Since these (basically open list of) areas especially depend on aspects such as the sector (ICT supplier or user) and the core and main ICT business of the companies, the findings were complemented and verified by parallel ICT market and technology surveys.

Main orientation of the ICT business areas in companies is generally on information systems, applications and services - more IT orientation unlike communications systems, applications and services which are a bit less represented. The sector specific ICT solution and internet and intranet systems and applications have also the significant representation. Many companies are also orientated to construct and provision of performance of network systems, business applica-

tions and ICT training solution. e-business and e-commerce solutions and also multimedia systems and applications are not now adequately developed but in near future will be purveyed.

- ICT service,
- Information systems and applications,
- Communications systems and applications,
- Sector-specific ICT solutions,
- Internet and intranet applications,
- E-business and e-commerce,
- Data management and databases,
- Networks systems and solutions,
- ICT security solutions,
- Business (process) applications,
- Industrial IT systems,
- Embedded systems and control,
- ICT training solutions,
- ICT manufacturing,
- Multimedia applications,
- Consumer electronics.

Aggregation of ICT work processes to generic ICT work areas

According to the concept of the case studies, different and concrete "ICT business processes" generate the basis of this identification as well as the methodological background of aggregation. In the further steps also the detailed results from the detailed investigations of ICT work processes, phases of activity and the concrete ICT work tasks and skills of the ICT practitioners can be aggregated to a complete work area orientated skills and qualification structure. In addition to this list of relevant ICT business and technology (sub-)areas which can be understood as one broad ICT business area, the case studies indicate within the second investigation step and according to the ICT business process variety different contents and structures of "ICT work processes".

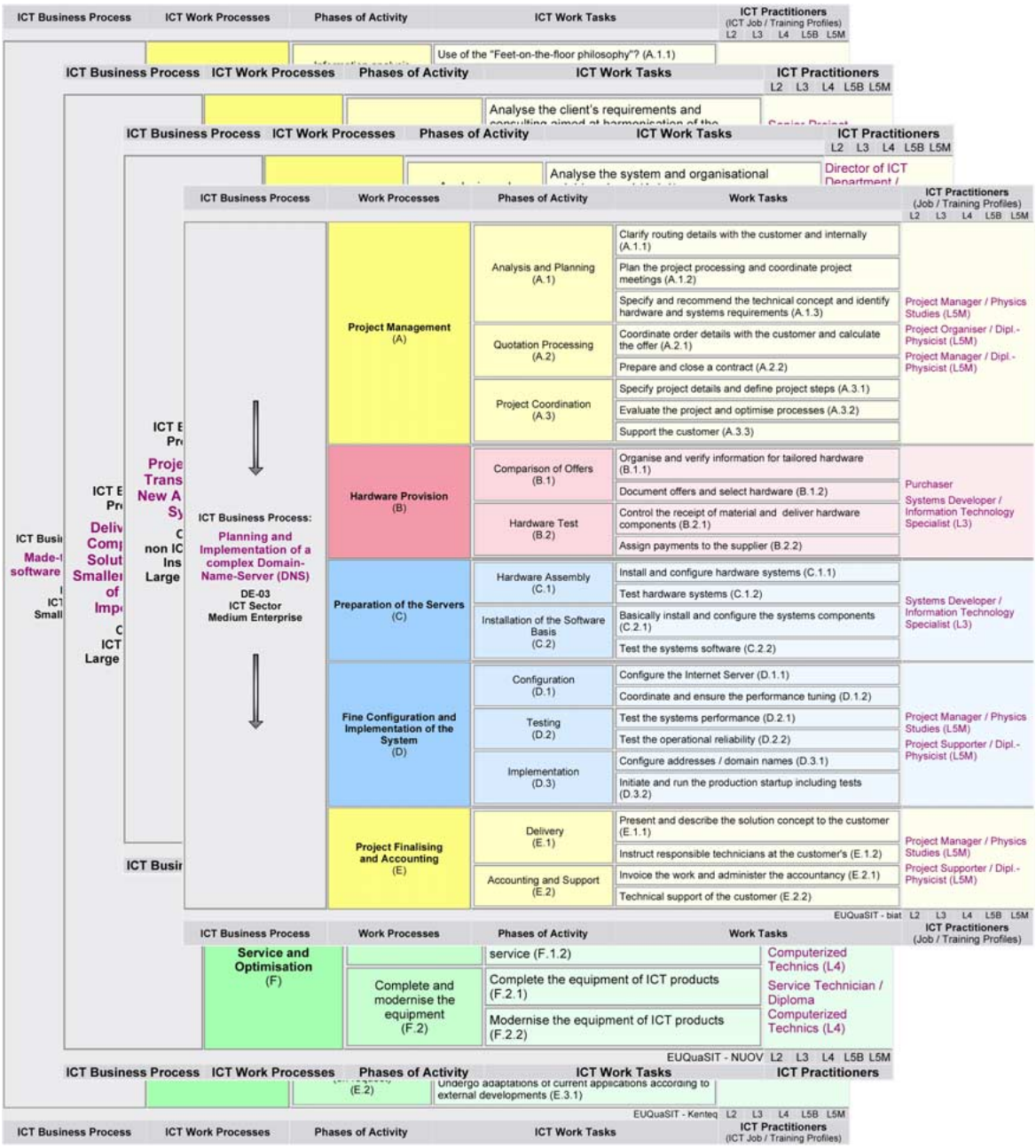


fig. 6-10: "ICT business processes" variety for the interpretation in a European comparative context

The following example of a case study also reflects a typical work flow of an ICT business process. All case study results are described in detail in the corresponding report from all project partners.

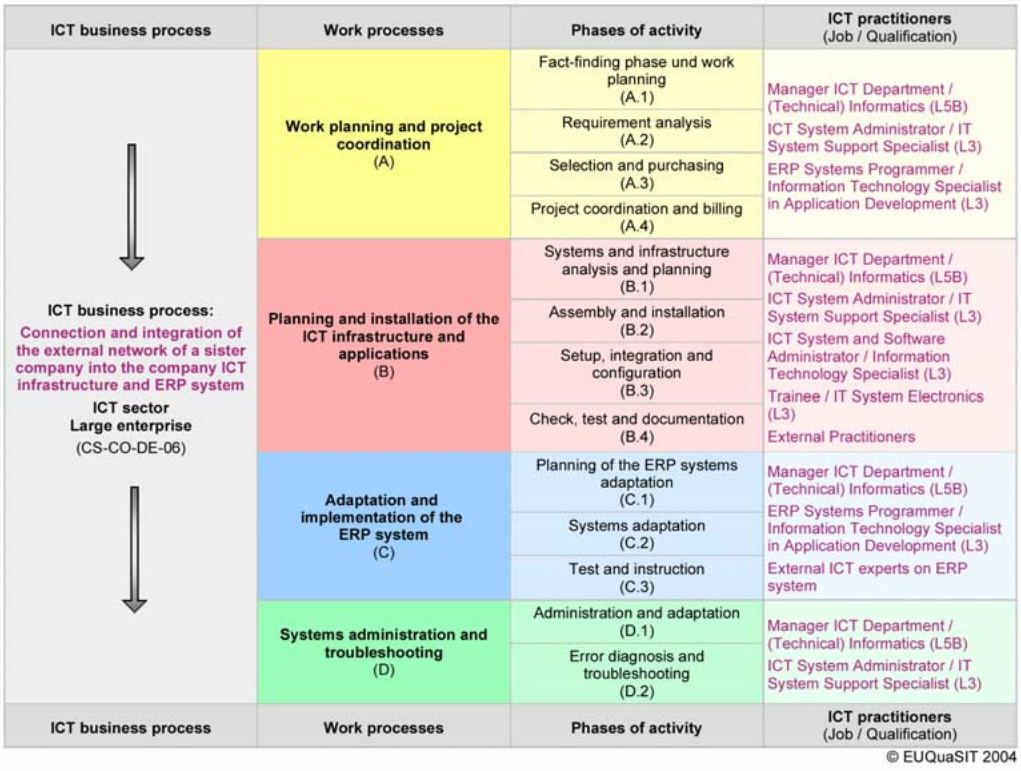


fig. 6-11: Example of an ICT business process in a large company of the ICT sector

The concrete contents of work processes always have a crosslink to the specific ICT business process. On the other hand and despite the variety of business processes the contents and especially the workflow structures of the "ICT Work Processes" show similarities which allow - based on common ICT work criteria - to aggregate and conclude the different structures of "ICT work processes" to an overall structure of six generic ICT work areas as indicated in the table below.

These six generic ICT work areas cover and represent the different contents and structures of "ICT work processes" of small, medium and large enterprises (SMLEs) of the ICT sector and ICT user sectors. Nevertheless, of course and like the broad ICT business area above the contents and structure of the six ICT work areas depend on each real ICT business process and on the different business and technology areas respectively. In addition the structure of the six generic ICT work areas depends on:

- the size of the company (S, M or L) and / or
- the company organisation (department structure, hierarchies etc.).

For instance, the contents and work area "ICT marketing, consulting and sales" is mainly relevant in ICT supply companies or the number and structure of the ICT work areas in large enterprises is normally higher and more detailed than in small enterprises. We find that compared to larger businesses usually less ICT practitioner are involved in projects or customer quotations and thus need broader skill basis to carry out the variety of work tasks in the different phases of activity. Thus, the consideration of the findings from small businesses are an important part to be considered for further conclusions.

Or the work area 'ICT support and systems service' especially reflects the significance of ICT work and skills in companies of the ICT user sector, e.g. Project SAP – transition to new accounting system (CS-CO-CZ-05). But all together and as one first relevant analysis result in view of the complexity of ICT practitioners skill needs, the broad ICT business area with the structure of six generic ICT work areas is supposed to reflect the breadth of 'real' ICT business

and work processes" in Europe's small, medium and large enterprises of both the ICT sector itself and the those of the ICT user sectors. This is impressively underlined by the significance of ICT business and work processes with an emphasis on 'development' projects and quotations in companies of the ICT user sector and indicates the range of competences that many ICT teams and department in the "ICT user sectors" do cover.

Within each ICT work area the ICT skill needs for example in ICT marketing or development or administration or service furthermore depend on the concrete content of the ICT business area like "Networks Systems and Solutions" or "Communications Systems, Applications and Services" or "Data Management and Database Solutions" or "Multimedia Applications". That means, depending on the different ICT business areas there are different ICT skill needs within all ICT work areas.

Because within these ICT work areas job roles, skills and competences are defined at all levels as well as for both, the ICT sector and ICT user sectors, the subsequent basic structure of a European ICT skills framework can be used to describe all further results in regard to the qualitative ICT skill needs. Already at this early and abstract stage of the work analyses some first qualitative conclusions on the needs of ICT skills at the different ICT skill levels can be drawn. Of course not very detailed at this stage, but for the employed and needed ICT practitioners in each work area the case studies indicate based on the practitioner work and their ICT job and training profiles that in each ICT work area there are needs of ICT skills at all ICT practitioner skill levels.

ICT business area	Generic work areas	ICT practitioners L2 L3 L4 L5 L6
⇩ **ICT business areas** ▪ ICT service ▪ Information systems and applications ▪ Communications systems and applications ▪ Sector-specific ICT solutions ▪ Internet and intranet applications ▪ E-business and e-commerce ▪ Data management and databases ▪ Networks systems and solutions ▪ ICT security solutions ▪ Business (process) applications ▪ Industrial IT systems ▪ Embedded systems and control ▪ ICT training solutions ▪ ICT manufacturing ▪ Multimedia applications ▪ Consumer electronics ▪ ... ⇩ **All sectors SMLEs**	ICT marketing, consulting and sales (A)	Teams of ICT practitioners
	ICT business and project management (B)	Teams of ICT practitioners
	ICT systems and application development (C)	Teams of ICT practitioners
	ICT integration and administration (D)	Teams of ICT practitioners
	ICT infrastructure and installation (E)	Teams of ICT practitioners
	ICT support and systems service (F)	Teams of ICT practitioners
ICT business area	**Generic work areas**	L2 L3 L4 L5 L6 **ICT practitioners**

fig. 6-12: GAHFA ICT skills framework with ICT business areas, generic ICT work areas and involved ICT practitioners

For these generic ICT work area a general skills description have been worked out in order to delimitate and specify each ICT work area as follows:

- **ICT marketing, consulting and sales skills**

ICT marketing, consulting and sales is a comprehensive work area covering commercial and consultancy activities with special focus on information and communications technology (ICT) projects, products and services. It applies to both the ICT industry and to companies of the ICT user industries (a key description being profit centre organisation). Successful marketing and sales of ICT products and services requires fundamental analyses of external and internal market and customer needs. Following various consultations, these requirements need to be translated into services and products that answer specific customer needs while providing benefits to the own company or department at the same time. These combinations of business and technical tasks ask for specific skills justify the elaboration and delimitation of a generic ICT work area and corresponding skills at different levels.

- **ICT business and project management skills**

ICT business and project management also combines business and ICT skills ensuring the work flow success of an ICT project and business process. Within a wide range of project activities and responsibilities, business and project oriented ICT practitioners at different skill levels closely collaborate with internal and external ICT experts, providers and customers to ensure that customer business needs are met when developing and deploying infrastructure and software ICT solutions and services. Business oriented ICT practitioners constitute the crucial interface between the customer and primary ICT specialists and technicians. A common goal of business and technically oriented ICT practitioners is a clear description of the business requirements within the technical specification of the ICT solution to be developed. In shared responsibility, business and technically oriented ICT practitioners organise and implement applied support, training and instructions to the customer.

- **ICT systems and application development skills**

ICT systems and application development covers far more than mere individual programming or coding. In this work area, practitioners at different skill levels work in development teams that design, realise, update, test and document ICT systems and software applications. The work is carried out based on comprehensive analyses and descriptions of ICT systems and applications needed by the market, a specific sector or a specific (internal or external) customer. In practice, contacts with the project manager and ICT business and technical practitioners within our outside the company are important. In the daily work processes, the transfer of the technical and business requirements into a consistent data processing specification is crucial for the final success of ICT systems and application development process. Primary criteria for software solutions are reliability and usability. Furthermore, the work as part of a team often runs under time constraints and must be constantly well communicated and documented. The customer and users often need applied support, training and instructions.

- **ICT integration and administration skills**

After the development of ICT systems and applications, these need to be professionally integrated, deployed, administered, optimised, supported etc., depending on the platform the applications run on. ICT integration and administration teams configure, integrate, maintain and administer newly developed or already running systems and software applications. The work is carried out based on comprehensive analyses and descriptions of systems environments essential to final success in the integration and deployment process. In daily work processes, contacts with the project manager and ICT business and developers within our outside the company are important. The customer and users often need applied (help desk) support, training and instruction. As part of the (continuing and often contracted) technical support, systems and

applications are optimised and up-graded, and troubleshooting needs to be coordinated and problems resolved at different levels.

- **ICT infrastructure and installation skills**

ICT infrastructure and installation work covers the planning, integration, modification and installation of the wide range of different systems, devices, telecommunications, networks etc., summarised as ICT infrastructure. The work is carried out based on problem oriented analyses and descriptions of what type and level of ICT infrastructure is needed by the market, a specific sector or (internal or external) customer. In practice, contacts with customers, project managers and ICT business and systems development practitioners within our outside the company are important. For the realisation of the projects or project parts, and depending on the skill and responsibility level, ICT infrastructure practitioners need to consider aspects such as cost effectiveness, expandability and upgradeability, reliability, security etc. The integration of standard, specific and innovative solutions (e.g. software applications, wireless network and telecommunication solutions, web-based infrastructure) is part of this work. The work, sometimes as part of a team, often runs under time constraints and must be constantly well communicated and documented. The customer and users often need applied support, training and instructions.

- **ICT support and systems service skills**

ICT support and systems service primarily concerns the analysis, troubleshooting and fixing of ICT infrastructure, systems and application problems. In principle this work covers a wide range of different ICT technologies and services and correspondingly the use of different soft- and hardware based expert and diagnosis tools, depending on the level of service and support. In order to narrow the faults down to concrete technical problems, ICT service practitioners need to communicate well with customers, users and colleagues. As part of the service and maintenance, ICT practitioners must be able to propose possibilities of optimising and upgrading existing ICT systems.

- **"Soft skills"**

By including the main contents and overall tasks within the six generic ICT work areas it becomes obvious that additional skills are also required. The need for these skills depends on the type and contents of the work. Such skills can be labelled ‘soft (or basic) skills’ and summarised in three categories as listed below:

behavioural and personal skills: flexibility, self learning, motivation and commitment, stress resistance and emotion, responsibility, managing risks, decision-making, negotiation, initiative and attention, persuasiveness, professional attitude (business or technical orientation and interests);

cross section and basic work skills: quality awareness, commercial and market awareness, entrepreneurship, customer orientation and relationship, company and business organisation, work and project organisation, work safety and health protection, labour law and data privacy, environmental and resource awareness;

soft and method skills: communication and moderation, languages and culture, collaboration and interaction, teamwork and mentoring, conflict and consensus, creative and innovation, analytical and reasoning, problem analysis and solving, strategy, conception and planning, context and causal connection thinking, information handling, documentation and presentation.

Needs of ICT skills and practitioners - summary of the case study results in terms of fields of activity and ICT work tasks and skills within the new European ICT skills framework

In order to concretely describe the skill needs of ICT practitioners the case study results can be finally aggregated in terms of generic ICT work tasks. Each of the fields of activity covers a characteristic set of ICT work tasks which describe overall and specific skills of ICT practitioners at different skill levels. The link between these work tasks and skills is based on the assumption that the ICT skills can be understood as the requirements to carry out work tasks in a competent, thorough and efficient manner. Just like the ICT work areas and fields of activity constitute the fundament for the overall framework of needed ICT skills in general, now these generic ICT work tasks are the fundament for the work oriented description of ICT skill needs in detail, i.e. for the concrete description of ICT skills profiles that are the reference for the description of work oriented ICT qualifications.

As we know, in all ICT work areas and fields of activity ICT practitioners at different skill levels work together in a (temporary) team. Insofar there are basically in all ICT work areas and fields of activities concrete ICT work tasks at all skill levels too. But according to the concept the detailed case study investigations concentrate especially within the fields of activity on ICT work tasks and skill needs at vocational skill levels and respectively on tasks carried out by ICT practitioners mainly with ICT job and qualifications at ‘skilled worker’ levels. In this assignment and because the levels and contents of the ICT work tasks are directly connected with the ICT skill needs at these three levels in detail, the tasks and skill needs have furthermore and in the view of companies' needs a specific importance for the structure and skills of the ICT qualifications of ICT practitioners involved in each ICT work area and in general.

Like the work areas and fields of activity also the skills requirements described in ICT work tasks depend on the concrete content of the ICT business area like "Networks Systems and Solutions" or "Communications Systems, Applications and Services" or "Data Management and Database Solutions" or "Multimedia Applications". For example to "obtain, analyse and prepare tailored ICT market, product and service information" or to "contribute to, edit and review an ICT business and project plan" can, on the one hand, comprehend different objects, methods, tools as well as requirements and regulations depending on ICT business area. However, there are also, on the other hand and more from a work orientated view, a lot of similarities that constitute an ICT work task as being typical and generic in terms of needed skills of ICT practitioners.

The work tasks and identified skills needs of ICT practitioners are described and structured in the GAHFA model of generic work area, fields of activity and linked to the ICT business areas as comprehensively summarised in the following tables.

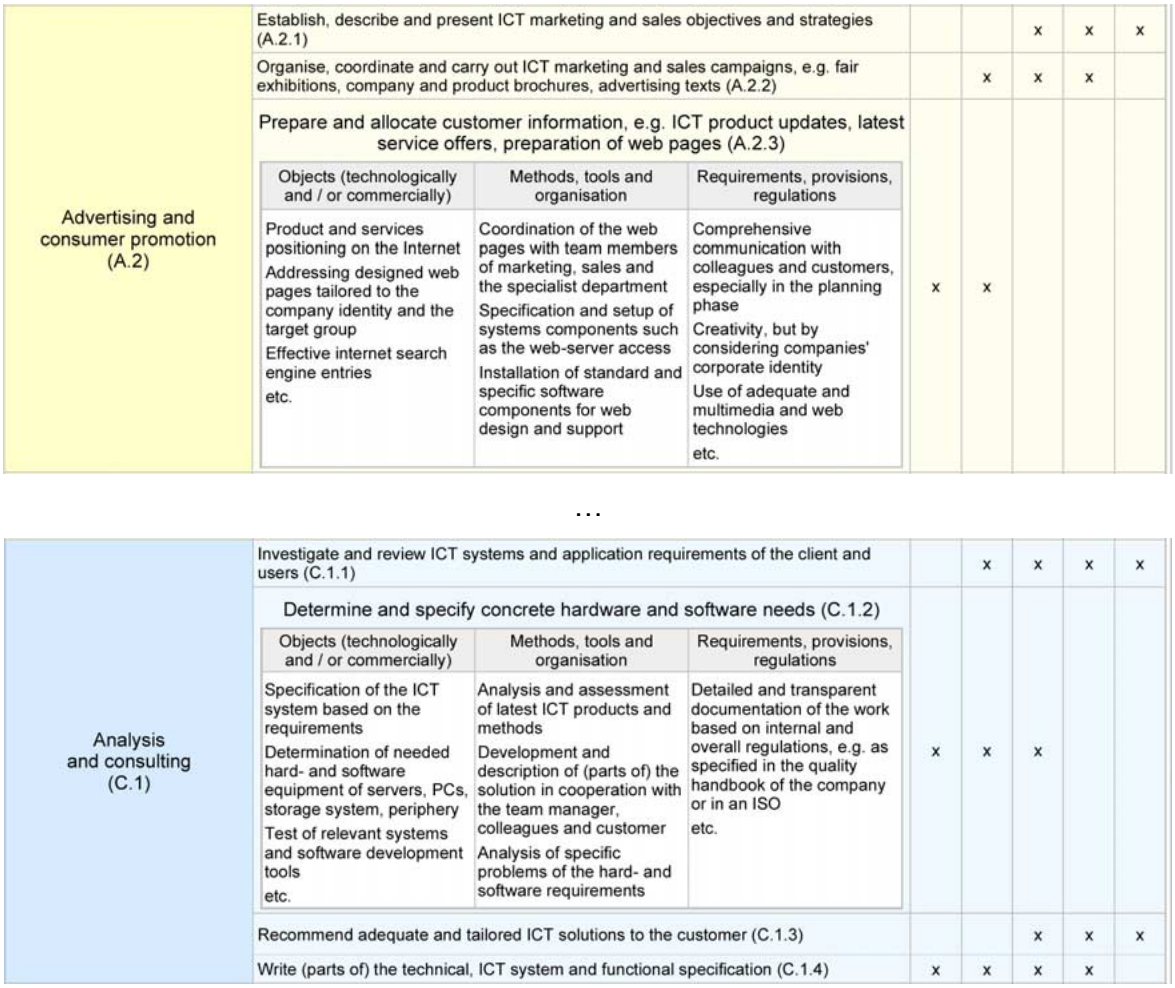
ICT business area	Generic work areas	Generic fields of activity	Generic ICT work tasks and skills	ICT practitioners				
				L2	L3	L4	L5	L6
⇩ **ICT business area** Skills linked to ... ▪ ICT service ▪ Information systems and applications ▪ Communications systems and applications ▪ Sector-specific ICT solutions ▪ Internet and intranet applications ▪ E-business and e-commerce ▪ Data management and databases ▪ Networks systems and solutions ▪ ICT security solutions ▪ Business (process) applications ▪ Industrial IT systems ▪ Embedded systems and control ▪ ICT training solutions ▪ ICT manufacturing ▪ Multimedia applications ▪ Consumer electronics ▪ ... "Soft skills" ▪ Behavioural and personal skills ▪ Cross section and basic work and technical skills ▪ Soft and method skills **All sectors SMLEs** ⇩	**ICT marketing, consulting and sales** (A)	Market analysis and benchmarks (A.1)	Obtain, analyse and prepare tailored ICT market, product and service information (A.1.1)	x	x	x	x	x
			Contribute to, edit and review an ICT business and project plan (A.1.2)		x	x	x	x
		Advertising and consumer promotion (A.2)	Establish, describe and present ICT marketing and sales objectives and strategies (A.2.1)			x	x	x
			Organise, coordinate and carry out ICT marketing and sales campaigns, e.g. fair exhibitions, company and product brochures, advertising texts (A.2.2)		x	x	x	
			Prepare and allocate customer information, e.g. ICT product updates, latest service offers, preparation of web pages (A.2.3)	x	x			
		Customer consulting and acquisition (A.3)	Receive, assess and forward customer inquiries (A.3.1)	x	x			
			Analysis and evaluate ICT systems and applications demand of customers (A.3.2)			x	x	x
			Meet customers and colleagues and present tailored ICT solutions (A.3.3)		x	x	x	x
		Requirement, product and systems analysis (A.4)	Investigate and determine requirement specifications of the customer (A.4.1)		x	x	x	
			Check and define overall ICT systems, software and user interfaces (A.4.2)		x	x	x	
			Coordinate, carry out and review financial and cost-benefit analyses (A.4.3)			x	x	x
		Conception and documentation of ICT solutions (A.5)	Evaluate and draft adequate ICT solutions for the customer in cooperation with specialised ICT staff (A.5.1)			x	x	x
			Formulate overall data base structures using various data models (A.5.2)		x	x	x	
			Recommend and present persuasive ICT systems, application software solutions and services to the customer (A.5.3)	x	x	x	x	x
			Prepare and administer product- and project specific documentations and manuals (A.5.4)		x	x	x	
		Quotation processing and contracting (A.6)	Manage and calculate customer quotations, i.e. prices, conditions, performance, services (A.6.1)			x	x	x
			Provide official written quotations for ICT solutions to potential (internal or external) customers (A.6.2)			x	x	
			Negotiate and set up ICT product and service agreements and contracts (A.6.3)			x	x	x
			Support and manage the contracting process, e.g. verify and change ICT system and functional specifications, service agreements (A.6.4)	x	x	x	x	x
	ICT business and project management (B)	Project and resource planning (B.1)	Determine and describe project objectives, work packages, milestones, costs etc. (B.1.1)		x	x	x	x
			Plan and manage human and ICT system resources and maintain project and customer data (B.1.2)		x	x	x	
			Coordinate und control external project and outsourcing activities (B.1.3)			x	x	x
		Selection and purchasing (B.2)	Identify and describe detailed ICT systems needs (B.2.1)		x	x	x	
			Compare offers of ICT systems and software solutions (B.2.2)	x	x			
			Purchase and provide ICT systems to the specialist teams (B.2.3)		x	x	x	
		Quotation coordination and project support (B.3)	Coordinate ICT work tasks and the work flow and project progress (B.3.1)			x	x	x
			Draft and advise overall data and security concepts (B.3.2)			x	x	
			Adapt and use information and communication platforms (B.3.3)	x	x			
		Order coordination and project support (B.4)	Evaluate and control objectives, outcomes, budget etc. of an ICT project or customer order, e.g. target/actual comparison, use of quality management handbook (B.4.1)			x	x	x
			Describe and run measures for the evaluation and assurance of quality, e.g. project, system, product service etc. (B.4.2)		x	x	x	
			Document the project and order process as well as quality control and technical checks (B.4.3)	x	x			
		Customer support and training (B.5)	Instruct and train customers and users on new or adapted ICT systems and applications (B.5.1)	x	x			
			Manage and provide business support and sustain relationships to customers and users (B.5.2)			x	x	x
			Develop and run escalation plans and handle customer complaints (B.5.3)		x	x	x	
		Project finalising and billing (B.6)	Finally calculate and fix project and service agreement costs (B.6.1)		x	x	x	x
			Prepare and provide project and billing data to the accountancy (B.6.2)	x	x			
ICT business area	Generic work areas	Generic fields of activity	Generic ICT work tasks and skills	L2	L3	L4	L5	L6
				ICT practitioners				

fig. 6-13: Work tasks and skills of ICT practitioners described and structured in the GAHFA model of generic work area, fields of activity and linked to the ICT business areas

