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Radio Frequency Identification (RFID) Qualification in Logistics

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Abstract

The meaning and the employment of RFID increase within many domains of the daily life - from the raw material producer to the consumer. This technology will spread strongly in the coming years. Many current arguments against RFID are of a similar nature as former reservations against the PC and the Internet. Begun from high investment risks, only unsatisfactory possibilities to have an overview on the monetary benefits, up to world-wide non-uniform standards and the perhaps subjective generally aversion of some humans to innovations. But each technology only is good if it is used at the correct place for the correct purpose and in addition it requires the correct qualification of those who work thereby. From an engineering view there are many application possibilities, the business economists already work at present also in a multiplicity of projects at the realization of a comprehensive view of cost-effectiveness and economic efficiency. One of the last hurdles is still another gap in qualification. At present only few learning contents exist beyond the basics. The text compares the development of PC and/or Internet with RFID, derives from it analogies and presents a possible modular qualification concept for RFID. Such a concept is currently in development at the Institute for Logistics and Service Management (ild) at FOM University of Applied Sciences in Essen (Germany) in the research project LOGFOR.

Keywords: Radio Frequency Identification, RFID, Logistics Qualification, RFID Qualification, LOGFOR.

1. General Guidelines (12 points from here and in remainder of text)

The objectives of innovations in production and logistics are to raise the quality of production, make it faster and lower production costs. This can be achieved e.g. by providing more information and transparency in order to provide rational data base and therefore better choice in management decisions. One modern technology to foster this *transparency* is *radio frequency identification* (RFID). But the *question* has to be asked: 'Is what happened to PCs in the past now being repeated about RFID?' In 1974 the first microcomputer was created. The PC, a new technology, promised an increase of efficiency. With the implementation significant risks were accepted: Investment risks for hardware, for training courses and for software customization. In Europe 85% of the households in Denmark had a PC in the year 2006 [2] - PCs are accepted in all industrial countries despite of i.e. investment risks [21].

In comparing the development of PCs and RFID, analogies come to mind: A very fast technological development paired with application and training problems in the starting phase in business. RFID technology could potentially have huge effects towards an increase of transparency and therefore efficiency in the logistics sector – today engineering research is very sophisticated and provides for a lot of implementation examples. Nevertheless the two pre-implementation questions are: First establishing standards in order to reduce implementation costs across the supply chain and second a support tool for economic investment calculations is needed and worked upon [13, 14, 23]. After these questions still a qualification gap remains for logistics: For a broad implementation of RFID along the whole supply chain it requires a general course contents for employees along the supply chain. The suggested paper details a modular qualification concept for RFID, according to the new European Qualification Framework (EQF), and enabling even SME to prepare their personnel for a broad RFID application.

2. Development of PC/Internet and RFID

Possibly the development of RFID is comparable with older technologies, which are established in the meantime and we can learn from the past. As example the computer (the Internet) can be named here. Various analogies can be recognized. The PC was provided with capital outlays, need of qualification, technical hurdles and many reservations, nevertheless it cannot be excluded in the meantime from the workday no more.

2.1. History of PC and Internet

Since beginning of the 1970's computer construction units were so low-priced that enterprises began with the development of computers for private purposes. The first computer, which fulfilled these requirements, was "Xerox Alto" of the company Xerox PARC from the year 1973. The first computer, which had commercial success, aligned for home users, was still as kit the refugee "Altair 8800" from the year 1974. The first industrially manufactured PC was Apple II of the company Apple and introduced in the USA in April 1977. The 1990's is the decade of the Internet and the World Wide Web. At the beginning of the 21st century computers are pervasively and generally accepted both in vocational and private sectors. In accordance with Eurostat 2006 in Denmark 85% of the households disposed over a personnel computer. Under the European Union member countries behind it followed Sweden with 82% and the Netherlands with 80%. Germany was with 77% on fourth place, Austria with 67% at figure eight place and near the European Union average of 62% [2]. In the USA a computer is present in approximately 71% of all households [21]. After somewhat older numbers (2005) at least a PC was to be found in Switzerland in 77% of the households [24]. Also in the vocational surrounding field this technology could establish itself in the meantime: 51% of the persons employed in the European Union sit at least once per week in front of a computer [6|17|20]- In Germany 2007 61% of all employees worked with computer. The average value in the 27 European Union member states was in the year 2007 about 50% [22]. The figure below shows the portion of persons employed using a PC at least once per week in 2007.

