SAMI LUSTE AND KATERINA MEDKOVA (EDS.)

Lifelong Learning and Wastewater Treatment in the Baltic Sea Region

Capacity Development Opportunities Observed in the IWAMA Project (2016-2019)

State of the Art in the Wastewater Treatment Education in the Baltic Region

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Foreword

The training needs and the methods are changing with the general drivers of the water industry and the global mega-trends that include, for example, planetary boundaries, ageing population and digitalization. The change opens up new type of work tasks with the need for new competencies. However, digitalization, e-media and smart technology can also work as a tailor-made tool to develop and deliver information, such as professional networks to achieve the new automatically verified skills. This development requires a different level of knowledge to make good decisions and to take the best actions in particular situations. The background of the WWTP operators is highly heterogeneous, thus the education structures should be flexible. The flexibility between formal, informal and self-directed learning methods are needed to deliver not only the tailor-made technical knowledge but also the development of soft skills that are, for example, needed with the knowledge retention in WWTPs.

The Lifelong Learning and Wastewater Treatment in the Baltic Sea Region report presents a cross-section of the state of the art, needs and the future possibilities/difficulties regarding the Lifelong Learning Opportunities in the Baltic WWTPs. This can be reviewed against the State of the Art in the Wastewater Treatment Education in the Baltic Region report from the IWAMA partner countries. We hope that the lifelong learning report gives new perspectives for the future training opportunities and the state of art report continues the culture of sharing the existing information and practices that were strongly present during the capacity development in the IWAMA project (2016-2019).

The present documents have been produced in partly EU funded Interactive Water Management (IWAMA) project (2016-2019; Interreg Baltic Sea Region program).

01

Lifelong Learning and Wastewater Treatment in the Baltic Sea Region

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Introduction

Fresh water production will be one of the biggest global challenges in the future. There is a need to improve the knowledge base related to water in Europe at all levels, from operators to designers and from authorities to citizens (WssTP 2016). The present document contributes to the capacity development of wastewater treatment plant (WWTP) operators and it is targeted at the people responsible for training and the development of the training opportunities in the Baltic wastewater treatment sector. (In the present article, the term "operator" refers to both the management (higher education) and the process workers (vocational education) of the WWTPs. When referring to a specific group of people in the WWTPs, the group is described in more detail).

The lack of training, awareness and interactive international information sharing has been identified as one of the major limitations regarding the energy- and resource-efficient management of the wastewater processes in the Baltic Sea region (e.g. PRESTO project 2011-2014; PURE project 2007-2013). Training needs and methods are changing with the general drivers of the water sector and the global megatrends, such as climate change, digitalization and robotization, urbanization, planetary boundaries, aging population and the growing demand for food, water and energy (IPCC 2014; United Nations 2015; UNWWAP 2015). Moreover, the water industry sector is facing the challenges that arise from the ageing of the infrastructure. New technological solutions are needed because of the new tightening purification requirements, the introduction of sustainable practices, energy and resource efficiency, circular economy opportunities and new green technologies.

The development and maintenance of the water management services involve heavy investments that should be planned with appropriate resilience. For example, the effect of urbanization and flexible process planning on the possible new treatment needs should be taken into consideration. The challenges of water resources are societal challenges that will increase if the technology is not developing. The pressure towards investments and implementation of new technology and the drivers of the general global change increase the need for capacity development of the wastewater operators. There is an increasing number of methods for delivering knowhow and improving cooperation, but one also has to identify the knowledge needs and the motivation of the highly heterogeneous group of those using the information.

These current changes require upgrading of skills, many of which involve the use of computers and applications relating to business, databases, analyses, monitoring, simulations, GPS systems and GIS applications, emergency systems, etc. (UNESCO 2012). However, digitalization, social media and smart technology can also act as tailor-made tools to develop and deliver information, such as professional networks to achieve and verify new skills. This poses a challenge for appropriate designing and maintenance of the capacity development structures and facilities. At the general level, the future education and learning should be a non-stop experience and there is an increasing need for individualized learning methods and contents due to the specific backgrounds and ages of the employees. Thus, flexibility in learning methods, as well as multiple, cross-cultural, multinational experiences, are needed.

To cope with the ongoing sectoral and global challenges, WWTPs need knowledge to make strategic decisions. It is vital to recognize what data and knowledge is needed for various activities and process steps, and where the

tacit knowledge exists. One of the starting points would be to evaluate the core competences needed for particular activities and the "training gap" (e.g. Is there a need for specialized education and recruitments or supplementary education of current employees?). Sandelin (2017) suggests that knowledge retention is tackled using a knowledge management and development strategy. This is also a more systematic way to manage the continuity of training and the need for training.

The present "Lifelong Learning and Wastewater Treatment in the Baltic Sea Region" report has been produced as one of the capacity development outcomes of the Interactive water management (IWAMA) project (2016-2019; EU co-funded by the Interreg Baltic Sea Region program). The goal of the activity was to promote lifelong learning in the Baltic wastewater treatment sector. The present document is a cross-section of the state of the art, needs and future possibilities regarding lifelong learning opportunities in the Baltic Sea region. The report focuses on opening the term "lifelong learning" as a multilevel enabler to update and maintain the skills of WWTP operators to meet the ongoing challenges (Chapters 2 and 3). The report reflects on the general development and future aspects in the fields of education and wastewater treatment (Chapters 3 and 4) and discusses the results of the capacity development surveys and discussions during the IWAMA project (Chapter 4).

The Lifelong Learning and Wastewater Treatment in the Baltic Sea Region was written by *Sami Luste (Editor) and Katerina Medkova (Editor), Faculty of Technology, Lahti University of Applied Sciences; Paula Lindroos and Mona Riska, Centre for Lifelong Learning, Åbo Akademi University; and Sirpa Sandelin, Faculty of Technology and Maritime Management, Satakunta University of Applied Sciences. The information for Chapter 4 has been collected from the Baltic area WWTPs with the help of the Union of the Baltic Cities Sustainable Cities Commission (Finland), DWA (Germany), EVEL (Estonia), ECAT-Lithuania, ECAT-Kaliningrad and Linnaeus University (Sweden).*

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LIFELONG LEARNING AND WASTEWATER TREATMENT IN THE BALTIC SEA REGION

Abbreviations

CVET; Continuous vocational education and training

E-; electronic, electronic form

EIT; European Institute of Innovation and Technology

EUA; European University Association

EurEau; European Federation of National Associations of Water Services

EWA; European Water Association

EQF; European Qualification Framework

FIWA; Finnish Water Utilities Association (former name Finnish Water Works Association)

HUB; Web network, a node with a huge number of links

ICT; Information and Communication Technology

IOT; Internet of Things; network of devices and connectivity which allows things to connect, interact and exchange data

IVET; Initial vocational education and training

IWA; International Water Association

IWAMA; Interactive Water Management

LLL; Lifelong learning; Ongoing, voluntary, and self-motivated pursuit of knowledge

NKBC; National knowledge based communities formed during the IWAMA project

NQF; National Qualification Framework

PE; Population Equivalent

Tacit (knowledge); Such knowledge which is embedded in the organisation, its people and processes, and which cannot be easily codified and shared

TVET; Technical and Vocational Education and Training

UAS; Universit of Applied Sciences

VET; Vocational education and training

WWTP; Wastewater treatment plant

WWT; Wastewater treatment

1. The Current Development and Needs of the Wastewater Treatment Sector

The World Economic Forum's (2016) dictum divided the main drivers of change in industry to demographic and socio-economic drivers (e.g. climate change, urbanization, planetary boundaries, ageing population) and technological drivers (e.g. automation, biotechnology, IoT, big data, new technologies). In addition, the wastewater management sector is facing its own specific challenges arising from the ageing infrastructure, the availability of workforce and the new technological solutions to meet the new tightening purification requirements as well as the needs rising from the circular economy requirements. These new solutions enhance the resource efficiency (energy efficiency, reuse of sludge/ nutrients) and integrate the industry more tightly to circular economy societies with the tightening environmental legislation and emission limits.

According to the European Union of National Associations of Water Suppliers and Waste Water Services (EurEau 2017), the main challenges for the water sector that will need more thorough research and knowledge in the next 10 years are:

- Protecting vulnerable resource
- Fostering sustainable economic growth and creating jobs
- The value of water in the circular economy
- Source-control approach for micropollutants
- Setting the right price for water services
- Growing impact of climate change on water
- Resource efficiency in the water sector
- Managing long-term assets in a fast changing environment
- Increasing the public understanding of the water sector

According to the previous Baltic Sea region projects, PRESTO, 2011-2014 and PURE, 2007-2013, the lack of training, awareness and interactive international information sharing are the major "bottlenecks" regarding the energy and resource-efficient management of the wastewater processes. According to the results from the previous Baltic projects, the skill requirements in the WWTPs of the Baltic Sea region are related to the operation of wastewater treatment and electrical facilities, mechanical aspects, as well as the additional requirements for WWTP maintenance. Regular training should include updates regarding current processes, capacity development for the future requirements and knowledge of upcoming technologies (Rettig & Barjenbruch 2017). It has been outlined that the required competences are changing from knowledge management to knowledge productivity, from controlling to flexible sharing, from programming to reality, and from teaching to learning (Savickas 2017). The concept of lifelong learning could be described as a "matrix tool" that is contributing to these issues.

The operators of water supply and wastewater facilities employ approximately 80 percent of the workers in the water industry. This technical operating personnel is trained very differently and are very differently further qualified. Moreover, the sector often suffers from a shortage of employees, because the attractiveness is not good (UNESCO 2012). The staff working at the WWTPs are in many cases elderly, while on the other hand, the new employees are usually short-term. This increases the value of the employee and emphasizes

the need for individualized learning and for flexibility regarding not only the training processes but also the learning methods. Moreover, in the cases where the number of retiring employees is high, there is a risk that "silent knowledge" will be lost. Part of this knowledge is critical to ensure the safe maintenance of the processes and regional water facilities (Sandelin 2017). The new technological developments, for example, towards smarter water systems, the collection, analysis and transmission of data, the Internet of Things and automation technology, are likely to create a need for intensive training programs.

Wastewater can be a cost-efficient and sustainable source of energy, and a source of different quality water products, nutrients and other useful by-products. It is one of the core sectors in circular economy and provides possibilities for industrial symbiosis connecting the hybrid part of the processes and material/ energy loops to gain economical and environmental benefits. The potential benefits of extracting such resources from wastewater go well beyond human and environmental health, with implications on food and energy security as well as climate change mitigation. These have already become part of the WWTPs' management of process planning and maintenance (United Nations 2017). On the other hand, global trends forecast a 55% worldwide growth in water use by 2050, due to growing demands from manufacturing, thermal electricity generation, agriculture and domestic use (Weerdmeester et al. 2017). This is also increasing the pressure for an efficient and cost-effective management of wastewater, as well as for recycling. Already, WWTPs have started to produce end products that have different qualities for different purposes of different end users. In practice, this would mean that, for example, water utilized by the industry does not have to fulfill the same requirement as, for example, drinking water.

UNESCO's report (2012) about the "Skills Challenges in the Wastewater Industry" reveals that there are only a few direct occupational matches for workers in traditional industries with declining employment. The workforce development system/institutions in society must have a more detailed understanding of occupational skills. This is especially true in the water sector, which is facing challenges that require upgrading significant skills (UNESCO, 2012). This is further complicated by the long-term situation in various societies where working in the water and wastewater industry receives minimal appreciation. The need for the knowhow can be expected to stay high in the WWT sector also in to the near future. This is not only due to the inner drivers of the sector, but also to the changes in society and the role of the water services in it. The competences needed in the WWTPs are also rising from the ongoing upper-level change. This general change is rising from the global drivers (e.g. automation, ageing workforce, need for cross-cultural multinational experiences) and affecting not only the actual content of work, but also the ability to receive the education generating the required new skills. The top 10 skills for 2020 listed by the World Economic Forum (2016) are:

- Complex problem solving
- Critical thinking
- Creativity
- People management
- Coordinating with others
- Emotional intelligence
- Judgement and decision making
- Service orientation
- Negotiation
- Cognitive Flexibility

At the moment, the change in the work life is faster than we may notice. According to the World Economic Forum survey (2016), on average 35% of core competences will change by the year 2020. In the infrastructure sector, where the wastewater management belongs, the corresponding value is 42%. At the general level, it is outlined that the competences (or their focuses) are changing from knowledge management to knowledge productivity, from controlling to sharing and flexibility (regarding content and delivery), from programming to reality and from teaching to learning (Savickas 2017). More attention should be paid to the methods how learning could be stimulated as well as the possibilities to learn in our daily interactions (Krumboltz 2009; Fischer 2000). The ongoing changes require flexible structures and interactive cooperation by the various actors so that predictability can be maintained, to ensure that the skills meet the needs of the community.

Wastewater management benefits from the automation and optimization that is enabled by the Internet of Things (IoT; Meola 2016). This is the case when IoT devices are integrated into all forms of energy consuming devices (switches, power outlets, compressors, bulbs, monitors, etc.). Thus, it is estimated that the integration of sensing and actuation systems, connected to the Internet, is likely to optimize the process of energy consumption as a whole (Demiris & Hensel 2008). Already, robots and digitalization in WWTPs have shown potential to make the wastewater treatment more cost-effective and efficient, compared to previous situations. For example in the Aarhus WWTP, in Denmark, drone technology is used for inspection of wastewater basins and sewage systems, as well as robotics for the maintenance of outdoor areas. Also, in the Viikinmäki WWTP, in Finland, a multivariable predictive control system is used for the optimization of WWTP operations (Mulas et al. 2015).

Working at the WWTPs requires an extensive multidisciplinary knowhow regarding the technical observations and management of the processes. The information and knowledge are shared by working side by side, through informal discussions and meetings, stories, and peer learning from the more experienced, by audiovisual means. However, information is not necessarily passing in the desired way. This may be due to the lack of time, job prioritization, organizational structures, information sharing culture and unwillingness to share information, but there may also be a gap between older and younger generations (Sandelin 2017). In the near future, the maintenance of WWTPs, as well as collection and transportation of the wastewater, could be performed by robots. This may reduce the need of physical work, such as cleaning, but will increase remote control and remote monitoring tasks in WWTPs. The ongoing digitalization and robotization have been estimated to open up new types of holistic work tasks with the need for new hybrid competences (Linturi & Kuusi 2018).

2. Lifelong Learning and Capacity Development – The Adaptation

Defined broadly, lifelong learning is learning from preschool to retirement age, including formal, non-formal and informal learning, and it is a lifelong and lifewide concept (EU Council Resolution 2002/C 163/01). From the working life perspective, lifelong learning is today seen as a process in which work and professional development are increasingly intertwined. Consequently, learning is most likely going to be a meta-skill in future working life and, at the same time, the working places are more and more developing into learning places. This situation is seen as essential in the development of a creative and knowledge-intensive economy and society, in which learning should be a continuous experience. For a successful implementation, there is an increasing need to individualize learning methods and contents, depending on the age as well as the educational and cultural background of the learner.

In which directions will work and working life change in the future? Which jobs will disappear and which will increase? Which new professions will enter the scene? How will labor markets, working conditions and employment relationships respond? Which competences are needed to master the changes? How do the changes influence learning?

Megatrends. A variety of factors influences the changes. Too often, debates about the future of work mainly focus on digitalization and technology, while other factors tend to be ignored or underscored, as described in the report The Nordic Future of Work by Dølvik & Steen (2018). There is a growing consensus regarding the main drivers expected to shape future developments, such as the above mentioned by the WEF 2016: globalization, technology, demography and climate change. These were mentioned again in the report by the ILO Global Commission on the future of work (ILO 2017). Furthermore, the potentially divisive effects of digitalization and artificial intelligence are assumed to be reinforced by the other megatrends so that rising inequality is singled out as an independent megatrend in itself (WEF 2014).

Skills provide the new infrastructure. The impact of the megatrends on work and working life is neither unidirectional nor independent of human agency. The opportunities and threats they pose to jobs and working conditions depend on several factors, such as the market conditions, the responses of social actors, and the way they are filtered across industries and groups of employees (Dølvik & Steen 2018). The ways to tackle these changes include the promotion of the human capital, innovation, responsibility and entrepreneurship. The organizations' capacity to master change will depend on commitment and capacity for innovation.

The lifelong learning policies serve as one set of tools in this new situation. Increased human capital and innovation capacity were addressed already in 2006, in the recommendations of the EU's Framework of key competences for lifelong learning (2006/962/EC). Following the changes in economy, society and technological progress after 2006, these recommendations were in need of updating. The renewed recommendations came into force in May 2018 (Council recommendation 2018/C 189/01). Among the changes, one remarkable addition is the reference to the UN Sustainable Development Goals, adopted in 2015, "to mainstream the ambitions of the UN SDGs, in particular

within the SDG 4.7, into education, training and learning, including by fostering the acquisition of knowledge about limiting the multifaceted nature of climate change and using natural resources in a sustainable way".

In addition to the need of a good basic level of skills, knowledge and competences and a continued upgrading of them, the creation of new knowledge has increasingly become an issue at policy level. Below are two examples of lifelong learning and adult learning in the policy discussions. The first example is a report produced for the Nordic Council for Ministers, Working Life in the Nordic Region (Nielson 2016), saying that much is already being done to raise the competence of adults, but that more of the same is not enough – something else is needed within education and training. The challenge is not to work harder, but to work smarter. The combination of the technological development and a longer work life also increases the need for new ways in adult learning. The author also suggests that it would be a visionary decision if the Nordic countries, jointly and with the involvement of the social partners, developed a model for putting into practice the principle that adult education and in-service training will be a mandatory element of working life.

The second example comes from the State of the Union Report 2018 - Our Destiny in Our Hands, published in autumn 2018. One way of taking forward the transformation processes, it says, is that skills are the infrastructure of the future. This current situation in the work life leads to an increased need for the individual to remain at the cutting edge of his/her skills, and up/re-skilling and retraining will increasingly become the norm. Very concretely, this situation is described in the German Guidelines for Skill Development in the Water Sector, stating that no functioning infrastructure can endure without skilled workers, or "no investment without qualifications". This notion is also quite in line with the outcomes from the previously mentioned PURE and PRESTO projects. One aspect, which also needs to be considered, is the tendency for skilled workers to complete training that moves them up the skills hierarchy.

The situation is challenging, as there is often a gap between slow-moving education systems and the shifting demands of employers. How has education changed in relation to the challenges? Without exaggeration, one can say that the educational landscape has drastically changed during the last decade, with a paradigm shift from input-based to output-based education, with the new focus on competences and learning outcomes. At the same time, there was a big change introduced through the implementation of distance learning. These huge changes mean that institutions need new staff profiles and new pathways to meet the needs of the learners, employers and communities.

2.1 Recent Trends Affecting Working Life and Adult Education

Today's working life is affected by rapid shifts due to technological, environmental and global changes. In a couple of years, many jobs will have disappeared due to increased digitalization and use of artificial intelligence, and new jobs will have emerged instead. The McKinsey Global Institute is forecasting that about half of all work activities globally have the technical potential to be automated by adapting new technologies, but the proportion of work actually displaced by 2030 is likely to be lower, because of technical, economic, and social factors that affect adoption. The proportion varies widely across countries, with advanced economies more affected by automation than developing ones, reflecting higher wage rates and thus economic incentives to automate (Manyika et al. 2017).

The digitalization of Europe's society and economy is bringing about profound changes in working conditions and traditional job dynamics. Different sets of skills are urgently required to avoid further skills gaps and mismatches in the labour market (CEPIS 2019). At the same time, it is alarming that half of the workforce in the EU is lacking basic digital skills. To solve the competence mismatch the employees need to develop their own competences to be able to produce additional value for the employers. The technological advances in the workplaces are associated with a higher level of work intensity and are in the worst case affecting the health and wellbeing of the employees negatively (ILO 2017). Table 1 below presents the use of ICT at work, answers by persons aged 25-64 years (OECD 2018).

Table 1. Frequency of use of ICT at work by educational attainment

	Daily use of e-mail at work			Daily use of Internet at work			Daily use of word processors at work		
	Below upper secondary education	Upper secondary and post-secondary non-tertiary education	Tertiary education	Below upper secondary education	Upper secondary and post-secondary non-tertiary education	Tertiary education	Below upper secondary education	Upper secondary and post-secondary non-tertiary education	Tertiary education
Estonia	44	58	85	30	46	68	15	23	45
Finland	53	59	86	25	29	54	14	14	39
Germany	39	61	80	18	36	52	23	41	57
Lithuania	-	49	84	39	46	76	-	27	57
Poland	29	48	76	18	41	65	-	26	54
Sweden	52	69	89	25	36	53	10	27	46

The Institute for the Future has listed some important working life skills for the 2020s. They are versatility, ability to evaluate the meaning and impact of topics, ability to act within different cultures, media and data literacy, and ability to cope with information overflow (Davies et al. 2011). Moreover, human curiosity, versatile ability of problem-solving, emotional intelligence, social flexibility, artistic talent and ability to learn are examples of human strengths, which will not be replaced easily by artificial intelligence in a near future (Andersson 2017). However, the majority of the current working force need continuing education and staff training in order to meet the requirements of the future working life. The basic requirement of the education is to provide the workforce with general competences, which provide an ability to react in flexible ways to upcoming changes in working life. Changes in working environments put emphasis on the ability of the employees to manage their own educational and professional career. The problem of today is that there are not enough opportunities for adults to participate in continuing education (OKM 2014; OKM 2017; OKM 2018). In addition, the opportunities to participate in continuing education are not equal between different categories of adult learners. Staff training is offered more often to employees in higher positions (gold and white collar) than to employees in lower positions (blue collar). Table 2 below presents the share of population by educational attainment, persons aged 25-64 years (OECD 2018).

Table 2. Educational attainment of the population

	Below upper secondary education	Upper secondary and post-secondary non-tertiary education	Tertiary education
Estonia	11,3	49,0	39,7
Finland	11,9	43,8	44,3
Germany	13,5	57,9	28,6
Lithuania	7,2	52,6	40,3
Poland	7,9	62,2	29,9
Sweden	17,0	41,1	41,9

During 2018, we have seen different initiatives from the Finnish government to broaden up the continuing education offered, to include new flexible ways of arranging continuing education in cooperation with the working life. The Finnish Ministry of Education and Culture has launched several legislation and funding proposals in order to develop new ways of providing continuing education to adult learners in working life (OKM 2018). The big question is who should pay for the necessary continuing education and staff training? The state, the employers or the employees themselves and in which ratio? We are talking about billions of euros spent on investments in new knowledge in society each year. The state or the municipalities are paying most of the costs of the general education and basic training, whereas the employers are paying for the biggest part of the staff training, i.e. for employees gaining new specific skills. In the future, a bigger part of the new knowledge, skills and competences needed will be obtained while working in the workplaces. This is hopefully the future target of the employers, because the opposite is not desirable, meaning older employees being fired because of lacking competences and new staff being hired instead. Nevertheless, the formal educational system also needs to support the development of new competences by supporting continuing education and lifelong learning.

2.2 Motivators and Barriers to Participate in Adult Education

Persons with low educational attainment and older persons are less motivated to participate in adult learning activities. These persons have low motivation for learning and training, while simultaneously they have deep learning and development needs. It is a fact that the majority of the participants in adult education have attained a higher educational degree. Table 3 below presents participation in formal and/or non-formal education, answers by persons aged 25-64 years (OECD 2018).

Table 3. Participation in adult education by educational attainment (% of employees/education level)

	Below upper secondary education	Upper secondary and post-secondary non-tertiary education	Tertiary education
Estonia	28	43	70
Finland	34	62	81
Germany	22	47	71
Lithuania	10	22	65
Poland	14	24	67
Sweden	43	64	81

There are also differences in the participation by gender; men are participating more often in staff training meanwhile women are participating in non-compulsory education. A typical adult learner is a woman of the age 30-54 years, who is participating in adult learning in order to gain a new profession, to ensure employability in the future, or to enhance her own career possibilities (OKM 2008). Table 4 below presents participation in formal and/or non-formal adult education, answers by persons aged 25-64 years (OECD 2018).

Table 4. Participation in adult education by gender (% of employees/sex)

	Total	Women	Men
Estonia	53	57	48
Finland	66	70	63
Germany	53	49	56
Lithuania	34	36	30
Poland	35	36	35
Sweden	66	68	64

A big challenge for the adult education providers is to be able to provide the working life with customer-oriented learning activities instead of supplier-based learning activities. The goal should be to provide adult learners with learning activities that correspond to individual needs and to reach out to persons who are not traditionally attracted by adult education. There is always a need for better recognition of prior learning and expansion of the services of lifelong guidance along with lifelong learning practices to help less motivated adult

learners to be successful in their studies (OKM 2017; OKM 2018).

According to OECD figures (OECD 2018), the most significant reason for not participating in adult learning is the adult learners' lack of time. The employees are too busy working and they are not given a chance to participate in adult education. The second most important barrier is money; it is too expensive to participate in adult education in many countries in the Baltic Sea region. The third barrier for participating is childcare problems and family responsibilities. In addition, the learning activities can be offered at an inconvenient time or place. The last barrier is the lack of the employer's support for participation in adult education. There are some differences between the countries in the Baltic Sea region. For example, the course fees are a barrier in many countries, varying depending on available national subsidies for adult education. Most of the barriers are due to political, social and cultural circumstances and depend on national policies, and therefore they are not easily solved. Table 5 below presents the reasons preventing participation in formal and/or non-formal education, answers by persons aged 25-64 years (OECD 2018).

Table 5. Barriers to participation in adult education (% of barriers for no participation)

	Did not have prerequisites	Too expensive	Lack of support by employer	Too busy at work	The course or programme was offered at inconvenient time or place	Childcare or family responsibilities	Something unexpected prevented from taking education or training	Other
Estonia	4	19	7	29	15	10	3	13
Finland	3	7	10	29	21	9	3	18
Germany	1	9	10	33	14	15	3	18
Lithuania	2	24	8	31	13	9	4	8
Poland	5	20	9	16	13	14	7	16
Sweden	4	12	8	26	11	13	4	21

Although adult learners in general are independent and self-controlled and take responsibility for their own learning, all adult learning activities should be followed up by lifelong guidance and counselling activities to encourage autonomous learning (OKM 2018).

The strength of adult learners is commonly their strong motivation for learning. An adult learner usually knows why she or he is studying and has a clear goal for the studies: to gain new knowledge and skills for professional use or for a new job. There are many potential challenges facing adult learners - financial problems, work conflicts, family situations, childcare and health problems. Adult learners can also feel anxious about studying, for example, about not being able to learn or remember new things, and they can have old habits and routines preventing personal development. Therefore, it is important to provide adult learners with lifelong guidance services besides new learning opportunities.

Common barriers to learning:

Social and cultural barriers: peer pressure and family background

Practical and personal barriers: transport, time, disability, caring responsibilities, childcare, finance, costs, age, language and lack of access to information

Emotional barriers: lack of self-esteem or confidence due to low skills levels; negative personal experience of learning; previously undetected or unaddressed learning disabilities; social problems such as unemployment, abuse or bullying

Workplace barriers: time off, access, discrimination, unsupportive managers, shift work, isolation

(TUC 2019)

3. The Current Situation and Development Needs in Teaching Regarding Lifelong Learning

3.1. Aspects of Teaching and Learning Today

Lifelong learning and adult education are expressions of the same practice, in which adults are engaged in systematic and sustained learning activities in order to gain new forms of knowledge, skills, attitudes, or values. Another definition includes all learning activities happening throughout life, with the aim of improving knowledge, skills and competences within a personal, civic, social and/or employment-related perspective. The legislation and the funding of the adult education can also be the basis for categorizing the practice into public workforce training, non-compulsory adult education and staff training provided by employers (OKM 2008).

In practice, continuing and further education refer to adult education. They refer to recognized forms of post-secondary learning activities like degree credit courses for non-traditional students, non-degree career training, workforce training, and formal personal enrichment courses both on campus and online.

Who is an adult learner? There are various ways of defining the term. Most often, an adult learner is defined by age or by professional or educational history, i.e. by previous working experience, educational attainment or degrees earned. For example, the OECD defines an adult learner by age, thus including persons of age 25-64 years in statistical reports concerning adult education (OECD 2018). The Finnish Ministry of Education and Culture has defined adult education as all kinds of education organized, planned and provided specifically for adults and, in addition, all persons of any age can take part in adult education (OKM 2009).

Learning itself is changing. It has increasingly become a process of knowledge generation and knowledge construction based on theoretical frameworks for critical selection and evaluation of information and knowledge. At the same time, education is looking for a new positioning, not only in the development of new provisions but also in finding new teaching practices and in how to deal with the overwhelming stream of information. For the individual as an actor in society, knowledge, skills and attitudes are intertwined in competences. The Figure below shows a visualization of this interrelationship, produced by the OECD (Figure 1). The OECD Learning Framework 2030 aims at challenging stakeholders to think ahead and foster innovative learning environments that focus on inclusive learner growth, and to facilitate changes in education systems.

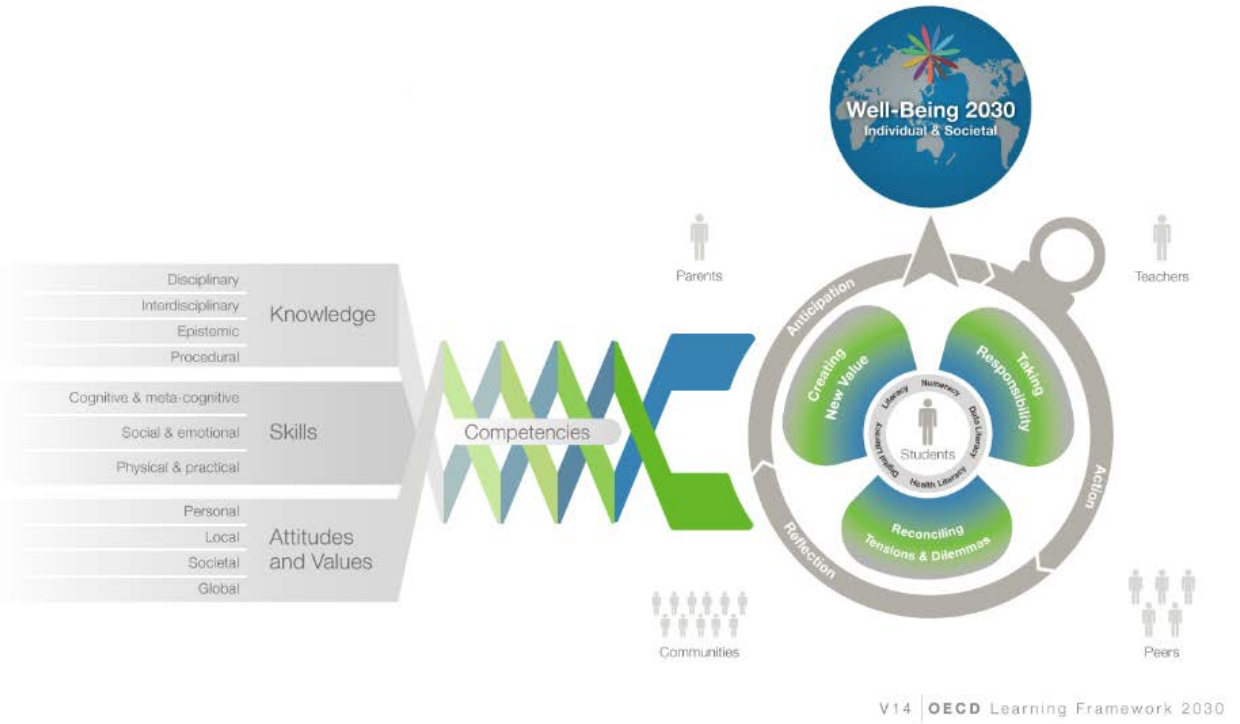


Figure 1. The Learning Framework 2030 offers a vision and some underpinning principles for the future of education systems (OECD 2018)

Competence means a proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and for professional and personal development, whereas learning outcomes are relevant in terms of the practicalities of curriculum design and assessment. In order to facilitate the transferability and comparability of competences, and the mobility of students and workforce, The European Qualifications Framework (EQF) was developed as a lifelong learning framework for all levels of education. Based on the framework, work is being done throughout Europe to study how staff within the water sector can demonstrate their competences.