ICT business area	Generic work areas	Generic fields of activity	Generic ICT work tasks and skills	ICT practitioners				
				L2	L3	L4	L5	L6
⇩ **ICT business area** Skills linked to ... ■ ICT service ■ Information systems and applications ■ Communications systems and applications ■ Sector-specific ICT solutions ■ Internet and intranet applications ■ E-business and e-commerce ■ Data management and databases ■ Networks systems and solutions ■ ICT security solutions ■ Business (process) applications ■ Industrial IT systems ■ Embedded systems and control ■ ICT training solutions ■ ICT manufacturing ■ Multimedia applications ■ Consumer electronics ■ ... "Soft skills" ■ Behavioural and personal skills ■ Cross section and basic work and technical skills ■ Soft and method skills **All sectors SMLEs** ⇩	**ICT systems and application development** (C)	Analysis and consulting (C.1)	Investigate and review ICT systems and application requirements of the client and users (C.1.1)		x	x	x	x
			Determine and specify concrete hardware and software needs (C.1.2)	x	x			
			Recommend adequate and tailored ICT solutions to the customer (C.1.3)			x	x	x
			Write (parts of) the technical, ICT system and functional specification (C.1.4)	x	x	x	x	
		Systems- and work planning (C.2)	Manage and specify own work and project priorities using project management tools (C.2.1)	x	x	x		
			Accompany, monitor and lead the development process of the ICT solution and ensure progress, quality, configuration management etc. (C.2.2)			x	x	x
			Test, choose and set up software and systems development tools (C.2.3)		x	x	x	
		Design and conception (C.3)	Define and design the ICT systems and software architecture and distribution (e.g. Client/Server, Mainframe, CORBA) considering latest research results (C.3.1)			x	x	x
			Analyse and define objects, frameworks, basic software classes, systems components, interfaces etc. (C.3.2)			x	x	x
			Create and specify concepts, prototyping, data structures, access, data base models etc. (C.3.3)		x	x	x	
		Programming and implementation (C.4)	Determine and describe software units, methods, attributes, modules, I/O-parameters etc. (C.4.1)		x	x	x	x
			Code, adapt and document systems, software and database applications, e.g. in 3GL and with 4GL IDEs, embedded SQL (C.4.2)	x	x	x	x	x
			Design, develop and implement graphical user interfaces as well as web-based applications (C.4.3)		x	x	x	x
		Software adaptation and testing (C.5)	Develop and coordinate test procedures and cases (C.5.1)			x	x	x
			Run, interpret and document ICT systems and software tests by using various test tools, methods and data (C.5.2)	x	x	x	x	
			Describe opportunities and undergo bug-fixing, systems upgrading and software adaptation (C.5.3)	x	x	x	x	
		Configuration management and documentation (C.6)	Write (parts of) the installation and user instructions and ICT systems and application manuals (C.6.1)		x	x	x	
			Document, version and register new systems, software and database applications (configuration- and report management) (C.6.2)		x	x		
			Document the work following overall and company standards, e.g. info and help centre, change management (C.6.3)	x	x	x		
	ICT integration and administration (D)	Planning and installation (D.1)	Advise the ICT systems and software development teams and customers on systems and software installation and operation (D.1.1)			x	x	x
			Assemble and test ICT systems, e.g. hardware, operating system, drivers (D.1.2)	x	x			
			Clarify and describe hardware and software requirements for the installation and integration of ICT systems and applications (D.1.3)		x	x	x	
			Plan and prepare automatic software installations (D.1.4)			x	x	x
			Manual and automatic installation and adaptation of operating systems, data bases and application software (D.1.5)	x	x			
		Systems integration and configuration (D.2)	Control compatibility between devices and ICT systems (D.2.1)		x	x	x	
			Check and adapt installation and configuration parameters to new and real circumstances (D.2.2)	x	x			
			Implement communication software and ensuring data mining and exchange (D.2.3)	x	x			
			Plan and set up systems parameters and user administration (D.2.4)		x	x	x	
		Integration and systems testing, release (D.3)	Define and describe test range and plan (test scenarios, cases, data etc.) in cooperation with developers, administrators and users (D.3.1)			x	x	x
			Coordinate, run and evaluate integrated tests of ICT systems and applications based on defined test cases (D.3.2)	x	x	x	x	
			Coordinate and undergo systems adaptations based on a test protocol and issue release (D.3.3)		x	x	x	
		Documentation and delivery (D.4)	Document systems specifications, test results and work tasks and provide them according to the arrangements (e.g. in the Intranet) (D.4.1)	x	x	x	x	
			Coordinate, run and document systems delivery according to company and customer requirements (D.4.2)		x	x	x	x
		Presentation, training and instruction (D.5)	Plan and coordinate tailored ICT systems presentations, training and instruction for customers and users, e.g. dates, target group etc. (D.5.1)			x	x	x
			Prepare and run systems and application related presentations (D.5.2)		x	x	x	
			Elaborate and edit training and instruction material (D.5.3)		x	x	x	
			Run and evaluate training measures using multimedia systems (D.5.4)	x	x	x	x	
		Systems administration and support (D.6)	Optimise and actualise ICT systems, e.g. hardware, operating system, libraries (D.6.1)	x	x			
			Arrange and guarantee ICT system and software security and data backup and restore (D.6.2)		x	x	x	
			Manage and run software distribution, remote configuration, data archiving, retrieving and reorganisation (D.6.3)			x	x	x
			Ensure and improve problem related support of customers and users through information, consulting and material (D.6.4)	x	x			
			Interpret, remove and document ICT systems and software bugs and coordinate external support (D.6.5)		x	x	x	
ICT business area	Generic work areas	Generic fields of activity	Generic ICT work tasks and skills	L2	L3	L4	L5	L6
				ICT practitioners				

ICT business area	Generic work areas	Generic fields of activity	Generic ICT work tasks and skills	ICT practitioners				
				L2	L3	L4	L5	L6
⇩ **ICT business area** Skills linked to ... ▪ ICT service ▪ Information systems and applications ▪ Communications systems and applications ▪ Sector-specific ICT solutions ▪ Internet and intranet applications ▪ E-business and e-commerce ▪ Data management and databases ▪ Networks systems and solutions ▪ ICT security solutions ▪ Business (process) applications ▪ Industrial IT systems ▪ Embedded systems and control ▪ ICT training solutions ▪ ICT manufacturing ▪ Multimedia applications ▪ Consumer electronics ▪ ... "Soft skills" ▪ Behavioural and personal skills ▪ Cross section and basic work and technical skills ▪ Soft and method skills **All sectors SMLEs** ⇩	**ICT infrastructure and installation** (E)	Analysis and consulting (E.1)	Advise and influence colleagues and customers on new or extended ICT infrastructure solutions (E.1.1)		x	x	x	x
			Determine, specify and describe technical requirements (E.1.2)	x	x			
			Write (parts of) the ICT infrastructure and functional specification (E.1.3)		x	x	x	
		Systems- and work planning (E.2)	Receive, assess and forward new customer orders (E.2.1)	x	x	x		
			Arrange the time schedule and coordinate work tasks (E.2.2)			x	x	x
			Ensure, select and use latest ICT product and service information and requirements, also in foreign languages (E.2.3)	x	x			
			Blueprint and determine ICT systems and network solutions and adaptations including security concept (e.g. firewall, encryption, access authorisation) (E.2.4)		x	x	x	x
			Order and dispose systems and installation material, tools, documents and manuals (E.2.5)		x	x	x	
		Assembly and installation (E.3)	Assemble, install and up-grade ICT systems and networks devices and components (E.3.1)	x	x			
			Plan and ensure ergonomics, interoperability, power supply and security of installed ICT infrastructure, applications and data (E.3.2)		x	x	x	
			Manual and automatic installation and configuration of operating systems, applications and communication software etc. (E.3.3)	x	x			
			Decommission and recycle old ICT infrastructure (E.3.4)	x	x			
		Setup, integration and configuration (E.4)	Check, evaluate and adapt ICT systems environment and infrastructure regarding design, performance, systems software and interoperability of systems components and interfaces (E.4.1)		x	x	x	x
			Plan, test and document new ICT systems and prototypes in test and real operating environments (E.4.2)		x	x	x	
			Undertake systems adaptations by parameterising, updating as well as adapt software applications by using macro- and programming languages (E.4.3)	x	x			
		Check, test and documentation (E.5)	Test and verify requested function of installed and integrated ICT systems based on given criteria and requirements (E.5.1)	x	x			
			Record, back up and archive systems- and configuration data (E.5.2)		x	x	x	
			Prepare and compile ICT systems- and installation documentations (E.5.3)		x	x	x	
		Delivery, instruction and finalising (E.6)	Coordinate and deliver installed and integrated ICT systems (E.6.1)		x	x		
			Prepare, compile and adapt user and training documents (E.6.2)		x	x	x	
			Instruct ICT support staff and users for new ICT infrastructure, applications and functions (E.6.3)	x	x	x	x	
	ICT support and systems service (F)	Service management and systems implementation (F.1)	Assess and document the quality and organisational effectiveness of company ICT service structures, support levels and action (F.1.1)			x	x	x
			Analyse and optimise the integration of ICT service and escalation concepts and platforms within the overall company- and process structure using various methods and sources (F.1.2)		x	x	x	
			Receive, interpret and confirm customer ICT service orders (F.1.3)	x	x			
			Check and assess service level agreements and advise colleagues and customers on ICT service possibilities (F.1.4)		x	x	x	x
			Suggest potential ICT service and maintenance improvements of the company (F.1.5)		x	x	x	
			Participate at the integration and implementation of new ICT systems and applications (F.1.6)	x	x	x	x	
		Systems upgrading and optimisation (F.2)	Investigate and assess ICT systems and process performance as well as configuration and security (F.2.1)			x	x	x
			Upgrade and modify ICT infrastructure and systems, e.g. new systems software, drivers, firmware etc. (F.2.2)	x	x			
			Recommend, present and setup new and upgraded ICT applications, e.g. office products, database systems (F.2.3)		x	x	x	
		Systems administration and control (F.3)	Coordinate ICT systems administration and control and setup required tools, e.g. time schedule, platforms, software, data back-up, visualisation (F.3.1)			x	x	x
			Maintain ICT systems and infrastructure regarding up-to-dateness, data- and systems security, user administration etc. (F.3.2)	x	x			
			Permanently run and document ICT systems- and process control (F.3.3)		x	x	x	
		Systems support, helpdesk and training (F.4)	Plan, develop, calculate and coordinate support activities of the company, e.g. hotlines, user helpdesk, internet- and intranet platforms (F.4.1)			x	x	x
			Provide, update and administer ICT system- and user information and resources, e.g. manuals, support documents, patch (F.4.2)		x			
			Support and advice customers and users within company support and helpdesk tasks and follow up complaints (F.4.3)	x	x			
			Instruct ICT support staff and users on new systems, safety, security, application changes, potential problems etc. (F.4.4)	x	x	x	x	
		Systems maintenance and documentation (F.5)	Create, update and document systems- and maintenance plans (F.5.1)			x	x	x
			Maintain ICT systems and infrastructure, e.g. PCs, networks, TC systems, print- and copy systems (F.5.2)	x	x			
			Report and document service work tasks following overall and company standards, e.g. working hours, material, resources, problems (F.5.3)	x	x	x	x	
		Error diagnosis and troubleshooting (F.6)	Ensure, select and use latest ICT product and service information and manuals, also in foreign languages (F.6.1)		x	x	x	
			Narrow and interpret ICT systems and infrastructure problems (F.6.2)	x	x	x	x	
			Select and run test and diagnosis systems and software tools (F.6.3)	x	x	x	x	
			Remove ICT systems errors and ensure safety and security of systems and data, e.g. repair and change hardware, configure systems components and software (F.6.4)	x	x			
ICT business area	Generic work areas	Generic fields of activity	Generic ICT work tasks and skills	L2	L3	L4	L5	L6
				ICT practitioners				

Based on the detailed investigation of ICT work tasks and skills of ICT practitioners, focusing on those with VET qualifications, profound information and material could be gathered and processed as exemplarily indicated in the two aggregated examples below. The complete report from the case studies furthermore provides numerous examples of ICT practitioners of all different work areas and skill levels.



Advertising and consumer promotion (A.2)	Establish, describe and present ICT marketing and sales objectives and strategies (A.2.1)			x	x	x
	Organise, coordinate and carry out ICT marketing and sales campaigns, e.g. fair exhibitions, company and product brochures, advertising texts (A.2.2)		x	x	x	
	Prepare and allocate customer information, e.g. ICT product updates, latest service offers, preparation of web pages (A.2.3)	x	x			

Objects (technologically and / or commercially)	Methods, tools and organisation	Requirements, provisions, regulations
Product and services positioning on the Internet Addressing designed web pages tailored to the company identity and the target group Effective internet search engine entries etc.	Coordination of the web pages with team members of marketing, sales and the specialist department Specification and setup of systems components such as the web-server access Installation of standard and specific software components for web design and support	Comprehensive communication with colleagues and customers, especially in the planning phase Creativity, but by considering companies' corporate identity Use of adequate and multimedia and web technologies etc.

…

Analysis and consulting (C.1)	Investigate and review ICT systems and application requirements of the client and users (C.1.1)		x	x	x	x
	Determine and specify concrete hardware and software needs (C.1.2)	x	x	x		
	Recommend adequate and tailored ICT solutions to the customer (C.1.3)			x	x	x
	Write (parts of) the technical, ICT system and functional specification (C.1.4)	x	x	x	x	

Objects (technologically and / or commercially)	Methods, tools and organisation	Requirements, provisions, regulations
Specification of the ICT system based on the requirements Determination of needed hard- and software equipment of servers, PCs, storage system, periphery Test of relevant systems and software development tools etc.	Analysis and assessment of latest ICT products and methods Development and description of (parts of) the solution in cooperation with the team manager, colleagues and customer Analysis of specific problems of the hard- and software requirements	Detailed and transparent documentation of the work based on internal and overall regulations, e.g. as specified in the quality handbook of the company or in an ISO etc.

fig. 6-14: Examples for “Generic ICT work tasks” aggregated from the detailed work task analyses

Beside the significance of these detailed ICT work tasks and skills descriptions for the design of work oriented ICT curricula, these results are a very important ‘direct’ source for ICT training institutions with regard to the design of project and ICT business and work process oriented learning units. The results from the case studies in ICT training institutions revealed that one of the major challenges for ICT teachers in vocational colleges - beside their daily teaching duties - is to get and prepare adequate information and teaching material related to the actual or prospective work practice of their trainees. Traditional reference books only rarely include such work process related material and material didactically prepared in view of business and work process oriented training is barely available for vocational education and training.

6.4 Aggregation of a European framework of ICT skills and the proposal of generic ICT job and skills profiles as a basis for European ICT qualifications

The description of a skills framework from the viewpoint of vocational education and training is an essential step for observing and further improving the skills supply and demand in Europe in both terms of quantitative and qualitative aspects. As comprehensively laid down in the previous chapter and focusing on the coverage of ICT practitioner skills in Europe existing frameworks currently neither adequately reflect latest ICT practitioner work and employment developments nor do they provide an intelligible orientation for prospective and work oriented European ICT qualification strategies and concepts. A mutually agreed European ICT skills framework would serve as a widely used scheme for ICT work and skills definitions at different levels and in sustainable ICT business and work areas. Major objective of a new ICT skills structure from a VET perspective, however, is its referential function for the development of European ICT qualifications that adequately consider national differences based on the principle of subsidiarity.

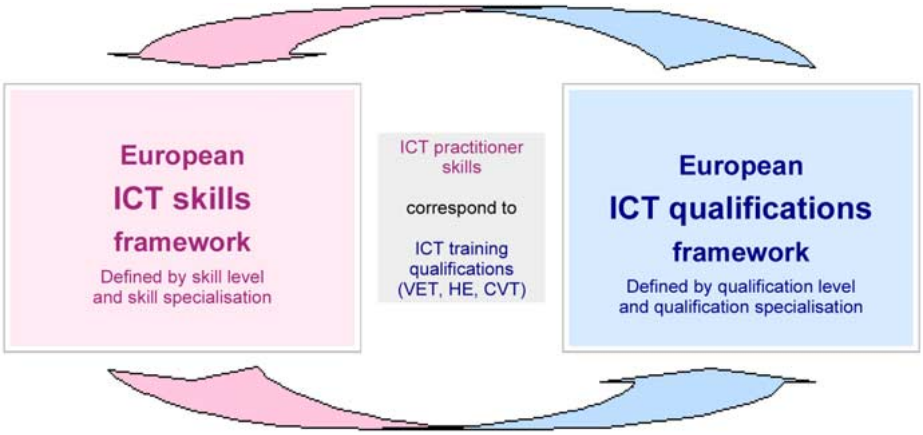


fig. 6-15: Towards a European framework of ICT skills and ICT qualifications

The description and delimitation of work and skill requirements in a "profiling process" (clustering) is a big challenge, especially in highly dynamic business and work areas such as ICT. Furthermore, the ICT skills profiles need to cover the skills requirements of ICT practitioners of the ICT sector and ICT user sectors in Europe - in particular of small and medium enterprises too. A precondition for the adequate nomination of the ICT skills profiles is the description of the ICT skill needs within a comprehensive skills framework covering the skills specialisation and levels.

Therefore, one of the most significant results of EUQuaSIT in terms of transparency and improved European occupational mobility and skills development (cf. Commission's Action Plan for skills and mobility) is a new, work oriented structure of generic work areas in the ICT business area, entitled GAHFA. Developed on the basis of comprehensive primary empirical and secondary analyses in five European countries the reference structure defines and describes

- the broad ICT business and employment area;
- six generic ICT work areas with phases of activity and
- the ICT work tasks and skills of ICT practitioners at different skill levels.

The profiling for different skill levels in terms of these "ICT skills profiles" can firstly be understood as a standardised definition and qualitative description of the current ICT skill needs and job profiles. Secondly and because these occupational ICT skills standards ought to correspond

and decrease the mismatch in regard to existing ICT qualifications, the results can be understood as one important precondition and reference for the development of a common European "Framework of ICT qualifications" as a basis for prospective and more work oriented ICT qualifications and curriculum guidelines, especially at vocational education and training (VET) levels.

The following paragraphs try to summarise the project discussion on the development of adequate generic ICT skills profiles at different skills levels aggregated from the large variety of ICT skill needs and job profiles in companies.

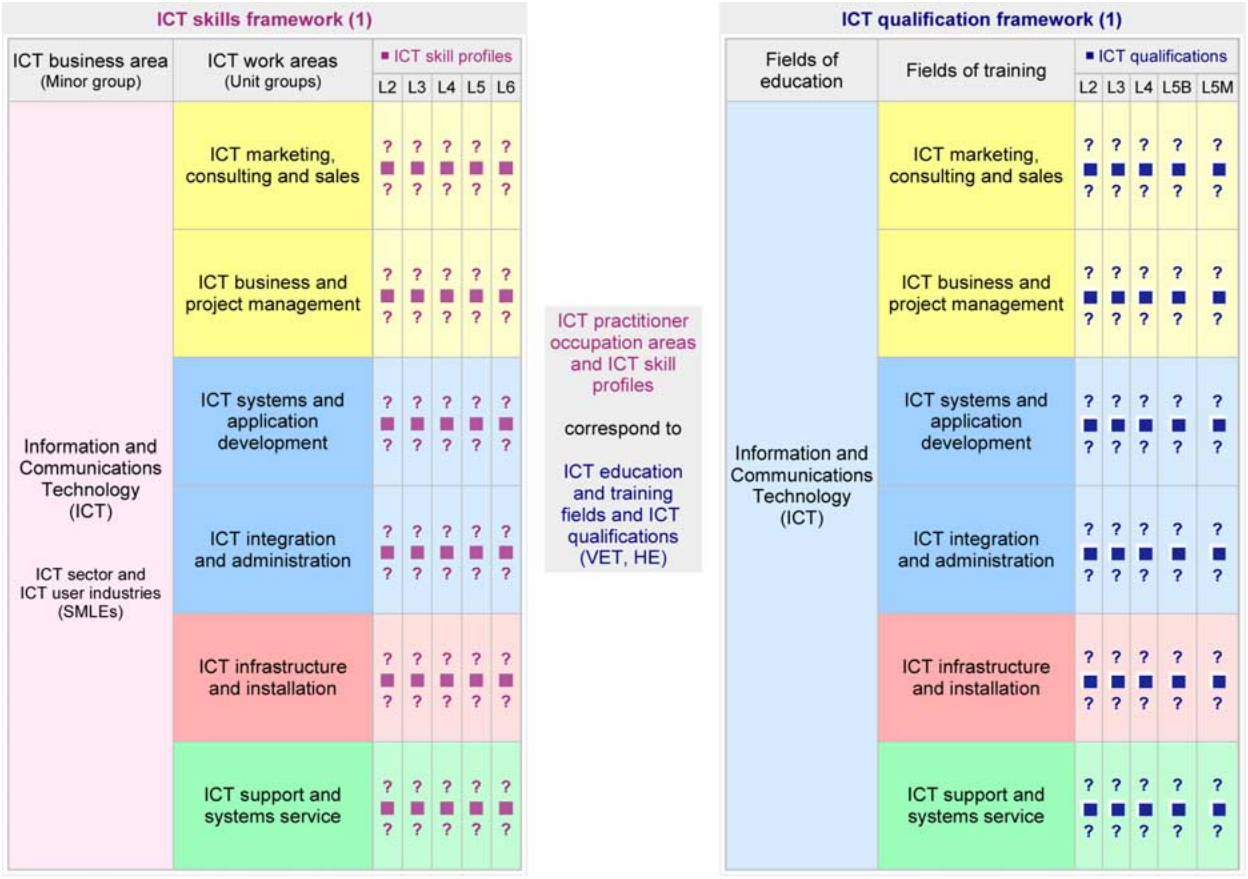


fig. 6-16: Correspondence of ICT practitioner occupation areas and ICT skill profiles and ICT education and training fields and ICT qualifications (VET, HE)

The variety of ICT job titles and ICT qualifications in Europe

Some of the investigated companies explicitly worked out a staff and career development plan for ICT practitioners. The table below indicates one example with five distinguishable ICT practitioner groups and levels respectively. Each ICT practitioner of the enterprise is allocated to one of these groups, for instance in order to fix and justify the wages of employees. In practice certain overlaps exist in order to justify one or the other skill. Like shown in another short example, often a certain work experience allows practitioners with lower qualification levels to reach more senior ICT jobs and positions.

- Product managers / Diploma Master in Informatics - Theoretical Informatics (level 5M) ; experience, 2 years
- Product managers / Diploma in Informatics and Automatics (level 5B) ; experience 4 years
- Product managers / Diploma in Computerized System (level 4) ; experience 8 years

However, as indicated in the example below, in most companies a clear correspondence between the qualification and the skill level in the company exists.