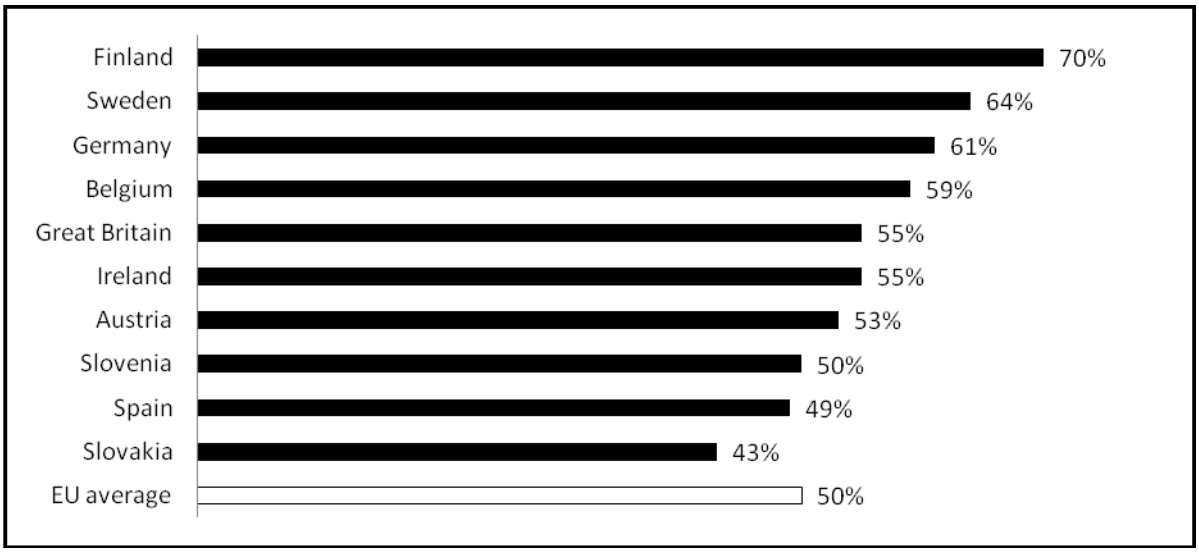


Figure 1. Vocational computer use [3].

The history of Internet can be seen similar: The ARPANet (Advanced Research Projects Agency Network) was originally developed on behalf the US Air Force starting from 1962 by a small group of researchers under the line of the Massachusetts Institute of Technology and the US Department of Defense. It was the forerunner of the today's Internet [11]. 1969

connected the ARPANET the four computer knots University of California Los Angeles, Stanford Research Institute, University of California Santa Barbara and University the of Utah. History can be divided in three phases. In the early phase starting from center of the 1960's the bases were put, which technology develops demonstrated and to the application ability. At the same time with the change from military to more academic research promotion end of the 70's began growth and the international propagation of the Internet.

date	no. of hosts	date	no. of hosts	date	no. of hosts
08/1981	213	12/1987	28,174	01/2007	433,193,199
05/1982	235	07/1989	130,000	07/2007	489,774,269
08/1983	562	10/1992	1,136,000	01/2008	541,677,360
10/1984	1,024	07/1996	12,881,000	07/2008	570,937,778
10/1985	1,961	01/2001	109,574,429	01/2009	625,226,456
02/1986	2,308	01/2004	233,101,481	07/2009	681,064,561

Table 1. Internet host count history [12].