Continuous learning in the workplace. In adult education, as well as in professional development, the recognition of prior learning and the approach to the provision of lifelong learning have become important aspects. As learning is increasingly becoming an integral part of the work, the methods to integrate learning to the work are reflected in the chosen methods. One main trend is to support methods of work-based learning (in the triangle learner-employer-education provider) and authentic learning situations in which learners are active partners and not education consumers.

Innovation, a term frequently used in current policies, together with the capacity to foster innovation, are seen as success factors at all levels, from the individual to society. Be it in the areas of lifelong learning, protection of new categories of workers, prevention of rising inequality, or the preparations needed to become fit for the future of work, all will entail engagement in innovation. Furthermore, as innovation is considered part of everybody's work, the responsibility to organize the work enables continuous learning and improvement.

The pedagogical and methodological directions. In relation to adult education and learning, the meaning of motivation for learning is among the most interesting questions. Adult learners can draw on previously learned skills and capacities when acquiring new knowledge. Curiosity-driven learning approaches are main drivers when learning is an active process of filtering, selecting, organizing and integrating information based upon prior knowledge. There are four key assumptions for adult learning: 1) they are self-directed

learners, 2) previous experiences are important resources for the learning process, 3) the motivation to learn is oriented towards applicability of the learning and problem-centered, and 4) motivation is intrinsic.

Social and cognitive constructivism maintains that learning is a process of constructing meaning, it is how people make sense of their experience. It is widely used in today's view of learning, which focuses on the learner's own process of actively constructing models of learning through interaction with the surrounding environment (Amineh & Asl 2015). Learning is seen as a socially-situated phenomenon, best understood as a feature of the individual's ongoing participation in a social context. Constructivism states that learning is an active, contextual process of constructing knowledge, and new information is linked to prior knowledge.

The learning environment: Adult learning is highly situational, which means that in some situations a face-to-face approach and practicing suits best, whereas e-learning could offer the best option in other situations. The cognitive theory of multimedia learning states that a person learns more deeply from words and pictures than from words alone. In order to design effective visualization for meaningful learning to take place, the main principle is to provide the learner with coherent verbal and pictorial information. There is a wide range of learning objects that can support learning: 1) on-line communities where learners can build 3D interactive environments, 2) collaborative construction environments, 3) augmented reality and mixed reality kits, and 4) environments for producing animated stories, simulations, interactive objects and video games (Vaz Rebelo 2018).

Situated learning and learning by doing are related to the phenomenon that whenever persons are engaged in social practice, learning will inevitably take place. Situated models of learning suggest that in adult learning, we need to understand the sorts of practice that learners want or need to participate in, and to offer opportunities that enable learning through these practices. Problem-based learning is a method in which complex real-world problems are used to promote learning of concepts and principles. It can promote critical thinking skills and also problem-solving and communication skills when based on group working (Vaz Rebelo 2018).

In these new learning environments and with the new learning methods, the role of the teacher is becoming radically different from the traditional one. The teacher becomes more of a coach who goes behind the group of learners, instead of standing in front of the group as in the traditional educational setting. The new role will also include more counselling and technical support (in e-learning), which implies that there is a need to involve more and different educational staff, with different profiles. It will also be important to provide the teachers and associated educational staff with optimal tools to meet the challenges of their future work life. Furthermore, there are great challenges to update the training materials, the training methods and training institutions. Thus, a functional and evolving Technical and Vocational Education and Training (TVET) strategy is in a critical role for providing youth and adults with the required skills and competences, which rise from the demands of the labour markets and have enough resilience for the future (UNESCO 2012).

Depending on the level of qualification, the technical operating personnel of a wastewater treatment plant is composed of: unskilled and semi-skilled workers; skilled workers, such as wastewater engineering technicians, and/or other skilled workers (electricians, industrial electronics technicians or similar); and engineers, such as civil engineers specialized in hydraulic design, or environmental engineers (Röstel 2015). All levels of qualifications need a feasible education that identifies the needs of the sector.

3.2 Current Education Typology

According to Aceto et al. (2010), the widely used pedagogical models of online communities today are challenged by a new type of learning and teaching that could be transferred to education and training systems to support lifelong learning. Knowledge shared in e-form or over the internet is substantially different from what we have used in traditional education and training environments. In the new type of knowledge sharing, a big role is played by the interaction among peers, which leads to informal knowledge sharing and knowledge creation. It also means developing of new skills and using existing skills in a different way. The main bottlenecks identified by Aceto et al. (2010) relate to the enhancement of soft skills (e.g. social networking), quality of the information shared, continuity and motivation (responsibility for your own learning).

Vocational education and training (VET) is divided to initial vocational education and training (IVET) and continuous vocational education and training (CVET). IVET refers to general or vocational education and training carried out in the initial education system, usually before entering working life (Lettmayr 2011). CVET is defined as training that takes place during the working life and aims to help people to enhance the knowledge, achieve new skills and continue personal or professional development (Cedefop 2008). Continuation of education is the core idea of lifelong learning and may encompass any kind of education forms: general, specialized or vocational, formal or non-formal, etc. However, according to the European Centre for the Development of Vocational Training (2011), there is not a harmonized singular VET model that would be feasible in all situations and would guarantee the maximum benefits. Context and effectiveness are interrelated to each other and the VET systems are highly dependent on the national cultures and the specific characteristics in each country. Thus, the State of the Art in the wastewater treatment education in the Baltic Region -report summarizes the current situation in each of the IWAMA Baltic countries (when information was available).

Formal education is goal and degree-oriented, society-certified training that includes adult education and school studies, as well as professional qualifications. Usually, the contents of the studies are based on the existing curriculum, based on the needs of a particular sector. The target groups are young people or adults and the knowledge transferred is often perceived as explicit information. From the perspective of the future, it would be important that curricula would more effectively support the new learning methods and opportunities. Curriculum reforms should be included in the principles of quality assessment of education institutions. New learning objectives cannot be implemented in practice if assessment for students and training institutions is not developed similarly (Cachia et al. 2010).

From the perspective of lifelong learning, it should also be easier to shape a person's own study profile, or change between study programmes, to achieve the desired competences. Thus, it has been suggested, for example, that the separation between study programmes at universities and UASs is decreased and the organizational distance between them is shortened (Melin et al. 2015). Besides the content, the formal education and training systems should support learners in developing the necessary skills to maintain the continuity in learning. Thus, it is crucial to develop soft skills, as well as, the digital and critical skills to select information and verify its reliability (Aceto et al. 2010). The policy areas where more effort and improvement are needed in order to support the development of teaching around formal education are curricula,

education, culture and leadership, ICT and digitalization, educators' professional development, assessment and creative pedagogies. Initial education has a major role in fostering and developing people's knowhow as well as their capacity for further learning, which they will apply later on during their working life (Aceto et al. 2010). The quality of courses or education offered may affect the perceptions of what people can gain from engaging in learning (OECD 2005).

Later in the work careers, the motivation for further studies should be encouraged by supporting participation. The importance of the supporting mechanisms is more important for low-income and elderly workers (OECD 2005). Flexible delivery methods have a key role in the education of the adults; the development of part-time and distance learning programs using communication technologies has increased participation in training (OECD 2005). The effectiveness of education and training could be increased by involving employee representatives in the planning of training processes. The certification systems are an important part of credibility; without certification the skills might be devalued in the labour market (OECD 2005).

Non-formal education is goal-oriented education that is not a part of the official education offered by society. It includes organized studies for adults as well as training by the companies' human resources units, social studies, study and reading circles, clubs, etc. Sometimes it is difficult to distinguish between formal and non-formal learning. Most learning is a mixture of both. In European countries, personnel is often employed from related trades: electricians, fitters, vehicle mechanics, plumbers or chemical laboratory assistants. Employees then become further qualified through courses and these particular courses transform into the necessary national qualifications (UNESCO 2012).

Like participation in formal studies, participation in non-formal training depends strongly on the internal motivation of the students. According to the Eurostat survey (2017), the elderly people (55-64 years) tend to avoid complementary education more than the younger ones. Also, the educational background has an impact on later education: the higher the education level of the person, the lower the threshold to attend further training (Pitkänen 2000; Eurostat 2017). Knowledge and skills should be updated regularly, in some disciplines every two years. The personnel should be included in discussions on what kind of training is really needed and how to best organize events

(Sandelin 2017). Supplementary education and training for WWTP personnel should be seen as investing in the future. Table 6 below presents the participation in formal and/or non-formal education, answers by persons aged 25-64 years (OECD 2018).

Table 6. Participation in adult education

	Formal	Non-formal	Both	No participation
Estonia	2	44	7	47
Finland	5	51	11	34
Germany	3	46	4	47
Lithuania	3	28	3	66
Poland	3	28	4	65
Sweden	5	53	9	34

Informal and unintentional learning forms the largest "potential learning source". It may happen through interaction, for example, as participation in forums, discussions and debates, self-production of videos, cartoons, drawings to self-express one's view, or collaborative production of material. It takes place in everyday life alongside other activities. It could be goal-oriented and self-directed learning, mentoring or coaching taking place, for example, as part of the work. It could also be merged with everyday learning, for example, from experience. Learning occurs through the active participation in the acquisition of horizontal skills, such as critical thinking, sense of initiative and socio-civic competences (Aceto et al. 2010). This is a highly important source for collecting and transferring tacit knowledge.

In the WWTPs, tacit knowledge is associated with the skills and knowledge that is gathered over the years of work at the same utility. It is shared in normal daily work and especially during malfunctions (Sandelin 2017). In practice, tacit and explicit knowledge complement each other (Sandelin 2017). Engineers' solutions are often complex, whereas the operators' solutions are based on tacit experience of the process and are, thus, context-specific and simple (Boiral 2002). However, both of the knowledge types are needed to solve the problems in WWTPs and should be taken into consideration when capacity development paths are built. The role of tacit knowledge is highly important from the perspective of knowledge retention. There are going to be growing problems with knowledge retention, especially when the elderly employees retire and the millennial generation (born in 1981–1999) take over their jobs (Sandelin 2017). The problem is pronounced in the WWTPs where documentation has not been done in the best possible way.

How could the role of tacit knowledge be enhanced in the WWTPs? According to Sandelin (2017), tacit knowledge should be rooted in knowledge management systems, and it has to be seen as a part of work management, since tacit knowledge should be made explicit. Tacit knowledge capture can be done along with normal daily tasks, by face-to-face storytelling, by regular knowledge audits or by exit interviews. The easiest way to transfer tacit knowledge is to share it with other employees through, for example, formalized mentoring or master-apprentice systems, storing it in documents and manuals, making videotapes or taking digital photos of pipeline construction and renovation sites, equipment and treatment processes, or employing external interviewers.

According to the WssTP (2016), the main general actions to improve education of the WWT sector described below:

- New education and training programmes for an upskilled workforce in the future digital water sector
- Develop and deploy new, ad-hoc skills and training programmes for upskilled workers in digital technologies, managing authorities, water sector specialists, innovators, etc.
- Creation of smart skill building tools for water and water-related sectors to facilitate replicability and applicability of water related technological solutions and facilitate capacity development.
- Talent building programme on Key Enabling Technologies (KET) and Future and Emerging Technologies (FET) for water and water in a circular economy.
- Vocational training for smart water systems, technologies, management / governance, and water economy
- Shorter to medium term impact measures for education

According to Savickas (2017), in the short term, the HR in organizations is responsible for updating the knowledge based on competences. This can be done through functions, such as, HR data analyses and competency models, more flexible working agreements and virtual talent platforms, etc. In the longer term, the institutional learning systems should increase the cross sectoral collaboration for the implementation of lifelong learning.

3.3 Competences in the Wastewater Management Sector

There is an ongoing European-level process (i.e. European Qualifications Framework; EQF; to determine what kind of skills are needed in different sectors of society (e.g. what the workers should know, understand and be able to do). The EQF is designed as a lifelong learning framework for linking the degree systems in different countries. It should enable, for example, a better mobility of workers within the EU and flexible workforce throughout Europe. The EQF defines eight education levels from the supervised beginners (Level 1) to the high-level specialist (Level 8) with three characteristics regarding professional competences: knowledge (described as theoretical and/or factual), skills (and abilities; described as cognitive and/or practical), and responsibility and autonomy (the element of attitude and behavior; the ability to apply knowledge and skills autonomously and with responsibility).

The EQF aims to relate different countries' national qualifications systems to a common European reference framework. In this way, it is possible to compare the qualification levels of different countries and different education and training systems. The national-level qualification frameworks have been produced in most of the Baltic countries (Table 9). Regarding the Baltic wastewater sector, the national-level qualification frameworks have been made at least in Germany, Finland, Estonia and Sweden. In some Baltic countries, for example, in Germany, Estonia and Finland, the water sector has generated an "occupational qualification standard" for the WWT sector. There are national differences in how the standards are implemented and what levels are highlighted. However, the needed competences of the wastewater sector rise from the actual needs in practice. It seems that more detailed knowhow is needed with the understanding of the bigger picture regarding the development of the legislation, dependencies and reasoning.

The eight education levels from the EQF can also be applied in the wastewater sector, according to the German Qualification Framework (DQR):

- **Level 1-2:** Sewer and Wastewater Treatment Plant Helper
  (e.g. 1 week theoretical and 2 weeks practical qualification)
- **Level 3:** Certified Sewer Operator
  (e.g. 3-5 weeks training and 3 years experiences)
- **Level 4:** Water/Wastewater Technician (e.g. 3 years dual education)
- **Level 5:** Foreman
- **Level 6:** Bachelors, Senior Master Technician
- **Level 7:** Master, Scientist, Head of Water Utilities
- **Level 8:** Prof., Dr.-Eng., PhD

There seems to be no harmonized way to present the actual qualifications for the wastewater sector. The German "job description for water treatment plant operations and maintenance" focuses on the technician level (Level 4) and it focuses on describing the qualifications from the perspective of the existing educational pathways.

The Estonian occupational qualification standard focuses on systematically presenting operator education and competences on Level 5 (Foreman). It describes the working environment and specific aspects of work, tools, personal characteristics necessary for this work, abilities and personality traits, occupational training needed, the most suitable titles, regulations on working in the job, mandatory competences (Table 7), competences related

to the specialization, competences required across the occupation and their performance indicators.

Table 7. The mandatory technical competences relating to wastewater management is Estonia

Mandatory competences	Headline of the specific competences
Monitoring of processes	- Regular monitoring of processes - Monitoring of equipment - Monitoring the water quality and production volumes
Managing and optimizing the processes	- Starting the processes and equipment and participating in the startup process - Managing and regulating the work of processes and equipment
Maintaining the equipment and the systems	- Performing regular maintenance of equipment - Scheduling and performing the repairs
Wastewater treatment	- Operating of the sewerage system - Operating and managing the wastewater treatment process - Operating of the sewage sludge treatment

The Finnish qualification standard is part of the qualification tool that describes qualities from the perspective of the WWTP maintenance and development opportunities. There are no EQF-based levels (1-8) mentioned in the Finnish document, but the structure takes into account levels 3-5 and ”acting as a supervisor” is mentioned separately. The criteria are divided to technical and non-technical knowhow (Table 8), classified into three groups: 1) opportunity to work independently, 2) overall responsibility of the process and acting as a supervisor, and 3) the ability to develop the operations of the organization. These groups contain case-specific competences.

Table 8. The mandatory technical competences relating to wastewater management is Finland (FIWA 2018)

Technical knowledge sections	Non-technical knowledge sections
Knowledge of the water supply industry and own WWTP process	Economic and procurement know-how
Management of the plant's technical process	Commitment
Occupational safety and risk management	Problem-solving and decision-making ability Interaction and leadership skills Project management Developing your own skills Clear written expression and documentation

The main competences in the descriptions above seem to rise from the technical needs in practice. The other types of skills, for example soft skills, are listed as non-technical skills in the Finnish document. These include such competences as interactivity (e.g. open information sharing with colleagues), active developing of your own skills (e.g. active and versatile information search) and documentation skills (to develop and guarantee the continuation after specific situations). In the Estonian description, the "competences required across the occupation" also include soft skills and behavior-related issues, such as the ability to apply knowledge and responsibility, when the document otherwise emphasizes technical management and maintenance. In the German description, the non-technical skills needed in the water sector are presented in other publications, for example, in "Skill Development in the Water Sector Guidelines, 2015". Moreover, the WWTP specific requirements for the qualifications of the personnel (rising for example from the plant technology and size) are listed in separate documents (Table 9). The country-specific qualifications can be seen in Table 9 and/or reviewed from the "State of the Art in the wastewater treatment education in the Baltic Region" report (when the information have been applicable).

Table 9. Examples of a) regional and b) national qualification frameworks (NQF) and c) definitions for the competences in the wastewater sector in the Baltic Sea area.

Country/ Region	Links
EU	a) https://ec.europa.eu/ploteus/content/descriptors-page
Estonia	b) https://www.hm.ee/en/activities/kvalifikatsioonid/occupational-qualifications b) https://www.kutsekoda.ee/en/kvalifikatsiooniraamistik/ekr_tutvustus c) https://www.kutsekoda.ee/et/kutseregister/kutsestandardid/10557935/pdf/veekaitlusoperaator-tase-5.4.et.pdf
Germany	b) https://www.ihk-nuernberg.de/de/media/PDF/Weiterbildung/Aktuelles-und-Projekte/englisch_informationen-zum-dqr-des-dihk.pdf c) https://ec.europa.eu/ploteus/en/content/sewage-engineering-technician c) https://www.germanwaterpartnership.de/fileadmin/pdfs/gwp_materialien/gwp-broschuere_skill_development_in_the_water_sector.pdf; c)https://www2.dwa.de/eva2/Files/veranstaltungprogramm/2_DWA-Veranstaltungsprogramm_2018_NETZ.pdf
Finland	b) https://www.oph.fi/mobility/qualifications_frameworks c) EQF based available in for the members of the FIWA on the: www.vvy.fi/vesilaitosyhdistys/in-english/ c) https://eperusteet.opintopolku.fi/#/fi/esitys/3536453/reformi/tiedot/ https://eperusteet.opintopolku.fi/eperusteet-service/api/dokumentit/5960722
Sweden	b) https://www.uhr.se/globalassets/_uhr.se/english/1212r-certification-swedish-nqf-eng3.pdf
Latvia	b) http://www.nki-latvija.lv/en/par-lki b) http://www.nki-latvija.lv/en/par-lki c) Training standards: https://e-seimas.lrs.lt/portal/legalActPrint/lt?jfwid=icx9058y&documentId=TAIS.324231&category=TAD c) Competences required: http://www.kpmpc.lt/kpmpc/wp-content/uploads/2015/08/kvalifikaciju-tyrimo-ataskaita_aplinkos-apsaugos-profesinis-standartas_final.pdf
Lithuanian	b) http://www.kpmpc.lt/kpmpc/en/kvalifikaciju-formavimas/qualifications-framework/lithuanian-qualifications-framework/
Denmark	b) https://ufm.dk/en/education/recognition-and-transparency/transparency-tools/qualifications-frameworks
Poland	b) http://kwalifikacje.edu.pl/en/polish-framework/1218-polish-qualifications-framework

3.4 New Educational Opportunities Contributing to Lifelong Learning

The European Union defines lifelong learning as a means of learning from preschool to the retirement age, including all formal and informal learning and the forms of "everyday" learning (European Council 2002). Today, lifelong learning is an important learning process, as work and professional development are increasingly intertwined. However, even if learning is more and more self-motivated, the workplaces are more and more also learning places (Fischer 2000). Thus, besides the content, educators should pay attention to the learning approaches in practice. Online communities with networking, customization and participation support the constructivist approaches requiring the learner's active involvement in knowledge construction and the learning process (Broadbent & McCann 2016).

E-learning: In order to facilitate international information sharing and knowledge exchange, digitality and e-form of learning are useful in the "tool box" (Aceto et al. 2010; Sandelin 2017). Utilization of e-learning requires that especially the management level understands it and is committed to developing skills for the use of e-learning resources. In the commissioning phase of e-learning, there has to be a good understanding of what the technology can offer and how it may affect, for example, the expectations and behaviour of the learners. It is essential to understand what people look for (and how they find it) and what types of devices/applications they use. The production phase requires the capacity to provide high quality learning supported by the deployment of the modern teaching pedagogies. In the operational phase, educators need to find appropriate resources and successfully integrate them into the curriculum (Broadbent & McCann 2016).

E-learning has several advantages from the perspective of teaching approaches. The massive amount of information available, enabling the use of the most suitable resources and customized learning processes, supports not only knowledge-centered but also student-centered learning. Moreover, it supports assessment-centered teaching via the fast feedback options (e.g. quiz applications, online tests and peer-to-peer feedback (Broadbent & McCann 2016). Social media platforms, games, blogs and forums strengthen the feeling of the community, which enhances learning (Aceto et al. 2010).

Social computing: Online tools have affected not only the people's professional lives but also the learning patterns and pathways. When early e-learning implementations were one-way information change, supporting more didactic forms of teaching, the social media has changed it in a more interactive direction. Social computing is interactive and collaborative behavior between computer users via social media applications. It supports lifelong learning by offering accessible, flexible and dynamic learning methods that can supplement initial training (Redecker et al. 2009). Moreover, social computing provides the opportunity to tackle time and space barriers, language barriers and institutional walls. It supports international interaction and networking among and between learners and teachers who are geographically dispersed (Redecker et al. 2009).

The social computing tools (e.g. blogs, email, skype, video connections, instant messaging, social network services, wikis, and social bookmarking) may bring many positive aspects also to the content of learning. They may enhance innovation and creativity by supporting a more engaging and playful approach. Social computing may also improve collaboration and empowerment, allowing

learners and teachers to discover new ways of actively and creatively developing their individual competences. It also offers a broad variety of versatile tools, which address different channels and involve learners more actively in constructing their own learning process, improve individual performance, actively foster the development of transversal competences, and nurture abilities to flexibly develop skills in a lifelong learning continuum (Redecker et al. 2009).

Peer learning, as well as teaching, is more and more taking place via "social computing" applications. This kind of peer support, for example, in discussion groups, professional forums or HUBs, may have some positive effects on the user interface. It has been reported to enhance the sense of belonging to the community and the collective identity of members (i.e. virtual family). Peer-to-peer interaction is an element that enhances the learning in communities: sharing experiences motivates members to learn and to critically reflect on how the experience of others could be adapted to their own contexts (Aceto et al. 2010). The idea of "studying at work" would cover many of the needs regarding lifelong learning and the changes taking place in the work life. It would contribute to improving of practicality (i.e. learning by doing) and the role of non-formal learning and peer-to-peer learning. According to Aceto et al. (2010), online peer-to-peer interaction and personal empowerment, when students feel part of a team of peers, are keys in enhancing motivation.

There are also some challenges regarding the knowledge exchange and education structures via internet-based applications. Access to ICT and basic digital skills constitute a major obstacle for the deployment of social computing in education and training, which is a key problem considering inclusion and equity (Redecker et al. 2009). The young people, who are the most wanted resource also in the wastewater treatment sector, are "digital natives", users of social computing, games and other internet applications (Prensky 2001). Still, too many educators (producing e-learning resources) are from the pre-digital age and are struggling to teach people that speak an entirely new language.

One of the main challenges in teaching via internet applications is the new role of teachers/educators as facilitators of the self-regulated learning processes. Teachers should have resources and pedagogical digital competence to adopt the new roles, new didactic methodologies, toolsets and training programs before they can promote innovative teaching methods, digital competence and teaching cross-curricular competences with plenty of hands-on practice and guidance (Redecker et al. 2009; Cachia et al. 2010). Essential questions from the perspective of the future development are also the reliability of user-produced content, certification strategies, valid pedagogical concepts, methods for learning with social computing and the availability of the current applications also in the future.

One of the current challenges in teaching is the outdated knowledge of the teachers/educators. This problem is further enhanced by the continuous diversification of the study fields. The group sizes are usually rather big and there is a growing need for an immediate response from the teacher. At least, this would be the optimal situation for learning. A possible tool to tackle these problems, or at least to correct the situation, is the **flipped learning** method, as well as computer-assisted training and competence tests. Flipped learning is a method where, for example, the explanatory or introductory traditional lectures (i.e. basic courses) are replaced by independently viewed educational videos, animations or other material that are available for the students independent of time and place. The teacher is no longer teaching but acting

more as a tutor/coach when guidance is needed, for example, in training and discussion/feedback sessions. Training could be simulations, games or tasks based on problem solving. Flipped learning enables the global use of the best teachers. Students' preparation for the lessons will save time and the student can listen to the introduction many times and, if desired, it can be explained by different people. Immediate feedback on the exercises and monitoring of the progress by the machine improve learning outcomes and increase learning motivation.

The flipped learning type of teaching is popular in the universities of applied sciences. Flipped learning could be executed as team learning, project-based learning and/or peer-to-peer learning, which have obtained good learning outcomes (O'Callaghan et al. 2017). For example, in the Department of Applied Physics in the University of Eastern Finland, flipped learning is being tested as a part of a Finnish development project (2017-2019) funded by the Ministry of Education and Culture. The method has been reported to increase the pass rate of the most difficult electricity course up to the 80-90%, compared to the traditional teaching methods, when only 20% of the students were able to pass at the first try (Saarelainen 2018).

Benchmarking helps to create an insight into the performance relative to peers and to improve operation. It allows identification of strengths and weaknesses to improve performance. It is an opportunity for managers in particular to network with their peers, to compare themselves with the others and to learn from the best (EurEau 2015). It requires public transparency, meaning public, reliable data. Benchmarking in the water sector has normally been used for the development of organizational efficiency, use of resources, quality and environmental performance and outcomes (EurEau 2015). National-level comparison is usually easier, because then the results are similarly dependent on the local context, unlike in international benchmarking.

Interactive e-learning includes the learners' active participation and enables feedback on the learning process. The use of assessments, scenarios, simulations or role-plays provides immediate feedback to learners. Learners have the opportunity not just to act, but to interact, and it is often assumed that these interactions provide rich opportunities for learning (Schwartz & Plass 2014). Through the interactivity, the learners are able to explore, evaluate, and become involved with the content, and at the same time, the activities also allow learners to apply the information to their own work and workplace.

Interactive e-learning creates a cognitive experience of involvement, which results in improved learning outcomes. It facilitates a deeper learning (understanding) by actively engaging the learner in the learning process, it enables the change of perspectives, and as a consequence, it influences the students' online learning performance (Damnik et al. 2017). Furthermore, interactivity allows the learners to direct their own learning process and enhances their motivation. To sum up, interactive e-learning activates long-term memory, but also improves attention, promotes motivation, and enhances knowledge retention.

The learners are encouraged to think about the content through exercises, by completing scenarios, and selecting adequate responses to quizzes. Interactivity in digital learning materials should provide learners with feedback to increase their understanding of the learning material, and should allow learners to practice the material through guided exercises and behavior-modelling demos. Interactivity in learning materials may include simple multiple-choice and true/false quizzes, real-life scenarios, drag-and-drop exercises, and inte-

ractive games. Interactive e-learning often contains both visual and auditory elements, and also simulations, games, hands-on exercises and assessments (Pilt et al. 2014). While interactivity can have an important function in planning effective e-learning, it has to suit the general pedagogical aims and learning methodology of the course.

Simulation is not a new teaching method but it is not widely used. With the developing applications, simulation provides the opportunity to detect the relationships and dependencies of many different phenomena. Simulations can be utilized, for example, in the teaching of physics, chemistry, machine operation, process management, and interactions of natural, human, or economic phenomena. Gamification in such simulations makes the "inside the phenomena" learning process more rapid and enhances motivation. However, this requires that the goals are set smartly and with a specific purpose. New observation tools, such as virtual or extended reality glasses, enhance the reality when the learning should take place in some specific environment. Virtual learning environments/tools (e.g. virtual WWTP tours) are reported to be effective "pre-information tools", which maximize learning during the actual learning process (Seifan et al. 2018).

Gamification and Quizzes in teaching can support collaboration and teamwork, simulate a context for problem-solving activities and reinforce iteration and continuous improvement (Broadbent & McCann 2016). Games need specific planning so that they educate, motivate to compete and are

neither too difficult nor too easy. Quizzes enable rapid feedback on the progress and an opportunity for teachers to save resources for the more demanding tasks. There are, at least, the following forms of online testing: multiple choice questions (MCQs); multiple response questions (MRQs); special types of multiple choice questions (i.e. Yes/No); and text/numerical questions (i.e. correct number or word).

According to Aceto et al. (2010), in order to be able to fully benefit from the digitality and e-learning possibilities, employers should learn the following "enabling basic skills", how to:

- use the necessary digital communication tools, methods and manners
- search for, understand, select, handle, modify and create knowledge
- develop creative attitudes, be curious
- manage change and complexity
- develop self-evaluation and self-analysis skills
- value solidarity, diversity, understanding others and the sense of belonging

Part of these basic skills are contributing to the soft skills. Soft skills have an important role especially in heterogeneous teams or situations that require flexibility and interpersonal skills, when employees are training or supervising other workers. This type of training can take place at the operator and process level, but also when, for example, a person from the management is sharing information regarding a changed operation framework (e.g. legislation, risk management, or new investments).

What to expect from the development of the future: Recent initiatives have aimed at harmonizing training and vocational certification within Europe via the European Qualification Framework (EQF) standard. The ultimate goal is to facilitate a high technical standard, which in the long term will enable common teaching materials (UNESCO 2012). The harmonization of knowhow and common terminology enhances information exchange and "twinning" of the good practices. Degrees and competences can already be automatized so that the competence can be tested via simulations, massive question boxes and AI. With such facilities the needed competence can be confirmed, whenever needed. Such technology already exists, but the implementation and adaptation to education structures has been slow so far (Linturi & Kuusi 2018).

Remote influencing refers to influencing things and events in places (not necessary physical places) where the person doing the controlling is not. This opportunity is growing fast and it includes such means as various forms of e-communication, virtual reality and remote controlling tools. It offers real-time participation through invitation or volunteering and without having to travel to a different location (Linturi & Kuusi 2018). This is opening new channels for the implementation of the new peer learning facilities with harmonized knowhow content via various ways to deliver the information. Virtual guidance makes it possible the get certain certified competence, for example, relating to specific technology, even if there is no specialized educator available at that moment or on that site.

One of the crucial issues after the necessary skills have been learned is the demonstration of competence. This means demonstrating skills, knowledge and understanding to those who already know the same things, but especially, the ability to demonstrate competence to those who do not know. The most important objectives are the recognition of competence, the understanding of meanings, and the procedural and methodological skills (Linturi & Kuusi 2018).

The proof of the degree and skills may be made automatic and upgradable. Competences would no longer be verified by the teaching institution, but by a third party, for example, an employer. This would increase opportunities for alternative learning (Linturi & Kuusi 2018), but also for an effective lifelong learning chain. Table 10 below contains examples of advance learning methods and practices.