ICT job profiles Category	Junior Developer / Junior Consultant	System Developer I, II / Application Developer I, II	System Analyser / Consultant	Senior Analyser / Senior Consultant / Manager Competence Centre	Principal Analyser / Principal Consultant
Qualification	According to following levels	University or applied university (without degree) or vocational training	University or applied university degree	University or applied university degree	University or applied university degree
EDP professional experience	< 1 year	at least 1 to 2 years	at least 5 years	at least 8 years	at least 8 years
EDP skills	**Developable** basic skills, programming on demand, consultation based on instruction	**Basic** EDP knowledge in various areas and profound knowledge and project experience in at least one area	**Comprehensive** EDP knowledge and practical experience in various areas	**Comprehensive** EDP knowledge and practical experience in various areas	**Very comprehensive** EDP knowledge and practical experience in various areas
Software development and methods			Knowledge of common SW development techniques and methods	Knowledge of common SW development techniques and methods	Detailed knowledge of common SW development techniques and methods
Intensive knowledge			Intensive knowledge in one specific area	Intensive knowledge and longtime experience in at least one specific area	Intensive knowledge and longtime experience in several specific areas
Industrial sectors			Sector specific knowledge and know-how	Sector specific knowledge and know-how	Sector specific knowledge and know-how
Functions		Ability: - autonomous development (medium complexity), - simple analyses, - test planning and realisation.	Autonomous functioning at the customer (also as independent consultant)	Self responsible realisation of projects, studies and difficult consulting tasks	Self responsible realisation of projects, studies and difficult consulting tasks
Project leading			Ability: - Own project realisation, - leading projects.	Ability: - Project leading, - Managing staff.	Ability: - Project leading, - Managing staff.
Training				Ability to pass on specific know-how to others	Ability to pass on specific know-how to others
Customer care			Guarantee and experience in expressing and presenting results to the customer		
Acquisition				Supporting acquisition tasks	Undergoing partly difficult acquisition tasks

fig. 6-17: Example for the description of ICT skills profiles and levels in a medium enterprise of the ICT sector

For the profiling of ICT skill needs described within the skills framework current ICT job titles and qualifications of ICT practitioners in Europe were exemplarily listed and evaluated at all skill and qualification levels and assigned to the work areas of ICT skills framework (of course there is a partly great number of ICT job titles in the countries). In summary the investigations allow to allocate a choice of ICT job titles and functions each covering a certain set of tasks and skills needed to perform and fulfil everyday work. Gathering and investigating these ICT job roles as done with the case study surveys is an important indicator for the “profiling” process within a skills framework. It becomes obvious that the job roles vary in terms of breadth and depth of the areas and tasks associated with the jobs. Depending on the business area, for instance in smaller companies usually the job roles cover broader ICT work areas and fields of activity. However, since the job titles chiefly represent work responsibilities of specific companies or ICT business areas, they need to be abstracted and rearranged to overall occupational and skills profiles respectively, considering the empirical findings in terms of ICT skill needs and levels.

In regard to the involved ICT practitioners the examples of ICT job and qualification profiles in the two economic-technical oriented ICT work areas show more or less comparable profiles. Questions, how far all results and skill needs of these two ICT work areas can be summarised are thereby not only of high importance for an adequate structure and set of the ICT skill needs in general, but likewise in the context of the evaluation of ICT qualification profiles. As described above, based on the European questioning the company evaluation of the current ICT qualification profiles for both ICT work areas complementary to the case studies results are also relevant to ascertain industry’s skill needs.

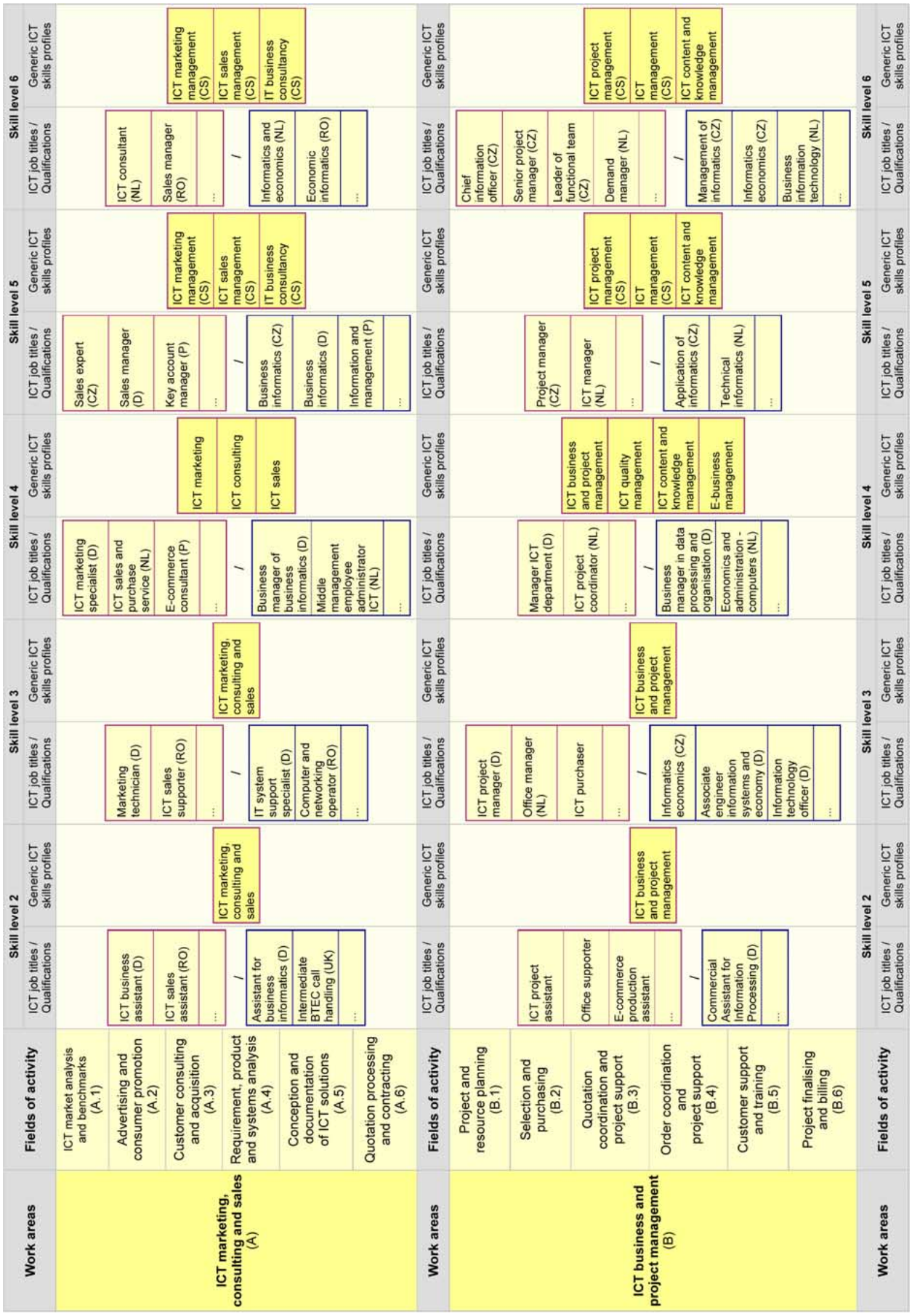


fig. 6-18: Variety of ICT job titles and ICT qualifications of ICT practitioners in two generic ICT work areas

The complete picture gathered of the variety of ICT job titles and ICT qualifications in European countries and in all work areas of the ICT skills framework can be found in the Annex of this report.

Aggregation of generic ICT skills profiles in the structure of the GAHFA framework

The ICT practitioner skills profiles set out professional competences linked to a respective profession or job. In its generic form they subsume on joint skills requirements for the performance of one or several relative jobs (set of skills). It respects the comprehensive ICT work and skills requirements from the sphere of work and enables them to be reflected in the VET strategies, concepts and programmes. Generic ICT job and skills profiles provide comprehensive information about the content of a job for which performance trainees and students are qualified. It is a starting point for the determination of qualification requirements that education in an appropriate education programme should meet.

In compliance with their description, the generic ICT job and skills profiles correspond to a group of related jobs and occupations or better to the set of work activities. Coping with these activities stipulates competency for a professional activity in the given field or rather in a broadly conceived field. Concrete skills profiles are based on the expression of skills requirements for particular jobs and thus reflect the skills and knowledge required to carry out a certain set of ICT work tasks.

As indicated in the overview as ‘CS’, the generic ICT skills profiles at level 5 and 6 have not been developed from the EUQuaSIT project work, since the activities focused on sub-degree / VET levels, but from the European Career Space Consortium (CSC) that developed “Generic ICT skills profiles” as an orientation for qualifications at higher education level (cf. CSC / Cedefop 2001).

This work orientated way of setting and describing occupational standards through the nomination of ICT skills profiles within the skills framework therefore provides an open platform for updating, developing and assigning ICT skills profiles and therefore flexibly and prospectively responding to emerging ICT skill needs. In detail the following examples of generic ICT skills profiles of the levels 2 - 4 are described in more detail (see one example below and in the Annex of this report):

- "ICT marketing" at skill level 4
- "ICT content and knowledge management" at skill level 4
- "ICT systems and application development" at skill level 4
- "ICT systems and application development" at skill level 3
- "ICT systems and application development" at skill level 2
- "ICT integration and administration" at skill level 3
- "ICT infrastructure and installation" at skill level 2
- "ICT support and systems service" at skill level 3.

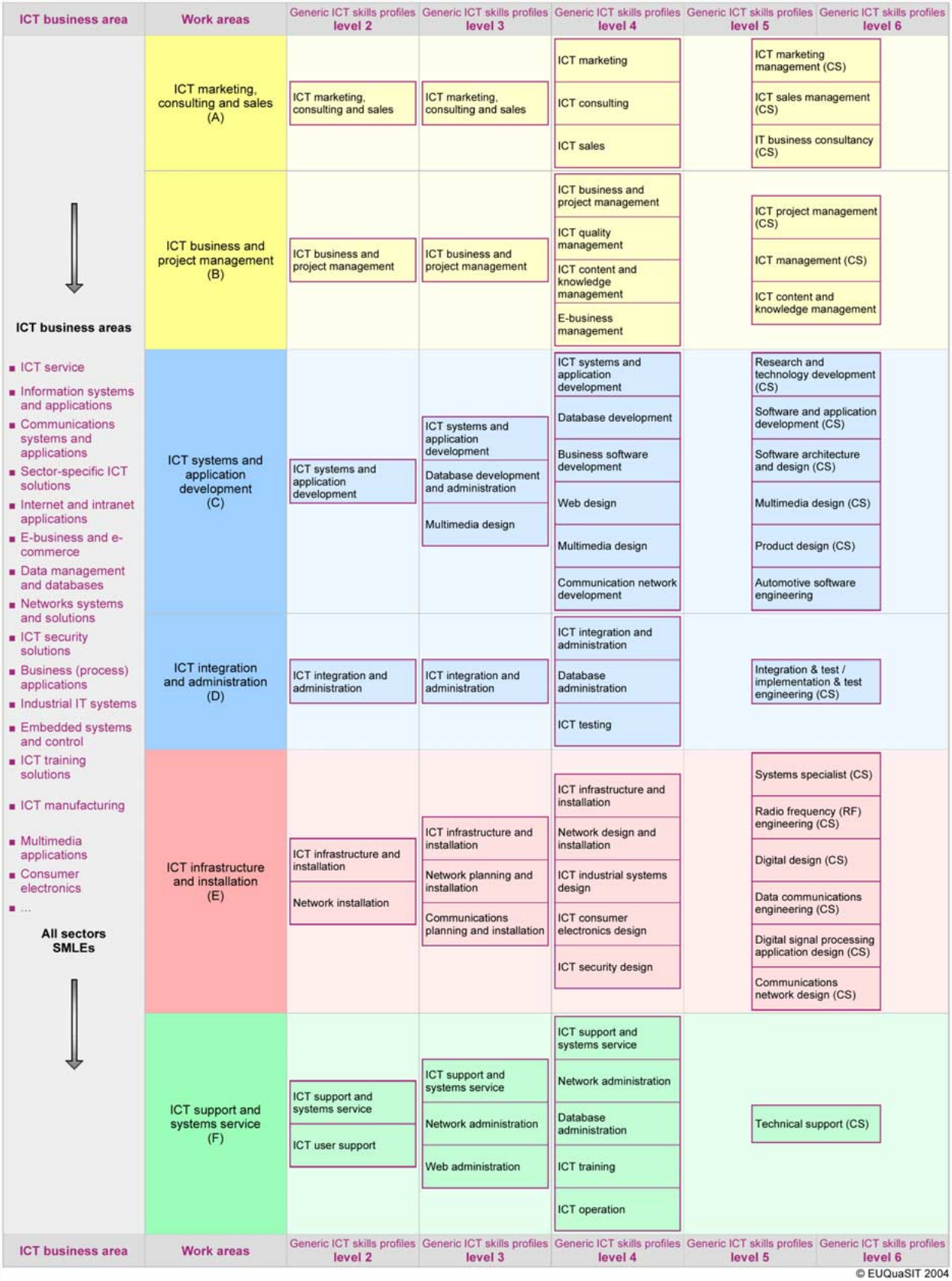


fig. 6-19: Nomination of “Generic ICT skills profiles” in the European GAHFA framework (*CS Career Space)

In accordance with the underlying skill model each ICT skills profiles provides a description of the following categories:

- The title and level of the generic ICT skills profile,

- examples of job titles and qualifications (country),
- a work and profile description,
- a list of complementary soft skills,
- technical ICT skills in the fields of activity and generic work tasks linked to the ICT business, technology and work area,
- cross work area technical basic ICT skills complementary to the technical ICT skills in the profile specific ICT work area and
- a career roadmap and future work opportunities.

1. Generic ICT skills profile

ICT systems and application development (L3; ISCO L2)

2. Examples of job titles and qualifications (country)

- Software developer
- Programmer
- Assistant software specialist
- Computerized system (CZ)
- Information technology specialist in application development (D)
- Informatics technician (P)

3. Work and profile description

'ICT systems and application development' is a comprehensive work area covering far more than just mere individual programming or coding. In these work area Informatics practitioners work in systems and software development teams that design, realise, update, test, integrate and maintain individual, enterprise, customer, sector-specific and standard applications using existing modelling and engineering methods, development tools and languages, (O).D.B.M.S. ((object-orientated) database management system) etc. Depending on the real ICT business area the work can cover also embedded systems solutions, specific telecommunications applications, multimedia and internet applications etc. The work tasks are carried out based on comprehensive analyses and descriptions of what is needed by the market, a specific sector or a specific customer.
Informatics practitioners at this skill level take over responsible parts in this work, usually as self-organised team members. In practise permanent contacts to the project and team manager and ICT business and technical practitioners within our without the company are important, e.g. ICT consultants, ICT infrastructure practitioners, research groups etc. In the daily work processes the transfer of the technical and business requirements to be clearly defined in the "technical specification" into a consistent "data processing specification" is crucial for the final success of ICT systems and application development as well as the final integration and deployment process. Primary criteria for the software solutions are reliability and usability. Furthermore the work as part of a team often runs under time constraints and must be constantly well communicated, reported and documented.

4. Soft skills

Behavioural and personal skills	Cross section and basic work Skills	Soft and method skills
▪ Flexibility	▪ Quality awareness	▪ Communication
▪ Self learning	▪ Commercial and market awareness	▪ Languages and culture
▪ Motivation and commitment	▪ Customer orientation and relationship	▪ Collaboration and interaction
▪ Stress resistant and emotion	▪ Company and business organisation	▪ Teamwork
▪ Responsibility	▪ Work organisation	▪ Analytical and reasoning
▪ Decision making	▪ Work safety and health protection	▪ Problem analysis and solving
▪ Initiative and attention	▪ Labour law and data privacy	▪ Context and causal connection thinking
▪ Professional attitude	▪ Environmental and resource awareness	▪ Documentation and presentation

5. ICT systems and application development skills

... in regard to the fields of activity and generic work tasks	... linked to the ICT business and technology areas

▪ Analysis and consulting
  ▪ Investigate and review ICT systems and application requirements of the client and users
  ▪ Determine and specify concrete hardware and software needs
  ▪ Write (parts of) the technical, ICT system and functional specification
▪ Systems- and work planning
  ▪ Manage and specify own work and project priorities using project management tools
  ▪ Test, choose and set up software and systems development tools
▪ Design and conception
  ▪ Create and specify concepts, prototyping, data structures, access, data base models etc.
▪ Programming and implementation
  ▪ Determine and describe software units, methods, attributes, modules, I/O-parameters etc.
  ▪ Code, adapt and document systems, software and database applications, e.g. in 3GL and with 4GL IDEs, embedded SQL
  ▪ Design, develop and implement graphical user interfaces as well as web-based applications
▪ Software adaptation and testing
  ▪ Run, interpret and document ICT systems and software tests by using various test tools, methods and data
  ▪ Describe opportunities and undergo bug-fixing, systems upgrading and software adaptation
▪ Configuration management and documentation
  ▪ Write (parts of) the installation and user instructions and ICT systems and application manuals
  ▪ Document, version and register new systems, software and database applications (configuration- and report management)
  ▪ Document the work following overall and company standards, e.g. info and help centre, change management
	▪ Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems etc.)
	▪ Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data etc.)
	▪ Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health etc.)
	▪ Internet and intranet systems and applications (web design, service providing etc.)
	▪ E-business and e-commerce solutions (B2B, B2C etc.)
	▪ Data management and database solutions (process databases, backup and recovery systems etc.)
	▪ Networks systems and solutions (LAN, ATM etc.)
	▪ ICT security solutions (antivirus, firewall, VPN etc.)
	▪ Business (process) systems and applications (CRM, ERP etc.)
	▪ Industrial IT systems (industrial and process automation etc.)
	▪ Embedded systems and control (diagnostics, monitoring etc.)
	▪ Multimedia systems and applications (video, simulations etc.)
	▪ Consumer and entertainment electronics (computer games etc.)
	▪ ICT training solutions (customer seminars, blended learning etc.)
	▪ ...

6. Cross work area / basic technical ICT skills

ICT commerce and business	ICT infrastructure and installation	ICT support and systems service
▪ Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability) ▪ Describe the impact of innovative ICT developments (e.g. hardware, software, internet, services) ▪ Collaborate within customers quotations, consulting, contracting and project processing ▪ Self-responsible and project related support of customers and users ▪ Provide project data for the invoicing and accountancy	▪ Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems) ▪ Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB) ▪ Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN) ▪ Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL)	▪ Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum) ▪ Describe support and communication channels (e.g. customers, business partners, suppliers, colleagues) ▪ Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware) ▪ Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications)

7. Career roadmap and future opportunities

Due to the rapid developments and changes in technologies, methods and process organisation, practitioners in 'ICT systems and application development' must be aware of the need of lifelong learning (LLL) both, in terms of primary informatics and technology subjects as well as overall aspects like ICT business process and market developments and trends. Based on some years work and project experience at this skill level next stage of a career in the work area 'ICT systems and application development' is described in the ICT skill profiles at skill level 4. This role, on the one hand, involves more self organised and responsible project management and commercial work and, on the other hand, the design, development and support of more complex and specific applications, e.g. in the fields of internet and e-business solutions, GUI design and development or configuration and test management.

fig. 6-20: Generic ICT skills profile 'ICT systems and application development (L3; ISCO L2)'

Some more examples of generic ICT skills profiles for each work area can be found in the Annex of this report.

One of the crucial aims of EUQuaSIT was to identify, structure and classify ICT work areas in companies. The results comprehensively presented above could be objectified based on the concrete results of the empirical case study surveys in European companies and ICT training institutions. The developed ICT skills framework by the project partners of EUQuaSIT is of crucial importance of combining in a comparative way information on skills and educational attainment on the one hand and occupations and job needs on the other hand. Some more transparency on ICT practitioner skill needs have been achieved that is finally and together with the other previous results the basis for the recommendations on European ICT qualifications. In this way the framework shift to a position where it is conceived as a reference describing the requirements of the national systems of qualifications in all countries of Europe. Concretely, the generic ICT skills profiles will play an important role for the development and implementation of the new ways in ICT vocational education and training (VET). Within each national system they should play a key role as far as initial and continuing VET are concerned.

The ICT skills framework takes also into account that such a reference is not only needed for formal qualifications but “for the sake of recognition in a wider, social sense” (CEC 2003, p. 4).

7 Aggregation and description of a European “Framework of ICT qualifications” and ICT curricula for vocational education and training in Europe

The European "Bruges-Copenhagen-Process", like the "Bologna-Process" for higher education (HE), aims at an increased cooperation and transparency in the field of vocational education and training (VET), which is one major precondition for adequate recognition procedures of qualifications and training credits. However, one needs to consider that national education and qualification strategies and structures in Europe still differ, often considerably. This is due to the fact that vocational education and training systems - like education systems as a whole - dynamically develop and change within each national socio-economic and historical context. The European Communities (EC) have considered this fact by the "principle of subsidiarity", so that each member state is autonomously in charge for educational policies by voluntarily participating in common European action in this field. Nevertheless, the activities within the "Bruges-Copenhagen-Process" stress the importance of moving towards cooperative and mutually recognised European VET activities rather than just focusing on national education policies (“zones of mutual trust”). However, there certainly still is a lack of concrete contributions to that crucial process.

The thematic surveys and investigations of the EUQuaSIT project provide a fundamental empirical basis for some overall and domain-specific conclusions on European ICT qualifications. The comparison and company evaluation of actual ICT qualifications in the partner countries as well as the profound analyses (case studies) in companies and ICT training institutions allow to generate a comprehensive picture of the actual ICT work practice, ICT practitioners skill needs and prospective ICT (practitioner) qualification concepts in Europe. By interpreting, comparing and aggregating the broad and detailed outcomes of the five project partner countries, European reference material have been developed that support various stakeholders in their international, national and regional initiatives such as:

- Estimation of the demand and tailored supply of qualified ICT practitioners based on a common European view of ICT business and work areas and levels for ICT practitioner skills and qualifications,
- description of specifications and commonalities of ICT practitioner work and skills requirements in complex ICT business and work processes in various sectors and business areas,
- ICT work area and skills demand oriented design of ICT qualifications and curricula based on European (reference) ICT qualifications in different qualification areas and levels,
- provision of ICT skills and qualifications material to companies (especially also SMEs) and ICT training providers and, therefore,
- more transparency of “good practice” ICT qualification and training concepts and didactics, e.g. up-dating goals and contents, teaching methods, media equipment, teacher training, need of specific training concepts for disadvantaged people.

The following chapters summarise all comparative analyses towards the development of a European (reference) frameworks of ICT qualifications. The procedure of analysing and asking the work practice is in line with the overall approach of the project, namely to investigate and implement the interaction of ICT practitioner skill needs and ICT qualifications supply. Correspondingly and based on these objectives at European policy level, the development of European (reference) structures of ICT skills and qualifications support the targets concerning com-

mon qualification strategies, e.g. especially by the definition and description of generic (reference) ICT skills and qualification profiles at all levels.

In this context it can be stressed that within the written questioning many companies supported the objective of common European standards for ICT qualifications and curricula. In little dependency of the level and country an average of more than 50% of the companies state that a European standardisation of ICT qualification profiles is urgently necessary. Divided by qualification levels the outcomes indicate that the higher the level of qualification, the higher is the proportion of companies stating there are such European initiatives needed. For VET profiles at level 3 an 2 the proportion is slightly lower with 50% of the companies that rather would "save national standards" of ICT training and qualification. One primary reason for this appraisal can probably be seen in a lack of mutual European trust in what concerns strategies and concepts of a common way to European wide accepted skills, training and curriculum frameworks. However, saving national standards does not necessarily mean that common European vocational qualification concepts and frameworks should not be taken into account for national and regional action.

7.1 Matching the “Framework of ICT practitioner skills” to a new European “Framework of ICT qualifications”

A European ICT skills framework has been developed and described representing the overall ICT skill needs of concerned industries. Taking into account the educational conventions shortly described above, it remains a European challenge to create and further concretise ideas towards a comprehensive European framework of ICT qualifications, e.g. in terms of tailored qualification profiles / descriptors at adequately defined qualification levels and transparent learning outcomes / standards including meaningful certificates of acquired ICT skills. Major objectives of such a reference framework of ICT qualifications are, on the one hand, to provide the labour market with transparent information on available qualifications for ICT practitioners and, on the other hand, to improve the training-employment transfer of individuals.

Within the current European debate in the scope of the above mentioned "Bruges-Copenhagen-Process" on reaching a common view on vocational education and training strategies one of the major challenges have been the definition of the term ‘qualification’ and zones of mutual trust (cf. CEDEFOP 2003, p. 12 et seq.). In its 1st report the European “Technical Working Group for Credit Transfer in VET” states that:

“…qualification can be considered as a sum of courses made up of units and modules and consequently a certain number of credits. Another approach sees qualification or vocational programmes as the result of the student learning activities, which are based on modules, corresponding to areas and competences of working life. A third group sees qualifications as certificates or diplomas or other evidence linked to the delivery and assessment of training received. The discussion on qualifications is closely linked to the on-going work on qualification frameworks” (ibid.).

The report then goes on to say that

“Qualifications systems include all activities that result in the delivery or recognition of all types of learning. These systems include legal frameworks, curricula, institutional arrangements, quality assurance processes, assessment and awarding processes, skills recognition and other mechanisms that may refer to the labour market and/or education and training. A qualifications framework is an instrument for the classification and definition of qualifications according to a set of criteria for levels of learning and/or skills. This set of criteria may be implicit in the qualifications descriptors themselves or made explicit in the form of a set of levels descriptors. The

scope of frameworks may be comprehensive of all learning achievements and pathways, or may be confined to a particular sector or area, e.g. higher education, initial education or adult education and continuing training. Some frameworks may be based in legislation whereas others are based on consensus with links to regulations. All qualifications frameworks, however, establish a basis for information on quality, accessibility, linkages and public or labour market recognition of qualifications within a country and internationally" (ibid., p. 13).

