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Lahti University of Applied Sciences

LIFELONG LEARNING TOOLS TO SUPPORT THE DEVELOPMENT OF STAFF SKILLS IN FINNISH WASTEWATER TREATMENT PLANTS

Electronic Training Material Package (TMP)

LAHTI UNIVERSITY OF APPLIED SCIENCES
Bachelor´s Degree in Technology
Energy and Environmental Engineering
Environmental Technology
Thesis
Spring 2019
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Tiivistelmä

Tekijä(t)	Julkaisun laji	Valmistumisaika
Karvonen, Sini	Opinnäytetyö, AMK	Kevät 2019
	Sivumäärä 45 sivua, 4 liitesivua	

Työn nimi

Elinikäisen oppimisen työkalut henkilökunnan ammattitaidon kehittämisen tukena suomalaisissa jätevedenpuhdistuslaitoksissa – Elektroninen koulutusmateriaalipaketti TMP

Tutkinto

Insinööri (AMK)

Tiivistelmä

Opinnäytetyön aiheena on elinikäisen oppimisen työkalujen käyttö suomalaisissa jätevedenpuhdistuslaitoksissa henkilöstön osaamisen kehittämisen tukena. Työssä keskityttiin erityisesti elektroniseen koulutusmateriaalipakettiin (TMP).

Työn yhtenä tarkoituksena oli selvittää sitä, miten elinikäisen oppimisen työkalujen käyttö ja tarve sekä henkilöstön ammattitaidon kehittämisen keinot elinikäisen oppimisen näkökulmasta tarkasteltuna ovat muuttuneet viimeisten kahden vuoden aikana. Vuonna 2018 toteutetun kyselyn tuloksia verrattiin vastaavaan vuoden 2016 kyselyn tuloksiin sekä arvioitiin hankkeen vaikuttavuutta kyselyn tuloksiin.

Tutkimusjoukon muodostivat 37 esimiesasemassa olevaa henkilöä suomalaisilta jätevedenpuhdistamoilta. Tutkimusmenetelmä oli kvantitatiivinen standardoitu kysely, johon saatiin 11 vastausta.

Perinteisten suosittujen menetelmien, kuten seminaarien, rinnalle on noussut uusia elinikäisen oppimisen työkaluja, kuten ”work shadowing”. Jätevedenpuhdistamoiden ja oppilaitosten välinen yhteistyö ja halu tehdä yhteistyötä tulevaisuudessa ovat lisääntyneet kahdessa vuodessa. Sähköisille oppimispaketeille uskotaan edelleenkin olevan tarvetta tulevaisuudessa. Automaation ja teknologisen kehityksen sekä riskien arvioinnin uskotaan vaativan tulevaisuudessa eniten resursseja henkilöstön ammattitaidon kehittämiseen.

Työn toinen tavoite oli arvioida sitä, miten TMP vastaa elinikäisen oppimisen haasteisiin sekä kyselyn tuloksista ilmeneviin tarpeisiin ja mahdollisuuksiin. TMP:n tavoitteena on tiivistää jätevedenpuhdistamoiden ja koulutuslaitosten välistä yhteistyötä, mikä tukee myös kyselyssä ilmennyttä tarvetta.

Asiasanat

Elinikäinen oppiminen, Ammattitaidon kehittäminen, Sähköinen koulutusmateriaalipaketti, Jätevedenkäsittely

Abstract

Author(s)	Type of publication	Published
Karvonen, Sini	Bachelor's thesis	Spring 2019
	Number of pages 45 pages, 4 appendix p.	

Title of publication

Lifelong learning tools to support the development of staff skills in Finnish wastewater treatment plants – Electronic Training Material Package (TMP)

Name of Degree

Bachelor of Engineering

Abstract

The subject of this thesis is the use of lifelong learning tools in Finnish wastewater treatment plants to support the staff competence and skills development. The work focused in particular on one lifelong learning tool created during the IWAMA project, the Electronic Training Material Package (TMP).

One of the aims of this work was to find out how the use and need for lifelong learning tools and the means of developing the skills of the staff from a lifelong learning perspective have changed over the last two years. The results of the survey conducted in 2018 were compared with the results of the 2016 survey. In addition, the impact of the IWAMA project on the survey results was evaluated.