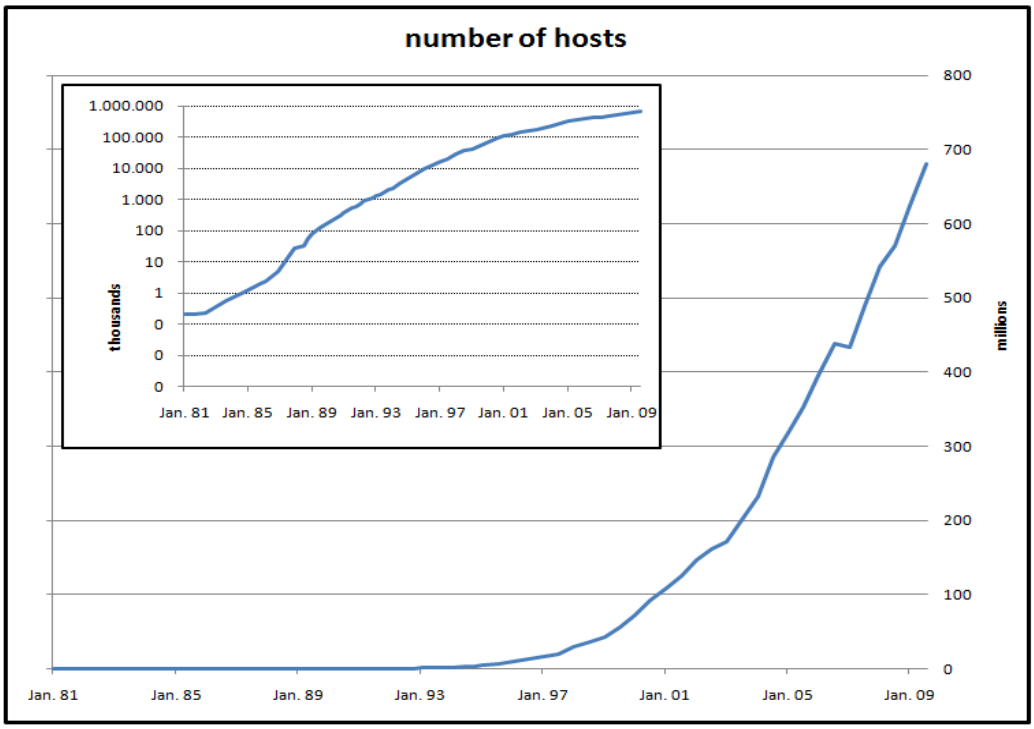


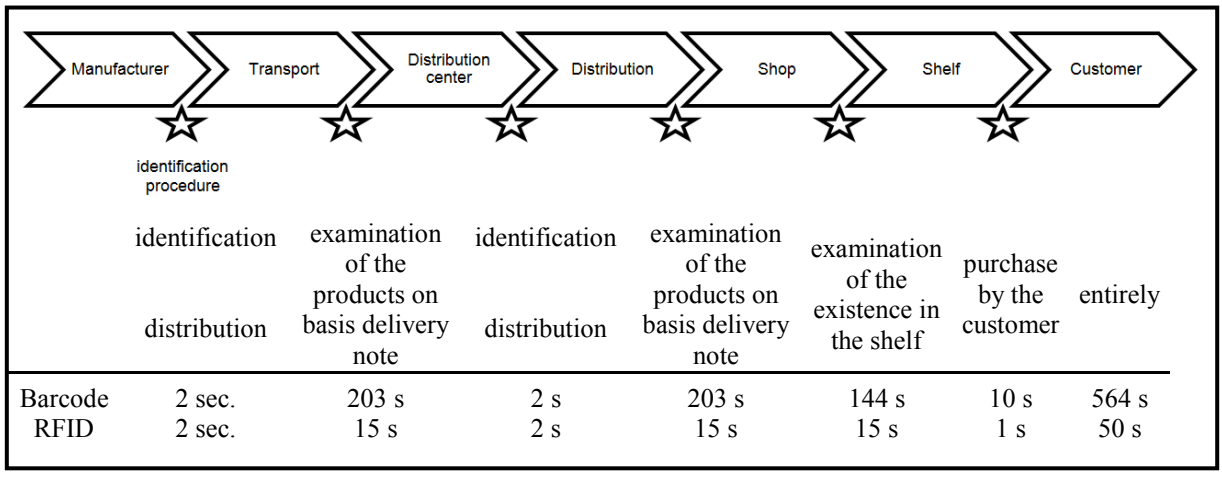
Figure 2. Growth of the Internet [12].