As comprehensively described in the previous chapters existing ICT qualifications and curricula at VET levels indicate a couple of differences in European countries with regard to the qualification levels, the number of ICT qualifications at each level and the main content of ICT qualifications. The analyses and outcomes chiefly point that a detailed comparison of current ICT curricula requires an enormous effort because comparable standards in a common European perspective do not exist. On the other hand, the ICT qualifications to be achieved contain a wide range of similarities. Therefore it is not surprising that the demand and evaluation of national ICT qualifications also indicates a comparable picture. Together with the findings from the case studies in companies and ICT training institutions, the results allow a transfer to common European ICT qualification standards.

For the concretisation of a European (reference) ICT qualification framework the matching of ICT qualifications with ICT skill profiles at different levels is a vital process (in sense of a particular sector or area as stated above). In terms of European transparency, all the different qualification and training systems in Europe (and therefore the study and training suppliers) need a reference to which they can appraise and evaluate their qualification programme offers and curricula. The generic ICT skills profiles constituting the skills framework therefore provide the fundamental reference, beside other criteria, for the determination and description of adequate ICT qualifications.

However, we need good criteria and an adequate structural approach to clarify the relationships between needed ICT practitioner skills and qualifications and correspondingly for the decision of the profiling of qualifications, their occupational delimitation avoiding unnecessary overlap and their sets of learning outcomes. In other words and in the broader sense, the ICT qualifications and outcomes must match the ICT skill needs if not in the short term then at least in the medium term.

The following table in principle indicates the interaction between the ICT skill needs expressed and described in the generic European ICT skills profiles on the left hand side and ICT qualifications on the right hand side.

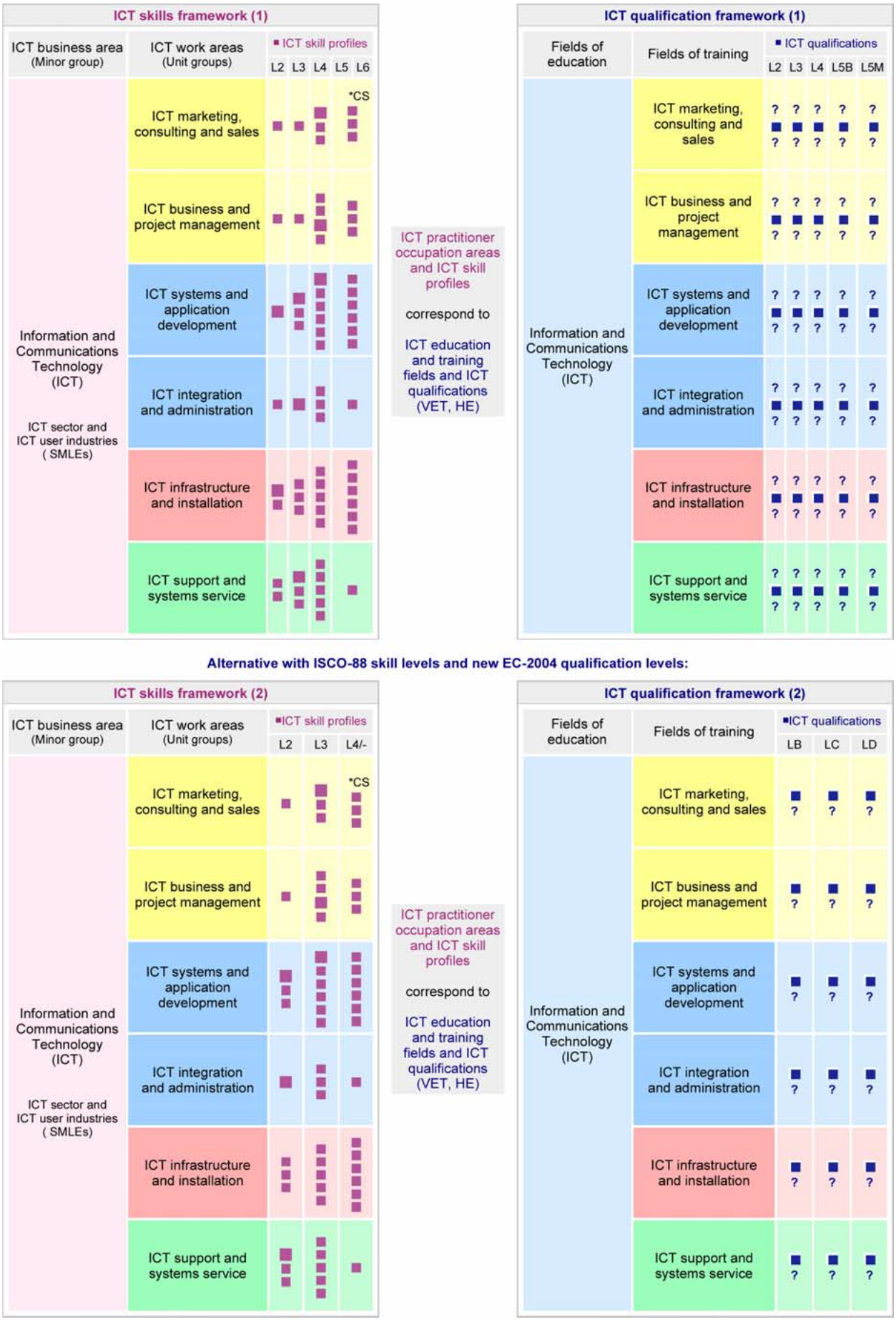


fig. 7-1: Correspondence of European frameworks of ICT skills and ICT qualifications

The two alternatives presented above are based on the EUQuaSIT five level solution as well as the latest 'Political agreement on the Council's common position' of May 2004 (CEU 9716/04 - ETS 42 CODEC 753) as indicated in the level structures below.

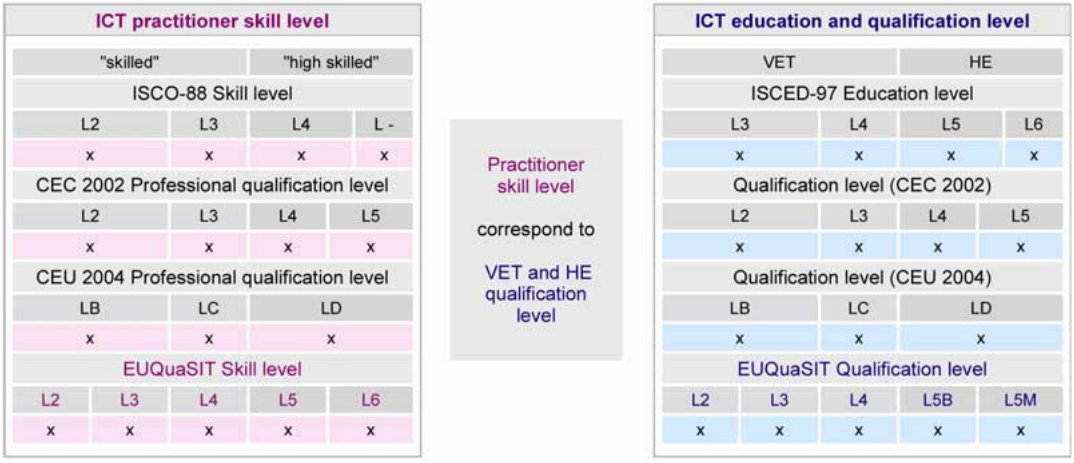


fig. 7-2: Correspondence of skills and qualification levels and the EUQuaSIT five level solution presented in a different direction (horizontal) as used for the project work

In the following chapter the concrete number of ICT qualifications as aggregated from the project results will be presented.

7.2 Recommendations with regard to a work oriented European "framework of ICT qualifications"

In general the design of ICT qualification profiles first of all requires a decision on their "horizontal (training field) and vertical (level)" profile structure. With regard to the identified skill needs of ICT practitioners and the challenges for the design of new and broad accepted European ICT profiles one answer and decision of the "vertical", level structure is fairly clear, we need profiles at degree and sub-degree qualification levels. And especially at sub-degree level we need qualification profiles at level 4, 3 and 2. Like the existing profile diversity has already shown too, the answer and decision of the "horizontal" profile structure of the ICT profiles at each sub-degree qualification level is not easy.

We need good reasons and an adequate curriculum approach for the decision of the right profile number and the delimitations of the profiles and their sets of qualifications. Without explaining the entire diversity of theories for curriculum approaches and profile development, these answers and decisions can basically either be more in reference to the subjects, scientific disciplines and technology areas or more in reference to a vocational pedagogic and education view or more in reference to the skill needs and contents of work areas. As shown by the analyses and evaluation of current European ICT qualification profiles there is not only one single way to cover and meet the needs of ICT work requirements and to ideally provide ICT competences for different people. For example the evaluation of ICT qualifications by the companies has indicated that different types of qualification profiles and programmes can meet the demand.

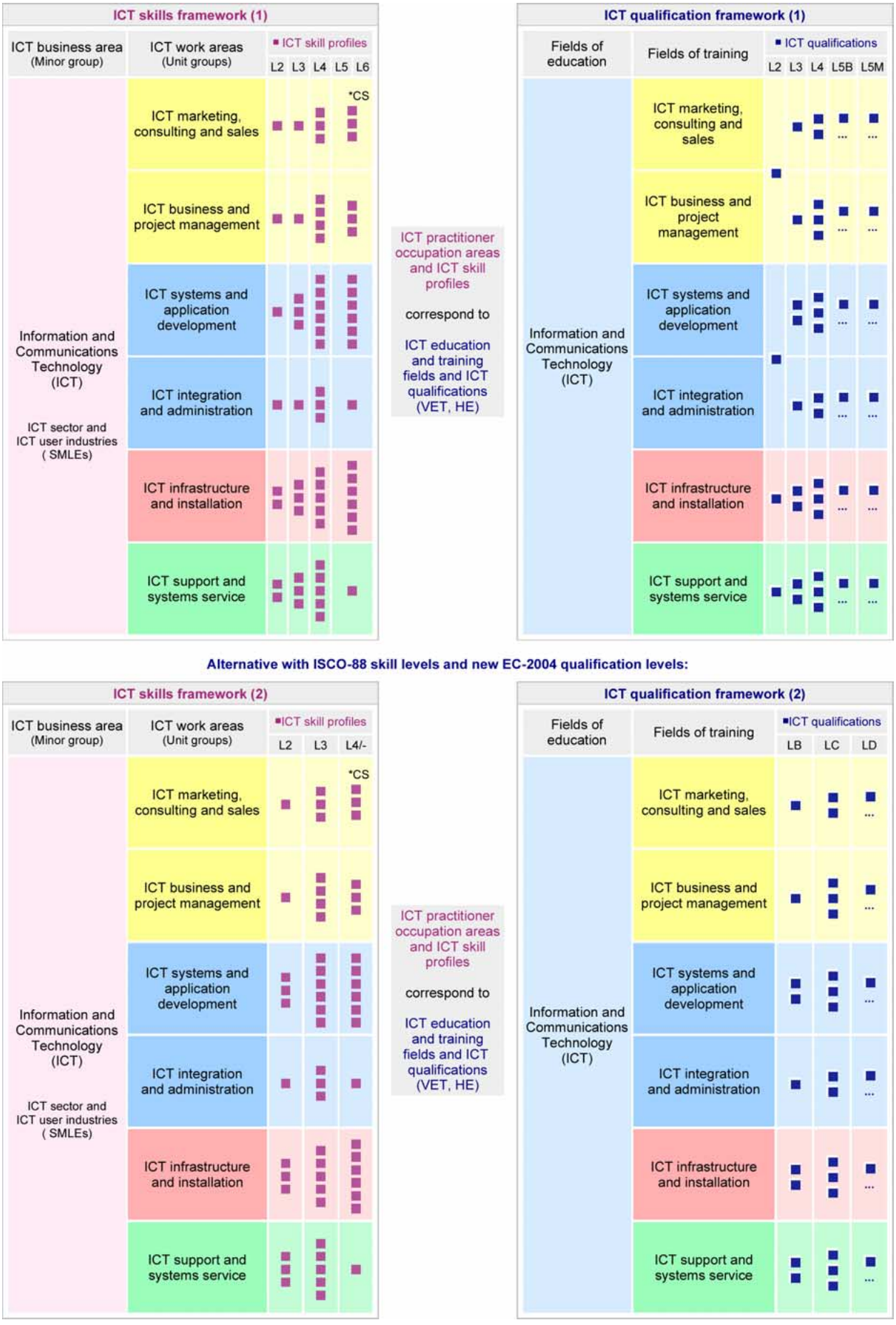


fig. 7-3: Potential structures for European ‘ICT qualification frameworks’

But in summary and mainly in regard to the mismatches and to improve the balance between ICT practitioner skill needs and the supply of ICT vocational education and training systems the answer and decision for the curriculum and profile approach is clear, namely that the curricula and profile structure need to be designed in reference to the current and prospective skill needs of the ICT work areas. Of course, for all ICT qualification profiles and curricula the subjects or concrete business and technology contents require a didactic reflection of the appropriate range and depth of the skill needs and qualifications. The composition of the "Generic ICT skills profiles" was already realised in this sense and especially their "horizontal and vertical" profile and level structure insofar is the relevant basis for the according curriculum decision of the profile numbers and the delimitations of the ICT qualification profiles between and at each sub-degree level. Consequently the recommendation and appointment in the EUQuaSIT level structure is the structure of the "Generic ICT skills profiles" is the fundament and reference of the framework for new European "Generic ICT qualification profiles" at VET levels with

- four generic ICT qualification profiles at VET level 2,
- nine generic ICT qualification profiles at VET level 3 and
- sixteen generic ICT qualification profiles at VET level 4 (see below).

Fields of education	Fields of training	European GAHFA "Framework of ICT qualification" (1)				
		Generic Assistant ICT qualifications **VET level 2**	Generic Technician ICT qualifications **VET level 3**	Generic Specialist ICT qualifications **VET level 4**	Generic Bachelor ICT qualifications **HE level 5B**	Generic Master ICT qualifications **HE level 5M**
Information and Communications Technology (ICT)	ICT marketing, consulting and sales (A)		Technician of ICT marketing, consulting and sales	Specialist of ICT Marketing Specialist of ICT consulting and sales	e.g. Bachelor of Science in Business Informatics	e.g. Master of Science in ICT marketing management
	ICT business and project management (B)	Assistant of ICT business and sales	Technician of ICT business and project management	Specialist of ICT project management Specialist of ICT quality management Specialist of ICT content and knowledge management	e.g. Bachelor of Science in ICT project management	e.g. Master of Science in ICT management
	ICT systems and application development (C)	Assistant of ICT systems and administration	Technician of ICT systems and application development Technician of multimedia development	Specialist of database development Specialist of business software development Specialist of multimedia and web design	e.g. Bachelor of Science in informatics	e.g. Master of Science in multimedia informatics
	ICT integration and administration (D)		Technician of ICT integration and administration	Specialist of database administration Specialist of ICT testing	e.g. Bachelor of Science in ICT integration and test	e.g. Master of Science in implementation and test engineering
	ICT infrastructure and installation (E)	Assistant of ICT infrastructure and installation	Technician of ICT infrastructure and installation Technician of communication systems installation	Specialist of network planning and installation Specialist of ICT communication systems planning Specialist of ICT security design	e.g. Bachelor of Science in IT networks	e.g. Master of Science in data communication engineering
	ICT support and systems service (F)	Assistant of ICT support and service	Technician of ICT support and systems service Technician of ICT systems administration	Specialist of ICT support Specialist of network administration Specialist of ICT training	e.g. Bachelor of Science in technical support	e.g. Master of Science in technical support
Fields of education	**Fields of training**	Generic ICT qualifications	Generic ICT qualifications	Generic ICT qualifications	Generic ICT qualifications	Generic ICT qualifications

fig. 7-4: The EUQuaSIT “Framework of ICT qualifications”

However, in correspondence to other level frameworks such as ISCO-88 skill levels on the one hand and the latest 'Political agreement on the Council's common position' of May 2004 (CEU 9716/04 - ETS 42 CODEC 753) on the other, alternatives are feasible and also mentioned below with three relevant ICT qualification levels (LB to LD). Therefore, there would be only one instead of two degree levels. Advantages of such a structure are the simpler delimitation of levels and more room for interpretation. A clear disadvantage is the high entrance level B (technician instead of assistant), reducing the career possibilities in ICT for low level school leavers or disadvantaged groups.

For the qualifications at the VET levels in the EUQuaSIT level structure the table indicates three different titles, namely Specialist (Level 4), Technician (Level 3) and Assistant (Level 2). These terms define the level of qualification. The concrete name of the qualifications in each field of training indicates either a one-to-one equivalence or at least a close correspondence to the work area and skills profile, e.g. Specialist of ICT project management (VET level 4), Technician of ICT systems and application development (VET level 3) or Assistant of ICT infrastructure and installation (VET level 2).

Furthermore a second alternative is based on a different didactical approach of the number of ICT qualifications at each level. This recommendation is also abstracted from the analysis and evaluation of current ICT qualifications that indicates the difficulties of overlapping curricula as well as the estimations of the companies that the number ICT qualifications at VET and HE levels is sufficient in European countries.

This view leads to:

- four generic ICT qualification profiles at VET level 2,
- four generic ICT qualification profiles at VET level 3 and
- seven generic ICT qualification profiles at VET level 4.

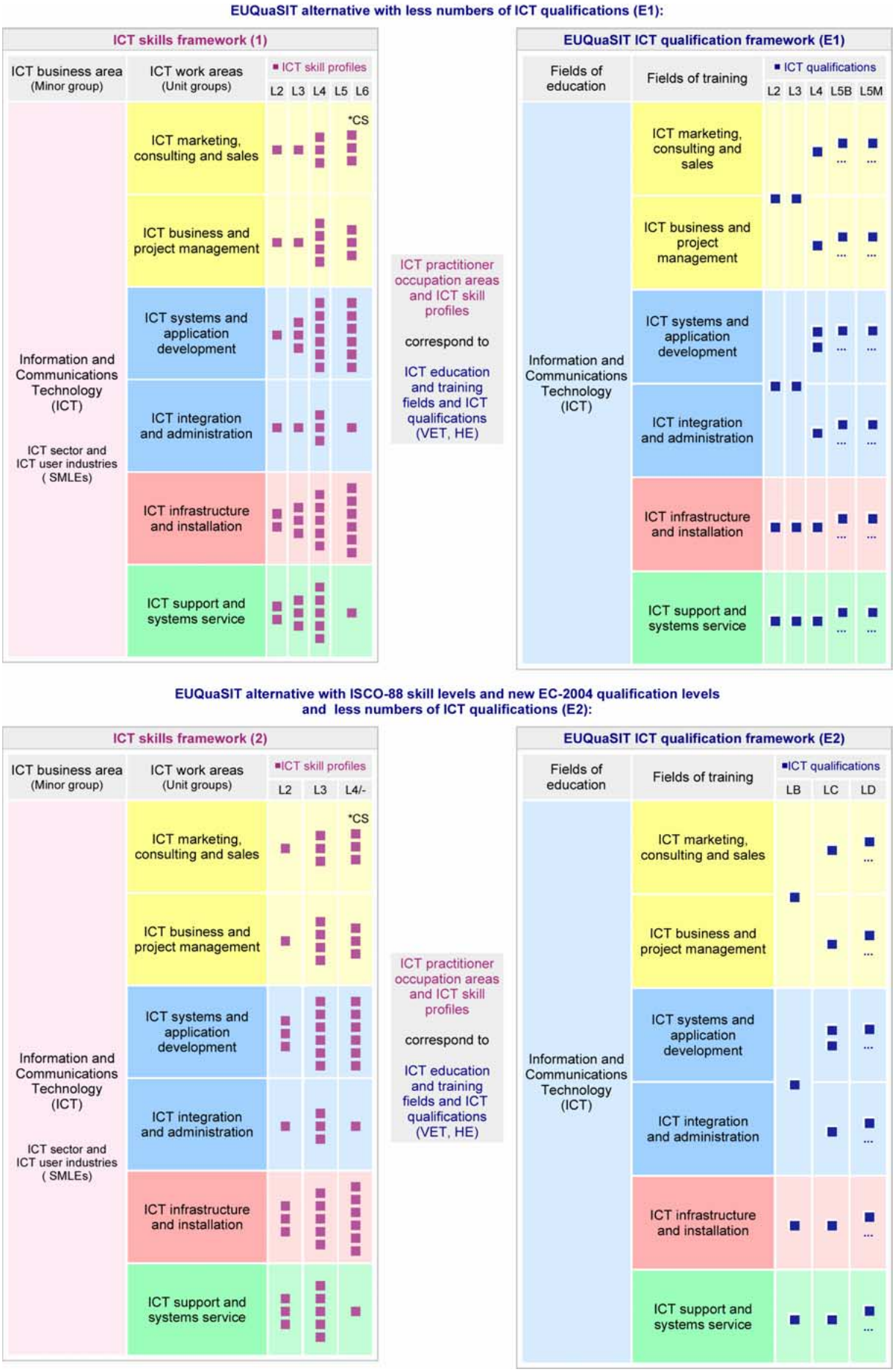


fig. 7-5: Potential structures for European ‘ICT qualification frameworks’

7.3 ICT curricula for vocational education and training in Europe

The aim of ICT vocational education is to produce skilled workers with sub-degree ICT qualifications and abilities that qualify him or her to work in different areas and fields of activity and to carry out a certain (occupational) range of ICT work tasks. The ICT qualification profiles and curriculum development guidelines emphasise the importance of qualification levels and profiles meeting the needs of the different ICT work area and labour market requirements. The ICT qualifications at VET levels and the structure and definitions of the ICT qualification profiles have already been described in such a way that outcomes definitions have strong relevance to the needed skills and profiles within the ICT and user sectors.

The identified structures and contents of the skill needs and work area oriented ICT skills profiles are relevant for the ICT curriculum development of the VET programmes. As seen with the ICT skills profiles and the profiles at each level, the skill structure of all profiles is basically identical with three main categories:

- behavioural and personal skills, cross section and basic work skills, soft and method skills;
- ICT practitioner skills (direct ICT work area oriented profile skills);
- cross work area ICT skills (complementary to the direct ICT work area).

Following this delineation of skills, and also qualification outcomes with their structure and contents of the ICT qualification profiles, the basis of ICT curriculum development can be described in a common curriculum model for all ICT qualification profiles at VET levels.

This curriculum model illustrates a framework of three main qualification and content fields that depend on level for the breadth and depth of their qualifications. Each qualification field also shows the qualification and content structure in detail, which includes, from didactic reflection of practitioner needs, a recommendation of the (quantitative) curriculum extent, e.g. the ICT technical qualifications cover 70 % of the curriculum.

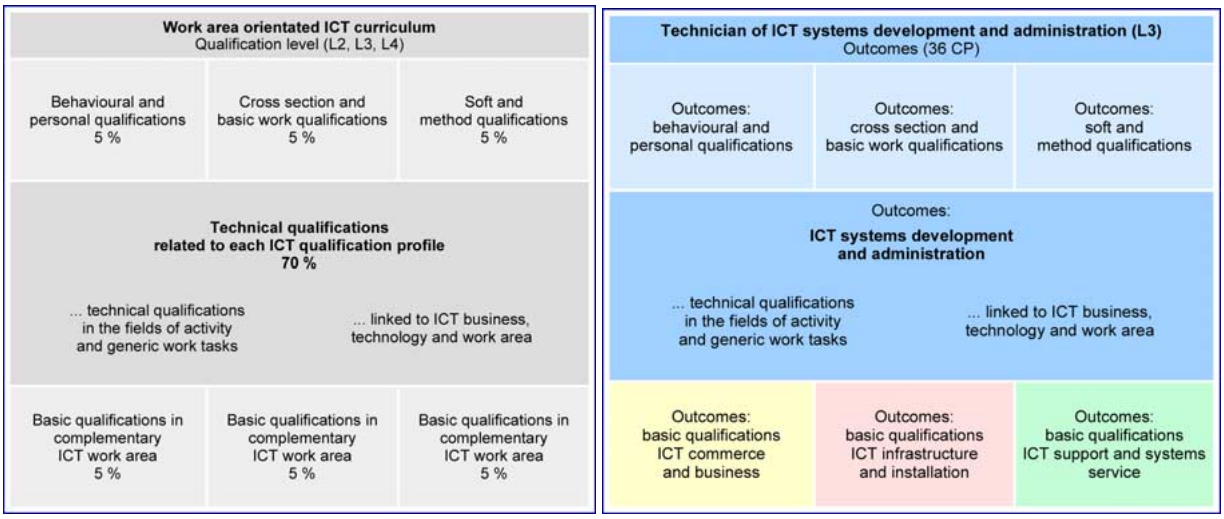


fig. 7-6: Structure and example of a work area orientated ICT curricula for all VET level profiles

The curriculum development guidelines are expressed as a guide to the didactically supported content development and expressed in terms of learning outcomes. This should enable their use independent of national VET system or terminology, allowing an interpretation suitable to the country of origin. Therefore it is important in regard to the ICT curriculum model in general and therefore the qualifications that the separated qualification and content fields and categories only show a common structure at this overall curriculum development level. For instance this structure is not the direct fundament to design courses or learning processes.

The case studies in ICT training institutions clearly indicated that especially the behavioural and personal qualifications or the cross section and basic work qualifications should be taught integrated into the isolation of the other qualifications e.g. the next qualification field. For example, motivation and commitment or the self learning competence can not be taught without contents and depends on the didactical and methodological concepts of the training as a whole. Also customer orientation, environmental and resource awareness or work and project organisation competence must be integrated and linked, for instance, to business and technology contents. All soft and method qualifications like communication and moderation or information handling, documentation and presentation must have in the same way a relation to the other qualifications and contents.