Table 10. Examples of the advance learning methods and practices to share and obtain knowledge

Advanced learning methods	Links to the tools and/or examples of the advanced methods/practices
E-learning:	https://www.raeng.org.uk/publications/reports/development-of-e-learning-resources https://onlinelearninginsights.wordpress.com/ https://www.edutopia.org/ http://theelearningcoach.com/ https://www.vvy.fi/ajankohtaista/uutiset/vesihuoltolaitosten-osaamisen-kartoitus-tyokalu-on-julkaistu/ https://elearningindustry.com/5-tips-transform-training-materials-into-engaging-elearning
Flipped Learning:	https://flippedlearning.org/ https://flippedlearning.org/wp-content/uploads/2016/07/FLIP_handout_FNL_Web.pdf http://www.flippedlearning.fi/p/kaanteinen-oppiminen.html https://cft.vanderbilt.edu/guides-sub-pages/flipping-the-classroom/ https://www.panopto.com/blog/infographic-how-to-flip-a-classroom/
Game and quizzes	http://engineeringmastermind.org/ https://docs.moodle.org/26/en/Quiz_module https://docs.moodle.org/26/en/Effective_quiz_practices http://www.hsiblowers.com/efficient-video-game.html http://seppo.io/en/ https://docubase.mit.edu/playlist/documentary-games/ https://gamesandimpact.org/transformational-play/ https://www.onlinecolleges.net/50-great-sites-for-serious-educational-games/ https://www.nfer.ac.uk/publications/FUTL60/FUTL60.pdf
Interactivity in learning material	http://h5p.org/content-types-and-applications http://learningapps.org https://www.educaplay.com/en/actividades.php https://www.snapapp.com/platform/interactive-content-types http://blog.dot.vu/12-different-types-interactive-content https://www.singlegrain.com/blog-posts/content-marketing/7-types-of-interactive-content-why-and-how-to-use-them
Simulations	https://www.labster.com/simulations/wastewater-treatment/ https://expeditionworkshed.org/workshed/push-me-pull-me-3d/ https://phet.colorado.edu/ https://www.compadre.org/osp/search/categories.cfm?t=SimSearch http://mw.concord.org/modeler/index.html http://learn.genetics.utah.edu/ https://www.lamk.fi/fi/node/1674 http://virtuallabs.nmsu.edu/ tps://www.explorelearning.com/
A virtual learning environment	https://uk.blackboard.com/learning-management-system/blackboard-learn.html https://www.sciencedirect.com/science/article/pii/S174977281830109X

4. Capacity Development in the IWAMA –Project

Aiming for Enhanced Development of Lifelong Learning in the Baltic WWTPs

According to the OACD definition (2006), feasible capacity development can be achieved "through a process of learning, transferring, acquiring and using new abilities to replace the old way of doing things. It means that knowledge has been created, shared, anchored and is available in an effective way by a variety of stakeholder groups". However, information needs and channels of WWTP personnel are largely under-examined (Sandelin 2017). Thus, it is difficult to find comparable results dealing with information needs and channels at WWTPs. The above-mentioned issues were on the worklist of the capacity development activities taking place in the IWAMA project. The present chapter gives an overview of the methods, reasoning and results of the capacity development done during the IWAMA project.

The starting point for the capacity development in the IWAMA project was the findings of the PRESTO project (2011-2014; Interreg BSR), which was conducted in the Baltic Sea area. The lack of training, awareness and interactive international information sharing have been previously identified as some of the major limitations regarding the energy and resource-efficient management of the wastewater processes in the Baltic Sea region (PRESTO project 2011-2014; PURE project 2007-2013). The capacity development focus of the IWAMA project is on the WWTP staff and on the identified bottleneck areas: the best available technologies, smart sludge and energy management. These have been reported to be the key elements affecting the maintenance of the WWTPs of the Baltic Sea region (Rettig & Barjenbruch 2016).

Based on the previous findings, the capacity development core during the IWAMA project has been internationality, interactivity and interactions between the WWTP operators, water and wastewater associations, universities, authorities and technology suppliers in the area of the Baltic Sea. The operational goals have been the sharing and developing of knowhow, methods to deliver and receive knowhow, finding the national synergies and increasing international interactivity. The substance has focused on increasing the mainstreaming of the best available technologies, and promoting the uptake of smart sludge and energy management in WWTPs of the Baltic Sea region. The partners (n=17) and associated partners (n=12) are contributing to the implementation of the activities and building national knowledge-based communities (NKBC) in several Baltic states. In the future, the supporting of the capacity development of the WWTP personnel and the dissemination of the tools and knowledge generated by IWAMA will be assisted by the national knowledge-based communities.

The capacity development during the IWAMA project has taken place in workshops (n=6), webinars (n=5)(Annex II) and several online meetings and dissemination events of the IWAMA project. Each workshop was attended by 65-90 peoples (e.g. project partners, associated partners, WWTP management, experts, authorities and suppliers), when the corresponding number of the webinars was 25-35. Moreover, information exchange, surveys and

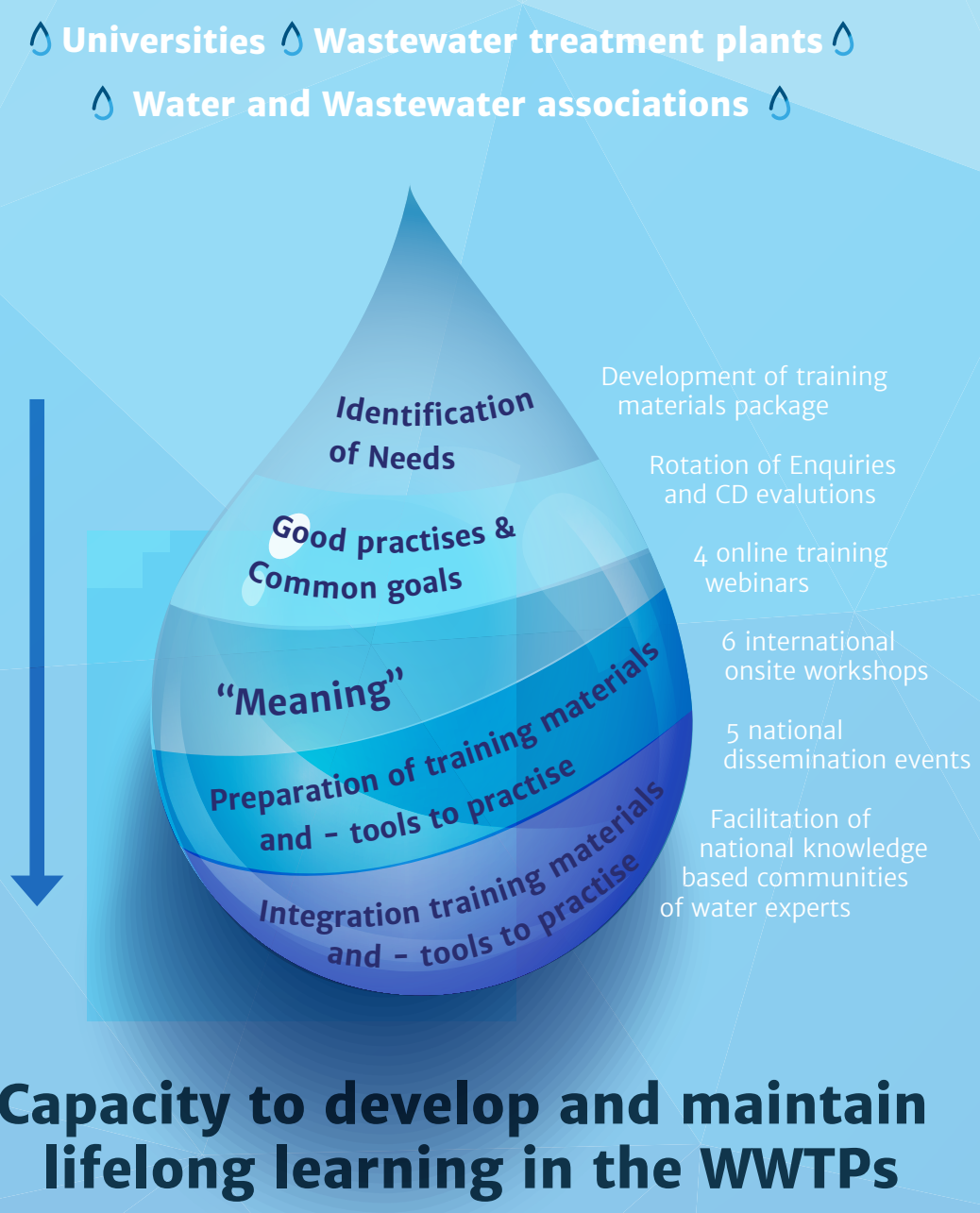


Figure 2. Capacity development steps during the IWAMA project

co-development of the lifelong learning tools (i.e. WWTP game, e-training material package with virtual tests) have taken place in a separate capacity development work package (Figure 2).

The capacity development, lifelong learning tools as well as the other deliverables of the IWAMA project (i.e. Hub, key figure analysis, self-audit for the WWTPs) are aiming at enhancing international knowledge sharing and providing opportunities for dialogue. The IWAMA capacity development surveys, whose results are presented below (See 4.1), were mainly collected from the WWTPs, but also from training institutions, such as water and wastewater associations and universities. The results give information about the needs and the changes in the needs in the WWT sector, the most feasible methods to deliver information and utilizing or supplementing already existing practices. Results are discussed from the perspective of the possibilities regarding lifelong learning (See 4.2; 4.2.1; 4.2.2). The national-level reforms, existing good practices and the current situation in the WWT sector in the Baltic countries (participating in the IWAMA project) can be reviewed in the State of the Art in the Wastewater Treatment Education in the Baltic Region co-report.

4.1 Results and Summary of the Capacity Development Surveys of the IWAMA Project

According to WWTP operators in the Baltic Sea area, the development trends can be summarized in this way: "Concentrating to larger units continues. Things like automation, energy issues and sludge recovery will be emphasized in the future. The general trend seems to be that the legislation of treatment requirements is tightening and there are new requirements for the removal of contaminants and micropores (e.g. plastic, medicine residues). New technologies, such as membrane processes, are becoming more and more widely used. There will be cross-sectional interfaces at every level of education" (IWAMA workshop WWTP interviews 2017).

The needs in the WWT sector: Just like with the faced challenges (see 1.0), there are also differences in how different WWTs evaluate the identified problems. At the WWTPs, knowledge, in practice, is defined as the ability to make good decisions and to take the best actions in particular situations (Sandelin 2017). This is similar to the IWAMA results, where the main needs in the WWTP sector (rising from the IWAMA survey 1; Annex I) was lack of knowledge in decision making and in the maintenance of the WWTP. The IWAMA needs survey (2016) listed four main categories (global, technical, economic and educational needs) and was mainly directed at the WWTP operators, but also at researchers, authorities, and employees of associations working in the field of WWT (i.e. experts). The needs of the WWTP operators were more technically and locally oriented, whereas the experts took up more global and regulative themes. The top ten needs of the wastewater operators were (IWAMA capacity development surveys 1; Annex I):

- Ageing of current infrastructure
- Lack of financial implementation instruments
- The integration of intelligent technology, automation and monitoring
- The creation of new operation models/methods (sampling, analysis, reports)
- Industrial symbiosis of WWTP with operators from other sectors
- Holistic management of the process
- Local/national legislation reforms/The new guidelines
- To obtain reliable information for the investment decisions
- To identify the most suitable technique
- Knowhow to react to extreme weather phenomena (heavy rain, floods, etc.)

The corresponding needs of the training organizations and the "WWT experts" were:

- To fulfill the demands of national legislation
- Local/national legislation reforms/The new guidelines
- Development of the business around the wastewater management
- Implementation of the EU legislation/To fulfill the demands of the EU legislation
- New compounds (e.g. chemicals, medicine residues) in the wastewater
- Holistic management of processes
- Enhanced cooperation with the client interface
- Operation planning via the customer needs
- The introduction of new water treatment technology

- Need of new standards, operation methods, business plans

Besides the general-level needs listed above, there were some national/ WWTP-specific characteristics that may affect not only the need for know-whow, but also resources and methods to attain it. These survey features are listed in Table 11 (IWAMA capacity development sessions survey 3, 4; Annex I).

Table 11. Issues and frameworks that have an effect on the training needs and resources (IWAMA interactive workshop discussions 2017)

	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
Ownership		x	-	x	x	x	x	x
Size		x	x	x	x	x	x	
Amount of employees	x	x		x	x	-		
BAT		x	x	x	x			
Type of WWTP			x					
Used technology	x	x	x	x	x	x		
Operation methods	x		x	x	x		x	
Operation environment	x	x	x	x	x	x	x	x
National certificates		x		x	x	x		x
International certificates		x		x	x	x		
Odor control/reduction					x			
Legislation: Nitrogen & phosphorus	x							
Required knowledge-based content for operators (personnel)	x	x					x	
Management							x	x

There are no studies available on how information and knowledge needs, acquisition channels, knowledge sharing and knowledge retention differ at WWTPs of different sizes and what effect ownership has on them (Sandelin 2017). Nevertheless, it may be useful to take these factors into consideration when training is developed. At least, the plant size was documented as one of the main factors affecting the qualifications of the technical manager, shift supervisor and machine operator (DWA-M 1000; DWA-A 199). Table 12 below opens the possible dependence between the WWTP characteristics and the training.

Table 12. Arguments concerning the specific features of WWTPS that may have an effect on the plant-specific training needs (IWAMA interactive workshop survey 2, 3; Annex I)

Size of the plant volume (e.g. small – medium – big)/ Number of employees;

"With less people more training is needed, because there is only one specialist for each sector. With more people, everyone does not need to know everything. More people also mean more opportunities for discussion (fi)."

"With larger plants there should be more educated workers as the plant has a bigger influence on the environment. Smaller plants have the opportunity to go and learn from the bigger WWTPs. Smaller WWTPs suffer most often from the lack of the specifically educated staff (lv, lt)."

"DWA has recommendations (DWA-M 1000; DWA-A 199) that determine educational needs for WWT personnel regarding the size of the plant. Small plants need wider knowledge. Larger ones need more specific training (de)."

"Small plants lack specifically educated staff. Thus, there is a need for support for smaller plants, since they often do not have sufficient resources. Bigger plants have different needs relating to the new technologies (ee)."

Ownership (e.g. public - private - both);

"Ownership is an important factor, but it still depends on the owner as such, not if it's private/public. It could be that new earning logic has a more important role on the private side and that a private company does not necessarily want to spend money on training. However, management is more important than ownership! " (fi)

"A municipally-owned WWTP has more potential and possibilities to train staff" (ru)

Used technology/operation methods;

"There is a relation between the complexity of the plant and the need to understand how the solutions work and how to operate them. Bigger plants might need more specific training due to more advanced technology and bigger resources." (fi, lv, lt, de, pl, ru, dk, ee)

"Technology affects the learning needs the most and is WWTP-specific. Biology and sludge treatment are the most important technologies (automation, bacterial activity, risk management). Information, what is needed to know by the operator" (lv, lt).

"More complex technologies require more skilled personnel, for example measurements and maintenance would need a qualified engineer." (de)
Operation environment;

"WWTP location can have an impact on training needs (tourism, season working, plant underground, resilience with the capacity). Municipal WWTPs are probably better prepared for educational purposes." (pl)

"The location and environment have a minor influence. Near the cities (odour control), possible special areas (sea side, river bank, natural environment, national park, reservoir) may need enhanced knowledge." (de, ee, lv, pl, dk fi, lt)

"Coastal places (tourist areas/summer cottages) or industries might have different seasonal loads reflecting to the operational requirements of WWTP." (ru)
National/international certificates/recommendations;

"Lithuania has different certificates: for employees (management/technical), certificates to use particular equipment, safety certificates. Learning is hierarchial: higher management has more learning practices." (li, ee)

"Certificates don't affect, at least remarkably". (dk, ee)

"The new HELCOM requirements (more strict phosphorus norms), we need a lot more training in order to achieve them." (fi)

"Electricity, gas, (automation) certificates are required by law. For the workers certificates mean higher salary. International certificates are not required but may be helpful to train the staff." (li, lv, de)

The most important need identified by both WWTPs and training institutions was the holistic management of the wastewater treatment processes. According to the survey (2016), only about 11% of WWTP personnel has sufficient knowledge of what partial process factors are affecting the outcomes of the process (i.e the utilization/reuse of the sludge and the energy obtained from the process). One important observation from the workshop and operator interviews (2017-2018) was that the impact of the employees' specific knowledge of the everyday routines, regarding the maintenance of the process, is not sufficiently understood. In normal cases, the operator's work was considered to be to monitor parameters. If actions are needed due to parameter deviation, the process is corrected following the instructions. However, only one day of shadowing (during the IWAMA audits and trainings) in WWTPs revealed several actions that are dependent on the experience and specific choices of different operators (Table 13). It seems that the everyday routine

maintenance of the WWT processes contains a lot of tacit knowledge, which is not well recognized. This can relate to the same perception described by Sandelin (2017): The need for the knowledge retention is not well recognized in the WWTPs.

Table 13. The short list of examples from the five WWTPs around the Baltic Sea on how the experience of the operator may affect

Second clarifier; Measuring of visibility depth. Feedback of the sludge is based on the estimation of the settleability of the sludge. Settleability is a strong indicator of the management process and via feedback it affects the function of the previous activated sludge process.

Mechanical cleaning stage: Mechanical cleaning needs continuous maintenance. Manual removal of the larger particles. Maintenance of the greens, screen conveyer, grit chamber, pumps and grit washer, fat removal works as it should. Amount of overflow rate is monitored and adjusted. The limits of the automation and monitoring have to be understood to check the condition of the machinery properly, for example the motor of a screen press can work although the press itself doesn´t work.

Addition of the chemicals and polymers for the flocculation or pH adjustment.

Biological treatment stage: Maintenance and calibration of oxygen sensors, Cleaning of bio-rotors, Technical check and understanding the effect of monitoring parameters.

Sludge management: Setting of the drying parameters affects the quality of the end product, polymer dosing, oiling and maintenance of the pumps (e.g. condensation water removal).

Changes in the operation environment & Risk management (e.g. rain falls, temperature changes, industry waters), affect specific maintenance needs of the process steps.

The specific educational needs that were identified in the capacity development workshop discussion (IWAMA capacity development survey 2, 3; Annex I) outlined the following issues. Some of the training needs are rising from the tightening legislation or certificates, such as the HELCOM requirements for more strict phosphorus norms (HELCOM 2017). A lot of training is needed in order to meet the new requirements and to update the information throughout the wastewater management sector. More advanced techniques and automation are replacing the aging infrastructure of WWTPs. Thus, competences needed by the operators are changing. At the moment, competence criteria and certification systems for the WWTP operators are under development in many European countries. This harmonizing development aims to enhance the availability of skilled employees inside the EU. Besides the operator skills needed for the maintenance of the process, there are also WWTP management level needs, for example:

How to identify the most suitable technology or how to make the decision based to the various data sources?
Information how to renew old infrastructure with less investments and chose right material and sustainable design?
How to find and select right financial sources to renew the infrastructure?
How to plan new investments?

The main need regarding education at various education levels was the need for specialization studies regarding WWTPs. The level of higher education (e.g. engineering studies) was considered to be at least adequate, but the competences related specially to the WWT sector was considered low. For example, this has been reported to be one reason why Bachelor's degree hol-

ders will not find employment in the water sector. Master's level supplementary education should be developed regarding water and wastewater engineering to meet the needs of digitalization, management and institutional issues (Sandelin 2017). Also, in the vocational and secondary level operator studies, there would be a need for deeper specialization in the WWTP operator's work (e.g. training relating to aeration tanks, pumping stations, risk management, and automation).

Around 70% of employees working in the WWTPs of the Eastern Baltic Sea region have no primary/secondary level studies in the area of wastewater treatment. Both specific secondary level WWTP operator and sanitary engineering studies are needed. In the Western Baltic Sea region, most of the employees have applicable studies for WWTP, but the educational material, as well as the quantity of higher education does not meet today's requirements (at all the levels) and it should be more practically oriented. In fact, the most outlined common need regarding the different level studies was "practicality and practice training". Training courses with practical classes in the WWTPs or simulation of the processes was mostly missing and should definitely be introduced to the training programs. Besides the specific education programs on different educational levels, on the job learning, education on-site, short term specific courses and possibilities regarding the new training methods (e.g. virtual courses, e-training material in internet, webinars) should be developed. Moreover, the increase of the international experience in the education has been considered important.

Methods and Education Practices: The most common methods to get information and increase the personal knowhow among the WWTP employees is peer learning, seminars and conferences, and the internet (Figure 3; IWAMA surveys 2017-2018). Simulations as introducers to the work in practice was welcomed especially by the WWTP operators.

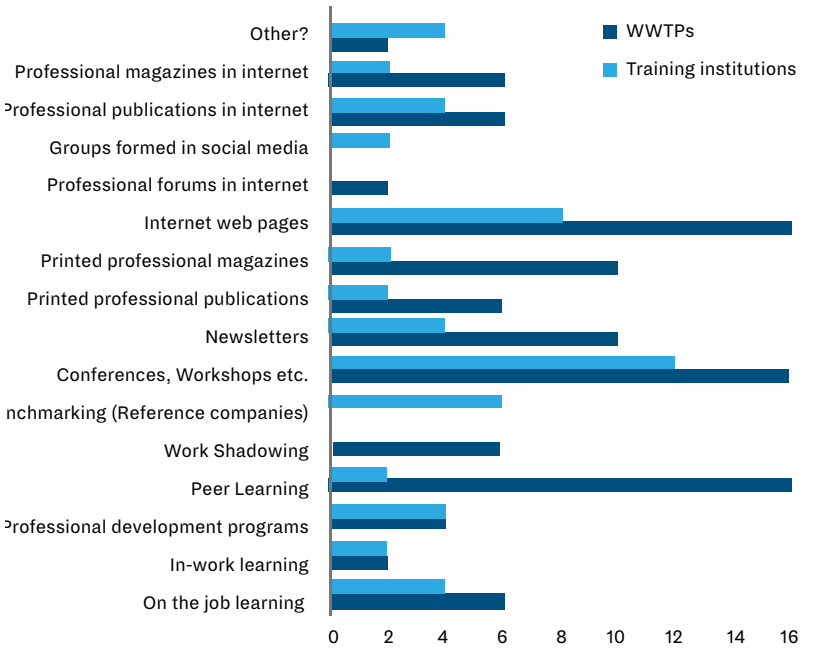


Figure 3. The top information sources for the WWTP operators and the training institutions (n = 38; IWAMA surveys 2017 - 2018)

The WWTPs as well as the training institutions have a demand for distance learning possibilities, peer learning/education on site and short-term specific

courses, and also practical classes and innovative international experiences. The specialization of the WWTP operators via "vocational college" is one of the core needs mentioned during the IWAMA discussions (e.g. aeration tanks, pumping stations, sludge treatment). Peer learning and electronic learning material with the certification of competences are considered to be the most feasible learning tools in the future (Figure 4).

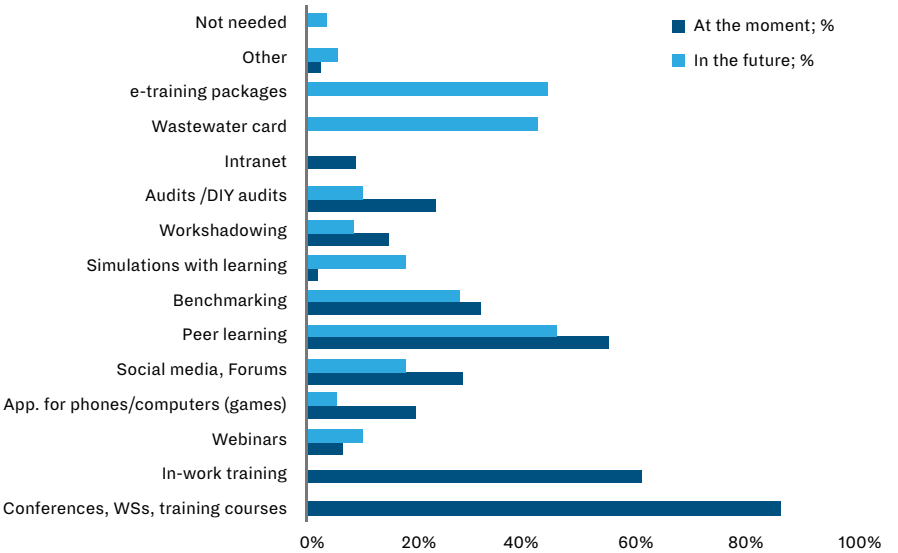


Figure 4. The most feasible learning tools for the capacity development in the area of the Baltic Sea (n = 78)

The popularity of the different e-learning facilities for using of the e-learning tools is described below (Table 14).

Table 14. The most used digital facilities for the learning purposes of WWTP operators and the training institutions

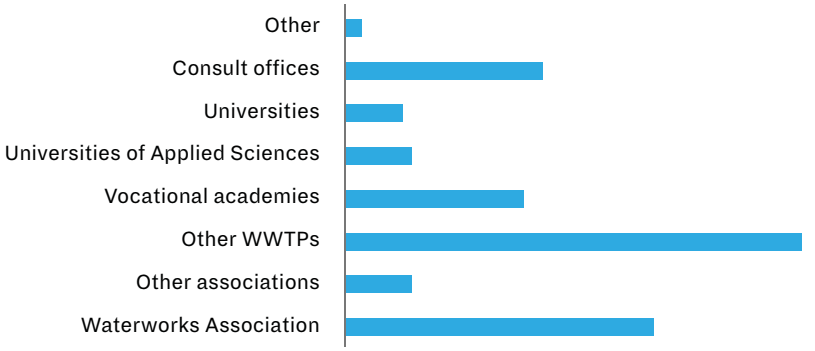
	WWTPs (%)	Training institutions (%)
Internet	41	43
Videos, visual material	12	14
Applications for learning (e.g. game)	0	0
Applications for mobile phones	10	7
Virtual learning environments	6	21
None	14	0
Other (e.g. intranet)	18	14

The previous results on the good practices underline the WWTPs' contacts and networks with other WWTPs. Benchmarking and networking are also included in the good national practices regarding training and education in the Baltic area (IWAMA survey 3, 4; Annex I). The identified good practices to get knowledge are mainly focusing to the WWTP comparisons or training of the larger amount of employees. However, the specific training opportunities

for different kind of needs are missing. The implementation of competence criteria in to the trainings tools bring this individual-oriented perspective. In addition, individual employees changing units or tasks or doing short working periods in other WWTP enhances the orientation of new employees, social activity, personnel's interest and finding of new information (Sandelin 2017).

- Visiting WWTPs constructed with technical and financial support of European partners
- Participation in conferences and seminars provided by foreign companies and consultancies
- Competence criteria for the WWTP personnel
- Regular development discussions with the employees/Working pass system
- Networking meetings among the WWTPs: benchmarking & knowledge transfer
- Target group based training and capacity building seminars for WWTP employees by the national waterworks associations
- Operators developing new businesses based on smart water management solutions/ Blue economy concepts
- Benchmarking tests: Comparison of effluent values with comparison with competitors such
- EU financed educational projects on raising awareness and capacity building of WWTP personnel
- Non-formal educational programs for WWTP employees, organized by different consultancy companies according to the needs
- Continuing vocational training programs for different categories of the operators in WWTP
- Peer learning practices in the form of training workshops
- Certification systems to enhance the circular economy (e.g. the certification system for sludge application to land)

According to the IWAMA surveys for the WWTPs (n=78), the co-operation of WWTPs and universities (also universities of applied sciences) in the Baltic Sea region is the lowest, when compared to the cooperation between the WWTPs and other stakeholders, such as consult offices, associations, other WWTPs and vocational academies (Figure 5). The previous findings of the good practices emphasize the role of professional networks that carry knowledge and shared experiences that otherwise would be impossible to trace.



Picture 5. The most common stakeholders of the WWTPs in the region of the Baltic Sea (n = 78).

4.1.1 The Rate of Change in Baltic WWTPs

The rate of the global change caused by the global drivers (see section 1) is described as fast (EurEau 2017; Saviscas 2017). Needs are changing when new technologies are introduced into practice. This increases the pressure on the relevance of teaching methods, teaching materials and the usefulness of shared knowledge. Thus, the changes in the capacity development gaps have to be monitored and the material, as well as methods, for lifelong learning updated. The change in the capacity development in the Baltic WWT sector was monitored via a two-year surveillance test during the IWAMA project (Survey 1, 6; Annex I).

The top three needs of the Baltic water sector (WWTP operator and training institutions) in the end of the year 2018 were:

- The need to remove new compounds (e.g. chemicals, medicine residues) from wastewaters
- Requirements for tighter limit values
- Objectives towards circular economy/resource efficiency

The survey on the changes regarding the lifelong tools was repeated for the WWTPs and training institutions in 2018 (Figure 6). The survey results were probably influenced by the IWAMA activities and CD tools prepared during the project (e.g. webinars, DIY audits, benchmarking, e-training material, and HUB). However, also some of the highly used practices in 2016 have remained topical (e.g. peer learning, conferences, training courses and work shadowing). More methods and opportunities are identified to receive and deliver knowledge than expected in year 2016. Practice-bound training is needed in the form of simulations. The most needed tool for the future is certification of the competences (wastewater card) and the development of the peer learning process with increased utilization of the on-line opportunities.

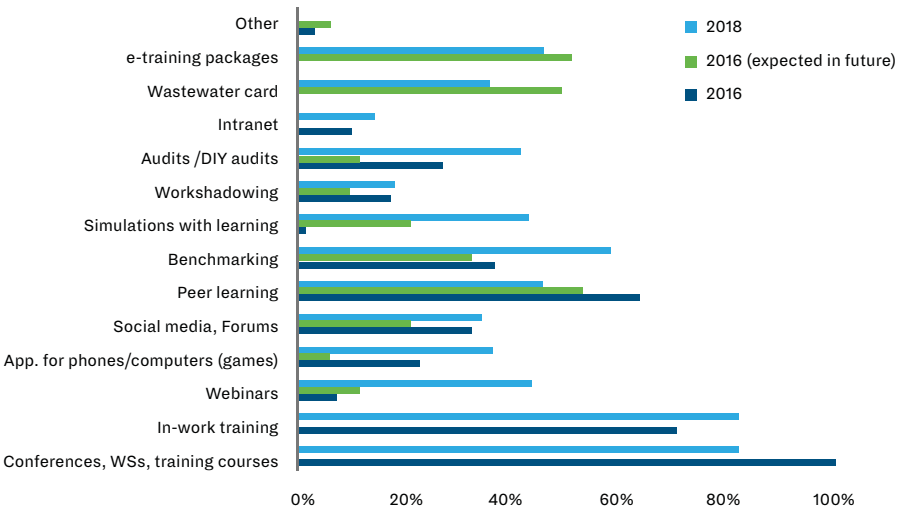


Figure 6. What kind of lifelong learning tools are needed in the year 2018, when compared to the situation during the year 2016 and the expectations for the future (in 2016) in the Baltic region (n=34)

The amount of training doubled during the project duration (3-4 conferences or training events during the 5-year period). The IWAMA project's international workshops have had their share in the figures, but a similar trend was also

seen among the Finnish WWTPs (n=12), which were not participating in the IWAMA workshops or webinars. The general guideline has been to update knowledge and skills regularly, in some disciplines every two years (Sandelin 2017).

New working methods for managing and monitoring the process and knowledge retention are more urgently needed in WWTPs, when compared to the situation in 2016. This would mean, for example, implementation of job training for staff about methods and applications, simulation and enhanced on-site training, which take into account that employees have to manage larger entities and more diverse work tasks.

4.2 The Usability and Applicability of IWAMA Deliverables and Results

The training needs identified in the IWAMA surveys are parallel to the general industry needs and bottlenecks described by the World Economic Forum (2016): "Digitalization, technological development with the tightening purification requirements and the needs rising from the flexibility, gap between research and reality, as well as need for crosscultural multinational experiences." When the needs are reflected to the methods available for information sharing and especially international information sharing, it is clear that digital and e-form learning should be in the tool box (Aceto et al. 2010; Sandelin 2017). On the other hand, technical drivers (e.g. digitalization, smart technology) of the global change can also be utilized as tailor-made tools to develop and deliver information and use professional networks to achieve the needed new skills.

Besides the capacity development workshops, the IWAMA project developed several facilities aiming to tackle the current challenges observed, but also to introduce tools that can be utilized in the future. However, the planning and predictability of the international knowledge exchange in the wastewater sector is highly dependent on the changes in the (national) operating environments, motivation and participation of the different level actors, maintenance and continuity of the capacity development actions. Even if the most usable method, peer learning (see Table 15), is chosen for the basic training method, it does not necessarily guarantee the success of knowledge transfer. Besides the motivation factor (i.e. interest to get knowledge), soft skills are identified as the tools to tackle the WWTPs' problem rising from the transfer of tacit knowhow between the workers, job rotation and heterogeneous backgrounds of the employees (Sandelin 2017). Existing, well-known best practices (e.g. an already known way to work or a platform to deliver knowledge), supplemented with the new e- facilities, offer opportunities to connect the people with the knowledge to the people who need it.