The study population consisted of 37 persons in supervisor positions working for Finnish wastewater treatment plants. A standardized questionnaire, a quantitative method, was used to collect research data. There were 11 responses to the survey.

Cooperation between wastewater treatment plants and educational institutions has increased in two years. It is expected that electronic learning packages and applications will be needed in the future. It is also believed that automation and technological development as well as risk assessment will require the most resources in the future for the development of personnel skills.

The second objective of the thesis was to assess how TMP responds to the challenges of lifelong learning and the needs and opportunities emerging from the survey results. The goal of TMP is to intensify cooperation between wastewater treatment plants and training institutes, which also supports the need expressed in the survey results.

Keywords

Lifelong learning, Professional development, Electronic training material package, Wastewater treatment

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1 INTRODUCTION

According to the World Economic Forum survey (2016), on average, 35% of core competencies will change by the year 2020. In the field of infrastructure, including wastewater management, the corresponding value is 42%. (Luste & Medkova 2019, 10.) This poses serious challenges for education and working life.

The importance of lifelong learning and continuous training is emphasized as learning, work and professional development are increasingly intertwined. The change in working life together with social, technical and environmental factors, such as evolving technology, ongoing generation change and the heterogenous backgrounds of employees pose serious challenges for wastewater treatment plants. (Salpaus Further Education 2017, 7.; Reardon et al. 2013, 8.)

These factors and challenges have increased the need for flexible and individual training processes and learning methods. There is also a need to develop training methods that support lifelong learning in order to meet these challenges.

Lahti University of Applied Sciences is one of the project partners responsible for developing know-how and producing lifelong learning tools to support the development of wastewater treatment plants. This thesis discusses the use of lifelong learning tools for developing personnel skills in Finnish wastewater treatment plants. The thesis focuses especially on one lifelong learning tool created during the IWAMA project, the Electronic Training Material Package (TMP). The aim is to examine the development, usability and maintenance of the virtual training material package (TMP) in relation to current needs and opportunities emerging from the survey results.

2 WASTEWATER TREATMENT SECTOR

2.1 Wastewater Treatment in Finland – History and Current State

The history of wastewater treatment in Finland extends to the beginning of the 20th century. The first wastewater treatment plants were built in Helsinki and Lahti in 1910. The actual obligations for wastewater treatment only came in the early 1960s, when the Water Act (264/1961) came into force. The number of wastewater treatment plants increased rapidly until the mid-1980s. Since then, the number of wastewater treatment plants has remained relatively constant at over 500. (Katko 2013, 173-175.) Municipal wastewater treatment in Finland has been generally implemented since the 1960s and 1970s (Finnish Water Utilities Association FIWA 2014, 2).

The Finnish wastewater network has a length of about 50,000 km (Vienonen, Rintala, Orvomaa, Santala & Maunula 2012, 14). Approximately 82% of all household wastewater is treated in about 540 Finnish wastewater treatment plants (Finnish Environment Institute 2015). In Finland, there are 412 municipal wastewater treatment plants with an environmental permit (Environmental Ministry of Finland 2015,1). Some of the urban runoff and industrial wastewater are also discharged to treatment plants. About 500 million m^3 of wastewater is treated annually in Finnish wastewater treatment plants (Laitinen et al. 2014, 8).

Finnish wastewater treatment plants with an environmental permit can be divided into five groups according to their population equivalent. Most of the Finnish wastewater treatment plants are small, with a population equivalent of under 500. (Ministry of the Environment 2015, 1.)

According to the 2011 study by FIWA, approximately 4,000 people were working in the wastewater treatment and water supply sector in Finland. The total number of employees has decreased by 1,000 people from the 2002 level. According to the 2015 study by FIWA, 19% of the staff had no degree, about half of the staff had a vocational education degree and 21% had a college degree. The percentage of personnel with higher education was 9%. However, the percentage of personnel with the higher education degree has decreased from the year 2002, when it was 11%. (FIWA 2013, Salminen et al. 2015.)

According to the 2015 study by FIWA, half (51%) of the wastewater treatment and water supply personnel in Finland was born in the 1960s or before, and they will reach retirement age by 2022. The aging of the personnel is one of the biggest challenges for the future in Finnish sewage treatment plants. (Salminen et al. 2015, 1, 11.)

2.2 Wastewater Treatment Process

The first wastewater treatment plants in Finland were based on the septic tank systems. More advanced activated sludge plants have been in use in Finland since the 1930s. (HSY 2015.)