The two graphs in figure 2 describe the same circumstances, only with logarithmic scaling in the smaller picture. The German enterprise "Quelle", its insolvency and ultimately the bankruptcy liquidation of the dispatch dealer points out, what can happen, if someone takes a trend not seriously enough or oversleeps it. Many humans and reports in media call as reason for the failure that "Quelle" discovered much to late the Internet as new sales way (by the way "Quelle.de" was online from 1994 on and already even in this year everyone was able to order there online) [18]. Apparently the former German competitor "Otto" dealt differently with the topic Internet. The fact that it has issued the enterprise "Otto" so much better than "Quelle" attributes industry insiders particularly to one: Those Hamburgers (Hamburg is the headquarters of the company "Otto") would have by far better created the leap to the E-Commerce. "The mail-order operation is not dead", said Marco Atzberger from research

institute EHI. "The problems are house-made. The Internet was not strongly enough integrated and too much trust laid on the catalog“ [26].

2.2. Status of RFID

RFID is a phenomenon. Although still far away to be a comprehensive application of masses it has developed itself in economics and innovative political discussions within short time to a central hope for industry and trade. The importantness is occupied of tags used with the reference to the almost exploding rise: In the next 10 years the quantity increases up to 450times of the today's number and the total RFID-market is (seen from 2006) till 2016 on world-wide 20.5 billion Euro - nearly to increase tenfold [4]. A look at the engineering science reveals that the research in the field RFID can be regarded as far advanced. Technically viable applications already exist in theory in a large number. A second look at the practice today reveals that we can talk only rudimentary about the use of RFID in workday and this would change short-term. Among the reasons are often lacking and if present only particular or often inconsistent international standards. For some time, the EU participates in this challenge with the aim to smooth the way for of the technology RFID. For example the mandate M/436 in information and communications technologies in application with radio frequency identification and systems was published on December 8th 2008 and will provide the development of a complete framework for the development of future RFID standards [23]. If the question of standards was largely resolved, it is to be expected that one of the next hurdles at present is still the insufficient possibility of economy calculation. If we recognize RFID only as “successor of the barcode“, the comparison of costs and benefits between barcode and RFID will be probably positive in each case for the barcode. An economical problem represents at present the entire monetary view of all prospective possible potentials of RFID [1]. Nowadays the use can fail deviating from RFID still for every enterprise, even if they are active in the same industry. Up-to-date some research projects dedicate themselves to this “economy calculation field“, among other things RFID EPA [14] - for the development of a system of evaluation, specific economy statements for concrete applications of RFID employments independently of the industry supplies or in addition many other projects [15]. It can be assumed that, at least in medium term, both (necessary standards and calculability) will be established and a larger predictability on RFID in the sense of a view of economy will be possible. The following illustration shows exemplarily the possibilities of saving time along the entire supply chain by using RFID. Further possible benefits are not considered by for example the increase of transparency.



	identification distribution	examination of the products on basis delivery note	identification distribution	examination of the products on basis delivery note	examination of the existence in the shelf	purchase by the customer	entirely
Barcode	2 sec.	203 s	2 s	203 s	144 s	10 s	564 s
RFID	2 sec.	15 s	2 s	15 s	15 s	1 s	50 s

Figure 3. Cost reduction potential of RFID [7].