Table 15. The main IWAMA outcomes from the perspective of lifelong learning and their contribution to the needs and opportunities identified

Tool	Justification	Aim, Future development
IWAMA Smart Water Hub http://www.balticwaterhub.net/	The need for international interactivity (WEF 2016). Lack of professional interactive e-forums and/or groups formed in social media (IWAMA surveys 2017-2018). HUB contains the positive sides of interactive e-learning, when learners are able to explore, evaluate, and become involved with the content, at the same time as the activities also allow learners to apply the information to their own work and workplace (Schwartz & Plass 2014). The peer learning site of social computing enhances the sense of belonging to the community and the collective identity of members.	Enhance international interactivity and share knowledge between different WWTPs and WWTPs and research institutions to maintain capacity development.

Training material package (TMP) with e-learning test http://www.training-material4wwtp.eu/	Strong existing role of on-site learning (IWAMA surveys 2017-2018). Increased need of computer-aided training and evidence-based qualifications (Linturi & Kuusi 2018). According to the cognitive multimedia learning theory, a leaner learns more deeply from AV material than only from words. This, along with translated transcription properties, has been taken into account in TMP. Online material supports non-formal learning, but is also base material for formal learning courses and new teaching methods such as flipped learning.	Tighter co-operation between the training institutions and WWTPs. Online test to indicate the national competences required for the operators. Data collection and analysis to review the updating and maintenance needs of the training material.
WWTP game http://www.trainingmaterial4wwtp.eu/course/view.php?id=19	Information gap relating to the holistic management of the process. ~15% of WWTP personnel knows what process factors affect the utilization of sludge and the energy obtained from the process. Thus, the game provides the opportunity to detect the relationships and dependencies of many different phenomena.	Data collection and analysis to review the updating and maintenance needs of the training material. Improved tasks relating to the dependencies between the process steps.
Lifelong learning summary and the national State of the Art (SOTA) reports http://www.trainingmaterial4wwtp.eu/course/view.php?id=18	There are already existing good practices, training methods and local platforms for information sharing. The main issue is to share these practices and modify them to methods that help to adapt to changes in the wastewater sector (IWAMA surveys 2017-2018). The report outlines the current possibilities for different level training with the existing specific capabilities and development needs of the Baltic wastewater sector.	Summary of the IWAMA capacity development findings and the suggestions that can be reflected against the national state of the art.
National knowledge based communities (NKBC)	The ongoing changes require flexibility of the structures and interactive cooperation by the various actors so that predictability can be maintained and the skills meet the needs of the community. Moreover, the co-operation between the training institutions and WWTPs should be strengthened (IWAMA surveys 2, EIT, EUA and research & development framework programs of the European Union, e.g. FP7, H2020).	Enhance the network of various actors of the national water sector and implement co-operation into practice.

Auditing tool & Key figure collection	Possibility to enhance cooperation between universities and WWTPs (WEF, 2016). Possibility to have knowledge to support the investment decisions (IWAMA surveys 2017-2018).	Benchmarking own process status on the international level and identification of future opportunities.
Other	The interactivity skills (both soft and technological) and networking during the capacity development activities in the IWAMA project (Survey 6; Annex I).	

4.2.1 Possibilities of the Currently Most Used Methods in WWTPs

The most common methods to acquire information among the WWTP employees are peer learning, seminars and conferences, and the internet. According to the IWAMA surveys (2016), about 70% of WWTPs' employees in the Eastern Baltic Sea region have no primary or secondary-level studies on WWT issues. Thus, there is also an obvious need for formal education. Under these circumstances, the use of the most popular learning method, peer learning, as a tool may result in systematic errors, especially if the training has not been adequate and consistent. However, in the Western Baltic Sea region there is an acute need for flexible on the job learning and utilization of the electronic knowledge sharing possibilities. The reliability of the most feasible training method, peer learning, could be increased via computer-aided training (e.g. interactive e-learning) and evidence-based qualifications, i.e. skills tests (Linturi & Kuusi 2018). The next step for the WWT sector would be, for example, to develop such on-line courses with e-tests, derived from the harmonized EQF-based qualification criteria.

Traditional media are more and more moving to interactive platforms, enabling almost real-time interactivity. The potentiality of the internet as a space where peer learning, sharing of practices and interactions between the operators and the experts could take place should be enhanced. National knowledge-based communities (i.e. stakeholders related to the development of WWT) as well as already existing international platforms have a big role in implementation and maintenance of e-ways to produce and share updated information. There is the question of heterogeneous and/or plant-specific knowledge needs, but a sufficient amount of basic e-training material for the WWTP operators is always needed. Moreover, this kind of material supports the larger background scenarios of the highly potential education method called flipped learning (see Table 10). The flipped learning method is an implementation of lifelong learning studies. Flipped learning is a combination of basic e-materials (e.g. videos, games, simulations), e-tests and advanced interactivity with the other students and the teacher. The basic knowhow could be transferred, for example, via videos, when virtual and enhanced e-learning/social computing enables place-independent and advanced teaching and knowledge exchange. Besides the flipped learning utilized in the vocational and higher training institutions, the basic e-material can be utilized in the guidance and training taking place in the WWTPs .

However, the increasing web-based information distribution will not alone be adequate to solve the training needs relating to the requirements of practice (See 4.1). As indicated by the IWAMA survey 2, the most popular methods for training the WWTP staff today are workshops, seminars and conferences (Heponiemi 2016). The long-term effectiveness of these tools may be uncertain. Studies have shown that in lecture-based training, learners remember only about 5% of the content (Sousa 2005), while learning by doing increases the percentage up to 75% (Järvilehto 2014). There are good existing synergistic educational practices that can be updated to meet the current needs. It could be outlined that the formal professional education gives general qualifications for the tasks, but particular knowledge and skills are learned on the job. Thus, professional training, including vocational training and apprenticeship training, or competence-based tests should be utilized in a systematic way in the training of the WWT sector. For example, apprenticeship training is a "learning from practice" tool that has been in use for many years in several European countries. Such flexible methods utilizing digitalization and existing

good practices should be developed to the interface of the practice, formal and informal study structures.

For training institutions, it is an important task to find methods to fulfil the individual learning needs relating to the employees' knowledge and skills, but the organizational culture also has a great effect on the sharing of the knowledge between the employees. The general situation in the Baltic area is that the number of retiring employees in WWTPs is high and there is a risk that part of the essential knowledge will be lost. This knowledge consists of the skills and experiences employees have gained on the job over decades. Thus, one of the most topical challenges that the management of the WWTPs should tackle now is the on-going generational change of employees. At the same time, young people are not interested to work in the WWTPs and the employment relationships are in most cases short-term contracts (IWAMA survey 2, 3; Annex I). Thus, the planning of the basic and supplementary training is difficult, but nevertheless part of almost everyday activities in many WWTP in the Baltic area (e.g. training of the short-term employees).

Experience at WWTPs and on-the-job training should provide the needed expertise, because WWTPs need technical workforce, which cannot be directly transferred from other industries. There are many effective on-the-job training means, such as mentorships (Sandelin 2017). In mentoring, employees with more experience transfer knowledge to those with less experience. In the current situation, transfer of tacit knowledge and adoption of new ways to communicate and acquire information (for example, social computing, e-documentation) could be achieved when apprenticeship training is supplemented with peer-to-peer learning opportunities. Employees learn with and from each other by solving actual problems and doing practical work together (Sandelin 2017). More young personnel, even from the neighbor countries, should get to work together with the retiring employees without the generational (Sandelin 2017) or cultural gap in knowledge sharing. The mobility of the young workforce between the countries would require harmonized minimum WWT competences between the countries with testing abilities to supplement and verify the needed skills. The specific role of the needed competences relating to the operation environments of the different kinds of WWTP should probably be taken into consideration, when harmonized/general training material is planned (see 4.1).

Whatever the methods or solutions are for the training of the new short-term workforce and knowledge retention, it will require enough soft skills to enhance the delivery and reception of information and knowledge. It is also easier for people of different ages and backgrounds to work side by side, when the WWTP has common goals and a purpose that is clear to every employee (Sandelin 2017). The management and HR of WWTPs should support information sharing and prepare resources to create a discussion among the employees and identify the most suitable platform/tool for this. Non-formal (but content-verified) learning alongside everyday practices could be the best solution regarding the general situation in the WWTPs.

How should WWTPs then start to develop their act regarding information change and training? It is vital that WWTP management identifies the situation and copes with the challenges by recognizing the core competences and qualifications needed for particular tasks, and recognizes where the tacit knowledge is hidden (Sandelin 2017). Management should offer the most up-to-date guidance and sophisticated documentation systems to ensure sufficient resources and opportunities for knowledge transfer. It has been suggested that WWTPs start to maintain a knowledge management and development strategy to solve the challenges rising from knowledge retention (Sandelin 2017). The starting point is that the WWTPs evaluate which core competences need a permanent employee, and which of the competences could be covered by providing supplementary training to current employees.

WWTPs' activity toward the training facilities and institutions plays an important role in the setting and updating of the practice-based requirements for the education. Learning from the industry sector is needed to better understand the skills, challenges and demands by the water industry. The gap between theory and practice hampers the cooperation opportunities between the WWTPs and universities. Improving local co-operation and knowledge exchange between the WWTPs and universities has been one of the development objectives of the European Institute of Innovation and Technology (EIT), the European University Association (EUA) and the research & development framework programs of the European Union (e.g. FP7, H2020). The same phenomenon was also verified in the IWAMA project (see Figure 5). One interesting detail that came up in the capacity development workshop (Survey 4) discussions was that WWTPs were expecting improvements from the university side, mostly regarding the engineering studies. The training institutions (including universities) in turn emphasized the on-site learning and short-term practical courses in WWTPs. On the other hand, the practicality and practical guidelines including industrial-based learning materials are also needed by the TVET teachers and trainers (UNESCO 2012).

According the IWAMA surveys (1, 3; Annex I) and workshop discussions (2, 4, 5; Annex II), tighter co-operation is needed in the wastewater sector both horizontally and vertically. There is a common need for practice-bound training methods that provide qualifications, for example, for proactive decision making regarding the more monitored and automatized management technology and changes in the operation environment. Knowledge and information exchange is needed, not only between the universities and WWTPs, but also with the suppliers of the technical solutions, stakeholders, owners, reference WWTPs, authorities and other training institutions. Different backgrounds of the people support the mixture of the courses or a wider "course plate" from different levels of the educational hierarchy to achieve the needed

competences with an adequate interface to practice. This would mean closer collaboration, co-study, curricula planning and common courses between the educational institutions. The TVET institutions are challenged to explore and to exchange information about innovative teaching and learning methods, such as programs, curricula, sustainable International training, materials, etc. (UNESCO 2012). Dialogue between the universities and operators could be increased already during their basic training via common practice sessions. This could also be an effective tool to narrow the gap between the universities and WWTPs.

According to the IWAMA surveys (1, 4; Annex I), there is an identified need for international information exchange, such as a need for platforms connecting the actors around the wastewater sector. However, the lack of such facilities as professional forums in the internet, social media, digital training material and training applications is evident. Social computing is a mainstream use of the internet and people of all ages are increasingly joining communities. This open possibility also enables interactive, international development of skills, exchange of experiences and problem solving (Aceto et al. 2010). However, mere participation does not lead to learning, neither is it available for all people. Thus, educators should recognize the feasibility of the methods for the delivery of content and development of desirable competences, but they should also ensure the skills to participate in the e-capacity development sessions (Ala-Mutka 2010). On the other hand, the existing information sharing platforms, (national) webinars, seminars, conferences and training courses, could be utilized better to serve the current needs. The increasing virtual and e-lecture possibilities introduce ways to enhance interactivity and international knowledge exchange via the already existing popular platforms, such as the national and local seminars and workshops.

4.2.2 Recommendations for Further Capacity Development in Baltic WWTPs for Enhanced Lifelong Learning of Operators

At the strategic level, the WWTPs should pay more attention to knowledge management and staff development. The WWTPs need to create systems for identifying such necessary information that is produced outside their own plant and how this new information, as well as existing knowledge, is shared with the employees. The management and HR of the WWTPs should also prepare resources to create a dialogue among the employees and identify the most suitable platform/tool for this.

To introduce heterogeneous, student specific needs to the teaching, the education structures should be flexible. The flexibility between formal, informal and self-directed learning methods are needed to share, not only the "tailor made" technical knowledge, but also the development of the soft skills – both for the "blue- and white collar" workers. This heterogeneous starting point with the information gaps rising, for example, depending on age and background, makes the development of "official" training paths challenging. Sharing of knowledge should be offered in the most appropriate way. The media applied for the sharing should meet the various capabilities of the employee groups and/or the individual needs of the employee.

The main "Baltic bottleneck" is the high number of older workers. The challenge is to motivate this staff group. E-solutions and existing best practices that support information exchange and documentation should be emphasized, but the methods should be carefully adjusted to the needs and the opportunities to take part in learning. Non-formal learning during the daily work tasks or daily routines could give the best results, especially relating to the capture of tacit knowledge.

E-learning: In the future, the basic online training material produced on the basis of the EQF competences for WWTPs, together with e-tests, should ensure that the operator has the basic level of qualifications required. This situation would resolve the problems related to the availability of the workforce (also from other EU countries) and verification of their competences. It would also constitute a next step towards an online certification system, which is an important part of the credibility of online studies.

Peer learning and participation in conferences and seminars are useful methods for professional development. The WWTPs should pay attention to the value of these methods, and develop a systematized approach to them. The role of internationalization, for example, international peer-to-peer learning, is increasing, as issues, such as extreme weather phenomena, industrial symbiosis or new technology, are increasingly developed in an international context.

Learning related to the soft skills (interpersonal, intercultural and international) needed by the operators of the WWTP should be relevant and close to practice. Collaboration with (vocational) educational institutions, apprenticeship training or interactive e-learning close to the practical work is highly important in all the educational levels regarding wastewater management sector.

Due to the different situations in the countries, there is no one-fit-all model. The motivations and barriers towards learning are different in the countries surrounding the Baltic Sea. The age structure of the workforce and the availability of computers at the workplace are two examples of such differences, and, therefore, different solutions are needed for successful staff development.

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Annex I: List of the Surveys and Data Collection Done During the IWAMA Project

Survey	For what	For who	When and how
Survey 1	The wastewater treatment sector "need survey"	IWAMA partner, associated partners and their co-workers (e.g. Baltic WWTPs)	Beginning of the project, 2016 (web-survey)
Survey 2	State of arts in the Baltic water sector, Capacities required and lifelong learning tools to "tackle" the needs identified	Workshop 1 participators	Documented, initiated groups discussions during the capacity development workshop 1 in Lahti, Finland, 2016
Survey 3	Good practices and lifelong learning references survey	For the capacity development partners of IWAMA (the heads of the "national knowledge based communities")	During the year 2017
Survey 4	Factors affecting the capacity development (characteristics & implementations) in practice	Workshop 2 participators	Documented, initiated groups discussions during the capacity development workshop 2 in Boltenhagen, Germany, 2017
Survey 5	Education and "lifelong learning tools" survey – the state of the art in the WWTP	Baltic WWTPs (Assisted by the water associations)	During the 2017-2018 (web-survey)
Survey 6	The change in the needs during and impact of the IWAMA project	IWAMA partner, associated partners and their co-workers (e.g. Baltic WWTPs)	End of the project survey, 2019

All the workshops (1-6) included the surveys that aimed to the monitoring of the capacity development impact during the IWAMA project. Reported separately.

ANNEX II: Capacity Development Workshops and Webinars During the IWAMA Project

Workshops

1st International Capacity Development Workshop:
Identification of Capacity Development needs in WWTP
20.–21.09.2016 Lahti, Finland

2nd International Capacity Development Workshop:
Energy Production in WWT
14.–15.02.2017 Boltenhagen, Germany

3rd International Capacity Development Workshop:
Energy Efficiency in WWT
7.–8.6.2017 Szczecin, Poland

4th International Capacity Development Workshop:
Smart Sludge Management
8.–9.2.2018 Tartu, Estonia

5th International Capacity Development Workshop:
Nutrient reduction and recovery
13.–15.6.2018 Kalmar, Sweden

6th International Capacity Development Workshop:
Constructional and operational challenges
20.–21.9.2018 Gdańsk, Poland

Project Final Conference:
Towards efficient wastewater management – current trends and future aspirations
30.1–1.2.2019 Turku, Finland

Webinars

1st IWAMA Webinar on Capacity Development 9.12.2016
2nd IWAMA Webinar on Energy efficiency 23.05.2017
3rd IWAMA Webinar on Management of maintenance 25.09.2017
4th IWAMA Webinar on Pre- and post-treatment on WWTP 09.04.2018
5th IWAMA Webinar on Co-operation and symbiosis 4.12.2018

02

State of the Art Report Summary from the WWT Sector in the Baltic Area

Sami Luste (ed.)
Katerina Medkova (ed.)

Introduction

The present State of the Art in the Wastewater Treatment Education in the Baltic Region report has been produced as a part of the capacity development activities in the IWAMA - Interactive Water Management project (2016-2019; Interreg Baltic Sea). The report is supplementing the Lifelong Learning and Wastewater Treatment in the Baltic Sea Region report and offers country-specific information about the wastewater treatment characteristics and education in the IWAMA project partner countries. The present report can work as a tool for benchmarking of the educational practices, such as helping to estimate the national suitability of the new lifelong learning opportunities (presented by the Lifelong Learning and Wastewater Treatment in the Baltic Sea Region report).

The report includes seven partner nations around the Baltic Sea (Finland, Germany, Estonia, Lithuania, Sweden, Latvia, and Kaliningrad and it is co-written with the IWAMA partners responsible for the capacity development of the WWTP operators in their countries. The partners involved are water associations (DWA, EVEL, LWWWA), environmental centres (ECAT-Kaliningrad, ECAT-Lithuania), and educational institutions (Lahti University of Applied Sciences, Linnaeus University). Due to the different backgrounds of the co-writer organizations and the highly heterogeneous development states around the Baltic Sea, the cooperation is needed in every level of the capacity development operations.

The State of the Art is written by Sami Luste (Editor), Katerina Medkova (Editor), Päivi Kärnä & Kimmo Heponiemi, Faculty of technology, Lahti University of Applied Sciences (Finland); Sandra Haase, Matthias Ebel & Ralf Schüler, German Association for Water, Wastewater and Waste, DWA regional group north-east; Sander Sepp & Lauri Lagle, Estonian Waterworks Association; Lina Gelažienė, Environmental Center for Administration and Technology; Baiba Gulbe, Latvian Water and Wastewater Works Association; Olga Sheshukova & Ekaterina Latysheva, State Autonomous Institution of the Kaliningrad Region, Environmental Center ECAT-Kaliningrad; and Fabio Kaczala & Juris Burlakovs, Linnaeus University (Sweden).

We thank all of the "partners in kind" for their valuable contribution and sharing information and interest toward the capacity development activities and tools introduced by the IWAMA project.

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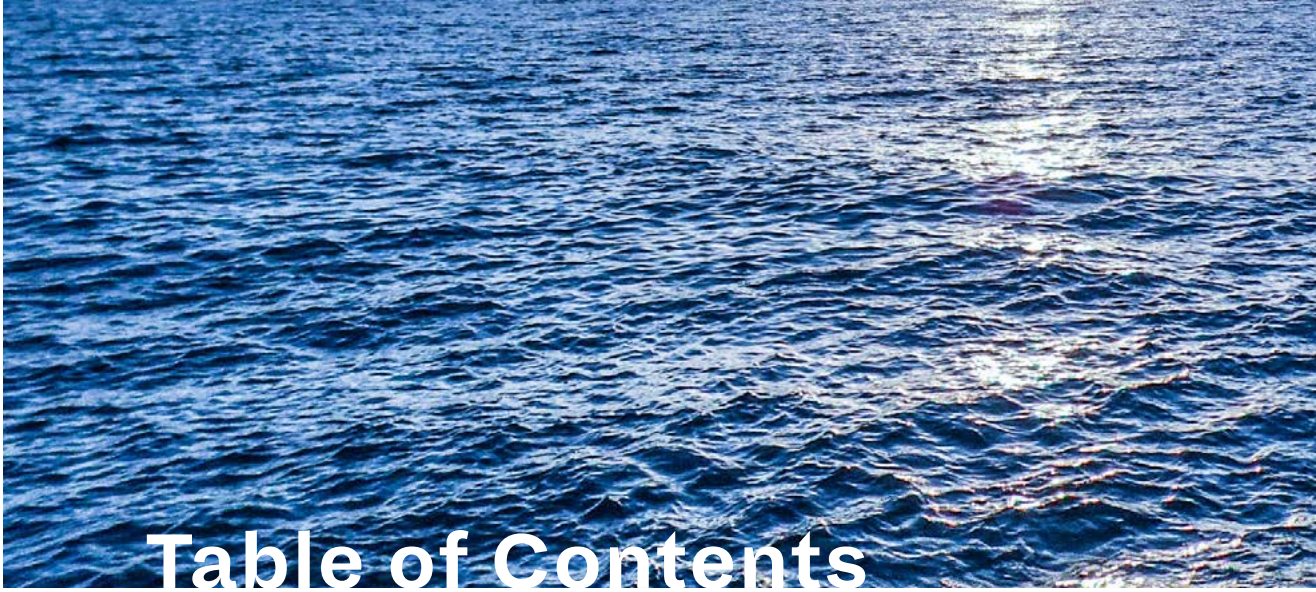

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STATE OF THE ART IN THE WASTEWATER TREATMENT EDUCATION IN THE BALTIC REGION

1. Current State of Art in WWTP's

The aim of this chapter is to describe the situation in the WWTPs in the BSR: what kind of WWTPs are there and what kind of workers work in them.

1.1 Finland

Current state of WWTPs

There are about 540 municipal wastewater treatment plants in Finland (Finnish Environment Institute 2015). According to the Environmental Ministry of Finland, there are 412 municipal WWTPs with an environmental permit in Finland (2015,1). They are treating about 500 million m^3 of wastewater annually (Laitinen et al. 2014, 8). Most of the plants use a mechanical-biological-chemical process in the treatment of wastewater (FIWA 2014, 4). The treatment efficiency of the Finnish WWTPs is high, with 97% organic matter, 96% phosphorus and 56% nitrogen (FIWA 2014, 3).

The wastewater treatment plants can be divided into five groups based on the WWTPs' population equivalent as described in Figure 1 below. Most of the wastewater plants are small, with a population equivalent under 500.

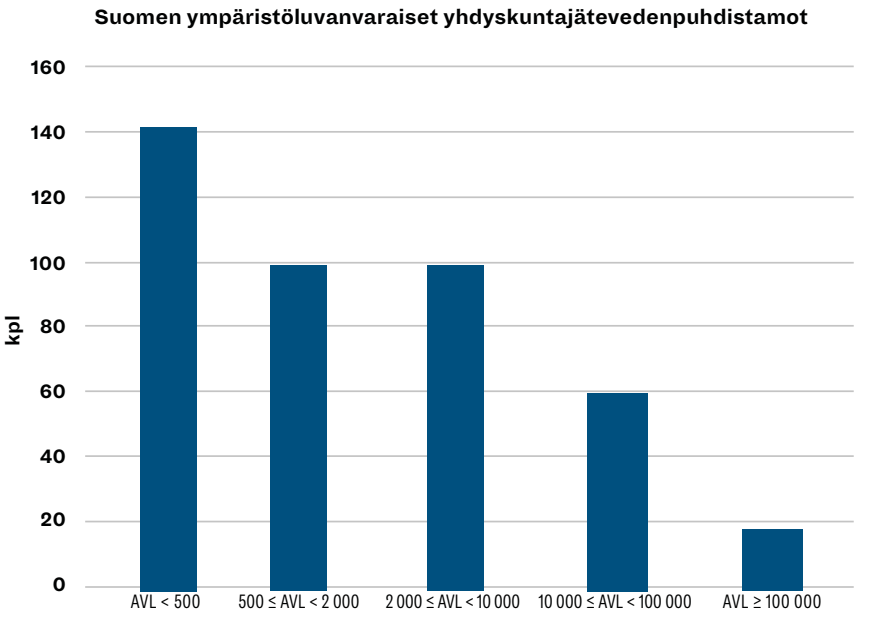


Figure 1. The division of Finnish municipal wastewater plants based on population equivalent (Environmental Ministry Finland 2015, 1)

Based on an interview with a representative of the Finnish Water Utilities Association (FIWA) (Kärnä 2017a), the special characteristics of the WWTPs are, for example, the size of the plant, the treatment method used and the type of organization (private, public). In bigger plants, the staff is more specialized, and in smaller plants the staff is expected to obtain a larger scale of know-how. In the smallest plants, one person can be held responsible for the whole plant. Bigger plants are also more capable of organizing their own training. The small and medium-size plants are more in need of external training materials. Small plants often do not have the possibility to send their staff to training, which should be taken into consideration when planning suitable training for the WWTPs.

Current state of workers in WWTPs

In 2011, there were about 4000 people working in the water supply and sewage systems sector in Finland. The number of the personnel has been decreasing when comparing to the numbers of the year 2002. The results include both the clean water and the WWT sector, since it was not possible to extract the share of wastewater treatment workers. (Salminen et al. 2015, 8)

The profile of a usual representative of the Finnish water supply and sewage systems personnel is a man born in the 60s or before, having a vocational education degree. Table 1 presents the division of the age groups between the different education levels. Half (51%) of the water supply and sewage systems personnel in Finland was born in the 60s or before. Most of them, 48 percentage units (of 51 percentage units) have no professional degree or have a vocational education or a degree from a vocational college (this form of education is no longer provided to new students in Finland). The other half, staff born in the 70s or after, consists mostly of staff with a vocational degree (28 percentage units of 49 percentage units) and then evenly of staff with no professional degree or with a college or a higher education degree. (FIWA 2015, 29)

Table 1. Educational level of staff of water supply and sewage systems (FIWA 2015, 29)

	Born in the 60s or before	Born in the 70s or after	Both
No professional degree	age groups	6 %	19 %
Vocational education	23 %	28 %	51 %
College degree	12 %	9 %	21 %
Lower university degree	2 %	5 %	7 %
Higher university degree	1 %	1 %	2 %
Age groups total	51 %	49 %	100 %
Degrees and age groups total	**100 %**		

All in all, an average of 19% of the staff of water supply and sewage systems have no degree; half of the staff, 51%, have a vocational education degree; 21% have a college degree; 7% have a lower university degree and 2% a higher university degree. The percentage of staff with higher education has decreased from the level of the year 2002 as has the whole number of staff. (Salminen et al. 2015)

Based on a questionnaire (n=27) for WWTPs' management and operators conducted in the IWAMA project, the development of the know-how of the staff is followed through training plans (9), occasional courses (5) and other ways (6), such as professional certificates, conversations and through following the treatment results (Lahti UAS 2015; 2016).

1.2 Germany

Current state of WWTPs

In Germany, there are approximately 9,500 WWTPs of which 5,832 WWTPs were registered in the seven regional groups of the DWA in the year 2015 (Table 2).

Table 2. Number of WWTP listed in the regional groups of DWA (DWA 2015)

DWA regional group	Baden-Württemberg	Bavaria	Hesse/ Rhineland-Pfalz/ Saarland	North	North-East	North Rhine-Westphalia	Saxony/ Thuringia	total
Number of WWTP	922	1,598	1,400	526	319	460	607	5,832

The WWTPs are divided into five groups based on the population equivalent (PE) (Table 3).

Table 3. WWTPs based on the population equivalent (PE)

Group 1	0 – 999 PE
Group 2	1,000 -5,000 PE
Group 3	5,001 – 10,000 PE
Group 4	10,001 – 100,000 PE
Group 5	>100,000 PE

In Figure 2, the number of WWTPs in Germany is illustrated depending on the capacity.

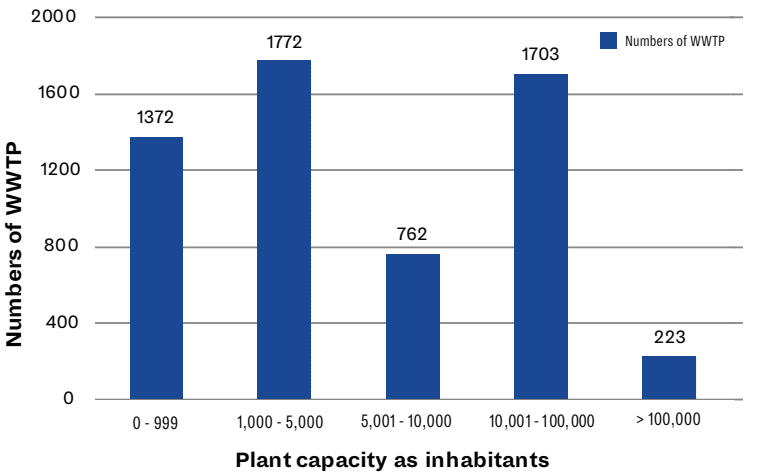


Figure 2. Number of WWTPs in relation to the capacity (DWA 2015)

The key figures of the listed WWTPs were also collected in the DWA study (2015). Data on inflow and outlet measurements (average values), the degree of degradation and further characteristic values are listed in Table 4.

Table 4. Key figure collection (DWA 2015)

DWA regional group	Baden-Württemberg	Bavaria	Hesse/ Rhineland-Pfalz/ Saarland	North	North-East	North Rhine-Westphalia	Saxony/ Thuringia	Total
Volume of wastewater per year (Mio. m³)	1,450	1,468	1,371	841	506	2,215	456	8,306
Plant capacity (Mio. population equivalent)	21.6	26.6	18.2	21.1	13.7	29.3	8.4	139.1
Specific waste water discharge (m³/(PE·a))	90	76	90	52	42	107	71	78
Specific energy consumption (kWh/(PE·a))	33.0	30.7	33.0	31.4	30.2	34.6	32.3	32.3
Chemical oxygen demand (COD)								
inflow (mg/L)	486	574	487	849	1,041	410	627	560
outlet (mg/L)	21	27	23	37	41	25	29	27
degradation (%)	95.7	95.2	95.2	95.6	96.1	93.9	95.4	95.2
TOTAL N								
inflow (mg/L)	44.8	53.3	46.6	70.8	88.3	38.0	61.6	51.0
outlet (mg/L)	9.4	9.7	8.4	8.6	11.1	6.8	9.7	8.6
degradation (%)	79.1	81.8	82.0	87.8	87.5	82.2	84.3	83.1
TOTAL P								
inflow (mg/L)	7.0	8.4	7.1	11.2	15.1	5.9	9.1	8.0
outlet (mg/L)	0.54	0.90	0.82	0.60	0.61	0.44	0.94	0.65
degradation (%)	92.4	89.3	88.5	94.6	96.0	92.5	89.4	91.8

The evaluation of the main cleaning steps was performed during 2012 in a further DWA study. Only one-stage wastewater treatment plants were considered where a clear allocation to the following cleaning procedures was possible.

- activated sludge system with anaerobic sludge stabilization
- activated sludge system with aerobic sludge stabilization
- SBR technology (sequencing batch reactor)
- trickling filter
- wastewater ponds (no aeration)
- wastewater ponds (aeration)
- constructed wetlands

The corresponding number of WWTPs is listed in Table 5 according to the above-mentioned treatment steps and the plant capacity.

Table 5. Number of WWTPs per treatment step in the German wastewater sector (DWA 2012)

Plant capacity (PE)	activated sludge system with anaerobic sludge stabilization	activated sludge system with aerobic sludge stabilization	SBR technology	trickling filter	wastewater ponds (no aeration)	wastewater ponds (aeration)	constructed wetlands
0 – 999	--	220	57	87	233	125	59
1,000 – 5,000	--	581	63	146	20	147	--
5,001 – 10,000	37	318	22	34	--	--	--
10,001 – 100,000	526	381	30	20	--	--	--
>100,000	113	--	--	--	--	--	--
Total	**676**	**1,500**	**172**	**287**	**253**	**272**	**59**

Current state of workers in WWTPs

Figure 3 shows the number of employees in the water supply sector in Germany.