Very important for the development of curricula is the definition of the outcomes of the ICT training profiles. But apart from all these decisions it is basically open in which learning institution and place or based on which learning way and qualification concept the qualification outcomes can concretely be achieved. In the same sense the following guidelines include recommendations for developing curricula without any preliminary decisions in this direction. Therefore the curricula can be the basis for different learning institutions and places or qualifying concepts like for instance only school or work based training, apprenticeship concepts etc. In the report of the European "Technical Working Group for Credit Transfer in VET" it is correspondingly stated:

"Central to the credit transfer system is the definition of the characteristics of credits in terms of:

- Determining units which will be assessed;
- Determining the value of these units by allocating a number of credits;
- Determining what type of process or what type of output equals one credit;
- Determining the rules for credit accumulation"

"Credits can be considered first as a measurement allocated to qualification units and/or modules and/or to part or full qualifications. More specifically credit is an instrument for quantitative measurement. Credit transfer systems, however, do not necessarily determine qualitative equivalence in themselves. Additional efforts are necessary e.g. to build mutual trust (see also 2.3.1. below). Credits in VET could be defined and awarded according, for example to type/areas of learning (theoretical, practical, transversal/basic skills, general education); learning outcomes (knowledge, skills, competences); learning location (in class, in apprenticeship, in an enterprise, at home); learning context (formal/non-formal/informal); learning duration (years, months, semesters). It is important, whatever the approach, that the objectives of provisions are also defined in terms of (outcome based) acquired competences. The measurement basis is part of the on-going discussion among the TWG members. The TWG is examining different bases for measurement using the concepts of notional learning time, of learning density, of workload, or a balance of these concepts.

"Secondly, credits can be considered as a basis for certification of (part) qualifications, or whole qualifications, linked to corresponding reference levels and sub-levels which should as far as possible be organised within a coherent qualifications framework (see section 3 below). When defining the value of credits it is important to take into account the marks allocated to the student, the notional learning time as well as the methods for valuing work-based learning activities and prior learning experiences within the VET courses/programmes. It is also important to mirror these elements against the expected knowledge, skills and competences required for a specific qualification profile" (Cedefop 2003, p. 12).

"The introduction of a credit system should be facilitated by the structuring of an educational course/qualification programme in a large number of modules which can be assessed individu-

ally, whereby the overall assessment of a partial or full qualification profile is cumulative. Even within a modularised system, specific ways of ascribing value to training acquired abroad are necessary, because modules are related to national or regional training contexts and specific legal frameworks” (ibid., p. 13).

In respect of describing qualification outcomes and level structure of the "Generic ICT qualification profiles" further described below it is one recommendation of the curriculum guidelines to define a corresponding structure of ICT qualification profiles and programmes by specifying “credits” as indicated in the following model. The model indicates a structure and combination of credit points (CP) first of all for (complete) ICT qualifications and vocational training programmes respectively with a more or less open learning organisation and different options for mutual recognition of certificates or examinations. The model shows that the 12 CP to be achieved at VET level 2 should be fully recognised for VET level 3 qualifications. This is not the case between VET level 3 and 4, that is designed as an explicit “Specialist” level. However, the complete set of 60 CP to be achieved with VET qualification is supposed to be recognised for the higher education Bachelor level.

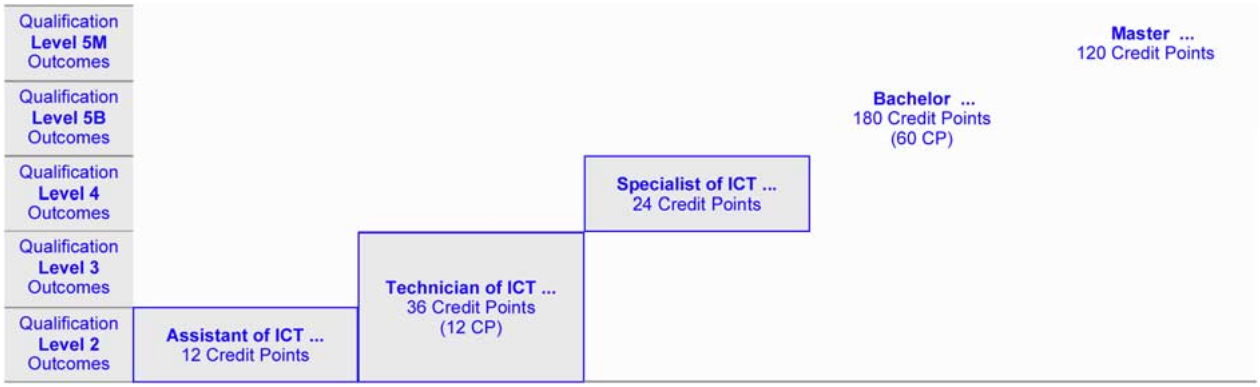
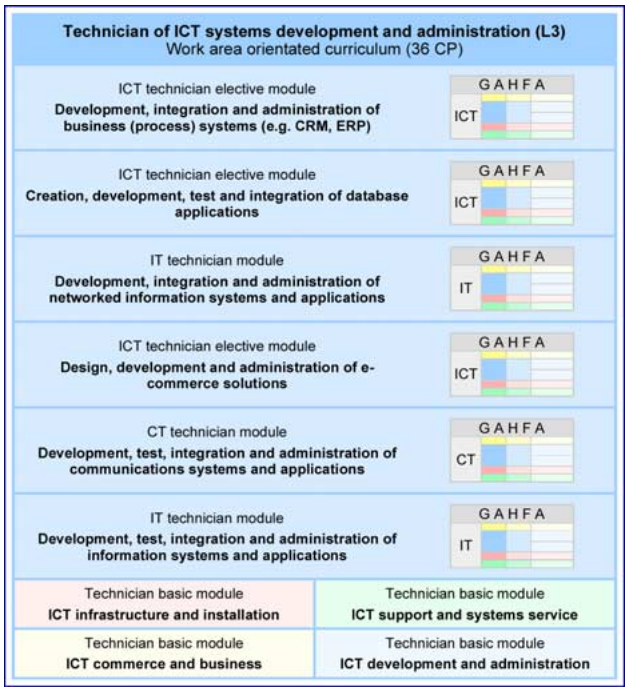


fig. 7-7: Certification and accreditation of ICT qualifications in view of the European Credit Transfer System (ECTS)

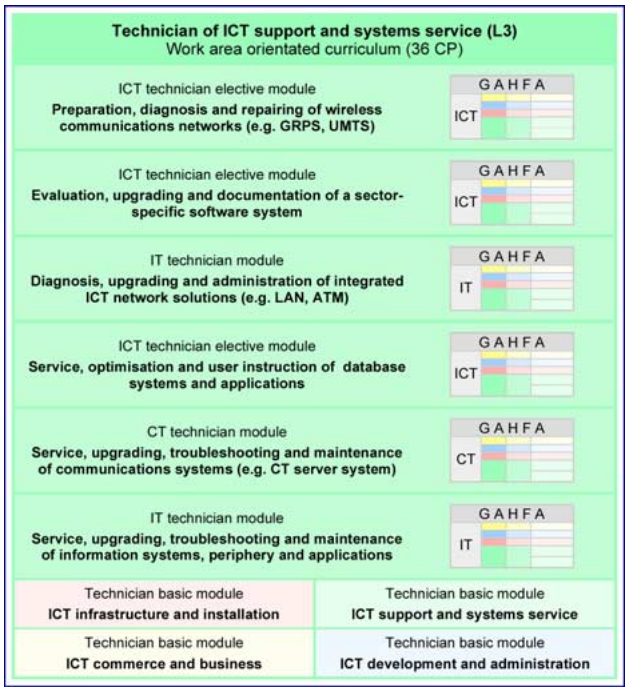
Following the recommendations of ECVET the curricula need a structure and definition of some specification of learning units. Based on the didactic approach they are defined as work area oriented ICT learning modules. This name and structure have been chosen because the qualifications and contents of each learning unit are geared to the description of the work areas; also each learning unit - like a module - is part of a didactic module set that constitutes each ICT qualification and training profile and programme. The module structure and sets show the following level variants, including a recommendation for valuing the ICT vocational training programmes in terms of credit points (CP):

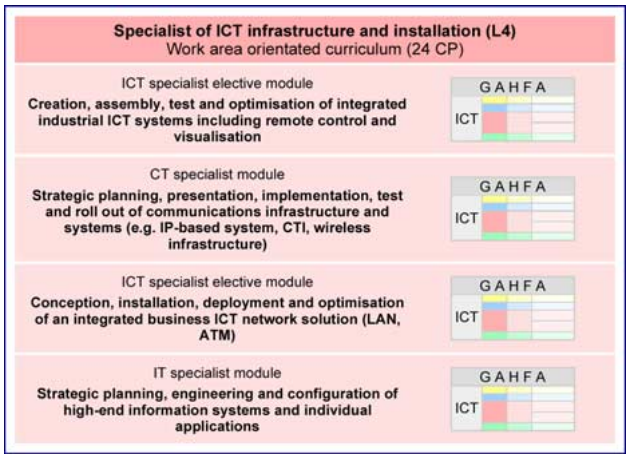
Sets of work area oriented ICT learning modules:		
ICT assistant curriculum (L2, 12 CP)	ICT technician curriculum (L3, 36 CP)	ICT specialist curriculum (L4, 24 CP)
- set of assistant basic modules - set of assistant modules - set of assistant elective modules	- set of technician basic modules - set of technician modules - set of technician elective modules - set of technician add-on modules	- set of specialist modules - set of specialist elective modules - set of specialist add-on modules

In correspondence to the model of work area oriented ICT curricula for all VET levels, and based on didactic reflections of the qualification outcomes, these sets of learning modules can be defined in more detail for the ICT assistant curricula at level 2, the ICT technician curricula at level 3 and the ICT specialist curricula at level 4.


Technician of ICT systems development and administration (L3)
Work area orientated curriculum (36 CP)
ICT technician elective module
Development, integration and administration of business (process) systems (e.g. CRM, ERP)
ICT technician elective module
Creation, development, test and integration of database applications
IT technician module
Development, integration and administration of networked information systems and applications
ICT technician elective module
Design, development and administration of e-commerce solutions
CT technician module
Development, test, integration and administration of communications systems and applications
IT technician module
Development, test, integration and administration of information systems and applications
G A H F A
ICT
IT
CT
Technician basic module
ICT infrastructure and installation
Technician basic module
ICT support and systems service
Technician basic module
ICT commerce and business
Technician basic module
ICT development and administration


ICT technician elective module (4 months, 4 CP)
Technician of ICT systems development and administration (L3)
Aim and content of outcomes:
Design, development and administration of e-commerce solutions
G A H F A
ICT
Defined outcomes: qualifications and knowledge in regard to ...
Requirement analysis and consulting of e-commerce applications
Systems- and work planning for the e-commerce solution
Design and conception for the e-commerce solution
Programming and implementation of the e-commerce solution
Test, adaptation and release of the e-commerce solution
Development documentation of the e-commerce solution
Planning and installation of the e-commerce solution
Systems integration and configuration of the e-commerce solution
Systems testing and release of the integrated e-commerce solution
Documentation and delivery of the e-commerce solution
Presentation and instruction to the new e-commerce applications
Systems administration and support of the e-commerce solution
Defined integrated outcomes: qualifications and abilities in regard to ...
Flexibility
Self learning
Motivation and commitment
Stress resistant and emotion
Responsibility
Decision making
Quality awareness
Commercial and market awareness
Customer orientation and relationship
Work organisation
Labour law and data privacy
Communication
Languages and culture
Teamwork
Creative and innovation
Problem analysis and solving
Documentation and presentation


Technician of ICT support and systems service (L3)
Work area orientated curriculum (36 CP)
ICT technician elective module
Preparation, diagnosis and repairing of wireless communications networks (e.g. GRPS, UMTS)
ICT technician elective module
Evaluation, upgrading and documentation of a sector-specific software system
IT technician module
Diagnosis, upgrading and administration of integrated ICT network solutions (e.g. LAN, ATM)
ICT technician elective module
Service, optimisation and user instruction of database systems and applications
CT technician module
Service, upgrading, troubleshooting and maintenance of communications systems (e.g. CT server system)
IT technician module
Service, upgrading, troubleshooting and maintenance of information systems, periphery and applications
G A H F A
ICT
IT
CT
Technician basic module
ICT infrastructure and installation
Technician basic module
ICT support and systems service
Technician basic module
ICT commerce and business
Technician basic module
ICT development and administration


Specialist of ICT infrastructure and installation (L4)
Work area orientated curriculum (24 CP)
ICT specialist elective module
Creation, assembly, test and optimisation of integrated industrial ICT systems including remote control and visualisation
CT specialist module
Strategic planning, presentation, implementation, test and roll out of communications infrastructure and systems (e.g. IP-based system, CTI, wireless infrastructure)
ICT specialist elective module
Conception, installation, deployment and optimisation of an integrated business ICT network solution (LAN, ATM)
IT specialist module
Strategic planning, engineering and configuration of high-end information systems and individual applications
G A H F A
ICT

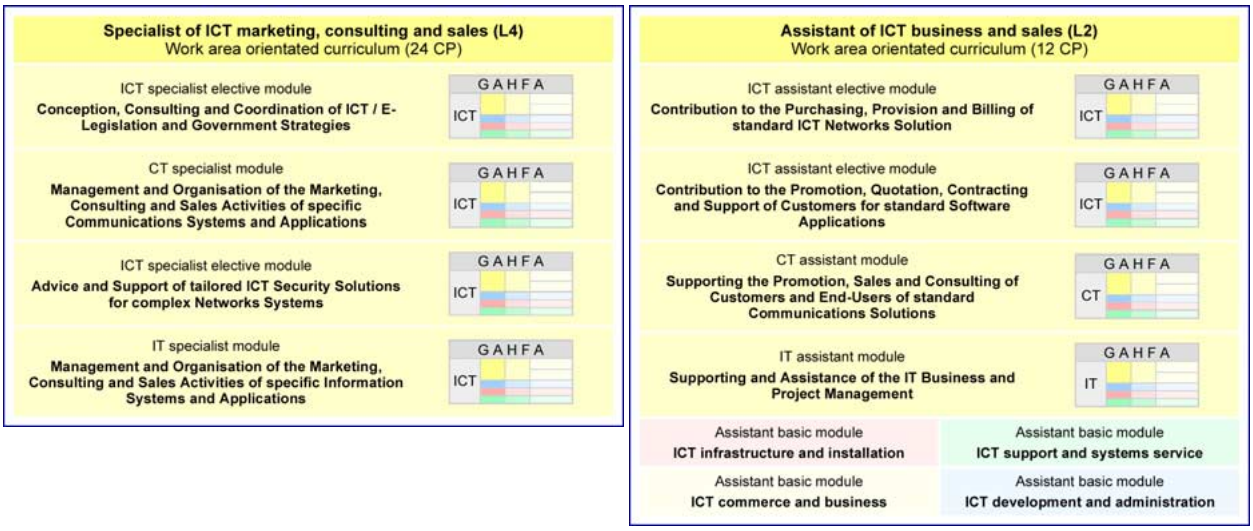


fig. 7-8: Examples for ICT qualification profiles and modules

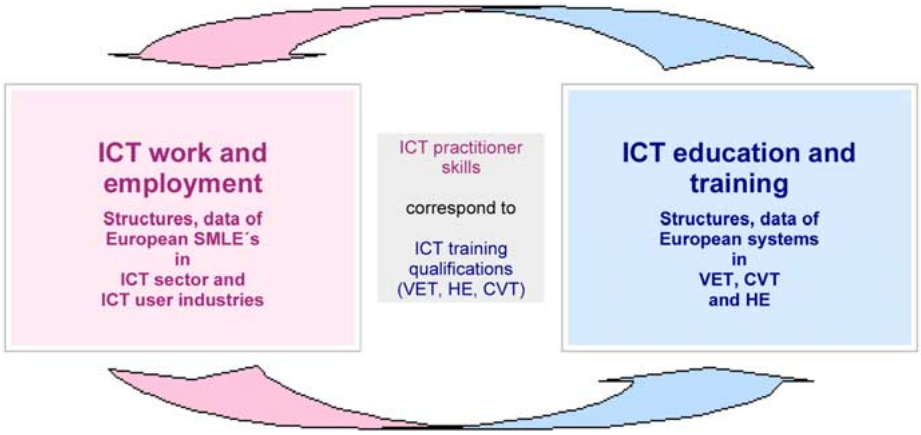
It is recommended that where a vendor (or vendor neutral) award can be demonstrated as meeting the specification requirements either as a whole, or in part, for one or more component parts within the guidelines, then the vendor award should be allowed to form a contributory element of a relevant vocational qualification. It is recommended therefore that this consideration be extended to allow such inclusion of vendor awards where they:

- Address the required specification of technical, component parts contributing towards a full vocational ICT qualification,
- Fulfil the appropriate accreditation criteria.

Whilst it is recognised that vendor awards often do not allow for the assessment of work-based competence they can be sought after by employers as they often attest to product-based competence. The opportunity to use appropriate vendor awards in contributing to vocational qualifications would assist in ensuring the relevance of such qualifications.

8 EUQuaSIT final conclusions and recommendations

All the investigations of EUQuaSIT especially took into account the interaction of ICT work and employment on the one hand and ICT education and training on the other as. The objectives and the methods of the quantitative and qualitative project investigations are based on this interaction in order to allow comparable research outcomes in a European context that sufficiently consider the ICT occupation structures and data of European SMLE´s in ICT sector and ICT user industries and the ICT training structures and data of European systems in VET and HE as well as CVT (or lifelong learning).



8.1 Final recommendations on the prospective development of classifications for ICT practitioner employment, work and skills

Some final recommendations on the prospective development of classifications for ICT practitioner employment, work and skills are given from the viewpoint of the educational system and its interaction to the employment and occupational system and its organisation. This correspondence will be vital for the prospective development of either sides. The future of employment system and the employability of workers relies on a corresponding structure of qualifications.

The definitions given as a result of the project work stressed the importance of the “practitioner” as being the overall term adequate for all skill levels. Terms such as ICT specialist or ICT professional or ICT expert sounds like high-skilled Computer specialist or Computer professionals (ISCO skill level 4) and include and produce misunderstandings especially in regard to not high-skilled ICT workers (a ICT occupation group which is often not in the focus and is quite agreeable to be excluded). The definition of the comprehensive term and occupation group of ICT practitioner is:

> **”ICT practitioners are practitioners who work with their skills and competences at different skill levels in research, development and design, management, the production, consulting, marketing and sales, the integration, installation and administration, the maintenance, support and service of information and communications technology systems”**

The important definition and delimitation of ICT practitioner skills and qualifications (including ICT job practitioners) to ICT user and e-business skills and qualification should be stressed as being vital for any further debates, e.g. within the widespread ICT skills or often called e-skills discussion.

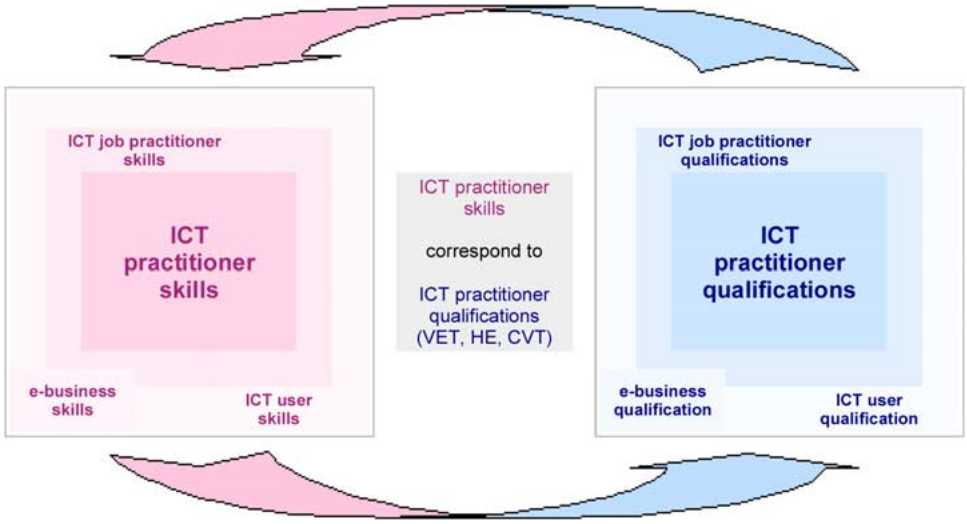


fig. 8-1: Definition and delimitation of ICT practitioner and ICT job practitioner qualifications to e-business and ICT user qualifications

Because most internationally available occupation data are analysed in regard to ISCO-88 (COM) also the initial project work of EUQuaSIT based on the definition and understanding of ICT practitioners for all relevant ISCO-88 ICT occupation groups. The view on Europe's ICT practitioner workforce was completely revised in the EUQuaSIT project so that an innovative contribution to the existing knowledge base on this labour market segment could be produced. This could be comprehensively shown for the broad area of information and communications technology (ICT). ICT means in the common understanding comprises, within the more or less old distinction, the occupation groups of IT practitioners and CT practitioners. Often studies focus on IT and only the two ISCO-88 (COM) occupation groups 213 (Computing professionals) and 312 (Computer associate professionals). Of course these are relevant IT groups. But it must be underlined these are not the group of all ICT practitioners (see definitions and classifications below).

The problem of these relevant ISCO-88 (COM) ICT occupation groups is, for example for the unit group "Electronics and telecommunications engineering technicians (ISCO 3114)" or "Electronics mechanics, fitters and servicers (ISCO 7242)", that not all occupations of these groups clearly belong to ICT practitioners. Otherwise other relevant and especially IT occupation groups at skill level 2 are completely not in the "old" considered. In difference for instance to clear ICT practitioners data and numbers "Computer associate professionals (ISCO 312) for the mixed or missed groups we need and have to do estimations. This is also the reason for partly very different data on ICT practitioners from European countries, e.g. collected for Eurostat´s Labour Force Survey (LFS). One other reason is, that ISCO-88 (COM) in many European countries not used and therefore the national statistics on ICT occupation groups must transferred to ISCO-88 groups. But like the ISCO-88 the most national classifications must be updated and harmonized in regard to the ICT statistics.

Occupational classification of ICT practitioners
ISCO-88 (COM) occupation groups

Level	Major groups	Sub-Major groups	Minor groups	Unit groups
Skill level -	Legislators, senior officials and managers (ISCO 1)	Corporate managers (ISCO 12)	Other specialist managers (ISCO 123)	Sales and marketing managers (ISCO 1233)
				Computing services managers (ISCO 1236)
			Production and operations managers (ISCO 122)	Production and operations managers in ... communications (ISCO 1226)
		Managers of small enterprises (ISCO 13)	Managers of small enterprises (ISCO 131)	Managers of small enterprises in transport, storage and communications (ISCO 1316)
Skill level 4	Professionals (ISCO 2)	Physical, mathematical and engineering science professionals (ISCO 21)	Computing professionals (ISCO 213)	Computer systems designers, analysts and programmers (ISCO 2131)
				Computing professionals not elsewhere classified (ISCO 2139)
			Architects, engineers and related professionals (ISCO 214)	Electronics and telecommunications engineers (ISCO 2144)
Skill level 3	Technicians and associate professionals (ISCO 3)	Physical and engineering science associate professionals (ISCO 31)	Physical and engineering science technicians (ISCO 311)	Electronics and telecommunications engineering technicians (ISCO 3114)
			Computer associate professionals (ISCO 312)	Computer assistants (ISCO 3121)
				Computer equipment operators (ISCO 3122)
			Optical and electronic equipment operators (ISCO 313)	Broadcasting and telecommunications equipment operators (ISCO 3132)
Skill level 2	Clerks (ISCO 4)	Office clerks (ISCO 41)	Secretaries and keyboard-operating clerks (ISCO 411)	Data entry operators (ISCO 4113)
				Calculating-machine operators (ISCO 4114)
	Service workers and shop and market sales workers (ISCO 5)	Models, salespersons and demonstrators (ISCO 52)	Shop, stall and market salespersons and demonstrators (ISCO 522)	Salespersons for ICT (ISCO 5221) (CZ)
	Craft and related trades workers (ISCO 7)	Metal, machinery and related trades workers (ISCO 72)	Electrical and electronic equipment mechanics and fitters (ISCO 724)	Electronics mechanics, fitters and servicers (ISCO 7242)
				Telegraph and telephone installers and servicers (ISCO 7244)

fig. 8-2: Occupational structure of ICT practitioners of "International Standard Classification of Occupations ISCO-88 (COM)" used and named by EUQuaSIT

It is furthermore a common and unquestioned result, that ICT practitioners work in the ICT sector and the ICT user sectors or industries and that the proportion more or less in all studies is between 40 and 50 % for the ICT sector and 50 and 60 % for all so-called ICT user sectors. But studies and reports often focus “facts and figures” only in view of occupations and the economic situation of the ICT sector. In this context a mixture of sector data of “ICT employment” and “ICT practitioner workforce” is not unusual. Therefore it is very important to distinguish ICT practitioners and the whole employment of the ICT sector often stated as ICT employment. And also it must be clear, like indicated for ICT practitioners from an occupational point of view, that the ICT sector comprises the IT and CT sector. Furthermore and as used by Eurostat the ICT sector comprises also IT and CT services and manufacturing. However there are similar statistical problems as for ISCO-88 (COM) ICT occupation groups because the economic classification include and consider not the actual development of the new ICT sector in a adequate structure of specific groups and classes.