2.3. RFID Qualification Gap

For the moment yet not many education contents are visible. For a broad employment with RFID along the complete supply chain it requires available course contents - there is no difference between RFID and each other technology. For these technological developments in their meaning for the operational and strategic expirations contents have to be formulated and made ready for use for teaching. On basis of the won theoretical knowledge specific academic and occupation-accompanying training programs have to be established. Therefore there have to be an impulse towards the education and further education and likewise a thought on adapted bachelor and master courses to become fair to the technological progress and also to be fit and sufficiently qualified in those increasingly technology-based processes for the future. Otherwise the competitive ability could suffer (see "Quelle"). In addition necessary education contents should not only be developed, this content should be integrated into the existing vocational education and the studies at universities. A modular qualification concept, which follows the new national qualification frameworks and the European framework, could be helpful. More about an modular model can be read later in this text [1].

3. Case Study RFID Implementation

3.1. DB Schenker

Schenker Deutschland AG supports industry and trade with the global exchange of goods: in inland traffic, with world-wide air and sea freight as well as in contract logistics and the supply chain management. In the whole world gain over 59.000 coworkers at approximately 1,500 locations a gross income of approximately 14 billion Euro per year. As a specialist for land transports in Europe on road and rail, Schenker AG is interconnected with a close network of transport services in the main regions in over thirty European countries. The enterprise is equally specialized in world-wide solutions in air and sea freight as well as all associated logistic services. The integrated logistics centers at the interfaces of the global goods stream create the effective connection between all modes of transport and make a broad pallet possible at value added services [16]. Initial conditions: The enterprise has about 3500 swap bodies (a German container similarly to TEU) which are marked with human readable IDs. These were seized sporadically in the framework by site inspection. Thus however no tracking of the swap bodies is possible. The last users could not be determined exactly that had decrease and damage as consequence. Highlights over the swap body existence were missing, thus were possible no inventory optimization. An RFID installation at approximate 60 locations makes in the meantime transparency, when which swap body the address reached and/or left and in the future a further development of the system is intended inclusive GPS modules. This closed system with active read-only UHF transponders on the containers is since 2006 in the use. The introduction expenditure amounted to approx. 50 person days + external costs. Technical advantages are the long durability and that the system is robust enough for using it outdoor. The here addressed bad states could successfully be fought owing to RFID.

3.2. Short questionnaire about the use of RFID

The study „RFID: potentials for Germany - conditions and perspectives of applications to basis of the radio frequency identification on national and international markets "of the German Federal Ministry for economics and technology from the year 2007 resulted in the following statement: RFID in substantial industries of the German national economy becomes medium-term a cross section technology. Into that RFID-relevant categories of the producing trade, the trade and traffic as well as the private and public suppliers are affected in the year 2010 roughly 8% of the gross value creation by RFID, while in the comparison in the year 2004 only 0.5% were. That corresponds twenty times more, from approximately 3 billion Euro in 2004 on about 62 billion euro 2010 [4]. Some industrial establishments and express

companies were asked about the momentary status of RFID in their enterprise: Is RFID already in the use? Yes / as a pilot project / no. If it is in use: Special qualifications become offered to the employers? If there are course contents, are there trainings or only short briefings?

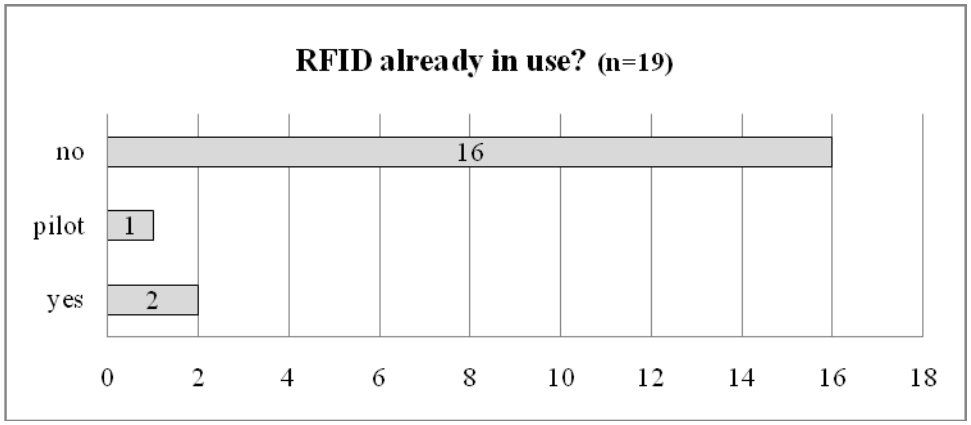


Figure 4. RFID short questionnaire.