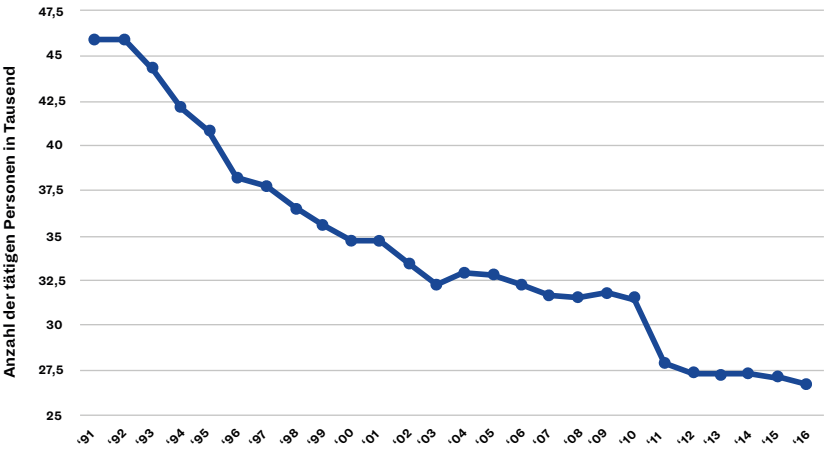


Figure 3. Number of employees in the water supply sector in Germany from 1991 to 2016 (in 1.000)

In 2016, a total of 26,700 employees were listed in the water supply sector (Statista 2017).Different sources give varying information on the numbers of employees in the water management sector. For instance, one source claims 60,000 employees in 2010 in the water supply sector and 40,000 in the wastewater treatment sector (Federal Environment Agency 2017). The average age of employees ranges from 42 to 48 (Haase 2017).

The following Figures 4 and 5 represent the age groups of the participants who answered the LAMK questionnaire (Lahti UAS 2016). They are separated into managerial and operational personnel. Out of 34 participants, 33 were male and one female.

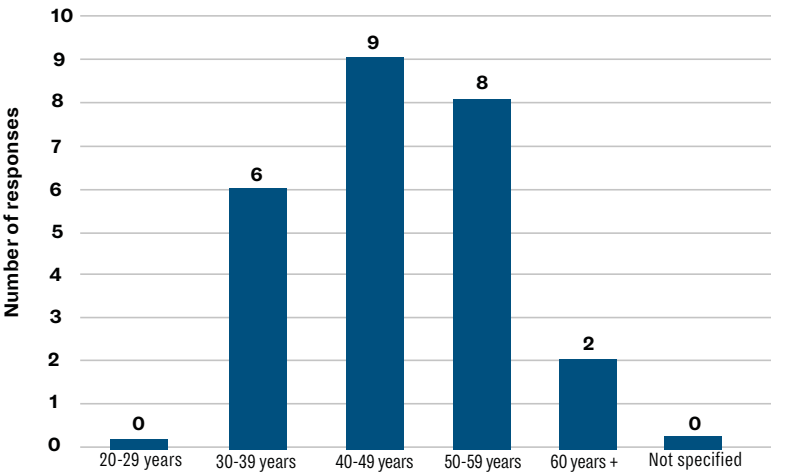


Figure 4. Managerial staff workshop participants, n=25

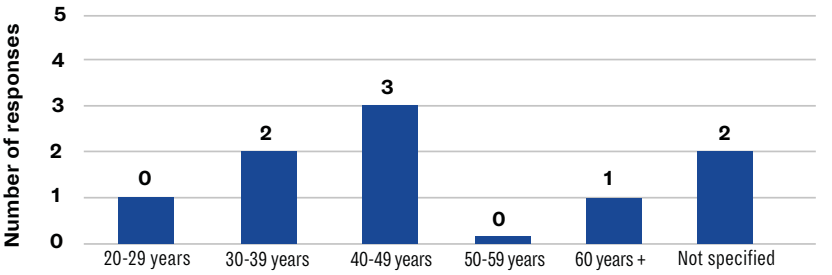


Figure 5. Operational staff workshop participants, n=9

Table 6 shows the educational level of the participants.

Table 6. Educational level of staff

Managerial staff	Operational staff
M.Sc.	Wastewater Technician
M.Eng.	Maintenance Technician
Chartered Engineer	Technician for closed substance cycle waste management
Water- and Wastewater Technician	Sewage works operator
Mechatronic Technician	Specialist wastewater technology
Measuring and regulation technician	
Electrician	
Maintenance Technician	

More complex technologies naturally require more skilled personnel. Also for measurements and maintenance, qualified engineers are needed. Big plants might need more specific training due to more advanced technology and bigger resources. The requirements for technical managers depending on the size and volume of the WWTPs are given in Table 7.

Table 7. Requirements for technical managers depending on size and volume of WWTP (DWA 2012b)

WWTP capacity (PE)	1 ≤ 1.000	2 ≤ 5.000	3 ≤ 10.000	4 ≤ 100.000	5 > 100.000
Operation of sewer system	A1	A2	A2/B	B/C	C
Operation of WWTP	A2	A2	A2/B	B/C	C
Operation of WWTP + sewer system	A2	A2	A2/B	B/C	C
Planning, construction, sewer system	C	C	C	C	C
Planning, construction, WWTP	C	C	C	C	C
Planning, construction WWTP + sewer systems	C	C	C	C	C

Legend

A1: specialized craftsmen (metalworker, electrician or equivalent degree with knowledge about wastewater)

A2: skilled labourer

B: certified wastewater manager/technician or equivalent degree

C: employee with a university degree (technical university, university, university of applied science) or equivalent degree

The number of employees is related to the size of the WWTP and cannot be generalized. For calculating staffing requirements, the DWA advisory leaflet M 271 (DWA 2017) can be used. The staffing requirements depend on the needed working time per month, which in turn depends on the technical standard.

As an example, the staffing requirements are calculated in the DWA advisory leaflet M 271 (DWA 2017) using a wastewater treatment plant with a capacity of 20,000 population equivalents (PE). The basis for the calculation is the statutory personnel hours per year (1,667 h) and the needed working time per year to manage the processes of mechanical treatment, biological purification, sludge stabilization, sludge utilization, energy production (4,130 h). The personnel expenses are calculated with a surcharge of 14% and amounted to 2.8 employees.

1.3 Estonia

Current state of WWTPs

There are ca. 700 municipal WWTPs in Estonia. Out of them, 245 have been renovated in 2004-2014 with the finances from the EU and local waterworks (Register of Estonian Environmental Information 2018). Besides renovated plants, a lot of smaller WWTPs are still using older technology without adding any chemicals and are generally amortized.

When commercial WWTPs and state-approved pre-treatment facilities are added, the total number of active wastewater treatment permits is 1106 (Register of Estonian Environmental Information 2018).

Current state of workers in WWTPs

Most of the everyday operators have gone through a 2-week course sponsored by the Ministry of the Environment. It lays a good enough foundation to get to know the basics of the WWT cleaning process if the student has no prior knowledge of the subject. Complemented with spontaneous on-site training in the company, this is the basic level of almost all operators. (Collective discussions 2010-2017)

A special 2-year course for water and wastewater operators started on September 1st 2017. The course consists of lectures in Järvamaa Vocational Centre and on-site training arranged by the employer. The following digital platforms have been used as learning tools: internet, video. (Järvamaa Vocational Centre 2017)

The workforce in Estonian WWTPs is showing the tendency of ageing. This is seen in other sectors as well. The average age of operators is around 45 with a working experience in the range of +15 years. The ratio between men and women is around 90/10. Men are usually skilled manual workers and have a vocational education closely related to waterworks. Women usually have a degree or higher education and tend to share multiple tasks in the companies as operators, environmental specialists, and laboratorians and are, therefore, well suited to work in a more complex WWTP. (Collective discussions 2010-2017)

According to collected information (Estonian WWTPs, EVEL), the best system of educating WWTP personnel in Estonia would be (Collective discussions 2010-2017):

- Training at basic levels (beginners, advanced)
- Specific secondary level for wastewater plant operators only

1.4 Lithuania

Current state of WWTPs

According to the National Commission for Energy Control and Prices (2015), there are 67 licensed water and wastewater treatment plants registered in Lithuania. Out of them, 50 companies concentrate their activities on water supply and wastewater treatment and 17 are combined companies, having other activities, such as waste management, water management, city cleaning activities, etc. Detail characteristics of WWTPs in Lithuania are provided in Table 8. Information on how many employees a WWTP has, the length of wastewater network and the treatment method was obtained from the companies' websites. (National Commission for Energy Control and Prices 2015)

Table 8. WWTP in Lithuania (National Commission for Energy Control and Prices 2015)

No.	Company	No. of employees	Length of wastewater network	Treatment method
1	UAB Birštono vandentiekis	25	Not available	Biological treatment
2	UAB „Skuodo vandenys“	30	58	Biological treatment
3	UAB Lazdijų vanduo	31	24 km	Not available
4	UAB Neringos vanduo	31	41 km	Mechanical and biological treatment
5	UAB Pagėgių komunalinis ūkis	32	25 km	Mechanical and biological treatment
6	UAB Pakruojo vandentiekis	33	116 km	Mechanical and biological treatment
7	UAB Zarasų vandenys	34	128,6 km	Not available
8	UAB Molėtų vanduo	37	60 km	Mechanical and biological treatment
9	UAB Kupiškio vandenys	39	69 km	Biological treatment
10	UAB Šilalės vandenys	39	95 km	Mechanical and biological treatment
11	UAB Širvintų vandenys	39	Not available	Not available
12	UAB Biržų vandenys	40	78 km	Not available
13	UAB Ignalinos vanduo	41	112,0 km	Not available
14	UAB Kelmės vanduo	43	Not available	Not available
15	UAB Prienų vandenys	43	Not available	Not available
16	UAB Kazlų Rūdos komunalininkas	44	Not available	Not available
17	UAB Pasvalio vandenys	45	98 km	Not available
18	UAB Joniškio vandenys	49	Not available	Not available
19	UAB Anykščių vandenys	50	226 km	Biological treatment
20	UAB Varėnos vandenys	53	88 km	Not available
21	UAB Šakių vandenys	57	175 km	Not available
22	Alytaus rajono savivaldybės įmonė Simno komunalininkas	59	Not available	Not available
23	UAB Raseinių vandenys	63	108 km	Not available
24	UAB Rokiškio vandenys	64	107 km	Mechanical and biological treatment
25	UAB Vilkaviškio vandenys	64	182 km	Not available
26	UAB Druskininkų vandenys	66	117,20km	Mechanical and biological treatment

27	UAB Jurbarko vandenys	69	300 km	Not available
28	UAB Plungės vandenys	71	199 km	Not available
29	UAB Radviliškio vanduo	74	191 km	Mechanical and biological treatment
30	UAB Kaišiadorių vandenys	75	Not available	Mechanical and biological treatment
31	UAB Kretingos vandenys	83	180 km	Mechanical and biological treatment
32	UAB Ukmergės vandenys	87	285 km	Not available
33	UAB Jonavos vandenys	89	220 km	Not available
34	UAB Trakų vandenys	92	Not available	Not available
35	UAB Giraitės vandenys	93	Not available	Not available
36	UAB Palangos vandenys	99	193 km	Biological treatment
37	UAB Šilutės vandenys	109	206 km	Not available
38	UAB Tauragės vandenys	111	303 km	Mechanical and biological treatment
39	UAB Kėdainių vandenys	129	348,1 km	Mechanical and biological treatment
40	UAB Telšių vandenys	129	213 km	Mechanical and biological treatment
41	UAB Utenos vandenys	133	227 km	Mechanical and biological treatment
42	UAB Mažeikių vandenys	135	227 km	Mechanical and biological treatment
43	UAB Dzūkijos vandenys	148	427,3 km	Mechanical and biological treatment
44	UAB Sūduvos vandenys	155	243 km	Not available
45	VĮ Visagino energija	205	68 km	Not available
46	UAB Aukštaitijos vandenys	248	822 km	Not available
47	UAB Šiaulių vandenys	267	620 km	Mechanical and biological treatment
48	AB Klaipėdos vanduo	384	720 km	Mechanical and biological treatment
49	UAB Kauno vandenys	473	-	Mechanical and biological treatment
50	UAB Vilniaus vandenys	654	1128 km	Mechanical and biological treatment

In Figure 6, the number of WWTP is illustrated depending on the capacity:

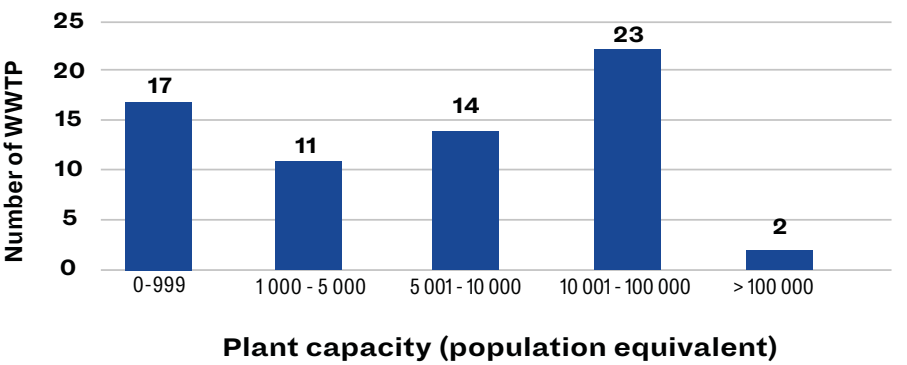


Figure 6. Number of WWTP in relation to the capacity

1.5 Sweden

Current state of WWTPs

In Sweden, the implementation of wastewater treatment plants began in the 1960s with the most intensive period of construction and implementation of treatment plants being between the 1960s and 1970s. Nowadays, in Sweden, there are more than 1700 wastewater treatment plants and a total of 101,000 km of sewage network. Most of these existing treatment plants usually receive domestic wastewater, industrial wastewater, drainage and infiltration waters and also stormwater from combined sewer systems. Most of the Swedish wastewater treatment plants (94%) rely on both biological and chemical processes for organic matter and nitrogen/phosphorus removal and the remaining 6% have either biological or chemical processes.

Usually, the hydraulic retention time in a Swedish treatment plant varies between ten and 24 hours depending on the treatment process and the volumes to be treated. In total, 1.5 billion cubic meters of wastewater is treated every year.

According to Statistics Sweden (Svenskt Statistik 2014), there are 431 wastewater treatment plants classified based on their treatment capacity (Table 9).

Table 9. Number of WWT plants listed in Sweden in relation to the capacity (Svenskt Statistik 2014)

Plant capacity [Persons equivalent]	<2 000	2 000-10 000	10 000-100 000	>100 000	**Total**
Number of WWTP	5	10	186	230	**431**

In Figure 7, the number of WWT plants is illustrated depending on the capacity.

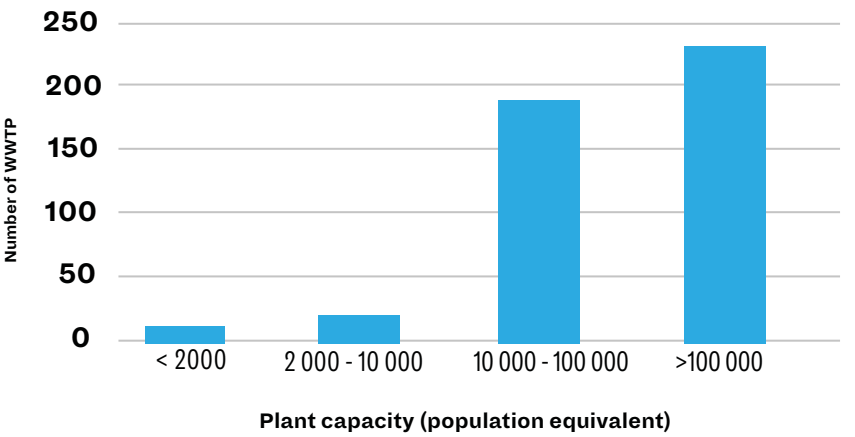


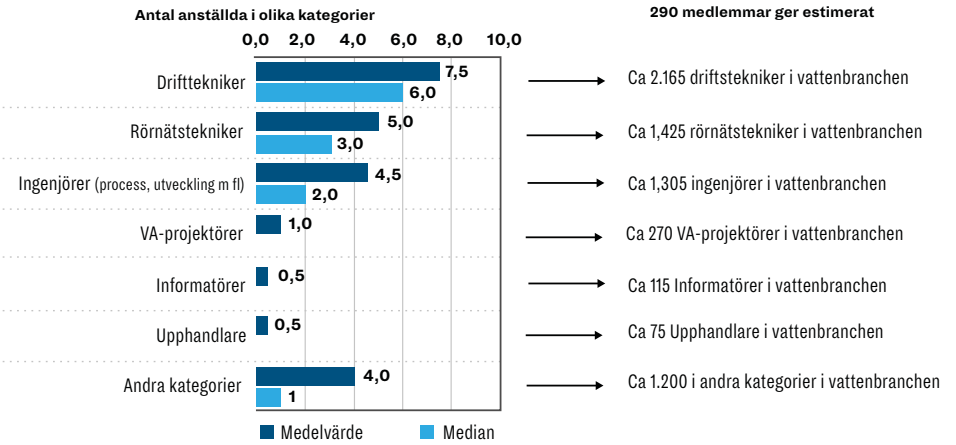
Figure 7. Number of WWT plants in relation to the capacity (Svenskt Statistik 2014)

The same report also presents the number of WWTPs in different regions within the Swedish territory as it can be seen in Table 10.

Table 10. Number of WWT plants in different regions of Sweden (Svenskt Statistik 2014).

Region	Bottenviken	Bottenhaven	Ostersjo	Oresund	Kattega	Skagerrak
Number of WWTP	26	93	161	15	112	24

In Sweden, the water and wastewater sector has always been organized as a municipal utility. Together, all water and wastewater treatment plants are operated/maintained by approximately 6 000 persons and the approximate number of employees and their respective functions is shown in Figure 8 below. This can give an idea of those working as technicias, working on the network and pipe systems as well as those working in the office as managers, engineers, lab technicians, etc. (SV 2017).



All population living in urban areas in Sweden are connected to a municipal sewage network and treatment. Most of the treatment plants built some decades ago had combined sewer networks. It means that storm water runoff was also being discharged into the Swedish WWTPs whereas the more recent treatment plants have separate sewer systems, thus avoiding the additional load brought by storm water. Approximately 20 to 25% of all urbanized areas are still connected to combined systems, although as previously mentioned, this is a more specific characteristic of older areas/districts (SV 2017; Sydvatten AB 2017).

In 2014, a study was reported that showed the number of treatment plants based on capacity and their main treatment processes as seen in Table 11 below (Svenskt Statistik 2014). It shows that most of the WWTPs (254) implement conventional technologies (Activate sludge + Chemical flocculation/coagulation).

Table 11. Number of WWT plants per treatment steps (Svenskt Statistik 2014).

P.E (person. equivalent)	Biological treatment	Chemical treatment	Biological-chemical (conventional treatment)	Biological-chemical (nitrogen removal)	Biological-chemical treatment
< 2000	> 100 000	1	0	1	1
2 000 - 10 000	> 100 000	1	3	0	5
10 000 - 100 000	> 100 000	37	127	8	14
> 100 000	> 100 000	0	124	105	0
Total	**>100000**	**39**	**254**	**114**	**20**

Based on performance information taken from Sweden as a whole, wastewater treatment plants reduced an average of 95-99% of the total phosphorus and organic matter load, and 40 – 80% of total nitrogen. The wide range of nitrogen reduction shows clearly that nitrogen relies very much on the technique and also operation/maintenance practices.

The average outlet concentration from municipal wastewater treatment plants of phosphorus, nitrogen, BOD_7, and COD_{cr} can be observed in Table 12 below.

Table 12. Water discharges from municipal WWT plants in 2014, average concentration of P, N, BOD_7, COD_{cr} (Svenskt Statistik 2014).

	Bottenviken	Bottenhavet	Östersjon	Oresund	Kattegat	Skagerrak
P [mg/l]	0.34	0.3	0.2	0.26	0.21	0.25
N [mg/l]	36.8	26.4	9.1	9.2	8.2	11.3
BOD_7 [mg/l]	14	7.9	3.5	5.9	7.5	6.1
COD_{cr} [mg/l]	52.2	42.7	34.9	34.8	40.3	43.9
Volume of wastewater [m^3]	23135	64378	333870	82605	179011	24659

The incoming and outcoming flows of Phosphorus, Nitrogen, BOD7 in municipal WWTP of different regions are observed in Table 13 below.

Table 13. Incoming and outcoming flows of P, N, BOD_7 at municipal WWTP in 2014 (Svenskt Statistik 2014).

	Bottenviken	Bottenhavet	Östersjon	Oresund	Kattegat	Skagerrak
P in [tonn]	110	322	1573	342	637	84
P out [tonn]	8	19	68	22	38	6
N in [tonn]	1026	2463	12595	2953	4772	705
N out [tonn]	851	1700	3029	757	1463	279
BOD_7 in [tonn]	4009	10582	59996	14230	28653	3129
BOD_7 out [tonn]	323	507	1175	486	1335	151

Table 14 shows the concentration of P, N and metals in sludge from municipal WWTP.

Table 14. Concentrations of P, N, metals in sludge from municipal WWT plants in 2014 (Svenskt Statistik 2014).

	[mg/kg]
P	26360
N	45150
Cd	0.9
Cr	24
Cu	248
Ni	16.3
Pb	19.4
Zn	568.2

1.6 Latvia

Current state of WWTPs

According to data of the year 2004 from the Latvian Environment, Geology and Meteorology Centre, there are 1270 WWTPs in Latvia. Population equivalents (PE) in relation to WWTPs are shown in Table 15 below. (Latvian Environment, Geology and Meteorology Centre 2017)

Table 15. Population Equivalents in Latvia

PE	Number of WWTP servicing the according to PE
<500	916
500 to <2000	156
2000 to <5000	26
5000 to <10 000	13
10 000 to <50 000	12
50 000 to <100 000	1
100 000 and more	3
WWTP matching no category	143
Total	**1270**

According to the Latvian Environment, Geology and Meteorology Centre 2014 data, 911 WWTPs use the biological treatment method, 4 WWTPs use chemical treatment and 355 WWTPs apply mechanical treatment (Latvian Environment, Geology and Meteorology Centre 2017).

1.7 Kaliningrad

Current state of WWTPs

In order to understand what factors affect the main needs in the training and education of WWTP personnel, it is important to mention that the Russian water and wastewater infrastructure is characterised by a high degree of wear and tear, high rate of service breakdowns and a meagre replacement of wastewater pipes per year.

Taking into consideration the regional specifics of the Kaliningrad region, we must say that during the past few years, great work has been done on the reconstruction and modernization of WWTPs. All large towns of our region are provided with WWTPs, but unfortunately, the majority of smaller settlements are still in need of treatment facilities.

There are 20 municipal WWTPs (Table 16) and all of them use biological treatment. There is only one exception at the Ilyushino village wetland plant (Nesterovskiy Municipality) where tertiary treatment is applied. The number of WWTPs' employees varies from 15 to 50.

Table 16. Overview of WWTP in Kaliningrad region

no.	Capacity, m^3 per day	Number of WWTPs	Total population
1	≤ 5,000	13	~ 75,000
2	5,000-15,000	3	~ 98,500
3	15,000-35,000	3	~ 117,000
4	> 35,000	1	~ 460,000

Describing the process of WWT in the Kaliningrad region, the main stages are: separation, pre-clarification, biological purification, secondary clarification, sludge treatment, and removal of phosphorus. At five WWTPs of the region (Figure 9), secondary settling tanks are not used. Regarding the process of phosphorus removal, it is applied at each WWTP but at one plant, chemical reagents are added during the winter period, and during summer, the removal of phosphorus is achieved by biological methods.

In 2014, a WWTP was constructed in the Soviet Union with the capacity of 25,000 m^3 per day. There is no similar WWTP in Russia. In the wastewater treatment process at this plant, additional cleaning is included with the application of membrane filters. Membrane technology allows achieveing bigger volumes of sludge concentration and reduction of the quantity of surplus sludge, which leads to the decrease of aero tank's volume. In this approach, all contaminants are held and there is no need for extra hygienisation, because treated water contains only tracks of dissolved substances, and as a result, a high-quality treatment is achieved.

Figure 9. Scheme of the WWTPs in the Kaliningrad region based on data received from the Ministry of Housing and Public Utilities of the Kaliningrad region (CACAT 2017)

Current state of workers in WWTPs

According to the expert survey (Lahti UAS 2016), at the WWTPs of medium size in the Kaliningrad region, the number of workers does not exceed 25 people. Out of which 75% are men and 25% women (Figure 10). Women usually work as laboratory assistants and technologists, men as operators and directors. Concerning the educational level, there is the following tendency: 35% of workers have no professional degree, 63% have vocational education and the remaining 2% have a higher university degree. Talking about the age structure, 65% are between 50-55 years old, and 35% are between 30-50 years old.

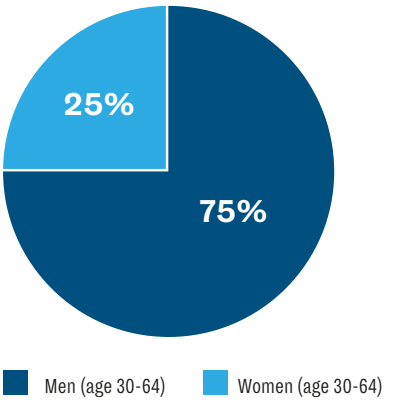


Figure 10. Overview of WWTPs' employees in the Kaliningrad region

The main requirements of the employer to the operator of the WWTP are:

- Level of education: vocational education
- Work experience: at least two years
- Understanding the wastewater treatment technology, how the WWTP operates and what equipment is applied and how it functions.

2. Current State of the Art in Wastewater Treatment Education

In this report, the current state of the art in WWT education in the BSR countries is viewed from the point of view of formal and non-formal education. Formal education includes such education that leads to a degree and non-formal education does not lead to any degree.

2.1 Finland

Formal learning

In Finland, the Ministry of Education and Culture prepares the legislation regarding education and also controls and supervises the education. It determines how many study places each education provider gets.

At the moment, there is a reform project regarding upper secondary level studies going on in Finland, which is planned to be finished in 2018. The reform concerns the control, supervision, degrees and forms of education and is basically aiming at making the VET education more flexible and fluent (Kivinen 2015; Ministry of Education and Culture Finland 2017a, 2017b).

Vocational education in WWT sector

In the vocational education, the education can be looked at from the upper secondary qualification point of view and further qualification point of view. Shortly described, upper secondary qualification studies are usually studied after comprehensive school. Further qualification studies are such that a person already working in the field might take.

Work in the WWTPs requires versatile know-how and understanding to keep up the process. Some of the degree studies offered for the need are, for example, processing industry and automation. Also, other professions/skills, such as electrician and business skills are needed in WWTPs.

Some programs offering vocational education related to the WWT field are described in Table 17 below.

Type of organization	Level of degree	Number of organizations	Programs offering WWT related education	Duration of programme
Vocational institution		53	Processing Industry	Estimation: 2 years
	Vocational upper secondary degree	135	Machinery and Production Industry	
		129	Electrical Engineering and Automation technology	
Vocational institution	Further qualification	Sykli Environmental School of Finland	Further qualification in Water Supply and Sewage	1,5 years, starting January 2018
Vocational institution	Qualifications degree		Qualification in Water Supply and Sewerage Specialist	
Vocational institution			Qualification in Sustainability and Environmental Technology	

Table 17. Organizations offering vocational education and programs (Studyinfo 2017; SYKLI 2017).

• Upper secondary qualifications

In Sykli, it is also possible to acquire vocational qualifications in the water supply sector as well as study in a degree program for water management (SYKLI 2017). In addition, there are other educational centres providing environmental qualifications, such as Savo University of Applied Sciences, Tampere Adult Education Centre TAKK and Saimaa Vocational College Sampo.

Processing industry qualifications are offered in 53 vocational institutions in Finland. A part of the qualification studies are aimed at participants with a comprehensive school and a part with an upper secondary school background (Studyinfo 2017).

• Qualifications degrees

There are two vocational education qualifications degrees aimed at the needs of the wastewater treatment sector in Finland. The names of the degrees are Further Qualification in Water Supply and Sewerage, and Specialist Qualification in Sustainability and Environmental Technology. Both programmes are aimed at people already working in the WWT field. Both degree studies are respected due to their practicality and the wide range of content (Arvonen et al. 2014, 17). Vocational competence is proven by a competency test in the degree programmes.

The qualification requirements for the degree studies for Further Qualification in Water Supply and Sewerage were set in April 2006. By March 2015, there were 396 graduates from the program, and out of them, 104 were specialized in wastewater treatment (Hallikas 2015). The people completing this degree are often already working in the WWT field and are aiming at increasing their theoretical knowledge to support their experience in work (Arvonen et al. 2014, 17-18; Hallikas 2015).

Specialist Qualification in Sustainability and Environmental Technology studies are meant for specializing in the field. The qualification requirements for the studies of this degree were set at the beginning of the year 2013. By March 2015, 15 graduates out of 47 from the program were specialized in developing wastewater treatment (Hallikas 2015). The people completing this degree are usually supervisors or they are working in other managerial duties. Usually, they already have supplemental and advanced studies and several years of working experience in the WWT field behind them (Arvonen et al. 2014, 17-18; Hallikas 2015).

• Higher education in WWT sector

According to Arvonen et al. (2014, 17), the possibility to study wastewater treatment-related studies has been available in Finland for a long time. However, in 2011, out of the 4000 people working in the field, there were only 9% with higher education. In comparison, the percentage was 11% in 2002.

The organizations offering higher education related to the WWT field are described in Table 18 below.

Type of organization	Number of organizations offering WWT related studies	Programs offering WWT related education	Duration of programme
University of applied sciences	9	Energy and environmental engineering (7) Construction engineering (2)	
Technical University	4	Energy and environmental engineering (2) Process engineering (1) Chemical engineering (1) Construction engineering (1)	
University (of Jyväskylä)	1		

Table 18. Organizations and programs in WWT higher education (Salminen et al. 2015, 27).

In 2015, there were nine universities of applied sciences in Finland offering degree programmes in engineering relating to WWT. Also, four technical universities and the University of Jyväskylä were offering WW-related education (Salminen et al. 2015, 27).

WWT education on the higher level was included in the degree programmes in Energy and Environmental Engineering (7 universities of applied sciences, 2 universities), Construction Engineering (2 universities of applied sciences, 1 university), Process Engineering (1 degree programme), and Chemical Engineering (1 degree programme) (Salminen et al. 2015, 27).

Non-formal education

Based on questionnaires to WWTPs through IWAMA (n= 27) and an interview of a representative of the Finnish Water Utilities Association (FIWA), the most commonly used methods of non-formal education in Finnish WWTPs are the following:

- training days/seminars/conferences (IWAMA 2016; 2017; Kärnä 2017a).
- learning at work (IWAMA 2016; 2017; Kärnä 2017a)
- short courses (Kärnä 2017a)
- visits to other WWTPs (Kärnä 2017a)
- peer learning (IWAMA 2016, 2017)
- benchmarking (IWAMA 2016, 2017)
- audits
- technical applications
- social media
- intranet
- work shadowing

Also, webinars and simulation were mentioned. Based on the questionnaires, the staff would have participated in training 3-4 times during the past five years (IWAMA 2016; 2017).

Based on a questionnaire by Lahti UAS (Table 19 below), almost all the WWTP representatives cooperate with the national WWT association. Other popular interest groups are other WWTPs, consulting companies and also vocational education institutions. The answers regarding the future seem surprisingly small – it is not likely that the cooperation would just stop. The trends of the most popular interest groups in the future remain the same: national WWT association and other WWTPs.

n = 27	Now	In the future
National WWT association	26	9
Other associations	8	2
Other WWTPs	19	8
Vocational education institutions	11	6
Universities of Applied Sciences	9	6
Universities	5	4
Consulting companies	19	6
Other companies	2	1
Other	1	1

Table 19. WWTP representatives' cooperation with interest groups, based on their answers to the question "With whom do you cooperate when you develop your personal know-how?" (Lahti UAS 2015; 2016)

The organizations offering non-formal education are described in Table 20.