The focus and the specific question is the number of ICT practitioners of the ICT sector and not just the ICT employment. And the problem is again for instance not the clear division “Computer and related activities (NACE 72)” but the mixed groups and classes with not only ICT services or manufacturing. This problem correspond especially to large sized ICT enterprises, which offer in a broad range for example electronics and ICT services and products. But of interest for the ICT skills debate is only to clarify the proportion and specific skill needs of ICT practitioners of the ICT sector. It seems not necessary to define the ICT user sectors although large enterprises like the automotive industries (Manufacture of motor vehicles NACE DM 34) today include ICT service departments comparable to ICT enterprises, so we can conclude that these ICT departments can be entitled “ICT service”.

Following and only on the fundament of these definitions and clarifications of ICT practitioners, ICT employment and ICT sector it is possible to present serious and clear “facts and figures” to the situation and development of European ICT practitioners and corresponding skill needs as well as to discuss the shortage and gap of ICT practitioners and the mismatch of ICT skills and qualifications. Of course a precondition are comprehensive empirical studies in the

fields of ICT business and work of the ICT sector and ICT user sectors. However being conscious of the changing ICT economic development like in the last years especially forecasts of the ICT practitioner demand and skill needs are rather difficult and remain an economic and political problem. Therefore actual and realistic numbers of the European shortage and gap of ICT practitioners are hardly available. Most numbers date from four or five years ago. Based on surveys and empirical analyses carried out in cooperation with partners of EUQuaSIT and using additional results of secondary analyses and Eurostat Labour Force Survey (LFS) data, the figures below present in a short form the most relevant number from 2000/2001 of 3 700 000 million ICT practitioners in Europe (EU-15) and its allocation by sectors.

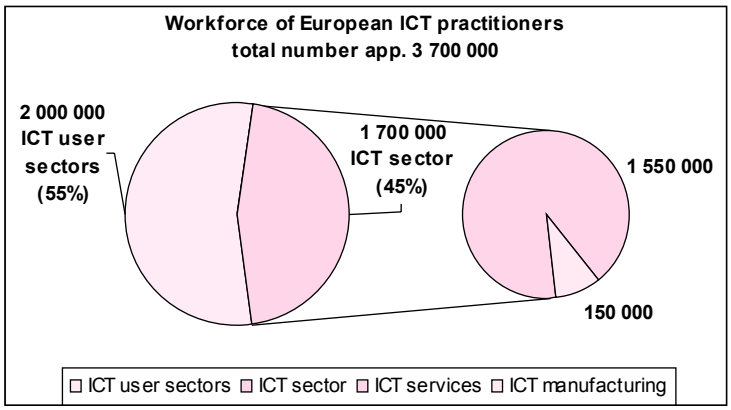


fig. 8-3: European ICT practitioner workforce of the ICT sector and ICT user sectors

The described problem on presenting exact numbers based on ISCO-88 (COM) and the Eurostat Labour Force Survey (LFS) data leads to the need of estimating the total number of European ICT practitioners. Therefore for the estimated result of 3 700 000 ICT practitioners the number of the two ISCO 213 and 312 “IT practitioners” and different sources and proportions where used. The share in total employment of the 3 700 000 in Europe seems also realistic in comparison to other European and international data. To discuss this core result compared to the results of the other studies is difficult, for instance indicated in the “e-Skills Forum” report (cf. European e-skills forum 2004), and partly not possible because other approaches, classifications and frameworks are used, for instance for national statistical purposes such as in the Netherlands or Germany.

More or less the same problems occur for the numbers of the ICT practitioners demand per year because one basis and start point is the total number of ICT practitioners. Based on the estimated number of 3 700 000 ICT practitioners in Europe and an assumption of an annual growth of 3.5 % and an additional replacement demand of 2.5 % the total demand for ICT practitioners is estimated at about 0.23 million per year. That means the 3.7 Mio. ICT practitioners in Europe is estimated to reach 5.1 million by 2010. However, other growth scenarios depending on the economical development are thinkable as indicated in the figure below. These comparative results are impressive insofar, that an assumed linear 5 % growth of the number of ICT practitioners in Europe leads to a considerable greater number of needed 2,2 million ICT trainees and students at all qualification levels in Europe compared to a 2 % growth of the ICT practitioner workforce with a need of “only” 1 million ICT trainees and students. Therefore the 5 % scenario constitutes a considerable challenge for both, the higher education and vocational education and training systems in Europe.

The comprehensive EUQuaSIT view attempting to cover the wide range of ICT practitioner groups aims at contributing to more reliable and harmonised statistical data collection, for example in order to compare the stock and demand of ICT practitioners to the supply side of ICT trainees and students in Europe. Corresponding recommendations will be given for this further below in the context of ICT qualification strategies.

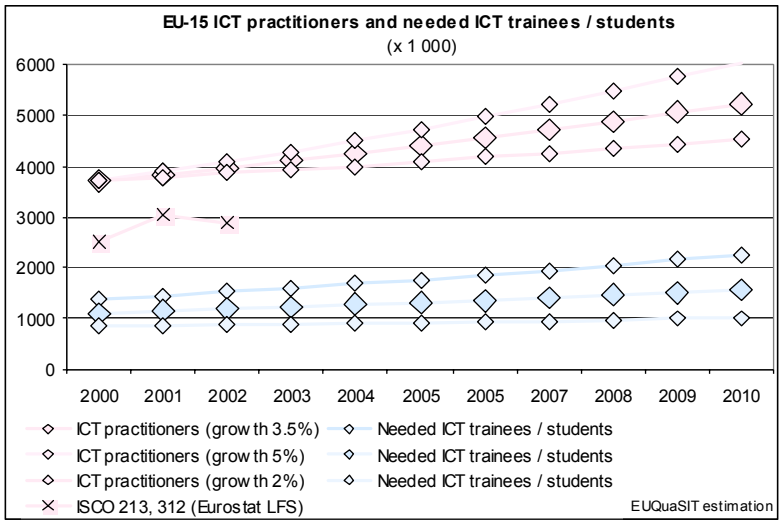


fig. 8-4: Three scenarios of the development of the ICT practitioner workforce and number of needed ICT trainees and students in Europe

In the qualitative view the analyses of the EUQuaSIT project lead to a new proposal for a European "Framework of ICT practitioner skills". The broad structure provides a recommendation for ICT business areas independently of the sector and size of companies and thus also taking into account specifications of small enterprises in Europe. These ICT business areas are intended as a contribution to currently discussed updates of economic-sector classification such as NACE or ISIC. Furthermore six generic ICT work areas were aggregated from the studies, to which the work tasks and skill needs of ICT practitioners at all different skill levels could be classified. Focus of the EUQuaSIT activities, however, was on ICT practitioners with VET qualifications. This work oriented structure may contribute to potential updates of occupational classifications such as ISCO-88 (COM) and therefore to statistical efforts in area of information and communications technology in Europe.

ICT business area	Generic work areas	ICT practitioners L2 L3 L4 L5 L6
⇩ **ICT business areas** ▪ ICT service ▪ Information systems and applications ▪ Communications systems and applications ▪ Sector-specific ICT solutions ▪ Internet and intranet applications ▪ E-business and e-commerce ▪ Data management and databases ▪ Networks systems and solutions ▪ ICT security solutions ▪ Business (process) applications ▪ Industrial IT systems ▪ Embedded systems and control ▪ ICT training solutions ▪ ICT manufacturing ▪ Multimedia applications ▪ Consumer electronics ▪ ... ⇩ **All sectors SMLEs**	ICT marketing, consulting and sales (A)	Teams of ICT practitioners
	ICT business and project management (B)	Teams of ICT practitioners
	ICT systems and application development (C)	Teams of ICT practitioners
	ICT integration and administration (D)	Teams of ICT practitioners
	ICT infrastructure and installation (E)	Teams of ICT practitioners
	ICT support and systems service (F)	Teams of ICT practitioners
ICT business area	Generic work areas	L2 L3 L4 L5 L6 ICT practitioners

fig. 8-5: GAHFA ICT skills framework with ICT business areas, generic ICT work areas and ICT practitioners

The following figure summarises the EUQuaSIT contribution to the actual debate on updating occupational classifications ISCO-88 (COM) in terms of ICT occupation groups by transferring the GAHFA ICT work areas as new 'unit groups' to the ISCO-88 (COM) structure. The "new" ISCO-88 "minor and unit groups" on the right hand side take into account the broad understanding of ICT practitioners, so that the actual group "Computing professionals" as well as the other relevant ICT (job) practitioner groups such as "Electronics and telecommunications engineers" would be revised to a common minor group "ICT professionals" at skill level 4. Furthermore it is indicated that at each skill level different "unit groups" in sense of the GAHFA ICT work areas are relevant in order to cover all ICT practitioners at all skill levels.

ICT practitioner occupation groups
Current ISCO-88 (COM) occupation groups

Level	Major groups	Minor groups	Unit groups
Skill level -	Legislators, senior officials and managers (ISCO 1)	Other specialist managers (ISCO 123)	Sales and marketing managers (ISCO 1233)
			Computing services managers (ISCO 1236)
		Production and operations managers (ISCO 122)	Production and operations managers in ... communications (ISCO 1226)
		Managers of small enterprises (ISCO 131)	Managers of small enterprises in transport, storage and communications (ISCO 1316)
Skill level 4	Professionals (ISCO 2)	Computing professionals (ISCO 213)	Computer systems designers, analysts and programmers (ISCO 2131)
			Computing professionals not elsewhere classified (ISCO 2139)
		Architects, engineers and related professionals (ISCO 214)	Electronics and telecommunications engineers (ISCO 2144)
Skill level 3	Technicians and associate professionals (ISCO 3)	Physical and engineering science technicians (ISCO 311)	Electronics and telecommunications engineering technicians (ISCO 3114)
		Computer associate professionals (ISCO 312)	Computer assistants (ISCO 3121)
			Computer equipment operators (ISCO 3122)
		Optical and electronic equipment operators (ISCO 313)	Broadcasting and telecommunications equipment operators (ISCO 3132)
Skill level 2	Clerks (ISCO 4)	Secretaries and keyboard-operating clerks (ISCO 411)	Data entry operators (ISCO 4113)
			Calculating-machine operators (ISCO 4114)
	Service workers and shop and market sales workers (ISCO 5)	Shop, stall and market salespersons and demonstrators (ISCO 522)	Salespersons for ICT (ISCO 5221) (CZ)
	Craft and related trades workers (ISCO 7)	Electrical and electronic equipment mechanics and fitters (ISCO 724)	Electronics mechanics, fitters and servicers (ISCO 7242)
			Telegraph and telephone installers and servicers (ISCO 7244)

ICT practitioner occupation groups
New recommended ISCO-88 (COM) ICT occupation groups

Level	Major groups	Minor groups	Unit groups
Skill level -	Legislators, senior officials and managers (ISCO 1)	ICT managers (ISCO ?)	ICT marketing, consulting and sales (ISCO ?)
			ICT business and project management (ISCO ?)
			ICT systems and application development (ISCO ?)
Skill level 4	Professionals (ISCO 2)	ICT professionals (ISCO 213)	ICT marketing, consulting and sales (ISCO ?)
			ICT business and project management (ISCO ?)
			ICT systems and application development (ISCO ?)
			ICT integration and administration (ISCO ?)
			ICT infrastructure and installation (ISCO ?)
			ICT support and systems service (ISCO ?)
Skill level 3	Technicians and associate professionals (ISCO 3)	ICT associate professionals (ISCO 312)	ICT marketing, consulting and sales (ISCO ?)
			ICT business and project management (ISCO ?)
			ICT systems and application development (ISCO ?)
			ICT integration and administration (ISCO ?)
			ICT infrastructure and installation (ISCO ?)
			ICT support and systems service (ISCO ?)
Skill level 2	Clerks (ISCO 4)	ICT clerks (ISCO ?)	ICT business and project management (ISCO ?)
	Service workers and shop and market sales workers (ISCO 5)	ICT sales worker (ISCO ?)	ICT marketing, consulting and sales (ISCO ?)
	Craft and related trades workers (ISCO 7)	ICT worker (ISCO ?)	ICT systems and application development (ISCO ?)
			ICT integration and administration (ISCO ?)
			ICT infrastructure and installation (ISCO ?)
			ICT support and systems service (ISCO ?)

fig. 8-6: Recommendation of new ISCO-88 (COM) ICT occupation groups

The results on ICT work, employment and occupations refer to various priority areas of European policies to ensure that

- the European ICT labour market concerning the demand and supply of ICT practitioners in all sectors can be monitored based on common indicators for a mutual understanding of the ICT practitioner workforce and that
- the skill needs of ICT practitioners can be investigated and evaluated based on adequate quantitative, qualitative and comparative analysis instruments.

In the EUQuaSIT project the work on prospective ICT employment and work strategies was undergone from the viewpoint of European ICT qualification strategies and therefore directly linked to the development of prospective ICT qualifications and here especially vocational education and training (VET) strategies in the field of ICT. The following recommendations try to conclude in a short form the major findings of these comprehensive and detailed investigations.

8.2 Final recommendations on the prospective development of European ICT qualifications

Basic questions on prospective developments of European vocational education and training (VET) strategies currently derive from the “Lisbon goals” and the corresponding “Bruges-Copenhagen-Process” and aim at „investigating how transparency, comparability, transferability and recognition of competences and/or qualifications, between different countries and at different levels, could be promoted by developing reference levels, common principles for certification, and common measures, including a credit transfer system for vocational education and training.” An important fundament of this process would be the development of a coherent European framework for qualifications to which the member states can mirror their national and regional qualification activities, both in terms of mutually agreed levels as well as fields of education and training.

The developed strategy for European ICT qualifications takes into account two major prospective aspects. Firstly the vital correspondence of ICT practitioner skill needs and recognised ICT qualifications having acceptance on the labour market. Secondly a European ICT qualification framework with generic and work oriented ICT qualification profiles. In this respect the specific strengthens of vocational education and training become obvious and can be underlined. Therefore it can be concluded that prospective vocational qualification strategies can best be developed in conjunction with profound analyses of actual and future occupation and employment trends and the skill needs of the corresponding practitioners.

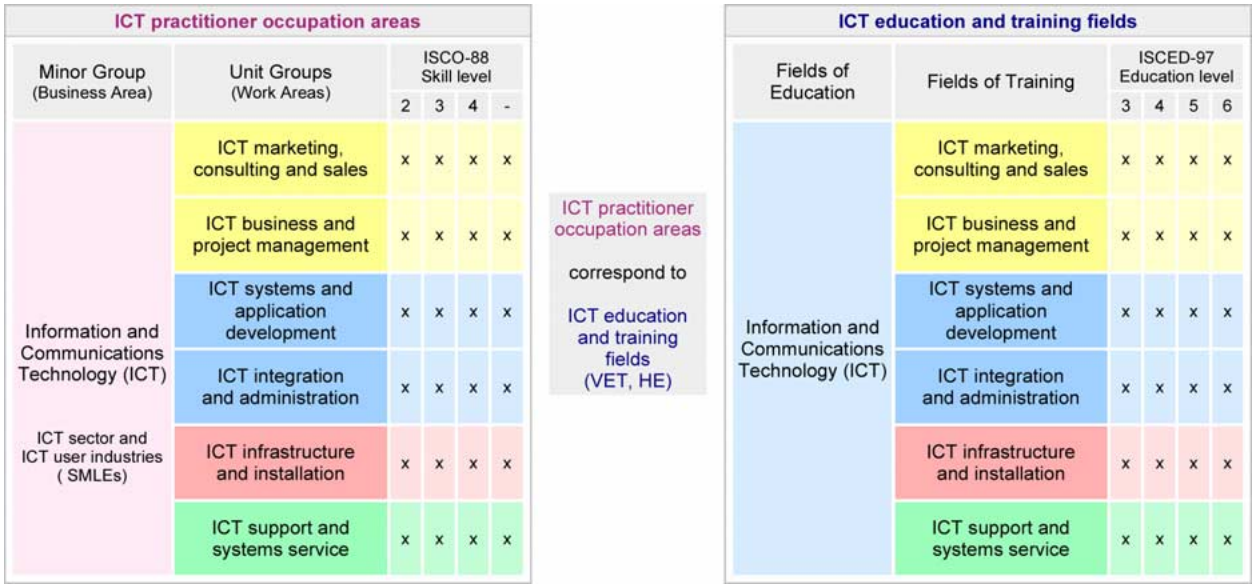


fig. 8-7: Recommendation for a revision of European classifications and frameworks based on the EUQuaSIT proposal on European reference “Frameworks for ICT skills and qualification”

With its outcomes and conclusions the EUQuaSIT project can contribute to this process, namely for the specific domain and “sector” of ICT. Based on all investigations of the current demand and empirical surveys on ICT practitioner skill needs, that constitute a vital basis for

prospective qualification objectives and contents, an EUQuaSIT reference proposal for corresponding European "Frameworks of ICT skills and qualifications" has been developed and comprehensively described in this report (see fig. 8-7). It illustrates the new ICT work oriented structures on either sides and indicates how to improve a mutual European framework for ICT qualifications and beyond. It is clearly intended and recommended with these common structures, especially in view of a prospective vocational education and training system in Europe, to establish a work oriented qualifications focusing on the correspondence of occupational work areas and training qualification fields.

Based on this common European ICT skills and qualification frameworks a transfer to existing framework such as ISCO-88 (COM) as well as ISCED-97/EC-99 is has been worked out in order to contribute to the debate on a harmonisation of skill needs and qualifications supply aiming at decreasing existing mismatches. In addition to the changes of ISCO-88 described above, a revision of the EC-99 fields of training is implemented in sense of concrete "ICT fields of training". However, such a revision would not solve the level problem with a primary level structure in the actual occupational structure and "fields of training" that are in principle "independent of levels" (Cedefop / Eurostat 1999, p. 8).

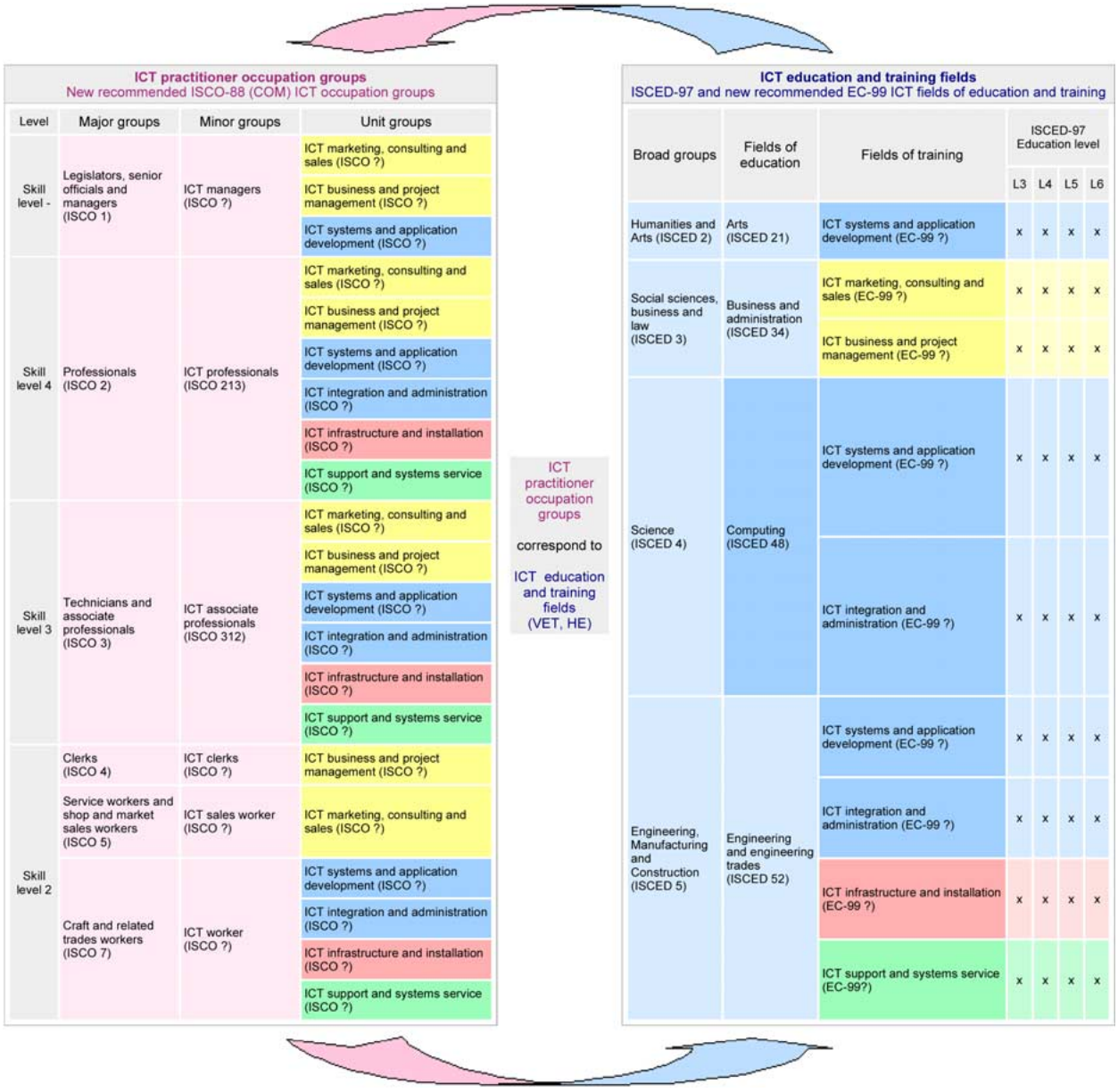


fig. 8-8: Complete recommendation of integrating the GAHFA skills and qualification structures in the current European classifications and frameworks

The detailed analyses on ICT practitioner skill needs furthermore and within the defined framework lead to a structure of European (reference) "Generic ICT skills profiles". Each of these generic profiles represents the skill needs at a specific skill level and in an ICT work area. The generic ICT skills profiles at “higher skill levels” were not developed in the scope of EUQuaSIT, but adopted from the results of the European Career Space initiative (cf. CSC / Cedefop 2001a).

The generic ICT skills profiles in its structure and contents provide - combined and based on a work orientated approach - one major fundament for the recommendation of European "Generic ICT qualification profiles" at VET levels and in delimitation to higher professional skill and education levels. Therefore and based on broad and empirical surveys, EUQuaSIT developed innovative reference material on European ICT qualifications and, in cooperation with Cedefop, it is recommended to promote these generic ICT qualification profiles and programmes as vital step towards a new European standard.

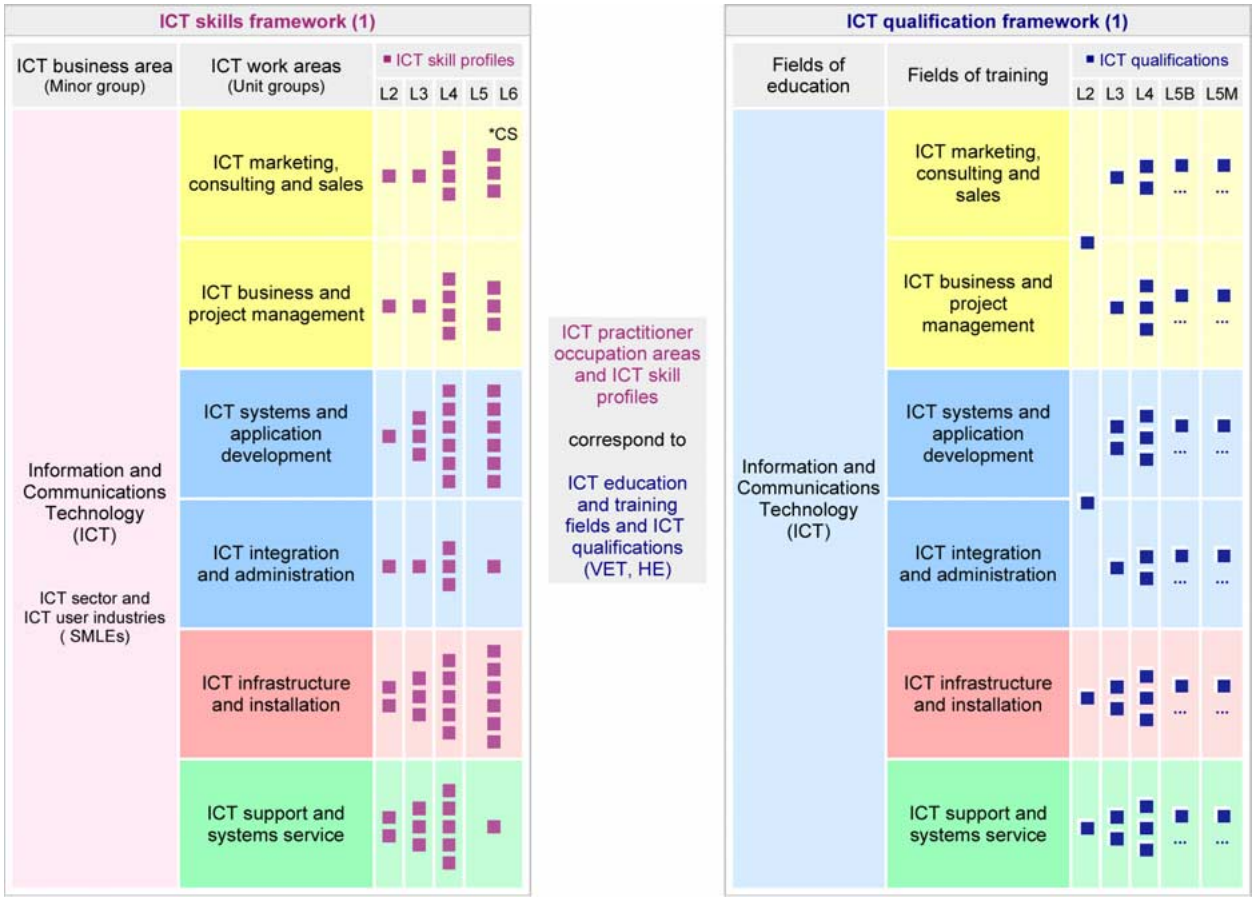


fig. 8-9: Recommendation of corresponding the ICT skills and ICT qualification framework

The second crucial fundament for prospective proposals on European ICT qualifications are existing national qualification frameworks and its quantitative and qualitative comparison. In this context, the major European challenge in regard to mutually trusted qualification strategies is surely given by the fact that national systems of vocational education and training have their own and partly considerable different structures, qualification frameworks and training standards. In the figure below this is reminded by the comparison of national ICT qualification frameworks. It is even not possible to indicate in such a picture, that in detail the curricula partly show considerably different structures and contents, so that the comprehensive surveys of national ICT qualification strategies as well as their acceptance and realisation in companies and ICT training institutions respectively have also revealed the variety of possibilities in terms of vocational education and training concepts.