With the question about instructional contents it always comes down to briefings. Which concerns the number of companies, which use RFID, the result is not surely representative due to the number of asked ones - in of this short questioning independent discussions with large enterprises set up world-wide resulted however likewise the picture, which lacks it special contents.

4. Qualification Concept RFID

4.1. Introduction of EQF/NQF

The European Qualifications Framework (EQF) is a new European tool that aims to increase the transparency of qualifications across Europe. The EU Member States are taking part in this voluntary scheme to link their national qualifications frames/levels (NQF) to the EQF and have committed themselves to do so by 2010. The European Commissioner for Education, Training, Culture and Youth, Ján Figel welcomed this development: "The EQF is a milestone in European education & training: for the first time, we will have a continent-wide framework for comparing people´s qualifications and certificates. No longer will employers need to say they don´t understand the level of qualifications presented by foreign job candidates, for example."

The EQF acts as a translation device to make national qualifications more readable across Europe, promoting workers and learners mobility between countries and facilitating their lifelong learning. The EQF will relate different countries national qualifications systems to a common European reference framework. Individuals and employers will be able to use the EQF to better understand and compare the qualifications levels of different countries and different education and training systems. The EQF was adopted by the European Parliament and Council on 23 April 2008 [19].

The objective of the EQF is to create a common reference framework which will help both individuals and employers to better understand and compare the different national qualifications systems and their levels, whether in general or higher education or vocational education and training. The EQF is based on eight reference levels which are described in terms of learning outcomes, i.e. what a learner knows, understands and is able to do, rather than focusing on the input side, such as length of study. The EQF is an ambitious and far-reaching instrument which has implications for education and training systems, the labour

market, industry and commerce and citizens. The EQF will make it easier to study or work in another European country by helping learners describe their competences to educational institutions or recruiters abroad. This transparency will help employers interpret the qualifications of applicants and so support labour market mobility in Europe. For example, currently an enterprise in Ireland may hesitate to recruit a job applicant from Hungary because it does not understand his or her qualifications. But once the EQF is fully implemented, the Hungarian candidate´s certificate would contain a reference to an EQF level, such as "EQF level 5". Since the relevant qualification authority in Ireland will have already provided such a reference to EQF levels in Ireland´s qualifications in the field concerned, the Irish employers will be able to understand the Hungarian´s qualification and compare it with Irish qualifications. The EQR stands in close relationship with the two systems of point of achievement on European level [8]:

a) ECTS (European Credit Transfer System) for the university education; ECTS is the furthest advanced projects of the European union to make different national education systems and education standards. Since for the entire education range within the European union a harmonization prohibition is valid, all relevant goals, initiatives and process are based on the voluntary and in certain degree also noncommittal co-operation of the member states. Regardless of this European legal definition the ECTS process contributed to one of the largest transformations of the German university landscape since 1945. The ECTS refers to training in the tertiary sector, thus to course of studies and degrees at universities [9].
b) ECVET (European Credit system for Vocational Education and Training) is a system of point of achievement for the vocational training, which is developed at present in the European framework. School learning achievements, vocational educations, in addition, individual vocational experiences and learning processes are to be illustrated in a uniform point system. The goal is, transparency, comparability, to make transferableness and mutual acknowledgment of vocational qualifications and authority possible on different levels in order to promote the mobility of employees in the European marketing area. In addition principles for examinations and a transfer system of point of achievement for different forms of the vocational education are to be developed [10].