Table 20. Organizations offering non-formal training and types of training (FIWA 2016; FIWA 2017; Tampere University of Technology 2016; Foundation for Professional Development 2017; Water Protection Association of the River Kokemäenjoki 2017; Uponor 2017)

Organization	Type of training	Topic	Target group	Occurrence
Finnish Water Utilities Association (FIWA)	Different pieces of training, e.g. continuing training	Certain topic	Certain professional group	25-29 times/ year (years 2015-2016)
	Tailored training	Varies	Varies	8-11 times/ year (years 2015-2016)
	Water management days	Current topics	Municipalities, WWTPs, authorities and exhibitors	3-4 times/ year (years 2015-2016)
Tampere University of Technology	Continuing training	VETO – Water supply and sewage leadership and development training	WWTP leaders and experts, water supply and sewage systems' planners, constructors, equipment manufacturers and authorities	Single times
Foundation for Professional Development	Four-day basic course	Operating environment, equipment and machines commonly used in WWTPs	WWTP operators, their substitutes and other water utilities' staff	Single times
Regional water protection associations (11 associations)	Customized training	Wastewaters and their treatment		Occasionally
WWT equipment manufacturers				Occasionally
Public funded projects, e.g. IWAMA – Interactive Water Management	Different types of training, e.g. seminars, webinars	Based on the topic of the project, e.g. smart sludge and energy management	Based on the goal of the project e.g. WWTPs, Associations, interest groups	Based on the project' plan (In IWAMA, 6 workshops & 5 webinars)
WWTPs development and management personnel, e.g. engineers	Benchmarking, on-site learning between WWTPs	Arising from the WWTPs own interest	WWTPs personnel (especially bigger plants)	Based on need and interest

• Training offered by the Finnish Water Utilities Association (FIWA)

The Finnish Water Utilities Association (FIWA) offers courses to the staff of the Water Utilities, including WWTPs. FIWA's training is especially continuing training and based on long experience. Training is organized annually. It can be aimed directly at a certain professional group or built around a certain topic. The topics for the training are collected from experts, feedback of the previous training and contacts from WWTPs. (FIWA 2016)

In 2015, FIWA organized 29 courses with 904 participants and 11 tailored courses with 324 participants. Additionally, FIWA organized four events, so-called "Water Management Days" in 2015, where 852 representatives of municipalities, WWTPs, authorities and exhibitors participated. In 2016, there were three Water Management Days with altogether 1141 participants. (FIWA 2016; 2017)

Most of the training was suitable also for the personnel of wastewater treatment plants, but there is no further information on the ratio between WWTPs' workers and other members of the association. The training organized by FIWA in 2015-2016 is presented in Table 21.

Table 21. Training organized by FIWA in 2015-2016 both aimed at WWTP and water treatment plant staff (FIWA 2016; 2017)

Year	Amount of trainings	Amount of partici-pants	Amount of tailored trainings	Amount of partici-pants	Amount of Water Manage-ment Days	Amount of partici-pants
2015	29	904	11	324	4	852
2016	25	577	8	107	3	1141

• Continuing training

One example of the continuing training is VETO – water supply and sewage leadership and development training, aimed at WWTP leaders and experts, water supply and sewage system planners, constructors, equipment manufacturers and authorities. VETO training develops, among other things, the leadership and development skills of the workers. The 11-day-long training enables the participants to deepen their viewpoints on the practices and working methods of the field. The requirements for the participants are Bachelor's level degree and working experience in the WWT field. (Tampere University of Technology 2016)

• Training offered by other parties

In addition to FIWA, there are also other parties offering training for WWTPs in Finland. Some examples of these parties are AEL (Foundation for Professional Development), water conservation associations and manufacturers, such as WWT equipment manufacturer Uponor (Foundation for Professional Development 2017; Water Protection Association of the River Kokemäenjoki 2017; Uponor 2017).

As a part of a training entity aimed at water utilities' professionals, the Foundation for Professional Development organizes a four-day basic course for WWT operators. The course is aimed at WWTP operators, but also their substitutes and other water utility staff. The course outlines the operating environment of WWTPs and familiarizes with the equipment and machines commonly used in plants. The aim of the course is to understand the phenomena, terms and functions of the field in a holistic way. For the new workers, the training offers an overall picture of the work and for more experienced employees the training will deepen the understanding of wastewater treatment and plant engineering (Foundation for Professional Development 2017).

There are altogether 11 regional water protection associations in Finland. One example of the training they organize comes from the Water Protection Association of the River Kokemäenjoki (Kokemäejoen vesistön vesiensuojeluyhdistys – KVVY), which has organized customized training on wastewaters and their treatment (Kokemäejoen vesistön vesiensuojeluyhdistys 2017). The water protection associations also promote the training organized by FIWA through their communications.

2.2 Germany

Formal learning in WWT sector

• Vocational education in WWT sector

In the wastewater sector, different types of vocational educations are offered. Especially for wastewater treatment, education as a specialist for wastewater technology is to be mentioned. The education includes theoretical and practical block lessons. A secondary school certificate is required. In the field of sewer systems, there is training for specialists of pipes, sewer system and industrial service. The duration of the education can be between two and three years.

There is also vocational education for specialists of water management and specialists of water supply engineering.

• Higher education in WWT sector

Table 22 provides an overview of universities, universities of applied sciences and technical universities that offer study courses in the water sector (Studieren 2017).

Table 22. Educational facilities in Germany that provide courses in the water sector

	Count	Course of study	Degree
Universities	10	Environmental Science (1) Construction Engineering (4) Renewable Energies (2) Environmental Engineering (1) Environmental Studies (1) Construction Engineering (Construction, Environment, Building Materials) (1)	B.Sc., M.Sc. B.Sc., M.Sc. B.Sc., M.Sc. B.Sc., M.Sc. M.Sc. B.Sc.
Universities of Applied Science	36	Construction Engineering (15) Environmental Engineering Construction (B.Sc.) (1) Sustainable Development (1) Renewable Energies (5) Underground Engineering (1) Environmental Engineering (7) Civil Engineering and Management (1) Industrial Engineering (1) Environmental Management and Urban Planning (1) Business Administration in Civil Engineering (Dual) (1) Project Management (1) Sanitary Environmental Engineering (Dual) (1)	B.Sc., M.Sc. B.Sc. B.Sc. B.Sc.,. M.Sc. M.Sc., M.Sc. B.Sc., M.Sc. B.Sc. B.Sc., M.Sc. M.Sc. B.Sc. B.Sc., M.Sc. B.Sc.
Technical Universities	6	Construction Engineering (1) Environmental Engineering (4) Economics (1)	B.Sc., M.Sc. B.Sc., M.Sc. B.Sc., M.Sc.

Non-formal education in WWT sector

This chapter summarizes further training methods which do not lead to a degree. Based on the LAMK questionnaire (Lahti UAS 2016), the main answers are summarized below. The results are split between managerial and operational staff.

Question 2 in the questionnaire reads:

"What tools are you using to develop your know-how and expertise?"

Results are shown in Figure 11 and 12.

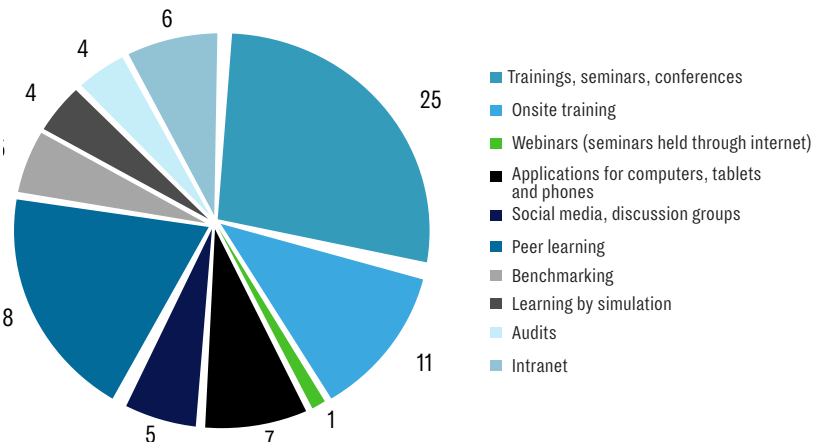


Figure 11. Distribution of the answers regarding question 2 (further training) for managerial staff, n=25, multiple answers possible

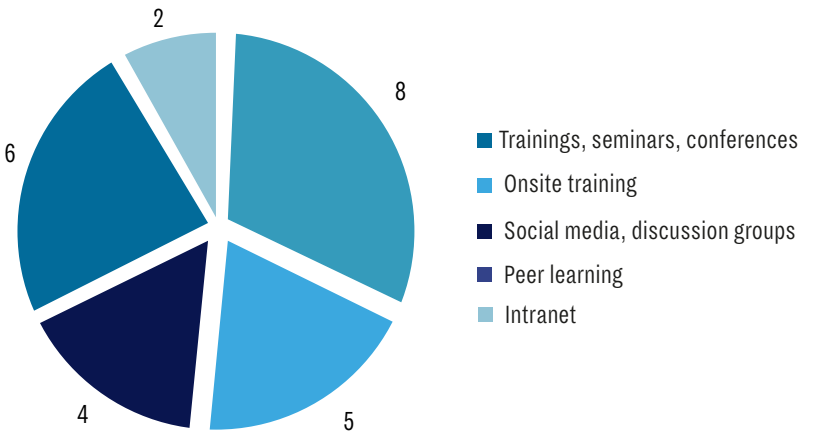


Figure 12. Distribution of the answers regarding question 2 (further training) for operational staff, n=9, multiple answers possible

The responses indicate that training, seminars and conferences; peer learning; and onsite training are in big demand for further education independent of position and educational level. Training by webinars and work shadowing are currently of minor to no interest.

The nature and extent of further training are not fixed and regulated by law. However, the participation in further training is recommended, to obtain the best knowledge in available technology.

Question 4 of the questionnaire reads:

"How many times have you participated in some kind of training?"

It details how many training courses a participant has completed within the last five years. The results are shown in Figures 13 and 14.

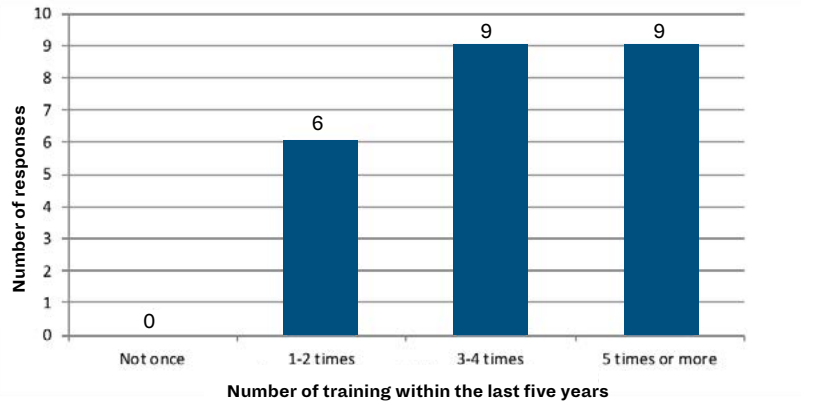


Figure 13. Number of further training within the last five years for managerial staff, n=24

Figure 14. Amount of further training within the last five years for operational staff, n=9

Figures 13 and 14 strongly indicate that further training is in high demand. All attendees that provided an answer have completed at least one or two training courses within the last five years. The majority of the group accomplished three to five training courses.

Some examples of necessary further training in the wastewater sector are listed below. In addition, the training intervals are shown. The documentation was done by employees of WWTP Magdeburg/Gerwisch.

1) Instruction on relevant regulations (depending on the respective field of activity), compulsory once a year (DWA-M 1000)
2) Instruction on accident prevention (depending on the respective field of activity), compulsory once a year (DWA-M 1000)
3) Instruction on technical rules (depending on the respective field of activity), compulsory once a year (DWA-M 1000)
4) Instruction on internal company instructions (occupational health and safety/ environmental protection), (depending on the respective field of activity), compulsory once a year (DWA-M 1000)
5) training with a focus on general responsibilities, safety regarding asbestos, course and examination, once every 6 years
6) fire prevention officer, theoretical and practical training, once every 3 years
7) fire prevention assistant; theoretical and practical training, once every 3 to 5 years
8) training with a focus on issues concerning the protection of workers, industrial paramedic training, once every 3 years
9) first aid training, once every 2 years
10) training with a focus on environmental issues, disposal responsibility, training, once every 2 years
11) dangerous goods safety adviser, training, regular (no precise indications)
12) accident coordinator, training, once every 2 years

Further training is very important for the education of employees to maintain the best available technologies, to offer knowledge exchange and to enable a continuous learning process. In addition, the technological processes and the management of the tasks can be improved. Also, further training is seen as a welcome change to the everyday work life. The interviewed employees had a strong interest in further training (responses to question 10 "**What motivates you to develop yourself as a worker?**").

An important question which arises in this context is the employer's interest in training tools. The evaluation of the question "**How does your employer follow the development of your (= the staff's) skills at the moment?**" is documented in Figures 15 and 16. The results indicate that there is still a need for structured training management. Nevertheless, a great interest of the employers in further training is evident.

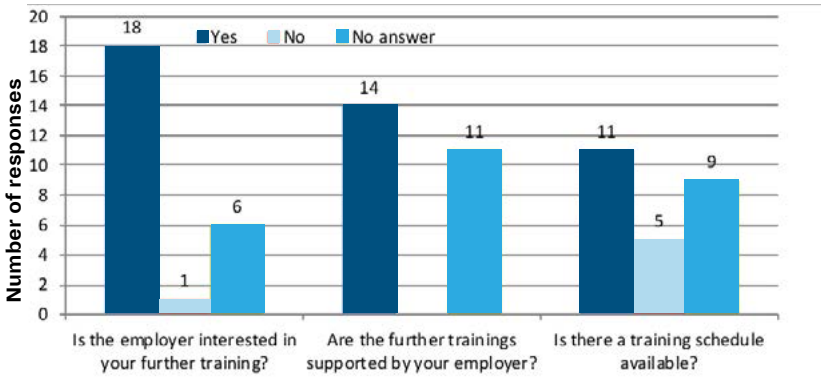


Figure 15. Responses on employer´s interest regarding further training by managerial staff (n=25)

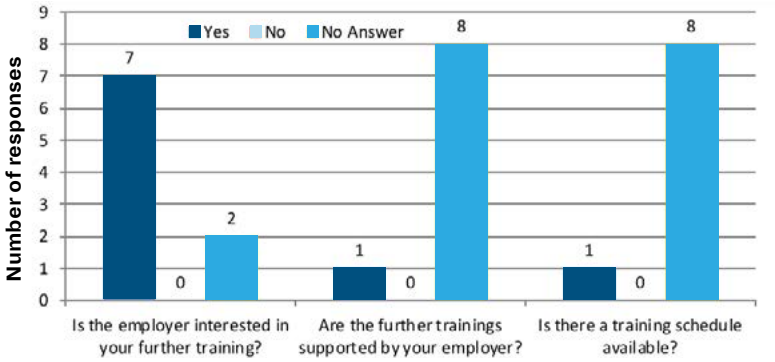


Figure 16. Responses on employer´s interest regarding further training by operational staff (n=9)

Learning by cooperation is another very important part in the wastewater treatment education. By cooperating with other organization, universities, etc. knowledge can be exchanged and problems can be solved directly. The evaluation of the question "**With whom do you cooperate at the moment and with whom would you like to operate more when you develop your personal know-how?**" reveals the strengthened cooperation with other WWTPs and wastewater associations, which can be attributed to the German neighbourhood concept. Future cooperation is negligible (see Figures 17 and 18). In some cases, cooperation with other companies (plant & electrical engineering, training centre) and projects (IWAMA) are indicated.

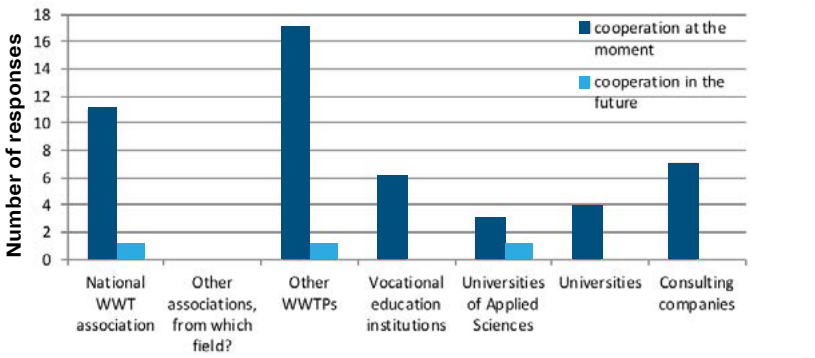


Figure 17. Cooperation in the wastewater section for managerial staff, n=25, multiple answers possible

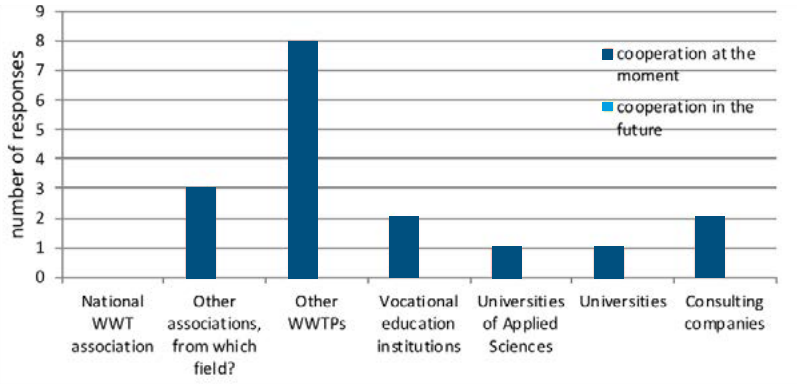


Figure 18. Cooperation in the wastewater section for operational staff, n=9, multiple answers possible

2.3 Estonia

Formal learning in WWT sector

The most common educational background in the technical personnel of Estonian WWTPs is related to water and sewerage but also to electricity and chemistry. Usually, the water and sewerage curriculums in universities cover the wastewater treatment area.

Also, there are many workers with a vocational education not directly related to wastewater treatment and maintenance but rather to agriculture, metal fabrication, and driving, welding, roadworks or similar. Since a hands-on approach to repair and service of wastewater processing equipment is needed, those professions are not so far away from the actual needs of basic WWT process maintenance. (Collective discussions 2010-2017)

2.4 Lithuania

Formal learning in WWT sector

The Lithuanian education system consists of traditional general education (preschool, pre-primary, primary, lower and upper secondary education), initial VET (IVET) at lower, upper and post-secondary levels, continuing VET (CVET), and higher education (college and university studies).

Main institutions responsible for the education of wastewater treatment sector specialists in Lithuania are universities, educational centres, Lithuanian Water Suppliers Association, Water Institute and consulting companies.

Vocational education in WWT sector

(Initial vocational educational training VET (IVET) and continuing VET (CVET))

Formal and non-formal VET providers

The Law on VET stipulates that a VET provider may be any VET institution, a freelance teacher or any other provider (general education school, enterprise, organisation whose main activity is other than VET) entitled to develop and implement VET programmes. VET providers may accept learners and provide formal VET programmes after receiving a licence from the Ministry of Education and Science. VET institutions may have licences for both IVET and CVET.

In addition to formal VET leading to state-recognised qualifications, non-formal VET is conducted. The Law on VET states that the requirements for non-formal VET programmes and their implementation may be set by the organisation that orders training under this programme or finances any such training. Objectives of VET programmes, admission criteria and duration are different and mostly depend on the target group. Non-formal adult education may be offered by any education provider, schools, freelance teachers, agencies, companies or organisations that do not have education as their main activity but are entitled to provide education. Non-formal VET is widely applied in continuing vocational training and is designed for acquisition of a vocational qualification or individual competencies. It is carried out in various forms: learning at the workplace, attending non-formal training courses, distance learning, etc. In most cases, non-formal training/learning of employees in the WWT sector is initiated and organized by the company itself. It is organized in various settings, using forms and programmes chosen by the company. Some companies have their own qualification frameworks or apply internationally-recognized sectoral qualifications and programmes. Such training/learning is funded by the company or agency or the learner.

Funding CVET for training employees

Continuing training of employees is funded by the enterprise or learner. According to national legislation, in certain cases, training can be sponsored by the state (Cedefop 2013).

The Qualifications and Vocational Education and Training Development Centre (2017) is the main actor in the field of education and training of the staff of WWTPs in Lithuania. It aims to ensure that the development of the Lithuanian lifelong learning system corresponds to the needs of the economy as well as national and international initiatives. The centre offers the following programs for WWTPs (Qualifications and Vocational Education and Training Development Centre 2017):

- Training program for pumping stations operators (duration 4 weeks, basic education)
- Training program for water plant operator (duration 12 weeks, basic education)
- Training program for sludge dewatering equipment operator (duration 4 weeks, basic education)

Higher education in WWT sector

There are four main universities offering Bachelor's and Master's Degree study programmes for the wastewater treatment sector:

Kaunas University of Technology, Department of Environmental Technologies (Kaunas University of Technology 2017)

• Bachelor's degree study programme - Sustainable Engineering and Environmental Technologies (Water preparation and water supply engineering, wastewater treatment and reuse technology)
• Master's degree study programme - Environmental Engineering (Industrial Wastewater Treatment Technology, Water Treatment technology).

Aleksandras Stulginskis University, Faculty of Water and Land Management (Aleksandras Stulginskis University 2017)

• Bachelor's degree study programme - Hydraulic Engineering.
• Master's degree study programme - Hydraulic Engineering.

Vilnius Gediminas Technical University Faculty of Environmental Engineering (Vilnius Gediminas Technical University 2017)

The Department of Water Engineering prepares specialists in three qualification levels: Bachelor's, Master's and PhD. After successfully finishing undergraduate studies, Bachelor's students can apply for a second study cycle and get a Master's of Science degree and later continue studies to become Doctors of Environmental Engineering Science. Students of Water Management get knowledge about drinking water preparation technologies, wastewater treatment technologies, storm water disposal and treatment systems, water supply and sewage networks as well as knowledge about hydraulic modelling.

Vytautas Magnus University Faculty of Natural Sciences (Vytautas Magnus University 2017)

Bachelor's Degree in Environmental Sciences and Master's Degree in Environmental Science and Ecology. Students get knowledge about drinking water preparation.

Non-formal education in WWT sector

Centre of Education is one of the largest education companies in Lithuania, offering training and educational programs for different Lithuanian enterprises (100 formal training programs and a number of non-formal education programs) (Centre of Education 2017). The company offers the following training programs for WWTPs:

- Pumping station operators
- Water Treatment plant operator
- Wastewater treatment plant worker
- Operator of sludge dewatering equipment
- Supervisor of wastewater treatment plant
- Technological pumping stations operator
- The workers of enclosed spaces (the wells in underground installations and buildings, enclosed containers and partially enclosed and confined spaces or partially enclosed machinery, etc.).
- Different non-formal programs.

Lithuanian Water Suppliers Association is an umbrella organization of Lithuanian Water and Wastewater treatment companies. Lithuanian Water Suppliers Association implements a number of educational activities (LVTA 2017):

- Prepares different working methodologies, provides water companies with information on the latest scientific and technological achievements, organize certified courses for the Association's members.
- Cooperates with different educational institutions and contributes to the development of training materials and programs.
- Organizes seminars, conferences, lectures, and training courses.
- Regularly organize professional development and professional training courses on topical issues for water specialists.
- Contributes to the promotion of research, helps for the WWTP to solve various problems, offers solutions and alternatives for the projects, helps to establish cooperative relations.
- Supports cooperation with scientific, consulting and business organizations as well as highly qualified consultants, lecturers and specialists from Lithuanian and foreign universities, consulting companies.

Lithuanian Water Suppliers Association has developed a special examination programme ”Professional knowledge assessment for the managers of technical projects in the field of construction”, which was approved by the Minister of Environment in 2012.

In 2006-2008, the Association initiated and implemented the educational project ”Improvement of basic and specific skills of WWTPs”. The goal of the general training was to provide the company’s employees additional managerial and social competencies that will enable them to better plan and organize their work and compete in the labour market. General training was organized for:

- Directors and heads of departments (topics – strategic and personnel management, public relations and labour law).
- Lower-level managers (topics – how to use information technology in company's management, the introduction of quality systems, project preparation and management).
- Secretaries, administrators and other service staff (training in customer service and the efficient administration of the office).
- Employees of the Financial department (new skills in financial management with particular emphasis on new accounting standards for businesses).

Special training aimed to provide additional knowledge and skills for different staff categories of WWTPs in specific areas of their work. Such training was organized for:

- Higher-level managers (information on the legal and quality requirements for the water sector).
- Lower-level managers (technological information in water supply and wastewater treatment fields).

In 2000, Lithuanian Water Suppliers Association (2017) has established one more educational institution - **Water Institute**. The main activities of the Water Institute at the moment are:

- Education of specialist for the water sector, capacity building (organization of training courses and seminars).
- Architectural and engineering activities, a technical consultancy.
- Preparation and publication of normative and methodological materials.
- Preparation, publication and distribution of newsletter "Water" for water sector specialists.
- Additional training.

Private consulting companies organize training for occupational safety, and health specialists offer qualification programs for managers and different specialists of WWTP.

JSC "Vilniaus vandenys" is the largest water supply company in Lithuania. The company has a separate staff training department, which organizes training not only for JSC "Vilniaus vandenys" employees but for other WWTPs as well. (Vilniaus vandenys 2017) The company has developed and offers a training programme for operators of wastewater treatment plants (AIKOS 2017).

The following topics are included in theoretical training: water management; mechanical equipment used in wastewater treatment plants; equipment for sludge processing; the construction and principles of operation, technical characteristics and technological parameters of the equipment used in the control zone; maintenance of wastewater treatment equipment; maintenance of mechanical equipment; maintenance of sludge processing equipment; wastewater treatment and sludge processing regulations; structure of wastewater treatment plants; wastewater treatment principles and methods; treated and untreated wastewater quality indicators; workers' safety and health; the requirements for work hygiene and environmental protection; electrical safety; fundamentals of economics and labour law.

Practical training is conducted in a wastewater treatment plant. The duration of the practical training is seven weeks.

The training programme for operators of wastewater treatment equipment is designed for people above 18 years old.

The staff training department also organizes seminars and training on different environmental questions and carries out certification for 48 different professions of WWTP employees on occupational safety and health issues.

Further training

The Environmental Centre for Administration and Technologies (ECAT-Lithuania) conducted a Capacity Development Survey of WWTP staff in May 2017. The questionnaire was sent to 50 Lithuanian WWTPs, and feedback was received from 22 respondents.

The following questions were asked:

1. *What tools are you using to develop your know-how and expertise?*
2. *With whom do you cooperate at the moment and with whom would you like to operate more when you develop your personal know-how?*
3. *How many times have you participated in some kind of training for the last five years?*
4. *How does your employer follow the development of your (the staff's) skills at the moment? How structured is the development of skills? Do you have any structured plan for developing skills at use, etc.?*
5. *In your opinion, which lifelong learning tools are needed in the future?*
6. *In your opinion, on which topics in WWT sector organized training or seminars would be relevant and important for you in the future?*

The evaluation of the question **"What tools are you using to develop your know-how and expertise?"** is shown in Figure 19.

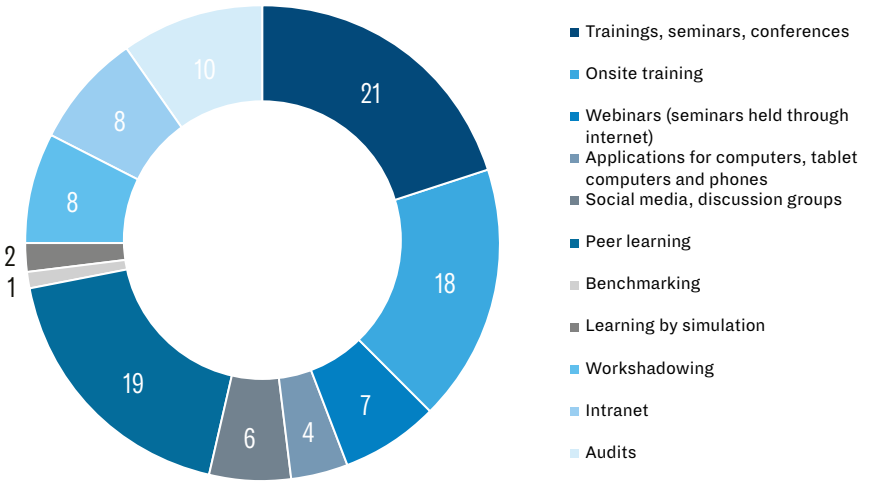


Figure 19. Tools for capacity development in WWTP

As it is seen from Figure 19, the most popular tools to develop capacity in WWTPs are participation in different forms of training, seminars and conferences, onsite training and peer learning. Methods such as applications for computers, tablet computers and phones, benchmarking or learning by simulation are not yet popular in Lithuania.

Figure 20 illustrates the answers to the question "**With whom do you cooperate at the moment when you develop your personal know-how?**"

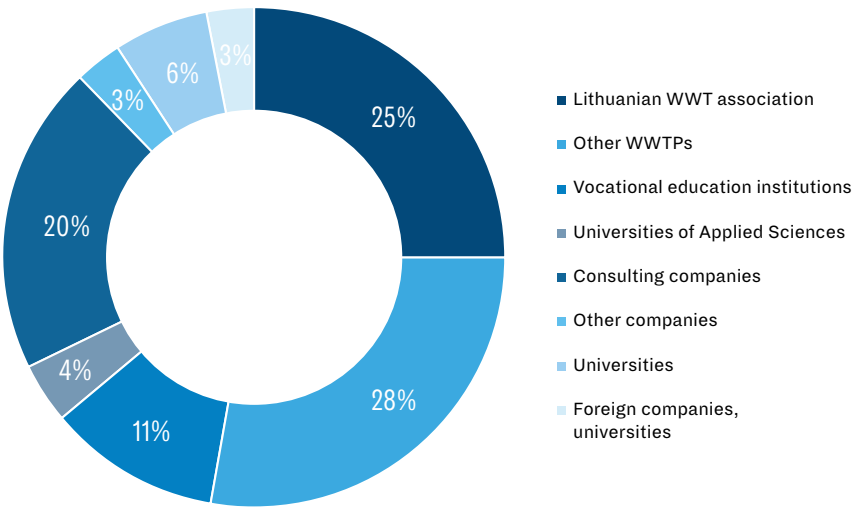


Figure 20. Overview of partner institutions in Capacity Development field

Most Lithuanian WWTPs are members or have good cooperation with the Lithuanian Water Supply Association. They participate in training, educational programmes and courses, seminars, conferences and other events offered by the Association and the Water Institute. Events organized by the Association are a good opportunity for WWTP employees to meet colleagues, establish contacts and cooperation, exchange experience, discuss common problems and look for possible solutions. Formal and non-formal meetings give a chance for peer learning as well.

WWTPs cooperate with vocational education institutions, different consulting companies and universities. There are a lot of possibilities to participate in conferences, workshops and seminars, organized by these institutions.

The illustration of the answers to the question "**How many times have you participated in some kind of training?**" is provided in Figure 21:

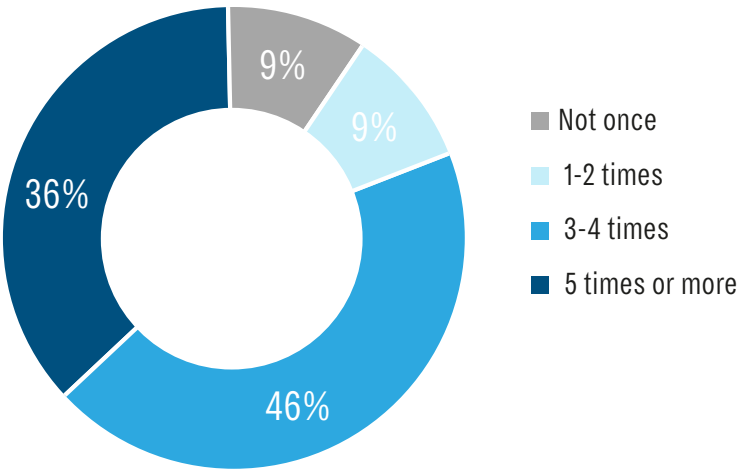


Figure 21. Frequency of education of WWTP staff

The feedback received from WWTPs shows that the staff of WWTPs has different possibilities to participate in training or seminars. Most of the answers were that employees participated in some kind of training 3-4 times or more during the last five years.