Furthermore the statistical data analyses provide numbers of ICT trainees and students in the EUQuaSIT partner countries for the complete scope of the documented ICT qualification profiles and programmes. These data had not been available yet and therefore provide an innovative knowledge base on the dimension of the ICT vocational education and training supply in European countries. By abstracting these national data, that represent a proportion of about 40 % of the EU-15 population, a stock of app. 1 100 000 ICT trainees and students at all relevant qualification levels in the EU-15 can be realistically estimated.

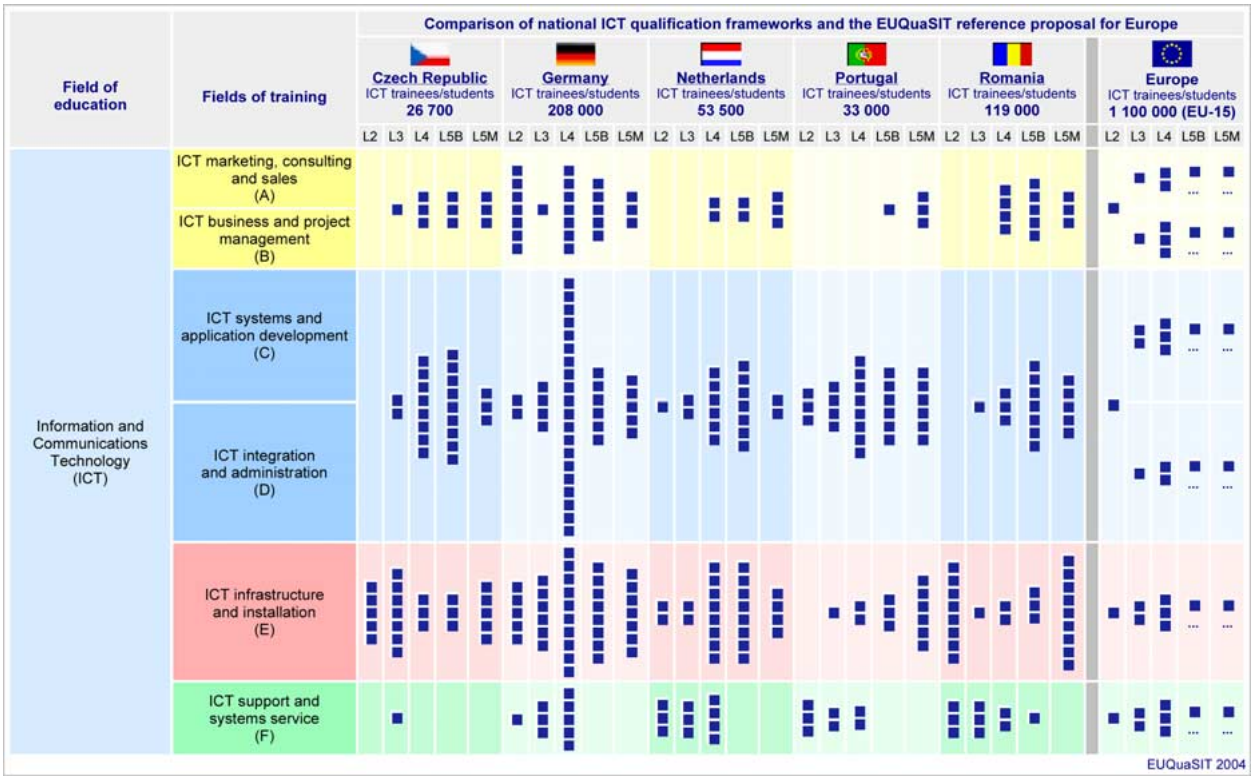


fig. 8-10: Comparison of national ICT qualification frameworks and the EUQuaSIT proposal as a new reference for Europe

In the scope of the definitions and used classifications the breakdown of the numbers of European ICT trainees and students as well as the estimated total supply of 220 000 can be confronted with the demand of ICT practitioners in Europe, estimated on the basis of a 3.5 % growth and a replacement demand of app. 2.5 %, of 230 000 per year. Even though presenting such concrete numbers is risky, the dimensions at least allow to conclude that partly announced huge shortages of ICT practitioners certainly do not exist rather than being manageable with certain shortages applying to specific levels or, of course, ICT business and work areas.

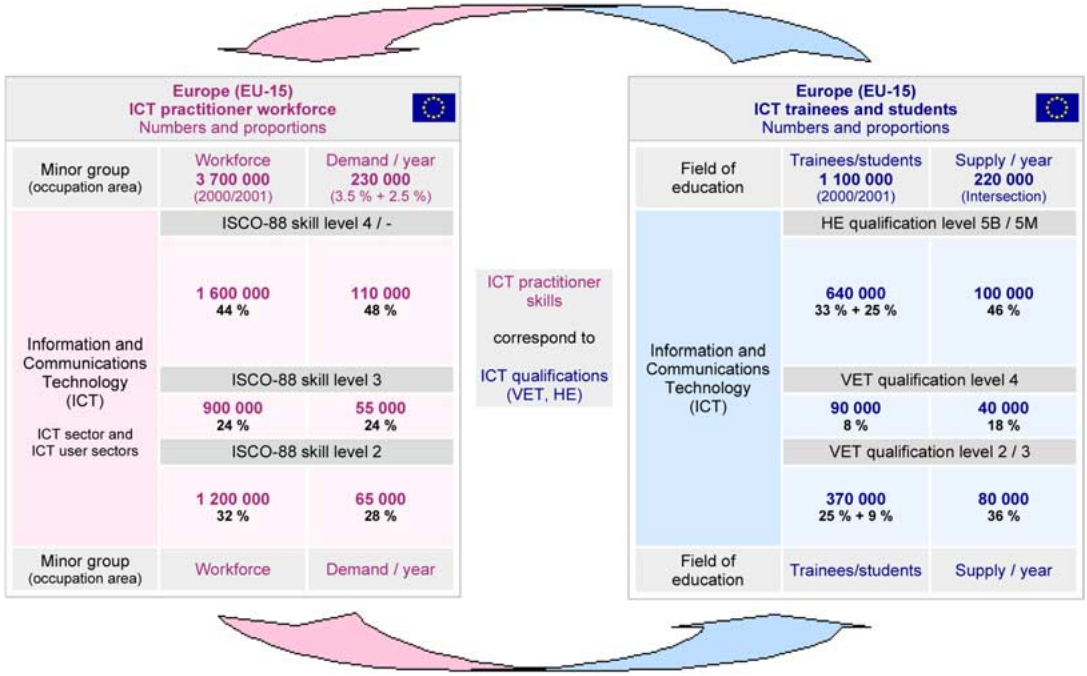


fig. 8-11: European correspondence of the ICT practitioner workforce stock and annual demand on the one side and supply of ICT trainees and students on the other in a quantitative view

In major orientation to this empirical reference frameworks and according to defined outcomes, the EUQuaSIT results furthermore present some guidelines for the ICT curriculum development and recommends European ICT training solutions for ICT practitioners focusing on the three vocational education and training levels 4, 3 and 2. The European ICT qualification profiles are further described through a didactic set of "Work orientated ICT learning modules" and a recommendation of valuing the ICT vocational training programmes and outcomes in terms of the European credit transfer with corresponding conclusions regarding entry requirements, assessment and certification, the qualifying processes and the design of ICT training courses.

One of the additional and lasting problems addressed within the project are the still rather low proportions of females in ICT vocational education and training and even lower proportions amongst ICT practitioner in the companies. Therefore, the investigations clearly indicate that any initiatives in this direction need to focus on the “transition to work” process accompanied by the attempt to clarify that gender diversity in daily business and work processes are of high importance. The results from countries like Romania and Portugal have clearly indicated that higher female proportions are realisable. Furthermore also ICT training institutions can contribute to this process, chiefly by engaging females as teachers and trainers.

The political task now is to further stimulate the European debate on ICT practitioner skills and qualification standards and certificates, without neglecting vocational education and training, in order to provide greater transparency and mobility across Europe for skilled workers in this innovative and prospective economic and social area. It is hoped that the presented results support the mutual understanding, definition, recognition and implementation of European ICT practitioner skills, qualifications, curriculum and training standards. The EUQuaSIT results have already had certain impact to the European debate on prospective ICT practitioner skills concepts, chiefly in cooperation with Cedefop, and on this basis produced innovative European reference material in terms of ICT skills and corresponding qualification strategies.

Therefore we finally recommend further and geographically broader surveys on ICT practitioner skill needs and adequate curriculum and training solutions for ICT practitioners not only but

with special focus on vocational levels and in a representative sample of European countries (e.g. EUQuaSIT II). Within the broad dissemination activities of the project various countries, especially in the Southern parts of Europe have signalised their interest of utilising the results of the project. We hope that the “Recommendations on European ICT qualifications” sustainable contribute to the prospective development of harmonised European vocational education and training strategies and concepts.

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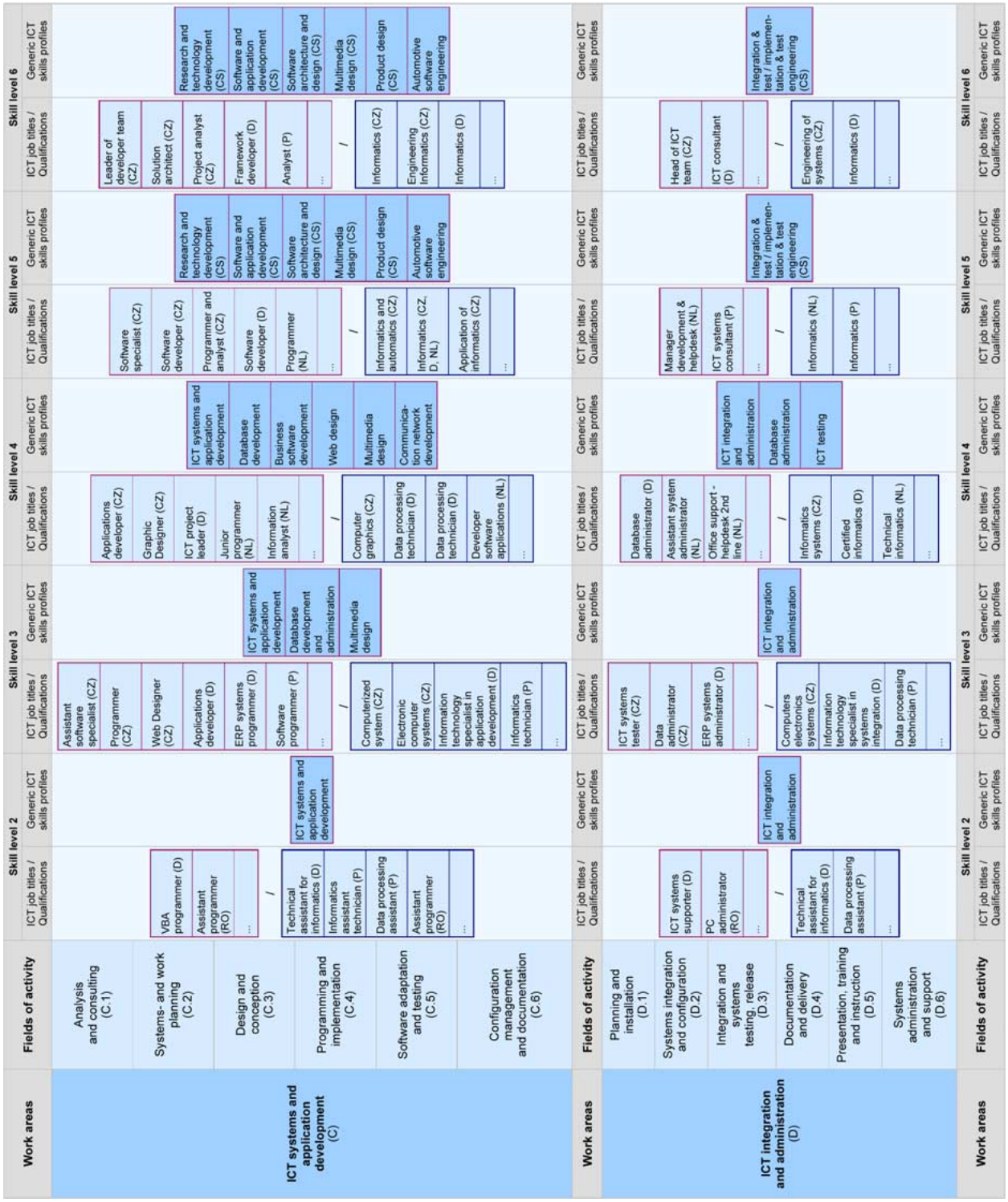
Annex

A. Examples of ICT job titles and ICT qualifications in the different work areas of the GAHFA structure



Work areas	Fields of activity	Skill level 2		Skill level 3		Skill level 4		Skill level 5		Skill level 6	
		ICT job titles / Qualifications	Generic ICT skills profiles	ICT job titles / Qualifications	Generic ICT skills profiles	ICT job titles / Qualifications	Generic ICT skills profiles	ICT job titles / Qualifications	Generic ICT skills profiles	ICT job titles / Qualifications	Generic ICT skills profiles
ICT infrastructure and installation (E)	Analysis and consulting (E.1)	ICT systems installer (D) Networks Installer (RO) ... / Information and Communi-cations Technology Assistant (D) Computer Systems Trouble-shooting Technician (RO) Electro-mechanic networks and cables (RO) ...	ICT infrastructure and installation Network installation	HW technician (CZ) Networks specialist (CZ) Systems installer (D) Computer technician (RO) ... / Computerized system (CZ) Computers electronics systems (CZ) Information technology specialist in system integration (D) Communica-tion electronic technician (D) Computer and networking technician (RO) ...	ICT infrastructure and installation Network planning and installation Communica-tions planning and installation	Service technician (CZ) Business manager (NL) Configuration manager (NL) Computer specialist (RO) / Diploma computerized technics (CZ) Technician in information electronics (D) Automation electronics (NL) Electronics and telecommuni-cations (RO) ...	ICT infrastructure and installation Network design and installation ICT industrial systems design ICT consumer electronics design ICT security design	Systems engineer Unix (D) Manager ICT department (D) Network specialist (NL) Applied electronics and communica-tions (RO) ... / Computer science engineering (D) (Technical) Informatics (D) Communica-tions systems (NL) Technical informatics (RO) Applied electronics and communica-tions (RO) ...	Systems specialist (CS) Radio frequency (RF) engineering (CS) Digital design (CS) Data communica-tions engineering (CS) Digital signal processing application design (CS) Communica-tions network design (CS)	Head of networks division (CZ) Head of communica-tions dept. (RO) Computer systems design team leader (RO) Hardware engineer (RO) ... / Informatics systems engineering (NL) Computer science (RO) Electronics and telecommuni-cations (RO) ...	Systems specialist (CS) Radio frequency (RF) engineering (CS) Digital design (CS) Data communica-tions engineering (CS) Digital signal processing application design (CS) Communica-tions network design (CS)
	Systems- and work planning (E.2)										
	Assembly and installation (E.3)										
	Setup, integration and configuration (E.4)										
	Check, test and documentation (E.5)										
	Delivery, instruction and finalising (E.6)										
Work areas	Fields of activity	Skill level 2		Skill level 3		Skill level 4		Skill level 5		Skill level 6	
		ICT job titles / Qualifications	Generic ICT skills profiles	ICT job titles / Qualifications	Generic ICT skills profiles	ICT job titles / Qualifications	Generic ICT skills profiles	ICT job titles / Qualifications	Generic ICT skills profiles	ICT job titles / Qualifications	Generic ICT skills profiles

Work areas	Fields of activity	Skill level 2: ICT job titles / Qualifications	Skill level 2: Generic ICT skills profiles	Skill level 3: ICT job titles / Qualifications	Skill level 3: Generic ICT skills profiles	Skill level 4: ICT job titles / Qualifications	Skill level 4: Generic ICT skills profiles	Skill level 5: ICT job titles / Qualifications	Skill level 5: Generic ICT skills profiles	Skill level 6: ICT job titles / Qualifications	Skill level 6: Generic ICT skills profiles
ICT support and systems service (F)	Service management and systems implementation (F.1) Systems upgrading and optimisation (F.2) Systems administration and control (F.3) Systems support, helpdesk and training (F.4) Systems maintenance and documentation (F.5) Error diagnosis and troubleshooting (F.6)	ICT service assistant (NL) Hardware supporter (RO) ... / ICT service worker (NL) Computer systems electric troubleshooting technician (RO) IT systems support technician (UK) ...	ICT support and systems service ICT user support	Service manager (CZ) Service centre technician (CZ) Communications networks administrator (D) Networks operator (D) ICT helpdesk employee (NL) ... / Electronic computer systems (CZ) Communication electronic technician in TC engineering (D) Assistant administrator ICT (NL) ...	ICT support and systems service Network administration Web administration	Head of ICT service (CZ) Service specialist mobile systems (CZ) System administrator (NL) Office equipment troubleshooting technician (RO) ... / Diploma in automatisation and informatics (CZ) Diploma in computerized technics (CZ) Electronics and telecommunica tions (RO) ...	ICT support and systems service Network administration Database administration ICT training ICT operation	ICT service manager (NL) Service engineer (RO) ... / Technical informatics (NL) Information technology (RO) ...	Technical support (CS)	Service dept. manager (RO) Service analyst (RO) Service analyst (RO) ... / Electronics and telecommunica tions (RO) Mathematics informatics (RO) Telecommunica tions and informatics engineering (P) ...	Technical support (CS)
Work areas	**Fields of activity**	Skill level 2: ICT job titles / Qualifications	Skill level 2: Generic ICT skills profiles	Skill level 3: ICT job titles / Qualifications	Skill level 3: Generic ICT skills profiles	Skill level 4: ICT job titles / Qualifications	Skill level 4: Generic ICT skills profiles	Skill level 5: ICT job titles / Qualifications	Skill level 5: Generic ICT skills profiles	Skill level 6: ICT job titles / Qualifications	Skill level 6: Generic ICT skills profiles

B. Examples of generic ICT skills profiles

1. Generic ICT skills profile

ICT marketing (L4; ISCO L3)

2. Examples of job titles and qualifications (country)

- ICT marketing specialist
- ICT commerce specialist
- Manager in business informatics (D)
- E-marketing developer (D)

3. Work and profile description

'ICT marketing, consulting and sales' is a comprehensive work area covering commercial and consultancy activities with special focus on information and communications technology (ICT) projects, products and services. At first sight this generic ICT work area seems to apply to the ICT industry only, but for instance structural changes in companies of the ICT user industries (keyword: profit centre organisation) lead to a strengthened consideration of such work areas. Increasingly 'internal' customers of ICT departments (e.g. in banks, insurance companies, industry departments like accounting, production etc.) have the same requirements as external customers have of their ICT suppliers in terms of the provision of advice and guidance on how to support their business processes through the effective use of ICT products and services. Therefore this work area though covers mainly work processes of the ICT industry, but partly also those of ICT user industries.
The successful marketing of ICT products and services requires fundamental analyses of external and internal market and customer needs. The most important step, however, is to translate these requirements into services and products that answer specific customer needs while providing benefits to the own company or department at the same time. Common goal of more business and technical orientated ICT practitioners is a clear description of the business requirements within the 'technical specification' of the ICT solution to be developed. These combination of business and technical tasks ask for specific skills and justifies the elaboration and delimitation of the two generic ICT work areas and corresponding skills profiles at different skill levels.
ICT marketing activities (in conjunction with ICT sales) guaranty the work flow success from the very first steps like 'ICT market analysis and -benchmarks' to the 'conception and documentation of ICT solutions'. Within these different phases of activity and responsibilities ICT marketing practitioners closely collaborate with internal and external ICT experts, providers and customers in order to ensure a solid market position of the company's ICT solutions and services.

4. Soft skills

Behavioural and personal skills	Cross section and basic work Skills	Soft and method skills
▪ Flexibility	▪ Quality awareness	▪ Communication
▪ Stress resistant and emotion	▪ Commercial and market awareness	▪ Languages and culture
▪ Responsibility	▪ Entrepreneurship	▪ Collaboration and interaction
▪ Managing risks	▪ Customer orientation and relationship	▪ Teamwork and mentoring
▪ Decision making	▪ Company and business organisation	▪ Conflict and consensus
▪ Negotiation	▪ Work and project organisation	▪ Creative and innovation
▪ Influence and persuasiveness	▪ Work safety and health protection	▪ Problem analysis and solving
▪ Professional attitude	▪ Labour law and data privacy	▪ Strategy, conception and planning
	▪ Environmental and resource awareness	▪ Documentation and presentation

5. ICT marketing skills

... in regard to the fields of activity and generic work tasks	... linked to the ICT business and technology areas

▪ ICT market analysis and -benchmarks
  ▪ Obtain, analyse and prepare tailored ICT market, product and service information
  ▪ Contribute to, edit and review an ICT business and project plan
▪ Advertising and consumer promotion
  ▪ Establish, describe and present ICT marketing and sales objectives and strategies (e.g. strategic planning, e-marketing and e-sales, network marketing and sales, direct marketing and sales)
  ▪ Organise, coordinate and carry out ICT marketing and sales campaigns, e.g. fair exhibitions, company and product brochures, advertising texts
▪ Customer consulting and acquisition
  ▪ Receive, assess and forward customer inquiries
  ▪ Analysis and evaluate ICT systems and applications demand of customers
  ▪ Meet customers and colleagues and present tailored ICT solutions
▪ Requirement, product and systems analysis
  ▪ Investigate ICT business processes and determine requirement specifications
  ▪ Coordinate, carry out and review financial and cost-benefit analyses
▪ Conception and documentation of ICT solutions
  ▪ Formulate overall data base structures using various data models
  ▪ Prepare and administer product- and project specific documentations and manuals
	▪ Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems etc.)
	▪ Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data etc.)
	▪ Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health etc.)
	▪ Internet and intranet systems and applications (web design, service providing etc.)
	▪ E-business and e-commerce solutions (B2B, B2C etc.)
	▪ Data management and database solutions (process databases, backup and recovery systems etc.)
	▪ Networks systems and solutions (LAN, ATM etc.)
	▪ ICT security solutions (antivirus, firewall, VPN etc.)
	▪ Business (process) systems and applications (CRM, ERP etc.)
	▪ Industrial IT systems (industrial and process automation etc.)
	▪ Embedded systems and control (diagnostics, monitoring etc.)
	▪ Multimedia systems and applications (video, simulations etc.)
	▪ Consumer and entertainment electronics (computer games etc.)
	▪ ICT training solutions (customer seminars, blended learning etc.)
	▪ ...

6. Cross work area / basic technical ICT skills

ICT development and administration	ICT infrastructure and installation	ICT support and systems service
▪ Differentiate and describe the architecture of ICT systems and software solutions (e.g. Client-Server, Mainframes, Web Services) ▪ Differentiate technologies of ICT systems and software design (e.g. machine-intimate, object-orientation, 4GL, 3GL) ▪ Describe ICT systems and software requirements (e.g. systems software, application software, communication software, specific applications, databases, security systems) ▪ Adapt databases (e.g. mainly SQL in MS Access, SQL-Server, MySQL)	▪ Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems) ▪ Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB) ▪ Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN) ▪ Arrange and run the delivery of ICT systems and infrastructure solutions	▪ Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum) ▪ Describe support, service and communication channels (e.g. customers, business partners, suppliers, colleagues) ▪ Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware) ▪ Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications)

7. Career roadmap and future opportunities

Due to the rapid developments in technologies, methods and process organisation, practitioners working in 'ICT marketing' must be aware of the need of lifelong learning (LLL) both, in terms of more informatics and technology subjects but chiefly economic technical aspects like market developments and trends. Based on some years work and project experience in ICT marketing next stage of a career in the work area 'ICT marketing, consulting and sales' is described in the relevant ICT skill profiles at degree level 5, e.g. Career Space. This role for instance involves more responsible consulting and strategic work, e.g. marketing and sales strategies, product management, external product promotion.