The acquisition of vocational authority must be considered on all stages and over all ways. All levels of the EQF can be achieved by means of different educational channels. In addition the EQF must implement a consistent "outcome orientation". That means the way, on which a certain level stage is reached, does not matter. Comparability: The EQF defines a set of education levels, which are to cover the entire possible spectrum of education results. Each level is described by descriptors. The descriptors refer to knowledge, skills and competences (KSC). By knowledge thereby theory and/or fact knowledge are understood. Skills can be of cognitive nature (ability to solve problems, creative thinking etc.) or practically (e.g. handling instruments and materials).
Competences in the EQF-context are the two aspects: responsibility and autonomy. The description of the demanded KSC becomes more fastidious with each level. The EQF is arranged into eight stages. These eight stages reach from fundamental general knowledge and talents (level 1) up to the control of a highly specialized field of knowledge (level 8). The three highest levels correspond in the context of the European university area to the university conclusions, like bachelor, defined in the course of the Bologna-processes, master and doctor-degree. They can stand however also for particularly fastidious vocational qualifications.

Level	knowledge in the context of EQF, knowledge is described as theoretical and/or factual	skills in the context of EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) and practical	competence in the context of EQF, competence is described in terms of responsibility and autonomy
1	- basic general knowledge	- basic skills required to carry out simple tasks	- work or study under direct supervision in a structured context
2	- basic factual knowledge of a field of work or study	- basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve problems using simple rules and tools	- work or study under supervision with some autonomy
3	- knowledge of facts, principles, processes and general concepts, in a field of work or study	- a range of cognitive and practical skills required to accomplish tasks and to solve problems by selecting and applying basic methods, tools, materials and information	- take responsibility for completion of tasks in work or study - adapt own behavior to circumstances in solving problems
4	- factual and theoretical knowledge in broad contexts within a field of work or study	- a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	- exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change - supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities
5	- comprehensive, specialized, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	- a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	- exercise management and supervision in contexts of work or study activities where there is unpredictable change - review and develop performance of self and others
6	- advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	- advanced skills, demonstrating mastery and innovation, required to solve problems in a specialized field of work or study	- manage complex technical or professional activities or projects, taking responsibility for decision making in unpredictable work or study contexts - take responsibility for managing professional development of individuals and groups
7	- highly specialized knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research - critical awareness of knowledge issues in a field and the interface between different fields	- specialized problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields	- manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches - take responsibility for contributing to professional knowledge and practices and/or for reviewing the strategic performance of teams
8	- knowledge at the most advanced frontier of a field of work or study and the interface between fields	- the most advanced and specialized skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	- demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research

Table 2. The European Qualifications Framework for Lifelong Learning [25].

The EQF has the function of a meta-framework for national qualifications frameworks (NQF), which can provide the member states similar to the EQF: In Germany until 2010 a German qualifications framework is developed, whose stages will presumably refer to those of the EQF. In this way the EQF serves as 'tertium comparationis' (t.c.) between different NQF.