Lithuanian WWTPs have a common practice to develop a Staff Education Plan for the coming year (in most of the biggest WWTPs), where the needs of different departments are included. Additional possibilities to participate in seminars, training and other educational events or programmes are offered for WWTP staff according to their needs all the time. Such comments were provided to the question "**How does your employer follow the development of your (the staff's) skills at the moment? How structured is the development of skills? Do you have any structured plan for developing skills in use, etc?**".

2.5 Sweden

Formal learning in WWT sector

Education in different levels towards Water/Wastewater sector

Programmes that are given in Swedish universities with a focus on Water/ Wastewater Engineering:

Uppsala University – Civil Engineer Program - Master's of Science in Environmental and Water Engineering

The Master's program is given in cooperation with the Swedish University of Agricultural Sciences and encompasses several technological and operational aspects of water and environmental engineering in combination with natural sciences giving the students the opportunity to learn within a broader concept and be well-prepared for the real problems and challenges concerning water and wastewater in the coming years. The program includes mathematics, computer science, physics, chemistry, biology and geoscience (soil, air and water).

Luleå University of Technology – Master's Program in Civil Engineer within the following topics to be chosen

Chemical and bioprocessing technology: This program is focused on how chemical engineering and environmental technology can be used and optimized to move our society towards sustainability. The use of chemical engineering knowledge combined with environmental issues and technology brings considerable skills for students to follow a career within the sector.

Mining and Mineral Engineering: Mineral engineering and metallurgy is also focused on the development of sustainable techniques for metals extraction including, for example, recycling of minerals and metals, and minimization of emissions and energy use. The program has a strong connection with other partners in Europe and other regions of the world and it will bring a good and solid base to perform in recycling schemes, new production and optimization of minerals and metals extraction. Within the circular economy approach and an increasing discussion on how to recover valuables from wastewater and also sludge, this program can certainly supply skilled persons for the sector.

Natural Resources Engineering with focus on Environment and Water: The program gives the students knowledge about water supply, waste and wastewater management, how environmental problems arise and can be prevented and/or remediated/treated. This program gives students the opportunity to gain experience in working as an engineer through ten weeks' practice with a focus on the environment and water or ore and mineral.

Lund University – Master's Program in Water Resources Engineering

The programme focuses on the development of strategies and implementation of integrated water resources management, surface water and groundwater, urban stormwater management, wastewater treatment, always introducing technologies and solutions that are sustainable and eco-friendly. The program also includes other challenges such as coastal hydraulics and modelling of

hydrological processes.

The programme given at Lund University is broad and covers the most important aspects of water resources engineering. Many of the courses included in the programme contain practical elements, allowing the students to have a deeper understanding of the more theoretical components and to develop both professional and academic skills. The strong links to industry and scientific cooperation projects with other research institutes and universities ensure a high level of relevance to current issues and developments within the water/wastewater sector.

Polytechnical Educational Programmes in Sweden with a duration between one and three years

Polytechnic education is a post-secondary education, comparable to education at university/college. These programs were developed to bring a response to the real needs in the labour market. Usually, the length of training varies from one to three years.

Folk University - Water Project Leader/planner (400 credits)
After completing this technical programme, the student should be able to work as a water planner and consultant. The students will be able to plan robust and sustainable water and sewage systems with a knowledge of dimensioning and designing a network taking into account technical, environmental and legal aspects.

Installers Educational Centre - Water planning (200 credits)
This course is recommended only for those who already have some experience in the water sector and want to further develop their career skills. Most of this programme is given within the distance learning concept with some meetings for lectures, field trips, theme days, presentations and examinations. In general, the students work independently or in groups supervised via a web-based remote platform.

Ludvika Education - Environmental and Sanitary Engineering 400 credits
This is a solid and practical environmental education that gives great opportunities to meet the labour market. The program gives focus on operational aspects and jobs as technicians can be sought.

Foundation University of Applied Sciences in Sweden
Water and Environmental Technologies (400 credits) - This program also focuses on technical aspects of operation and maintenance and the students will be able to work as technicians in water or wastewater treatment plants.

Water Project Leader/Planners - This program gives the student professional skills to work as a designer and planner, within the water/wastewater sector. The program also provides expertise in project management, project planning/assessment and management.

Capacity development and education through collaboration between Universities and the Swedish Water Association

The Swedish National Water and Wastewater Association (Svenskt Vatten) has been giving financial support to a number of research initiatives and projects at Swedish colleges and universities. The idea is to invest in educational programmes and support the development of centres of excellence in water and wastewater located at these different institutions in a way that skilled professionals are formed and can work either in the academia or in the business sector with a focus on water issues. Therefore, the association plays an important role in supplying the continuous needs for skilled personnel and filling the educational gaps. (Svenskt Vatten 2017) A brief description of some projects and the collaborative network is given as follows:

- DagNät Competence Network established at Luleå Technical University
- DRICKS – From raw water to the tap – DRICKS is a competence and research education centre with a focus on drinking water research that is a joint effort of Chalmer University, Swedish University of Agricultural Sciences and Lund University.
- Water Cluster Mälardalen – Collaboration between researchers from universities, high schools, research institutes and water organizations that has the main focus on water and wastewater subjects including sustainable management of sludge. This cluster has a considerable support from the Swedish Water Association and other water organizations in the region of Mäladalen.
- Water Research School - The Water Research School is a collaboration between The Swedish Water & Wastewater Association through the research clusters VA-teknik Södra, DRICKS, VA-kluster Mälardalen, and Dag&Nät and Sweden Water Research, involving researchers from seven Universities in Sweden. The aim of the research school is to establish a platform for research education of high quality within the water sector and support community building and collaboration between individual PhD students, supervisors and Universities.

The following activities are included in the Water Research School:

- PhD courses, the courses will be given at the different participating Universities. Participation in courses within the research school is free of charge for the members of the Water Research School. Travel costs and accommodation are generally covered by the research school.
- Yearly seminars, every year a seminar with a specific theme is given.
- Networking, t he research school will create meeting points encouraging PhD students to interact both socially and scientifically.
- A mentorship program will be launched where experienced mentors will guide PhD students to improve performance and support them in their career now and in the future.

2.6 Latvia

Formal learning in WWT sector

Currently, there are three universities offering study programs (Bachelor's, Master's and Doctoral degrees) in the WWT sector or studies that can be related to the WWT sector:

- Riga Technical University (2017)
- University of Latvia (2017)
- Latvia University of Agriculture (2017)

Related faculties are as follows: Faculty of Construction Engineering; Faculty of Geography and Earth Sciences; Faculty of Chemistry; Faculty of Power and Electrical Engineering.

Related study programmes are as follows: Environmental Science; Heat, Gas and Water Technology; Chemical technology; Industrial engineering and management; Energetics.

Non-formal education in WWT sector

For those working in the field of WWT, there are courses and seminars available, organized by different related organizations and also by the Latvian Water and Wastewater Works Association (2017). In addition, visits to other WWTPs, both in Latvia and neighbouring countries, are organized.

Based on the information collected from the Capacity Development questionnaire (Lahti UAS 2016), one Latvian WWTP answered that the new professional information/the latest information from the (waste) water sector is usually obtained from participation in conferences, seminars, workshops, training courses, newsletters, printed professional magazines, and internet web pages. Currently, the chance of direct contact between WWTP personnel seems to be more effective when compared to remote communication.

2.7 Kaliningrad

Formal learning in WWT sector

In order to describe the current state of the art in WWTP education, it is important to mention "Standard Wage-Rates and Skills Reference Book" in Russia, which defines the educational level and competence required for WWTP operators (Standard Wage-Rates and Skills Reference Book 2017).

The operators are divided into three categories. The category of operator depends on the WWTP capacity (Table 23).

Table 23. Categories of operators in relation to WWTP capacity

	WWTP capacity
1st category operator	< 5.000 m^3 per day (in a manual way)
2nd category operator	< 5.000 m^3 per day
3rd category operator	> 5,000 m^3 per day

There are also requirements for operators of aero tanks, biofilters, sludge beds, metatanks, digesters, pre-clarification, and sludge removal. Usually, it is demanded by the employer that WWTP operators should have a vocational education.

Describing the role of NKBCs in Russia, it is crucial to note that they are the main sources of state-of-the-art technology and contemporary education, so their contribution to the capacity building and advanced research is essential. On the nation-wide level, in the sphere of water resources management, an important role is played by the Russian Association of Water supply and Sewerage. In the region, NKBCs organize and provide higher and vocational education, as well as advanced training and short-term courses.

Higher education in WWT sector

In the Kaliningrad region, there is only one institution that provides higher education in the sphere of WWT. From 2015, Kaliningrad Technical University started to implement the Master's programme Environmental Engineering and Water Use with specialization in "Water Supply and Water Disposal". The programme is organized by the Department of Water Resources and Water Use. Five students were enrolled for the above-mentioned programme in 2017. (Kaliningrad Technical University 2017)

Vocational education in WWT sector

Immanuel Kant Baltic Federal University prepares specialists with secondary vocational education in the Water Supply and Water Removal programme. After the graduation the students acquire the qualification "technician". In 2017, six students were enrolled for the programme. (Immanuel Kant Baltic Federal University 2017)

Among the main outputs of the programme, there are following competencies:

- To be able to develop technological schemes of wastewater treatment and sludge handling
- To detect, analyse and plan technical and economic indicators of water supply and disposal systems

Non-formal education in WWT sector

There are two educational institutions in the field of water supply and sewerage in the Kaliningrad region, which provide training for masters and specialists. There are no professional training courses for working specialists to increase their capacity. ECAT already carries out training courses on environmental safety and waste management. ECAT is going to include information about the WWTP operation and the best practices in this field.

ECAT is currently working on organizing the training courses for wastewater treatment specialists and managers. Taking into account the significant development of the construction of wastewater treatment facilities in towns and settlements of the region, and the essential need to ensure the meeting of the Russian Federation norms and HELCOM requirements, there is a crucial necessity to provide WWTPs of the region with high-qualified professionals for wastewater treatment facilities.

The training courses will include practical sessions on the existing WWTP OKOS. It collects and cleans up the sewage from the three cities that are located on the coast of the Baltic Sea in the Kaliningrad region. It had been under the process of reconstruction until 2015. It is a biological WWTP and now its capacity is 35 thousand cubic metres per day. There is also the possibility for operators and managers to advance their competence via courses held in Russia (predominantly in Moscow and Saint-Petersburg).

Advanced education in the Operator of WWTP programme; 80/100 h (theoretical/practical) (Training Centre "ProfStandard" 2018):

- Tailor-made training workshops on the broad range of themes within the biological treatment of wastewater

The new professional information/the latest information from the (waste) water sector is usually obtained from:

- Training/ professional development programs, conferences, seminars workshops, training courses, internet web pages, and online professional publications
- Peer learning, work shadowing, newsletters, internet web pages
- In-work training arranged by the employer/ on-the-job learning, peer learning, work shadowing, conferences, seminars, workshops, training courses, printed professional publications, printed professional magazines, internet web pages, online professional publica tions, and online professional magazines

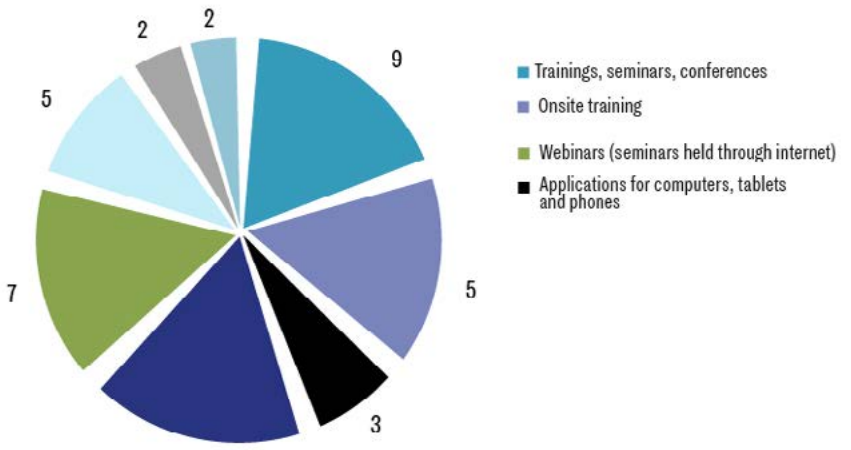


Figure 22. Educational methods for WWTP personnel

The most suitable methods to educate WWTP personnel in the Kaliningrad region are training courses with practical classes using the simulation of sewage treatment processes and tailor-made short-term courses (Figure 22).

3 The Needs in the Wastewater Treatment Field

3.1 Finland

Needs and challenges related to the know-how

Based on Salminen et al. (2015, 1), the WWT field is not at this moment a growing industry. When compared with its competing countries, Finland is falling behind the technological development, even though the treatment performance is on a top level. Laitinen et al. (2014, 65) predict that the new technologies will become more common.

Needed skills based on IWAMA questionnaire

Based on a questionnaire (n=27) for WWTPs' management and operators conducted in the IWAMA project, the following skills (Table 24 below) were estimated in terms of required resources in the future, for developing the skills of WWT personnel (Lahti UAS 2015; 2016). It seems that in general, the WWTP operators have estimated the need for the skills bigger than the manager level. Both groups find the risk assessment and preparedness, ageing infrastructure and equipment, and the integration of smart technology and automation important. Additionally, operators highlight the need to handle bigger and more versatile tasks in the future and ability to react to the changing weather conditions caused by climate change as important skills.

Table 24. Skills needing most resources in the development of know-how of WWTPs personnel.

	WWTP managers (n=21)	WWTP operators (n=6)
The need to handle bigger and more versatile tasks in the future	3,2	3,5
Fulfilling the tightening national and EU level requirements for purification	3,3	3,3
Risk assessment and preparedness	3,5	3,8
Ability to react to the changing weather conditions caused by the climate change	3,0	3,7
Need for a more efficient handling and utilization of the energy and heat potential of sludge	2,9	3,3
Working on the ageing infrastructure and equipment	3,4	4,3
Integrating smart technology and automation	3,8	3,7
New ways of working in the following of the process (e.g. distant monitoring), sampling, analysing and reporting	3,3	3,3

When the operators were interviewed about which themes in WWT require more training, the respondents dealt with the following matters (n=6): process (different processes, process management, managing pumping stations, adjusted for new operators), knowledge of automation, utilizing ICT and learning by doing (Lahti UAS 2016).

When looking at the literature, the topics which rose up most often as challenges and needs in the WWT field were: handling management, technology, quality of treated water, future and energy, but especially sludge-related topics.

Management

When looking at topics regarding management, the tightening requirements came up both as a challenge and a need. Matters related to costs came up, for example, the pressure of going into bigger plants and the challenge of small plants being cost-efficient enough alongside with the tightening requirements. Another thing coming up was the need for smart process management to optimize the purification. This also has a connection to the capacity of handling the wastewater with storm waters: how to scale and manage the plant taking storm waters into consideration. The managemental factors were pointed out mainly by WWTP representatives, but there were some comments related to costs coming also from interest groups (Heinonen & Takala 2011, 15; Ryynänen et al. 2012, 20-21, 33, 35; Lahti UAS 2015; 2016).

Technology

The needs related to technology concern process technologies (e.g. modular equipment processes), utilizing ICT, automation, remote monitoring and development of new purification technologies (e.g. membranes, nitrogen removal). Comments to technology-related needs came both from WWTPs and interest groups (Heinonen & Takala 2011, 15; Ryynänen et al. 2012, 33, 35; Lahti UAS 2015; 2016).

Sludge

The challenges concerning sludge deal with the high cost of treatment, missing legislative support regarding the utilization and the lack of commitment of the WWTPs. Utilizing sludge (e.g. as energy, nutrients, organic substance) is distinguished as one of the needs. Answers regarding sludge mostly came from the WWTPs. (Heinonen & Takala 2011, 15; Ryynänen et al. 2012, 20, 33, 35)

Quality of treated water

In the replies concerning the quality of the treated water, two topics, harmful substances and hygiene of wastewater, came up. Harmful substances were seen as a challenge, but more importantly, it was listed as a development need, e.g. from the monitoring, discharge prevention and study point of view. This was important especially for WWTPs. Keeping up the hygiene and updating hygienization methods came up several times as development needs and they were listed by the interest groups. (Heinonen & Takala 2011, 15; Ryynänen et al. 2012, 20, 33, 35)

Future

Some comments regarding the future were pointed out as development needs. The lack of innovation in the WWT field was seen leading into a lack of exports. Highlighting the client perspective was seen as a future need. Also, there was a comment about the need to change the whole perspective of seeing the

field: the future possibility is to go into separating lavatory water and washing water to enable utilization and recycling. These future perspectives came up as development needs from interest groups and also as the conclusion of Ryynänen et al. (2012, 20, 33, 35).

Energy

Meeting the energy efficiency requirements was seen as a challenge by the interest groups. Energy techniques and energy efficiency both in WWT and sludge handling were pointed out as development needs. (Heinonen & Takala 2011, 15; Ryynänen et al. 2012, 33, 35)

In a project carried out by Sykli, it was found out that the tasks in the water management field most urgently in need of new workers are (n=89):

- operational personnel for network operations	43
- operating personnel for wastewater treatment	23
- supervising tasks	20
- operating personnel for drinking water obtaining and treatment	20

(SYKLI Environmental School of Finland 2011, p. 4)

Out of those WWTPs, which had recruited personnel, 96% were in need of offering training to the new personnel (SYKLI Environmental School of Finland 2011, 4).

Qualification requirements for WWTP personnel

FIWA has been conducting a project defining qualification requirements for WWTP personnel in Finland in 2017. The criteria are divided to technical and non-technical know-how. The know-how levels with the descriptions are divided into the 1) opportunity to work independently, 2) overall responsibility for the process and acting as a supervisor, and 3) the ability to develop the operations of the organization. In the project, a tool is prepared. With the help of the tool, the WWTPs can estimate, for example, the level of know-how and the need for training of the personnel. The goal is to make the tool such that the WWTPs can modify the tool to best meet their needs. The tool and the national qualification requirements for WWTP personnel are available in the FIWA's intranet. (Kärnä 2017b)

Based on a study among water supply and sewerage system employers (2015), wide-ranging technical know-how concentrating especially on the skills needed in water supply and sewerage systems are important. Another topic found important was construction. The employers were concerned about the lack of knowledge in some subjects. For example, there was a lack of basic knowledge related to hydraulics and planning of the networks. Also, there was a lack of skills in commercial activity and understanding its position as a part of the built environment. (Salminen et al. 2015, 18)

Educational needs in the wastewater treatment sector

Factors affecting the educational needs are, for example, the size of the plant, the treatment method used and the type of organization (private, public).

In a report on the competence needs in the water treatment sector (Heinonen & Takala 2011, 15), it was outlined that the water sector will be more and more linked to other fields in the future. Networking, communicating and overall

management skills are important for all workers. Especially the ability to work in diversified groups was found vital. Additionally, specific skills based on each worker's tasks were seen important. (Heinonen & Takala 2011, 5). The availability of water sector skills on all levels of education was found important. Finally, the possibility to develop one's skills was outlined (Heinonen & Takala 2011, 22).

There is a need to develop undergraduate degree studies in the water sector. Based on a seminar organized by the Finnish Water Forum (FWF), for example, a degree programme for water utility keepers or pipe fitters is needed (Heinonen & Takala 2011, 19).

Needed educational tools

Based on a questionnaire (n=27) for WWTPs' management and operators conducted in the IWAMA project, the following lifelong learning tools are needed in the future (Table 25).

Table 25. Importance of lifelong learning tools in the future (Lahti UAS 2015; 2016)

	Management n=21	Operators n=6	Total
E-learning materials on the internet (for education and self-study)	13	5	18
Peer learning	10	4	14
Benchmarking	9	0	9
Wastewater treatment certificate (or some other certificate indicating the competence)	8	0	8
Learning through simulation	4	2	6
"Do-it-yourself" audits	4	0	4
Webinars	2	1	3
Social media, discussion groups	2	1	3
There is no need for new tools	1	0	1
Applications and games	0	0	0
Work shadowing (following another person at work and learning by observing)	0	0	0

When the operators were asked about what motivates them to develop themselves as workers, the respondents gave the following replies (n=6): opportunities/will to develop (3), results (2), pay (2), and variety (1) (Lahti UAS 2016).

3.2 Germany

Needs and challenges related to the know-how

Needed skills based on IWAMA questionnaire

Figures 23 and 24 illustrate the results regarding the question "**How much resources will the following matters require in the future in your opinion in terms of developing the skills of WWT personnel?**".

The graphs of both groups show that a lot of resources will have to be allocated in the future to "new ways of working in the monitoring of the process (e.g. distant monitoring), sampling, analysing and reporting". It comes with a surprise that especially operators indicate an average need of resources (3) necessary in the areas that require the development of new skills. However, there is also some strong interest in smart technology and automation as well as working on the ageing infrastructure and equipment.

Managerial staff showed more interest in a variety of fields. A lot of resources will be required for smart technologies and automation, and for meeting the tightening national and EU level requirements for purification, risk assessment and preparedness.

In summary, the answers in both groups are quite mixed. Therefore, it cannot be said that one matter is more important than the other. The focus has to be on a variety of new future challenges and a lot of new skills have to be gained.

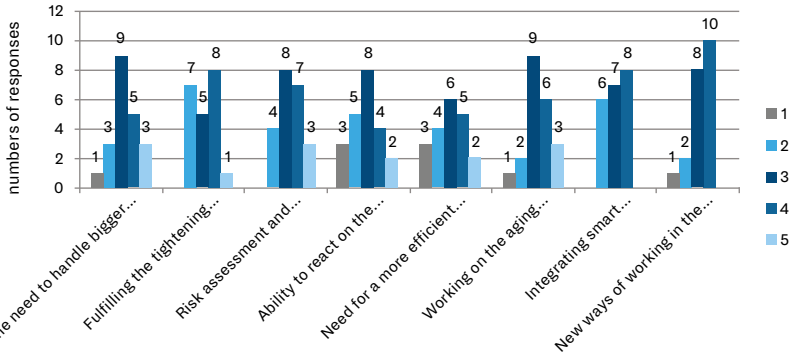


Figure 23. Resources which will be required in the future to develop the skills of WWT personnel answered by managerial staff; legend: 1 = does not require any resources, 2 = requires little resources, 3 = requires some resources, 4 = requires a lot of resources, 5 = requires very much resources, n=25, multiple answers possible

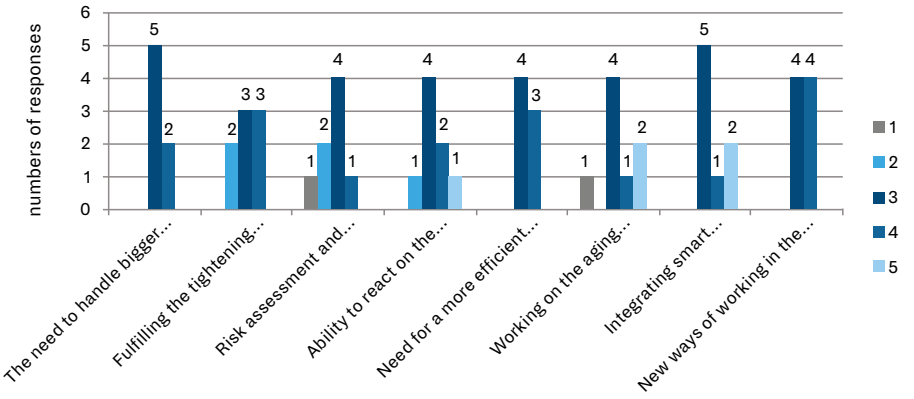


Figure 24. Resources which will be required in the future to develop the skills of WWT personnel answered by operational staff; legend: 1 = does not require any resources, 2 = requires little resources, 3 = requires some resources, 4 = requires a lot of resources, 5 = requires very much resources, n=9, multiple answers possible

Legal changes, for example, in the Fertilizer Ordinance and Sewage Sludge Ordinance, currently require rethinking in the wastewater treatment process in Germany. The current version of the German Sewage Sludge Ordinance (German: AbfKlärV) specifies the requirements for the removal of phosphorus. It is indicated that phosphorus has to be recovered with appropriate measurements if the P-content of the sludge is >20 g/kg DM (dry matter). Appropriate phosphorus recovery technologies must be indicated by the end of 2023.

Operators of WWTPs with a capacity of > 100 000 PE and a P-content of > 20 g/kg DM need to implement appropriate technologies by 2029. In WWTPs with a capacity of > 50 000–100 000 PE, the deadline for the transposition is set to 2032.

Below 50 000 PE, land-based usage as fertilizer is still possible (Fertilizer Ordinance 2017).

Changes to the Fertilizer Ordinance also lead to a further reduction of land-based usage of sewage sludge.

Frequent challenges in the water sector are:

Ageing infrastructure: Changing demands on the wastewater treatment often require high investments, and there is a need for young employees with new ideas, an open mind and different perspectives

Creating new operation: Capacity development and cooperation between technological companies, WWTPs and universities are needed. It is important to connect the people who have the knowledge to the people who actually need the knowledge.

To identify the most suitable technique: More cooperation with research institutes/universities to test new ideas/development/techniques, participation in workshops/fairs/exhibitions/conferences to exchange knowledge, to be convinced that more advanced techniques are needed and the treatment plant needs to be upgraded.

Educational needs in the wastewater treatment sector

The evaluation of the question "**Which lifelong learning tools are needed in the future?**" is shown in Figures 25 and 26. Indicated tools with a large majority are training with a certificate, peer learning and E-learning. Also, benchmarking and learning by social media seem to be promising tools in the future.

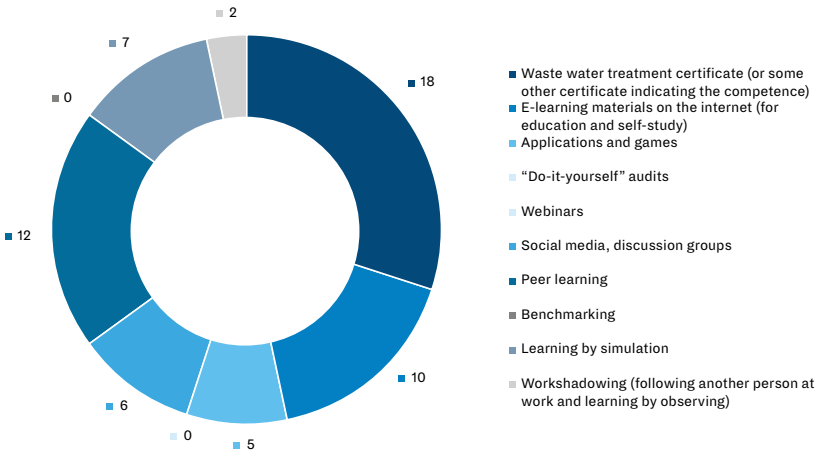


Figure 25. Distribution of the answers by managerial staff regarding question 7 (lifelong learning in the future), n=25, multiple answers possible

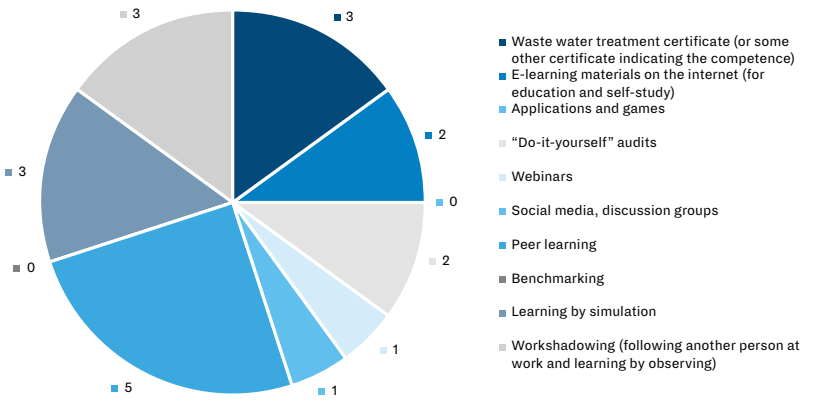


Figure 26. Distribution of the answers by operational staff regarding question 7 (lifelong learning in the future), n=9, multiple answers possible

The evaluation of the question "**How will the WWT sector change in the future?**" points out that the employees interviewed have a clear idea of how the sewage sector will change during the next ten years. The answers are summarized below.

- The main focus of wastewater treatment will take a back seat (more efforts will go towards energy management, sewage sludge removal and altering wastewater treatment systems)
- Enhanced automation and centralisation
- Higher complexity
- Increase in investment costs

- Consumer price increase
- Self-sustaining technology
- Sewage sludge removal / combustion / P-recovery
- Sewage sludge reduction
- Shortages in the recruitment sector (qualified personnel)
- Higher educational expectations regarding process and technology
- Increased/decreased volume of sewage and lowering of threshold values
- reduces workforce
- Energy efficient procedures
- Filtration as a 4th cleaning step
- Increased requirements for cleaning steps
- More transparency

Changes in the sewage sector require an adaptation of the training materials at the same time. These must be specifically targeted at current issues.

The survey of the themes with the need for further training (question 9 "**In your opinion, which themes in WWT require more training?**") led to the following list:

- Basics
- Online measurement
- Nitrification
- Rehabilitation and modification of old plants
- Additional treatment
- Legal regulations and ordinances
- Anaerobic preliminary treatment
- Aeriation
- New technologies
- Analytics
- Indirect discharger
- Operation of sludge gas plant and block heating station
- Measuring, regulating and control systems
- Sludge utilisation, treatment, digestion, dewatering, disposal, combustion
- P-recovery
- Wastewater disposal
- Ventilation
- Work Health and Safety
- Electricity

The results of further training tools, which are currently used in Germany (Figures 11 and 12) and which will be used in the future (Figures 25 and 26), indicate an age-dependency. Therefore, it seems probable that the use of further training tools by web, games etc. will increase. The current need is pointed out in Figures 25 and 26.

The focus of further training tools should not only be on exchanging knowledge but rather on stimulating the interest in the wastewater topic.

3.3 Estonia

Needs and challenges related to the know-how

General needs based on collected information in the wastewater treatment sector are (Collective discussions, 2010-2017):

- Quite often, small plants lack specifically educated staff. There are complications if an operator has to leave for sometime (vacation, additional courses, health problems, maternity leave etc.)
- Specific secondary level studies for WWTP operators needed
- Defined profession of WWTP operator; training at different levels (beginners, advanced)
- Young and inspired scientists and lecturers
- Since the processes, equipment and computer technology have been getting more complicated, a need for more WWT-process-oriented education has risen.
- Legislative solutions for sludge handling, the basic decisions if sludge is best handled separately by WWTPs or should there be private regional sludge handling centres.

Educational needs in the wastewater treatment sector

In Estonia, the educational needs in the wastewater treatment sector identified through interviews with waterworks managers and universities consisted of (Collective discussions 2010-2017):

- Operators courses, biological treatment
- Operators courses, SCADA
- Operators courses, operators replacement
- Operators courses, energy audit
- Young students

3.4 Lithuania

Needs and challenges related to the know-how

General needs in the WWT sector depend on several factors: the size of the plant, the age of employees, used WWT technologies and operation models/ methods, ageing infrastructure, etc.