1. Generic ICT skills profile

ICT content and knowledge management (L4; ISCO L3)

2. Examples of job titles and qualifications (country)

- Intranet knowledge manager
- ICT content manager
- Automotive knowledge manager
- Business manager in business informatics (D)
- Information management (CZ)

3. Work and profile description

'ICT content and knowledge management' covers the design and development of technical solutions to support business processes in an organisation based on ICT knowledge management systems. As user and customer specific solution developers the ICT practitioners carrying out this work arrange the solutions in cooperation with the user department (or company) and the ICT developers (e.g. software developers).
For instance, automotive knowledge manager deal with the key know-how of a company (manufacturer or repair workshop) and process this information with the aid of data bases. A transparent documentation is the challenged to be tackled. The most important tasks are the compilation of process oriented data, an access-friendly data processing and the safeguarding of a flawless information flow.

4. Soft skills

Behavioural and personal skills	Cross section and basic work skills	Soft and method skills
▪ Flexibility	▪ Quality awareness	▪ Communication
▪ Stress resistant and emotion	▪ Commercial and market awareness	▪ Languages and culture
▪ Responsibility	▪ Entrepreneurship	▪ Collaboration and interaction
▪ Managing risks	▪ Customer orientation and relationship	▪ Teamwork and mentoring
▪ Decision making	▪ Company and business organisation	▪ Conflict and consensus
▪ Negotiation	▪ Work and project organisation	▪ Creative and innovation
▪ Influence and persuasiveness	▪ Work safety and health protection	▪ Problem analysis and solving
▪ Professional attitude	▪ Labour law and data privacy	▪ Strategy, conception and planning
	▪ Environmental and resource awareness	▪ Documentation and presentation

5. ICT content and knowledge management skills

... in regard to the fields of activity and generic work tasks	... linked to the ICT business and technology areas

▪ Project and resource planning
  ▪ Determine and describe project objectives, work packages, milestones, costs etc.
  ▪ Re-design of work processes
▪ Selection and purchasing
  ▪ Purchase and provide ICT systems to the specialist teams
▪ Quotation coordination and project support
  ▪ Coordinate ICT work tasks and the work flow and project progress
  ▪ Investigation of communication structures and information flows
  ▪ Design of company communication structures
  ▪ Development of knowledge data bases
  ▪ Development of tele-cooperation platforms
▪ Order coordination and project support
  ▪ Describe and run measures for the evaluation and assurance of quality, e.g. project, system, product service etc.
  ▪ Project management for projects for the safeguarding and documentation of information as well as for the optimisation of document structures (document management) and information flows
▪ Customer support and training
  ▪ Manage and provide business support and sustain relationships to customers and users
  ▪ Selection, coordination and introduction of content and collaborate management systems by involving the workforce
▪ Project finalising and billing
  ▪ Finally calculate and fix project and service agreement costs
	▪ Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems etc.)
	▪ Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data etc.)
	▪ Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health etc.)
	▪ Internet and intranet systems and applications (web design, service providing etc.)
	▪ E-business and e-commerce solutions (B2B, B2C etc.)
	▪ Data management and database solutions (process databases, backup and recovery systems etc.)
	▪ Networks systems and solutions (LAN, ATM etc.)
	▪ ICT security solutions (antivirus, firewall, VPN etc.)
	▪ Business (process) systems and applications (CRM, ERP etc.)
	▪ Industrial IT systems (industrial and process automation etc.)
	▪ Embedded systems and control (diagnostics, monitoring etc.)
	▪ Multimedia systems and applications (video, simulations etc.)
	▪ Consumer and entertainment electronics (computer games etc.)
	▪ ICT training solutions (customer seminars, blended learning etc.)
	▪ ...

6. Cross work area / basic technical ICT skills

ICT development and administration	ICT infrastructure and installation	ICT support and systems service
▪ Differentiate and describe the architecture of ICT systems and software solutions (e.g. Client-Server, Mainframes, Web Services) ▪ Differentiate technologies of ICT systems and software design (e.g. machine-intimate, object-orientation, 4GL, 3GL) ▪ Describe ICT systems and software requirements (e.g. systems software, application software, communication software, specific applications, databases, security systems) ▪ Adapt databases (e.g. mainly SQL in MS Access, SQL-Server, MySQL)	▪ Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems) ▪ Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB) ▪ Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN) ▪ Arrange and run the delivery of ICT systems and infrastructure solutions	▪ Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum) ▪ Describe support, service and communication channels (e.g. customers, business partners, suppliers, colleagues) ▪ Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware) ▪ Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications)

7. Career roadmap and future opportunities

Due to the rapid developments and changes in technologies, methods and process organisation, 'ICT content and knowledge management' practitioners must be aware of the need of lifelong learning (LLL) both, in terms of primary ICT technical subjects as well as overall aspects like ICT business process and market developments and trends.

1. Generic ICT skills profile

ICT systems and application development (L4; ISCO L3)

2. Examples of job titles and qualifications (country)

- Database developer
- Software developer
- Test analyst
- Technician in data processing technology (D)
- Developer software applications (NL)
- Informatics applications programmer (P)

3. Work and profile description

'ICT systems and application development' is a comprehensive work area covering far more than just mere individual programming or coding. In these work area Informatics practitioners work in systems and software development teams that design, realise, update, test, integrate and maintain individual, enterprise, customer, sector-specific and standard applications using existing modelling and engineering methods, development tools and languages, (O).D.B.M.S. ((object-orientated) database management system) etc. Depending on the real ICT business area the work can cover also embedded systems solutions, specific telecommunications applications, multimedia and internet applications etc. The work tasks are carried out based on comprehensive analyses and descriptions of what is needed by the market, a specific sector or a specific customer. Informatics practitioners at this skill level take over responsible parts in this work, usually as self-organised team members. In practise permanent contacts to the project and team manager and ICT business and technical practitioners within our without the company are important, e.g. ICT consultants, ICT infrastructure practitioners, research groups etc. In the daily work processes the transfer of the technical and business requirements to be clearly defined in the 'technical specification' into a consistent 'data processing specification' is crucial for the final success of ICT systems and application development as well as the final integration and deployment process. Primary criteria for the software solutions are reliability and usability. Furthermore the work as part of a team often runs under time constraints and must be constantly well communicated, reported and documented.

4. Soft skills

Behavioural and personal skills	Cross section and basic work skills	Soft and method skills
▪ Flexibility	▪ Quality awareness	▪ Communication
▪ Stress resistant and emotion	▪ Commercial and market awareness	▪ Languages and culture
▪ Responsibility	▪ Entrepreneurship	▪ Collaboration and interaction
▪ Managing risks	▪ Customer orientation and relationship	▪ Teamwork and mentoring
▪ Decision making	▪ Company and business organisation	▪ Conflict and consensus
▪ Negotiation	▪ Work and project organisation	▪ Creative and innovation
▪ Influence and persuasiveness	▪ Work safety and health protection	▪ Problem analysis and solving
▪ Professional attitude	▪ Labour law and data privacy	▪ Strategy, conception and planning
	▪ Environmental and resource awareness	▪ Documentation and presentation

5. ICT marketing skills

... in regard to the fields of activity and generic work tasks	... linked to the ICT business and technology areas
▪ Analysis and consulting ▪ Investigate and review ICT systems and application requirements of the client and users ▪ Recommend an adequate and tailored ICT solution to the customer ▪ Write (parts of) the technical, ICT system and functional specification ▪ Systems- and work planning ▪ Manage and specify own work and project priorities using project management tools ▪ Accompany, monitor and lead the development process of the ICT solution and ensure progress, quality, configuration management etc. ▪ Test, choose and set up software and systems development tools ▪ Design and conception ▪ Define and design the ICT systems and software architecture and distribution (e.g. client-server, mainframe, CORBA) considering latest research results ▪ Analyse and define objects, frameworks, basic software classes, systems components, interfaces etc. ▪ Programming and implementation ▪ Determine and describe software units, methods, attributes, modules, I/O-parameters etc. ▪ Code, adapt and document systems, software and database applications, e.g. in 3GL and with 4GL IDEs, embedded SQL ▪ Design, develop and implement graphical user interfaces as well as web-based applications ▪ Software adaptation and testing ▪ Develop and coordinate test procedures and cases ▪ Run, interpret and document ICT systems and software tests by using various test tools, methods and data ▪ Describe opportunities and undergo bug-fixing, systems upgrading and software adaptation ▪ Configuration management and documentation ▪ Write (parts of) the installation and user instructions and ICT systems and application manuals ▪ Document, version and register new systems, software and database applications (configuration- and report management) ▪ Document the work following overall and company standards, e.g. info and help centre, change management	▪ Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems etc.) ▪ Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data etc.) ▪ Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health etc.) ▪ Internet and intranet systems and applications (web design, service providing etc.) ▪ E-business and e-commerce solutions (B2B, B2C etc.) ▪ Data management and database solutions (process databases, backup and recovery systems etc.) ▪ Networks systems and solutions (LAN, ATM etc.) ▪ ICT security solutions (antivirus, firewall, VPN etc.) ▪ Business (process) systems and applications (CRM, ERP etc.) ▪ Industrial IT systems (industrial and process automation etc.) ▪ Embedded systems and control (diagnostics, monitoring etc.) ▪ Multimedia systems and applications (video, simulations etc.) ▪ Consumer and entertainment electronics (computer games etc.) ▪ ICT training solutions (customer seminars, blended learning etc.) ▪ ...

6. Cross work area / basic technical ICT skills

ICT commerce and business	ICT infrastructure and installation	ICT support and systems service
▪ Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability) ▪ Describe the impact of innovative ICT developments (e.g. hardware, software, internet, services) ▪ Collaborate within customers quotations, consulting, contracting and project processing ▪ Self-responsible and project related support of customers and users ▪ Provide project data for the invoicing and accountancy	▪ Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems) ▪ Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB) ▪ Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN) ▪ Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL)	▪ Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum) ▪ Describe support, service and communication channels (e.g. customers, business partners, suppliers, colleagues) ▪ Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware) ▪ Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications)

7. Career roadmap and future opportunities

Due to the rapid developments and changes in technologies, methods and process organisation, practitioners in 'ICT systems and application development' must be aware of the need of lifelong learning (LLL) both, in terms of primary informatics and technology subjects as well as overall aspects like ICT business process and market developments and trends. Based on some years work and project experience at this skill level next stage of a career in the work area ' ICT systems and application development' is described in the ICT skill profiles at skill level 5. This role, on the one hand, involves more self organised and responsible project management and commercial work and, on the other hand, the design, development and support of more complex and specific applications, e.g. in the fields of internet and e-business solutions, GUI design and development or configuration and test management.

1. Generic ICT skills profile

ICT integration and administration (L3; ISCO L2)

2. Examples of job titles and qualifications (country)

- ICT systems integrator
- Database supporter
- ERP systems administrator
- Computers Electronics Systems (CZ)
- Information technology specialist in system integration (D)
- Informatics technician (P)

3. Work and profile description

'ICT integration and administration' covers first of all the final integration and deployment process of ICT systems and software development processes. Primary criteria for a smooth integration process are reliability and usability.
The work as part of a team often runs under time constraints and must be constantly well communicated, reported and documented. Eventually, the customer and its users often need applied (helpdesk) support, training and instructions. As part of the (continuous and often contracted) technical support systems and applications are optimised and up-graded and troubleshooting need to coordinated and problems resolved.

4. Soft skills

Behavioural and personal skills	Cross section and basic work skills	Soft and method skills
▪ Flexibility	▪ Quality awareness	▪ Communication
▪ Self learning	▪ Commercial and market awareness	▪ Languages and culture
▪ Motivation and commitment	▪ Customer orientation and relationship	▪ Collaboration and interaction
▪ Stress resistant and emotion	▪ Company and business organisation	▪ Teamwork
▪ Responsibility	▪ Work organisation	▪ Analytical and reasoning
▪ Decision making	▪ Work safety and health protection	▪ Problem analysis and solving
▪ Initiative and attention	▪ Labour law and data privacy	▪ Context and causal connection thinking
▪ Professional attitude	▪ Environmental and resource awareness	▪ Documentation and presentation

5. ICT integration and administration skills

... in regard to the fields of activity and generic work tasks	... linked to the ICT business and technology areas

▪ Planning and installation
  ▪ Assemble and test ICT systems, e.g. hardware, operating system, drivers
  ▪ Clarify and describe hardware and software requirements for the installation and integration of ICT systems and applications
  ▪ Manual and automatic installation and adaptation of operating systems, data bases and application software
▪ Systems integration and configuration
  ▪ Control compatibility between devices and ICT systems
  ▪ Check and adapt installation and configuration parameters to new and real circumstances
  ▪ Implement communication software and ensuring data mining and exchange
  ▪ Plan and set up systems parameters and user administration
▪ Integration and systems testing, release
  ▪ Coordinate, run and evaluate integrated tests of ICT systems and applications based on defined test cases
  ▪ Coordinate and undergo systems adaptations based on a test protocol and issue release
▪ Documentation and delivery
  ▪ Document systems specifications, test results and work tasks and provide them according to the arrangements (e.g. in the Intranet)
  ▪ Coordinate, run and document systems delivery according to company and customer requirements
▪ Presentation, training and instruction
  ▪ Prepare and run systems and application related presentations
  ▪ Elaborate and edit training and instruction material
  ▪ Run and evaluate training measures using multimedia systems
▪ Systems administration and support
  ▪ Optimise and actualise ICT systems, e.g. hardware, operating system, libraries
  ▪ Arrange and guarantee ICT system and software security and data backup and restore
  ▪ Manage and run software distribution, remote configuration, data archiving, retrieving and reorganisation
  ▪ Interpret, remove and document ICT systems and software bugs and coordinate external support
	▪ Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems etc.)
	▪ Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data etc.)
	▪ Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health etc.)
	▪ Internet and intranet systems and applications (web design, service providing etc.)
	▪ E-business and e-commerce solutions (B2B, B2C etc.)
	▪ Data management and database solutions (process databases, backup and recovery systems etc.)
	▪ Networks systems and solutions (LAN, ATM etc.)
	▪ ICT security solutions (antivirus, firewall, VPN etc.)
	▪ Business (process) systems and applications (CRM, ERP etc.)
	▪ Industrial IT systems (industrial and process automation etc.)
	▪ Embedded systems and control (diagnostics, monitoring etc.)
	▪ Multimedia systems and applications (video, simulations etc.)
	▪ Consumer and entertainment electronics (computer games etc.)
	▪ ICT training solutions (customer seminars, blended learning etc.)
	▪ ...

6. Cross work area / basic technical ICT skills

ICT commerce and business	ICT infrastructure and installation	ICT support and systems service
▪ Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability) ▪ Describe the impact of innovative ICT developments (e.g. hardware, software, internet, services) ▪ Collaborate within customers quotations, consulting, contracting and project processing ▪ Self-responsible and project related support of customers and users ▪ Provide project data for the invoicing and accountancy	▪ Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems) ▪ Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB) ▪ Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN) ▪ Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL)	▪ Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum) ▪ Describe support and communication channels (e.g. customers, business partners, suppliers, colleagues) ▪ Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware) ▪ Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications)

7. Career roadmap and future opportunities

Due to the rapid developments and changes in technologies, methods and process organisation, practitioners in 'ICT integration and administration' must be aware of the need of lifelong learning (LLL) both, in terms of primary informatics and technology subjects as well as overall aspects like ICT business process and market developments and trends. Based on some years work and project experience next stage of a career in the work area 'ICT integration and administration' is described in the ICT skill profiles skill level 4. This role, on the one hand, involves more self organised and responsible project management and commercial work and, on the other hand, the design, development and support of more complex and specific applications, e.g. in the fields of internet and e-business solutions, GUI design and development or configuration and test management.

1. Generic ICT skills profile

ICT infrastructure and installation (L2)

2. Examples of job titles and qualifications (country)

▪ Systems operator ▪ Network installer	▪ Informatics assistant technician (P) ▪ Information and communications technology assistant (D)

3. Work and profile description

'ICT infrastructure and installation' work covers the planning, integration, modification and installation of the wide range of different ICT systems, devices, telecommunications, networks etc., summarised as ICT infrastructure. The work is carried out based on problem orientated analyses and descriptions of what type and level of ICT infrastructure is needed by the market, a specific sector or (internal or external) customer. ICT practitioners use these information for the description of what is needed in concrete cases. For this contacts to customers, project managers and ICT business and systems development practitioners within our without the company can partly be important, but may not in any case carried out by at this level . However, for the realisation and integration of ICT infrastructure solutions like networks or telecommunications they need to consider aspects like reliability, cost effectiveness, upgradeability etc. The integration of standard solutions (e.g. software applications, wireless network and telecommunication solutions, web based infrastructure) is part of this work. The work, sometimes as part of a team, must be constantly well communicated and documented. Eventually, the customer and its users often need applied support, training and instructions.

4. Soft skills

Behavioural and personal skills	Cross section and basic work Skills	Soft and method skills
▪ Flexibility ▪ Self learning ▪ Motivation and commitment ▪ Initiative and attention ▪ Professional attitude	▪ Quality awareness ▪ Customer orientation and relationship ▪ Company and business organisation ▪ Work safety and health protection ▪ Labour law and data privacy ▪ Environmental and resource awareness	▪ Communication ▪ Languages and culture ▪ Collaboration and interaction ▪ Teamwork ▪ Problem analysis and solving ▪ Documentation and presentation

5. ICT infrastructure and installation skills

... in regard to the fields of activity and generic work tasks	... linked to the ICT business and technology areas

▪ Analysis and consulting
  ▪ Determine, specify and describe technical requirements
▪ Systems- and work planning
  ▪ Receive, assess and forward new customer orders
  ▪ Ensure, select and use latest ICT product and service information and requirements, also in foreign languages
▪ Assembly and installation
  ▪ Assemble, install and up-grade ICT systems and networks devices and components
  ▪ Manual and automatic installation and configuration of operating systems, applications and communication software etc.
  ▪ Decommission and recycle old ICT infrastructure
▪ Setup, integration and configuration
  ▪ Undertake systems adaptations by parameterising, updating as well as adapt software applications by using macro- and programming languages
▪ Check, test and documentation
  ▪ Test and verify requested function of installed and integrated ICT systems based on given criteria and requirements
▪ Delivery, instruction and finalising
  ▪ Instruct ICT support staff and users for new ICT infrastructure, applications and functions
	▪ Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems etc.)
	▪ Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data etc.)
	▪ Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health etc.)
	▪ Internet and intranet systems and applications (web design, service providing etc.)
	▪ E-business and e-commerce solutions (B2B, B2C etc.)
	▪ Data management and database solutions (process databases, backup and recovery systems etc.)
	▪ Networks systems and solutions (LAN, ATM etc.)
	▪ ICT security solutions (antivirus, firewall, VPN etc.)
	▪ Business (process) systems and applications (CRM, ERP etc.)
	▪ Industrial IT systems (industrial and process automation etc.)
	▪ Embedded systems and control (diagnostics, monitoring etc.)
	▪ Multimedia systems and applications (video, simulations etc.)
	▪ Consumer and entertainment electronics (computer games etc.)
	▪ ICT training solutions (customer seminars, blended learning etc.)
	▪ ...

6. Cross work area / basic technical ICT skills

ICT commerce and business	ICT development and administration	ICT support and systems service
▪ Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability) ▪ Collaborate within customers quotations, consulting, contracting and project processing ▪ Provide project data for the invoicing and accountancy	▪ Describe ICT systems and software requirements (e.g. systems software, application software, communication software, specific applications, databases, security systems) ▪ Modify, configure and administrate basic software and web applications (e.g. algorithms, data structures, I/O parameters, e.g. VB, JavaScript, ABAP, HTML, XML)	▪ Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware) ▪ Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications)

7. Career roadmap and future opportunities

Due to the rapid developments and changes in technologies, methods and process organisation, practitioners working in the area of 'ICT infrastructure and installation' must be aware of the need of lifelong learning (LLL) both, in terms of primary ICT and technology subjects as well as overall aspects like ICT business process and market developments. Next stage of a career in the work area 'ICT infrastructure and installation' is described in the ICT skill profiles at skill level 3. This role, on the one hand, involves more self organised and responsible project work and, on the other hand, the integration of more specific ICT infrastructures and systems, e.g. in the fields of printing systems, mobile communications systems, audio and video systems, ICT security systems.

1. Generic ICT skills profile

ICT support and systems service (L3; ISCO L2)

2. Examples of job titles and qualifications (country)

- Networks fitter
- ICT service technician
- Network (PC's) maintenance technicians (P)
- IT system electronics (D)

3. Work and profile description

'ICT service and maintenance' primary concerns the analysis, troubleshooting and fixing of ICT infrastructure, systems and application problems. In principle this work covers a wide range of different ICT technologies and services and correspondingly the use of different soft- and hardware based expert and diagnosis tools, depending on the level of service and support. In order to narrow the faults down to the concrete technical problem, ICT service practitioners need to well communicate with customers, users and colleagues. As part of the service and maintenance the ICT practitioners must be able to propose possibilities of optimising and upgrading existing ICT systems.

4. Soft skills

Behavioural and personal skills	Cross section and basic work Skills	Soft and method skills
▪ Flexibility	▪ Quality awareness	▪ Communication
▪ Self learning	▪ Commercial and market awareness	▪ Languages and culture
▪ Motivation and commitment	▪ Customer orientation and relationship	▪ Collaboration and interaction
▪ Stress resistant and emotion	▪ Company and business organisation	▪ Teamwork
▪ Responsibility	▪ Work organisation	▪ Analytical and reasoning
▪ Decision making	▪ Work safety and health protection	▪ Problem analysis and solving
▪ Initiative and attention	▪ Labour law and data privacy	▪ Context and causal connection thinking
▪ Professional attitude	▪ Environmental and resource awareness	▪ Documentation and presentation

5. ICT support and systems service skills

... in regard to the fields of activity and generic work tasks	... linked to the ICT business and technology areas

▪ Service management and systems implementation
  ▪ Analyse and optimise the integration of ICT service and escalation concepts and platforms within the overall company- and process structure using various methods and sources
  ▪ Receive, interpret and confirm customer ICT service orders
  ▪ Check and assess service level agreements and advise colleagues and customers on ICT service possibilities
  ▪ Suggest potential ICT service and maintenance improvements of the company
  ▪ Participate at the integration and implementation of new ICT systems and applications
▪ Systems upgrading and optimisation
  ▪ Upgrade and modify ICT infrastructure and systems, e.g. new systems software, drivers, firmware etc.
  ▪ Recommend, present and setup new and upgraded ICT applications, e.g. office products, database systems
▪ Systems administration and -control
  ▪ Maintain ICT systems and infrastructure regarding up-to-dateness, data- and systems security, user administration etc.
  ▪ Permanently run and document ICT systems- and process control
▪ Systems support, helpdesk and training
  ▪ Provide, update and administer ICT system- and user information and resources, e.g. manuals, support documents, patch
  ▪ Support and advice customers and users within company support and helpdesk tasks and follow up complaints
  ▪ Instruct ICT support staff and users on new systems, safety, security, application changes, potential problems etc.
▪ Systems maintenance and documentation
  ▪ Maintain ICT systems and infrastructure, e.g. PCs, networks, TC systems, print- and copy systems
  ▪ Report and document service work tasks following overall and company standards, e.g. working hours, material, resources, problems
▪ Error diagnosis and troubleshooting
  ▪ Ensure, select and use latest ICT product and service information and manuals, also in foreign languages
  ▪ Narrow and interpret ICT systems and infrastructure problems
  ▪ Select and run test and diagnosis systems and software tools
  ▪ Remove ICT systems errors and ensure safety and security of systems and data, e.g. repair and change hardware, configure systems components and software
	▪ Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems etc.)
	▪ Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data etc.)
	▪ Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health etc.)
	▪ Internet and intranet systems and applications (web design, service providing etc.)
	▪ E-business and e-commerce solutions (B2B, B2C etc.)
	▪ Data management and database solutions (process databases, backup and recovery systems etc.)
	▪ Networks systems and solutions (LAN, ATM etc.)
	▪ ICT security solutions (antivirus, firewall, VPN etc.)
	▪ Business (process) systems and applications (CRM, ERP etc.)
	▪ Industrial IT systems (industrial and process automation etc.)
	▪ Embedded systems and control (diagnostics, monitoring etc.)
	▪ Multimedia systems and applications (video, simulations etc.)
	▪ Consumer and entertainment electronics (computer games etc.)
	▪ ICT training solutions (customer seminars, blended learning etc.)
	▪ ...

6. Cross work area / basic technical ICT skills

ICT commerce and business	ICT development and administration	ICT infrastructure and installation
▪ Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability) ▪ Describe the impact of innovative ICT developments (e.g. hardware, software, internet, services) ▪ Collaborate within customers quotations, consulting, contracting and project processing ▪ Self-responsible and project related support of customers and users ▪ Provide project data for the invoicing and accountancy	▪ Differentiate technologies of ICT systems and software design (e.g. machine-intimate, object-orientation, 4GL, 3GL) ▪ Describe ICT systems and software requirements (e.g. systems software, application software, communication software, specific applications, databases, security systems) ▪ Modify, configure and administrate basic software and web applications (e.g. algorithms, data structures, I/O parameters, e.g. VB, JavaScript, ABAP, HTML, XML) ▪ Adapt databases (e.g. mainly SQL in MS Access, SQL-Server, MySQL)	▪ Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems) ▪ Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB) ▪ Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN) ▪ Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL)

7. Career roadmap and future opportunities

Due to the rapid developments and changes in technologies, methods and process organisation, ICT practitioners in 'ICT support and systems service' must be aware of the need of lifelong learning (LLL) both, in terms of primary ICT service and technology subjects as well as overall aspects like ICT business process and market developments and trends. Based on some years work and project experience at this level next stage of a career in the work area 'ICT support and systems service' is described in the ICT skills profiles at skill level 4. This role, on the one hand, involves more self organised and responsible project management and commercial work and, on the other hand, the service and maintenance of more specific ICT systems, e.g. in the fields of ICT systems and network administration, mobile systems helpdesk and support, ICT application and user training, ICT troubleshooting and recovery.