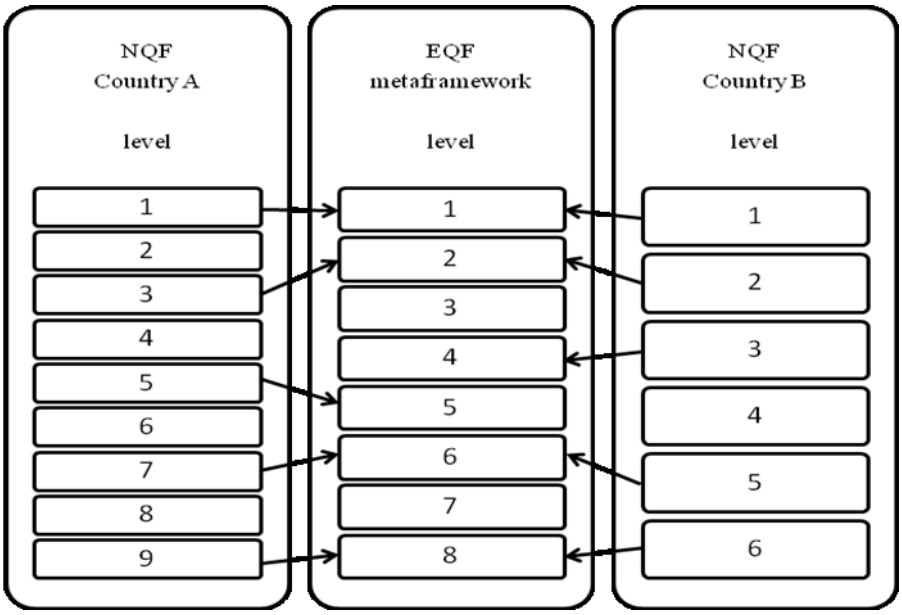


Figure 5. EQF as t.c. to different NQF[5].

The EQF is partly still controversially discussed in some member states of the European Union, among them also in Germany. Particularly over the kind and number of stages and the arrangement of the descriptors there are discussions. Of German view main problem of the EQF consists of the fact that the dual system of the professional training is disadvantaged during the intended classification on level 2, since the operational training sections find too little consideration. The EQF is to be supplemented by the European system of point of achievement for the vocational education (ECVET), which still in development.

4.2. Draft Qualification Structure and Content Example

The following table presents some examples for modular qualification contents for RFID. *Level 7* means to have competence for the treatment of new complex problem definitions as well as for the solely responsible control of processes in a scientific subject or in a strategically oriented vocational field of activity - this level is characterized by frequent and unforeseeable changes. - *Exemplary qualification contents:* placing „all" possibilities of view of monetary effects and potentials of RFID in the entire area of responsibility - keyword: investment calculation for a whole department. - *Goal:* the members of staff have new ideas or procedures-specialized technical and conceptual talents for the solution of also strategic problems. They can trade off also with incomplete information alternatives, develop new ideas or procedures, etc.

Level 3 means to have competence for the independent fulfillment of technical requirements in a still manageable but partially openly structured learning range or a vocational field of activity. - *Exemplary qualification contents:* to have knowledge around the problems with the a) batch capturing in practice (multiple recognized duplicates can lead to a crash of the data base) and b) technical hurdles in handling of combination of liquids/metals and RFID and their solutions. - *Goal:* the members of staff are able to recognized independently application-oriented technical errors after briefing.

Level 2 means to have means over the professional fulfillment of fundamental requirements in a straightforward and stable and structured learning or work area - the fulfillment of tasks takes place far going under guidance. - *Exemplary qualification contents:* fundamental fact knowledge about legal regulations to the data and health protection in connection with RFID - e.g. over the EN standard EN50357, where the limit values valid for RFID systems are fixed. - *Goal:* the members of staff know those their work area concerned legal regulations and are able to act law-conformal.

level	knowledge	commercial	technical	lawful
8	very good knowledge in a work or a learning field and at the interface between different domains	*these three divisions are exemplary*		
7	highly specialized knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research	Be able to do a complete investment calculation		
⋮				
3	knowledge of facts, principles, processes and general concepts, in a field of work or study		knowledge about: batch capturing, different materials, etc.	
2	basic factual knowledge of a field of work or study			Knowledge of the health and/or data protection regulations
1	basic general knowledge			

Table 3. Examples of modular education contents.

5. Conclusion

If the addressed topics (global uniform standards | possibility of economy calculation | education contents) are advanced, the possibilities rises that the theoretical knowledge around RFID would be successfully and profitably used in practice. The project LOGFOR dedicates itself in this listing of task in particular to the domain of the course contents for the first education in the vocational like high-school and university range as well as for the internal and external further training of the logistics coworkers, which can be made available. In addition among other things a modular qualification concept is developed about RFID, which leans against the EQF - RFID in logistics is a cross section topic, which is enough over different function and qualification stages in the shipping and forwarding agencies away.

Such a raster can help to find the correct education contents and training depth for the respective operational area. On strategic level the knowledge need is differently than on operational level, so no brick should remain unnoticed. RFID cannot develop its entire potential if only the managers know the “how to” and what would be theoretically possible with this technology, while the users have no notion from which how to work with RFID.

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