- Size of a plant: small plants need wider knowledge and large ones need specific training.
- Age of employees: young specialists are more used to different info technologies and are more open-minded, therefore the use of further training tools by web, games etc. is much more excited for them than for an older generation.
- Ageing infrastructure: development of stronger cooperation between WWTP and Universities is necessary. Universities could help WWTPs to understand and to find solutions for how to renew old infrastructure with smaller investments or to find the right financial sources to renew the infrastructure, etc.
- Creating new operation models/methods: WWTPs usually need outside help and advises to identify the most suitable technology, to analyse and use the data, etc.

Educational needs in the wastewater treatment sector

Among the main topics, the Lithuanian WWTPs would be interested are:

- Automatization of water extraction stations and wastewater treatment plants
- Management of the wastewater treatment process
- New legal requirements in WWT sector and their practical implementation
- Maintenance and supervision of small wastewater treatment plants
- Prompt repair of sewage networks and wells, work safety, effective methods
- Effective maintenance and supervision of sewage pumping stations
- Improvements in water system, automation and development of the information system
- Water and wastewater sampling and testing methods

The answers were received from the respondents to the question "**In your opinion, on which topics in the WWT sector organized training or seminars would be relevant and important for you in the future?**"

The illustration of the answers to the question "**In your opinion, what kind of methods should be used to educate WWTP personnel in your country?**" is provided in Figure 27.

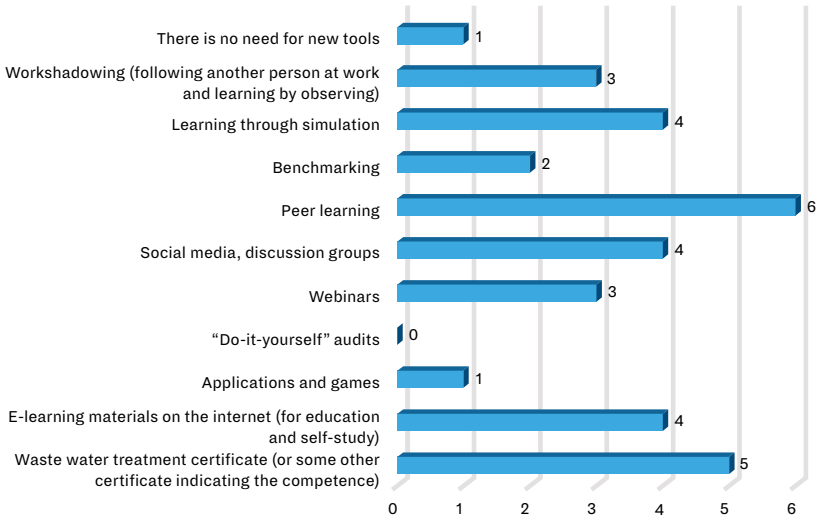


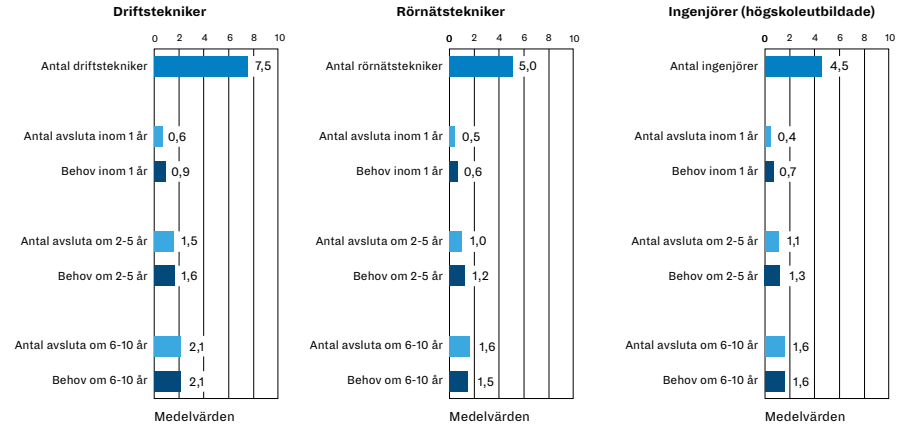
Figure 27. Future educational methods

Figure 27 shows that among Lithuanian WWTPs, the most popular educational methods in the future would be a wastewater treatment certificate (or some other certificate indicating the competence) and peer learning. Most of the respondents answered that e-learning materials on the internet (for education and self-study), social media, discussion groups, learning through simulation as well as webinars and work shadowing would be popular as well. Benchmarking, applications and games are less interesting at the moment.

3.5 Sweden

Needs and challenges related to the know-how

Based on the Swedish National Water Association (SV 2017), some data regarding the future needs of personnel in WWTPs is shown in Figure 30 and Figure 31 below. The results are based on the number of employees in different categories that will go on retirement and the number of years until retirement will take place.



Bas kommunal verksamhet: 135 intervjuer

Figure 30. Number of employees that will reach retirement in the short- to medium-term perspective. (n=135) (SV 2017)

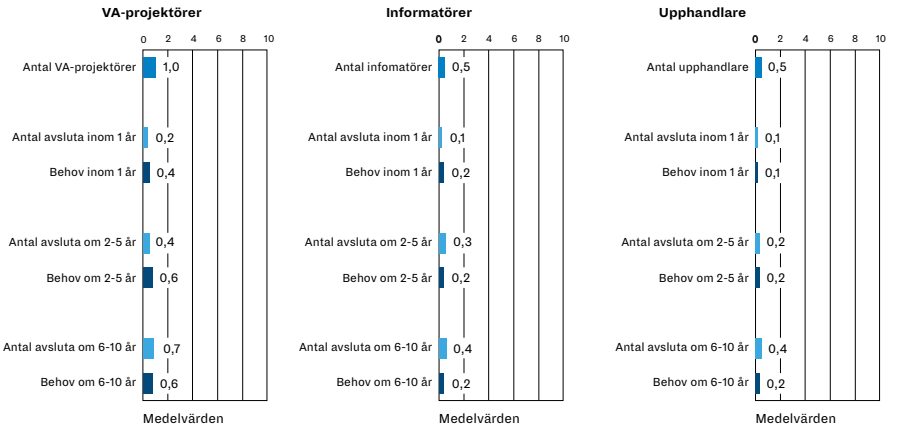


Figure 31. Number of employees that will reach retirement in the short- to medium-term perspective. (n= 135) (SV 2017)

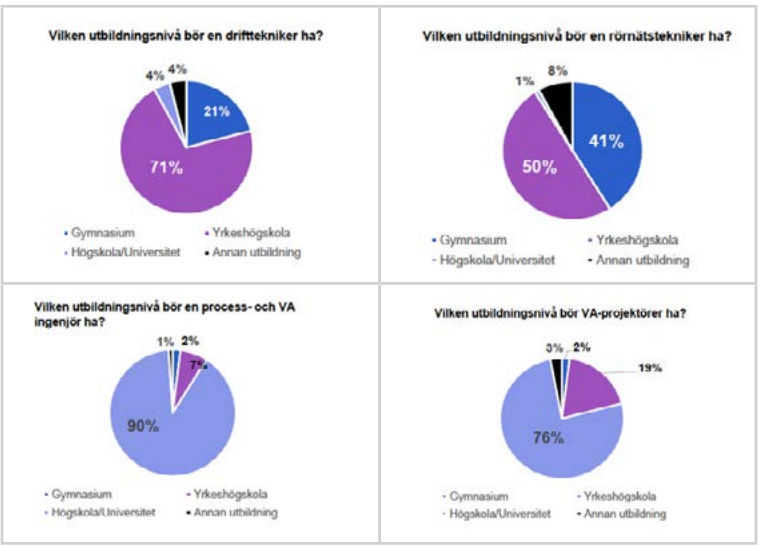
Needs for WWT sector education (based on collected information) are seen in Table 27 below.

Table 27. Number of employees that will retire and respective needs within the wastewater sector in short and medium-term perspective (n= 135) (SV 2017)

Vattenbranschen	Drifttekniker	Rörnäts-tekniker	Ingenjörer (högskoleutbildade)	VA-projektörer	Informatörer	Upphandlare
Totalt antal anställda i vattenbranschen	**2166**	**1426**	**1304**	**271**	**115**	**75**
Antal som kommer sluta inom 1 år	161	119	103	20	11	4
Antal som kommer sluta om 2-5 år	410	248	288	56	29	16
Antal som kommer sluta om 6-10 år	576	384	402	85	37	32
TOTALT kommer att sluta	**1147**	**751**	**791**	**161**	**77**	**52**
Andel av personalstyrkan som kommer sluta inom 1 år	7%	8%	8%	7%	10%	5%
Andel av personalstyrkan som kommer sluta inom 5 år	26%	26%	30%	28%	34%	27%
Andel av personalstyrkan som kommer sluta inom 10 år	53%	53%	61%	59%	66%	69%
BEHOV						
Antal behov inom 1 år	258	187	208	114	47	45
Antal behov av om 2-5 år	458	342	388	170	59	50
Antal behov av om 6-10 år	613	440	450	188	66	68
TOTALT behov av	**1329**	**970**	**1047**	**472**	**172**	**164**
Förändring i personalstyrkan i % inom 1 år	4%	5%	8%	35%	31%	55%
Förändring i personalstyrkan i % inom 5 år	7%	11%	10%	77%	58%	100%
Förändring i personalstyrkan i % inom 10 år	8%	15%	20%	115%	83%	149%
Förändring i personalstyrkan i antal inom 1 år	97	68	105	94	36	41
Förändring i personalstyrkan i antal inom 2-5 år	145	162	207	208	67	75
Förändring i personalstyrkan i antal inom 10 år	182	219	256	311	95	112

Educational needs in the wastewater treatment sector

Required level of education for different functions in the wastewater sector is visible in Figure 32 below:



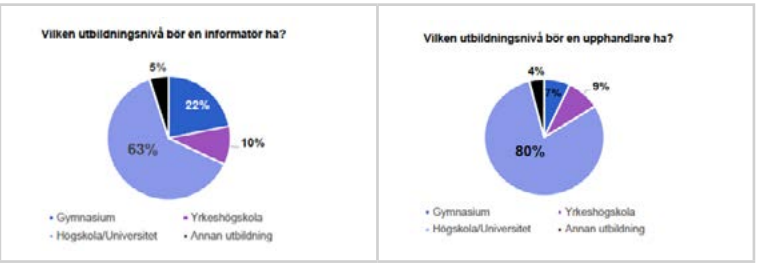


Figure 32. Educational level requirements for different functions within the wastewater sector. (n= 135) (SV, 2017)

Based on responses of the recruitment and capacity development needs survey (Figure 33 in Swedish), mostly management problems as well as missing specific educational courses were mentioned. It is worth mentioning that the popularity of environmental engineering is growing due to its support of professional growth through lifelong learning.

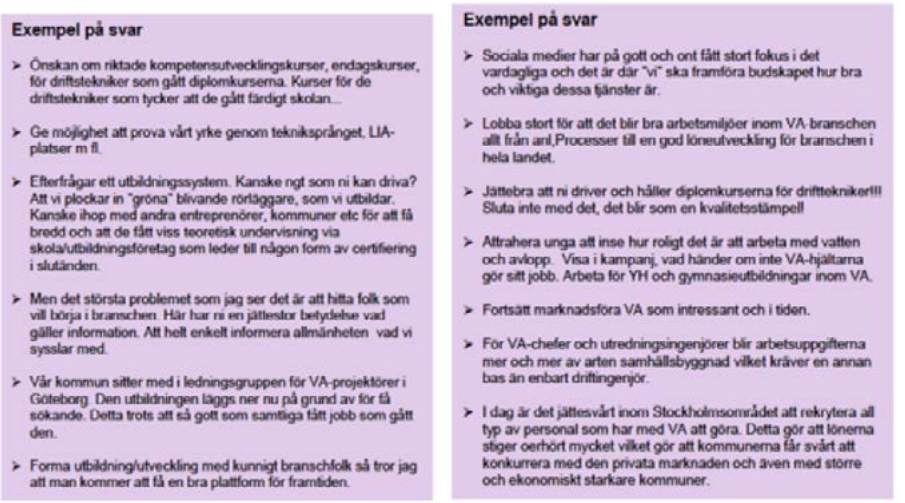


Figure 33. Recruitment and capacity development needs survey

3.6 Latvia

Needs and challenges related to the know-how

Regarding the general challenges and needs in the wastewater treatment sector in Latvia, the following challenges were identified:

- lack of national regulation in regard to waste sludge utilization/ further use
- lack of municipal involvement/cooperation in regard to further use/utilization of waste sludge as well as the wastewater treatment field in general.

Educational needs in the wastewater treatment sector

In terms of educational needs in the wastewater treatment field in Latvia, the following was identified:

Consistent lifelong education for the WWTP personnel in the form of regular seminars, courses, meetups. This depends more on the management and structure of each company.

More active student involvement during studies. Combining theoretical knowledge with practical aspects at the early stages of studies would facilitate a better understanding, higher interest and involvement, as well as better future perspective for both plants and students.

3.7 Kaliningrad

Needs and challenges related to the know-how

Ageing infrastructure: Very high costs are needed to maintain this infrastructure. That is why it is essential to attract investments. The demand for young and high-qualified personnel is rising.
Creating new operation models/methods: It is necessary for the Kaliningrad region to establish an integrated regional system in WWTP management. Identifying the most suitable technique: We need independent expert support and high-qualified personnel.
Introducing new water treatment technology: A range of workshops need to be organized in the near future. There are no secondary settling tanks at the 5 WWTPs of the region, which causes low-quality treatment. This is the reason to apply additional cleaning, which is very expensive.

Meeting the Russian national and HELCOM requirements on the quality of wastewater treatment can be very challenging for recently constructed/reconstructed WWTPs in the region. There is a range of external and internal factors that affect this situation, for example, wind-driven effects, high level of groundwater, heavy precipitation, and of course, a lot depends on the work performance of WWTP specialists. In this respect, it is essential to provide a high professional level of WWTP employees for qualitative wastewater treatment.

It is important to make educational possibilities available in the territory of the Kaliningrad region.

Educational needs in the wastewater treatment sector

The most essential and topical educational need in the wastewater treatment sector is the enhancement of the practical component. It is also crucial to pay attention to and develop a simulation of sewage treatment processes. Tailor-made short-term courses are also applicable and in high demand.

4 Examples of Lifelong Learning

As an addition to the list of lifelong learning practices related to formal and non-formal education described in Chapter 3, there were some practices, which were worth mentioning. This chapter describes them shortly and outlines different examples of the ways how workplaces are keeping up the lifelong learning of the employees.

4.1 Finland

Good lifelong learning practices in WWT sector

According to FIWA, the most common ways to keep up lifelong learning in the WWT sector are (Kärnä 2017a):

- completing degree studies
- taking short courses
- organizing own training days in the WWTP
- visiting other WWTPs
- on-site learning

Complementary training can also be targeted for the higher educated staff in the WWTPs. For example, the national "VETO training" focuses on the management and development of the water supply sector (Salminen et al. 2015, 18).

WWTPs cooperating with each other

Cooperating with other WWTPs is a common way to implement lifelong learning in the WWT field. The cooperation might not always be very active and strive for keeping up the know-how of the workers. Mostly the cooperation consists of guidance, exchange of information and helping with problematic situations. (Heponiemi 2016, 22)

Web-based key indicator system

FIWA is keeping up a web-based key indicator system called VENLA for water supply and sewerage systems for benchmarking. The system has been used since the year 1995. Previously, the system has been available for paying customers, but starting in year 2016, a lighter version was brought available to all FIWA members (90% of Finnish water supply and sewage systems plants). The system enables benchmarking the practices in different WWTPs in Finland (FIWA 2017, 14).

Benchmarked lifelong learning practices from other fields of society

Passes and certificates

There are many pass or certificate systems used in different industries. These certificates are, for example, plant protection certificate, security guard pass, hot work licence, national occupational safety card, swimming pool pass, hygiene passport, and the one with the closest link to WWT, water work permit. This kind of certificate is usually obtained through a half-day or full-day training and an exam with multiple-choice questions. The certificates are valid for a certain time, usually five years at a time. Obtaining a certificate might be a requirement to work in certain duties.

Negotiation day organized with regulation changes in urban planning

This example is from the field of urban planning. The Finnish Centres for Economic Development, Transport and the Environment (ELY) organize a "Built Environment Negotiation Day" on a needs basis, mostly 1-2 times a year for cities' personnel and consultants. These conferences are organized whenever regulations regarding urban planning are changed by the authorities. (Centres for Economic Development, Transport and the Environment 2016; Kärnä 2016)

Management and chief training organized by the employing company in food retail

The Finnish food retailers Kesko and S Group both organize management and work training to train their future workers. The S Group has programs for S-supervisor and S-Trainee.

The K-food retailer programme is meant to train future K-retailer entrepreneurs. The training lasts 4-18 months. The studies consist of on-the-job training in a K-food store, the necessary theoretical online studies as well as regional and national group study modules. (Kesko 2017)

The S-Trainee training programme is a management and leadership programme, which takes place in two phases of seven months and 1-2 years. It is meant for young people with higher education. The training consists of classroom teaching and on-the-job training, also in the Baltic countries. At the end of the programme, the participants are granted permanent work. (S Group 2017a)

The S-Supervisor program is meant for S group workers. It is a training programme to train future superiors to work in the S group. The training lasts 1-1.5 years and consists of classroom teaching and on-the-job training. The working place and tasks given after the training are defined based on the skills of the participants. At the end of the programme, the participants are granted permanent work. (S Group 2017b)

Online training materials in farming

Some of the training related to farming is offered using online possibilities. Examples are the online test for farmer support and online learning materials related to plant protection certification.

The online test for farmer support is a compulsory requirement for obtaining farmer support. It can be performed by a person who is entitled to farmer support application or who is in charge of farm management. The online test is based on online materials, in practice, a PowerPoint presentation. The test is passed with 15 right answers and can be done as many times as needed in order to pass. The test is carried out at the farmers' online service, where one can enter with an online bank account. There is still also a chance to carry out traditional training with one training day and a hand-written test. (Finnish Agency for Rural Affairs 2017)

Plant protection certification is compulsory in order to gain the permission to handle plant protection chemicals. The training helping to achieve the compulsory plant protection certification is voluntary, but most probably needed in order to pass the test. The training is offered by parties with a training licence, but materials of this training can be studied also online through materials delivered by the Finnish Safety and Chemicals Agency (Finnish Safety and Chemicals Agency (Tukes) 2017). The online training materials consist of 8 parts including a general part, legislation, good practices and risk assessment, for example. The material includes interactive presentations, videos, and links to other sources. Figures 34 and 35 show examples of an on-going video and a page with links to more information.

Figure 34. Example of a video in the training materials for Plant protection certification

Figure 35. Example of an interactive page in the training materials for plant protection certification.You can get more information through the icons and their pop-up windows.

Online seminar – webinar in the waste treatment field

Organizing webinars is becoming a more common way of sharing information. One benchmarked example of a webinar is the webinar on current legislation changes organized by a waste treatment company L&T. The duration of the webinar is one hour, from 9:00-10:00. The content includes three legislative changes in waste treatment. The webinar is meant for the company's clients. (Lassila & Tikanoja 2017)

Also, the IWAMA project has organized several webinars for its partners and interest groups.

4.2 Germany

Good lifelong learning practices in WWT sector

The lifelong learning concept is implemented in Germany in various ways by the DWA, regional group north-east. The neighbourhood sessions are very successful with regard to the exchange of knowledge. There are 18 neighbourhoods in the regional group north-east of the DWA (see Figure 36). Several meetings are organized during the year to clarify important issues, to solve current problems, to exchange knowledge and to learn from other WWTPs.

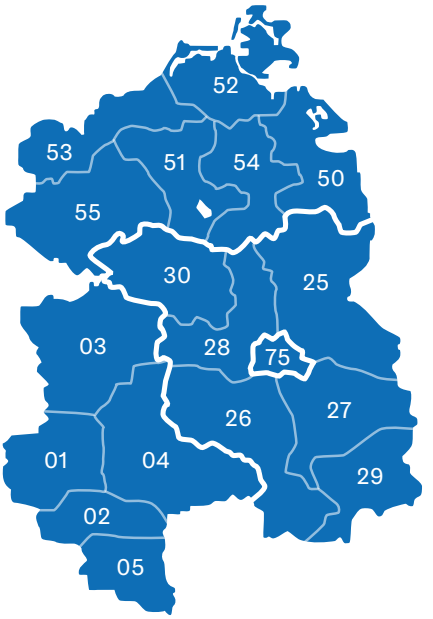


Figure 36. Neighbourhood organization in the DWA, regional group north east

The groups are led by a "teacher" and a "chairman" who organize the neighbourhood meetings. Every year, there is a meeting of teachers and chairmen to inform the other neighbourhood groups about the activities, to exchange ideas and to learn from each other. Important information, legal changes and current topics can be passed on to the operators of the WWTPs and implemented through the concept of the neighbourhoods. The WWTPs cooperate very strongly with each other, which becomes clear in Figures 17 and 18.

The WWTPs organized in the neighbourhood groups participate in benchmarking annually. The current wastewater levels, cleaning levels, degradation rates, cleaning performance, energy consumption and production of the individual plants are recorded. This data is published annually and thus enables a direct comparison of the plants.

Another very successful concept of lifelong learning is the networking group on sewage sludge in the north-east region of the DWA. Due to the current legislative changes in Germany with regard to sewage sludge treatment and recycling of phosphorus, this networking group becomes more important. The group is divided into three regional groups in order to take regional characteristics into account and to ensure a more structured organization. Three

meetings per year are organized for each group to present current topics of the wastewater sector. The aim of the networking group on sewage sludge is to develop concepts for a more efficient sludge handling. Once a year, a networking day is organized where all members of the three regional groups are invited for knowledge exchange. With the establishment of the networking group, a complete inventory of the plants was performed and summarized. The inventory includes the most important key figures which are continuously updated to ensure a comprehensive database.

By offering various seminars, conferences and workshops concerning several topics like dewatering, energy, industrial and municipal wastewater treatment, sewage sludge, hydrology, flooding, soil, surface water development, economics, and law, DWA can offer a comprehensive knowledge for lifelong learning. Invited speakers are often active members of the DWA who work in research facilities, universities, universities of applied sciences, authorities, ministries, etc. Also, training, professional development programs and printed professional publications provide knowledge in several sectors of water management. For the first time, the DWA app for mobile phones was presented this year. The app is used to provide and distribute information. DWA members also have the opportunity to visit trade fairs where they can find out about current topics and exchange with professional staff.

Benchmarked lifelong learning practices from other fields of society

In the field of horticultural science, academic E-learning courses were offered at the University of Hannover, Germany. Two universities and one university of applied sciences were involved in performing lectures as a webinar. The E-learning courses were performed as a test run and content of a doctoral research study. The interest of the students to participate in these courses was very high.

Professor Dr.-Ing. Jürgen Wiese from Magdeburg-Stendal University of Applied Sciences reported great success in the cooperation with the Greek Hellenic Open University (HOU) in Patra (Ebel 2018). This university is specialised in E-Learning & Distance Education in the English language, and he participated as a lecturer in the 2017 Summer School on Wastewater and Biosolids Management. Professor Wiese gave lectures via internet from Magdeburg while students participated either on site in Patra or online from all over the world. They could listen and ask questions. These courses are very compact and can be conducted within a few days. They are very much suitable for lifelong learning and continuous education for skilled labourers and senior management. Another experience Professor Wiese had was at the Bauhaus University in Weimar where he gave a guest lecture, which was recorded on video, professionally edited afterwards and put online. That way students, labourers or management could catch up on the matter via the internet at their convenience.

Professor Dr.-Ing. Wolfgang Pfeiffer from the University of Applied Sciences Wismar mentions the importance of the balance between practice and science preferably being free of economic and political interests and influences (Ebel 2018). This is the call of the professional associations, where lifelong learning best belongs to.

4.3 Estonia

Good lifelong learning practices in WWT sector

In Estonia, there are no special requirements for process engineers. However, on September 1st 2017, a special water and wastewater operator's 2-years In Estonia, there are no special requirements for process engineers. However, on September 1st 2017, a special water and wastewater operator's two-year course will start for the first time. (Järvamaa Vocational Centre 2017)

Also, each year since 2011, the Ministry of the Environment has funded a two-week training for wastewater operators. The first week covers a theoretical part, followed by a practical part in the second week. (Taltech 2017)

Also, visiting other WWTPs is very popular. Since the beginning of the 2000s, a lot of completely new WWTPs of various sizes and of different types have been built thanks to the financial support from the EU funds. (Ministry of the Environment study 2016) Due to good relations between local water companies, it is very rare not be allowed to access a plant for educational purposes or not to share know-how with colleagues. Since the plants and technology are fairly new, the know-how is also up-to-date.

When new facilities are built, the contractors are usually obligated to conduct training on the equipment - basic maintenance, operation and work safety. The customer, in this case the water company in question, is allowed to send any their own employees to this training. It depends on the customer (WWTP) and supervising engineers to decide whether the training would be beneficial or rather a formality.

It is also worth noting that water companies have quite often been cooperating with universities in various forms. Students are often interested to conduct a research paper on some parts of WWTP processes, analyse energy consumption etc. At the same time, the WWTP workers also get mutual beneficial knowledge exchange and contacts, and the company can use the outcomes of such small-scale studies internally.

Benchmarked lifelong learning practices from other fields of society

After two-year studies, the graduates of Järvamaa Vocational Centre could apply for a 5-level operator's qualification. There is a similar qualification system in others sectors too. (Estonian Qualifications Authority 2017)

After the qualification, an operators' replacement system could begin, as already seen in an agriculture area in Estonia. When the operator goes on vacation, then a replacement operator takes over the daily duties. Such substitutions will provide an opportunity only for qualified operators.

The Unemployment Insurance Fund arranges training where new qualifications and training grants can be acquired (Unemployment Insurance Fund 2017). The aim is to teach people new skills and sometimes take into account previous work experience.

4.4 Lithuania

Good lifelong learning practices in WWT sector

The lifelong learning concept is implemented in Lithuania in various ways mainly by the Lithuanian Water Suppliers Association, the Water Institute and some vocational training institutions. Based on collected information from official websites of these organizations, the following LLL practices are used in Lithuania:

- Several EU-financed educational projects on raising awareness and capacity building of WWTP personnel were implemented
- Organization of meetings, seminars, workshops of good practice exchange, conferences by Lithuanian Water Suppliers Association
- Organization of training courses, seminars and capacity building seminars for WWTP employees by Lithuanian Water Institute
- Non-formal educational programs for WWTP employees, organized by different consultancy companies according to the needs
- A number of continuing vocational training programs for different categories of operators in WWTP

Benchmarked lifelong learning practices from other fields of society

Different LLL activities are organized in Lithuania in other sectors. Good practices and examples are described below:

- Vocational training centres offers educational programmes and courses for adult education on different topics.
- Non-formal education for elderly persons is managed by the Third Century University (~56 nowadays in Lithuania).
- Lifelong learning possibilities are offered by Lithuanian libraries - here are often organized lectures, libraries are equipped with computers, and therefore, there are many opportunities for learning via internet. For example, a variety of open learning programs are offered in an adult learning information system - from virtual lectures lasting a few hours to workshops or distance courses. People can also choose from a range of educational programmes offered by universities, as well as vocational training and education centres..
- Non-formal adult education coordinators are employed by Lithuanian municipalities. They can advise where and what kind of lifelong studies people can find close to their living area.
- For those who wish to learn via the Internet, some portals are open:
    - Lithuanian distance learning network (LieDM 2017)
    - Adult Learning Information System (SMIS 2017)
    - Open Information, Counselling and Guidance System (AIKOS 2017)
    - European adult learning platform (EPAL 2017)
- The training and educational programs for adults in Lithuania are offered by:
    - Vocational schools
    - Universities and colleges
    - Municipal education centres
    - Universities of the Third Age
    - Various organizations

4.5 Sweden

In general, examples of lifelong learning methods include: training, seminars, conferences; on-site training; social media, discussion groups; peer learning; benchmarking; audits; workshops

Good lifelong learning practices in WWT sector

Based on the collected information, the following practices were identified in Sweden:

REVAQ Certification - the Swedish certification system for sludge application to land.

The Swedish REVAQ certification system was launched in 2008 to coordinate and strengthen the sludge quality work of WWTPs with respect to control and elimination of contaminant sources and putting down strict requirements on the reuse of nutrients in sludge on agricultural land. REVAQ certification is the result of a long-term cooperation between stakeholders in agriculture, the food industry, retailers and the water sector. Today, more than 50% of the Swedish population is connected to a REVAQ-certified WWTP.

The REVAQ certification system has shown that it is possible to simultaneously build confidence, reduce contaminants and increase the recycling of nutrients and organic matter by implementing a systematic, transparent and goal-oriented cooperation between key stakeholders.

- Further training in the form of advanced courses for water and wastewater engineers that have worked for some years.
- Mentoring for the dissemination of knowledge from older to younger employees at WWTP
- Exchange of experiences between municipalities and other stake holders at WWT.

All these lifelong learning practices are used to improve services for end customers, to optimize operations and to find economies in order to better meet the financial requirements imposed on the business.

Benchmarked lifelong learning practices from other fields of society

Based on the above information, it can be asserted that Sweden is moving towards a genuine system for lifelong learning. Each year shows a state effort to invest further in a comprehensive system for education. A great deal of investment was done between 2001 and 2002 for the upgrading of teachers' skills, while a validation system for adults' knowledge and skills was under consideration (Bostrom et al. 2001).

4.6 Latvia

Good lifelong learning practices in WWT sector

The good practices of LLL in WWT sector in Latvia include:

- visits at other WWTP and water company have proven to be effective experience exchange tools
- merging more economical and finance related subjects in technical study programmes have helped future engineers to better understand the financial side of the WWT sector
- seminars

Benchmarked lifelong learning practices from other fields of society

- Educational reforms - basically every field is now considered in combination with its financial/economical side. Even though there are separate study programmes for economists etc., these fields are no longer viewed as separate entities.
- Seminars are a time-tested way of facilitating lifelong learning practices in almost any field.
- Development of IT technologies has made field related magazines and publications more available and therefore a more popular way of self-education.

4.7 Kaliningrad

Good lifelong learning practices in WWT sector

The good practices of LLL in WWT sector in Russia:

- International centre of advanced water technologies, Training Centre of State Unitary Enterprise "Vodokanal Saint-Petersburg" (State Unitary Enterprise "Vodokanal Saint-Petersburg" 2017)
- Peer learning practices in the form of training workshops, organized for management personnel of WWTP of Russia, Open joint-stock company “Combined Waste Water Treatment Plant of Resort Towns Group”, Zaostrovye, Kaliningrad region (JSC OKOS 2017)
- Advanced training professional programme for managers and specialists of environmental services and ecological control systems on the provision of environmental safety. As a result of the training, participants get a certificate which is not limited in time. Duration of the programme is 216 h. It is held in the format of distant learning which consists of video tutorials and a final test (CACAT 2017)

Benchmarked lifelong learning practices from other fields of society

- Advanced training programmes which allow to acquire new professional perspective and start a career in a different area (duration: approx. 10 months, 512 academic hours)
- Universities for the elderly, where pensioners can acquire knowledge in various areas (health-related courses, handicrafts, psychological training, and creative workshops)
- Amateur/creative associations of adults at cultural institutions (culture palaces and centres, museums, philharmonics) which carry out different kind of educational courses and activities
- Personal growth and development schools
- Distance learning
- Platforms for development of online courses

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The present publication introduces Lifelong Learning and Wastewater Treatment in the Baltic Sea Region and the State of the Art in the Wastewater Treatment Education in the Baltic Region reports that are made during the partly EU funded Interactive Water Management (IWAMA) project (2016-2019; Interreg Baltic Sea Region program). Both reports promote and further develop the lifelong learning opportunities in the Baltic WWTP operators and enhance the knowledge of the training institutions responsible for the training in the WWT sector. The reports encourage WWT sector education cooperation and synergies in the Baltic region.

IWAMA project aims at improving wastewater management in the Baltic Sea Region by developing the capacity of the wastewater treatment operators and implementing pilot investments to increase the energy efficiency and advance the sludge handling.

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EU STRATEGY FOR THE BALTIC SEA REGION
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