A wastewater treatment plant is a kind of plant where different waste materials are removed at each stage of the process. Most plants use a mechanical-biological-chemical process for wastewater treatment (see Figure 1). To simplify, in this process, solid material is removed mechanically, phosphorus is precipitated chemically, and organic matter and nitrogen are removed biologically. At the end of the process, sewage sludge is separated from clean water, after which the purified water is discharged into water bodies. (FIWA 2014, 4.) There are also many other treatment methods available, but this kind of method is most common.

In Finland, the treatment efficiency of wastewater treatment plants is high: on average, 97% of organic matter, 96% of phosphorus and 56% of nitrogen are removed (FIWA 2014, 3).

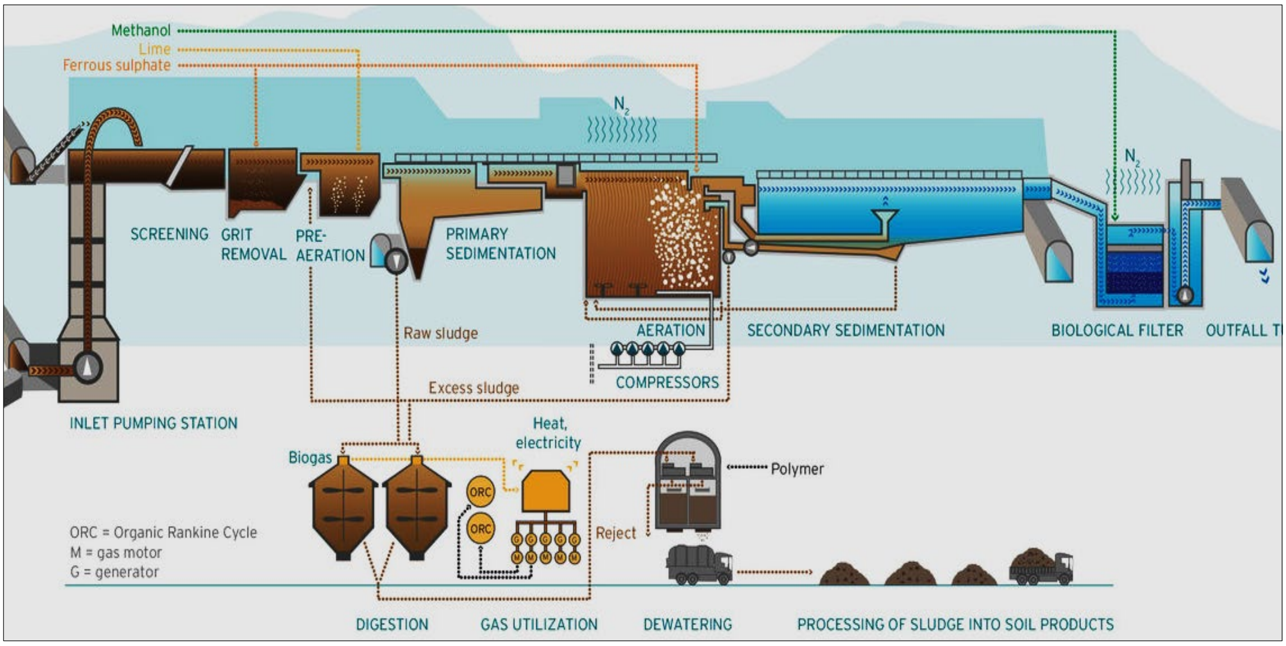

FIGURE 1. An example of a mechanical-biological-chemical wastewater treatment process, a conventional activated sludge method at the Viikinmäki treatment plant (HSY 2018).

2.2.1 Mechanical Processes

In the first stage of wastewater treatment, solid material is mechanically removed from wastewater. The material to be removed during pre-treatment includes gravel, sand, grease and other mixed waste, referred to as screening by the water services. Removing solid material at the beginning of the process is important, so that it does not hamper the water treatment process and damage the equipment. (HSY 2018.)

Primary sedimentation is also part of the mechanical cleaning process. Wastewater flows through large tanks, commonly referred to as primary clarifiers or primary sedimentation tanks (Huber Company 2012). They are used to settle suspended solids (lightweight organic matter), whilst oils and grease rise to the surface and are removed (EPA 2004, Laitinen et al. 2014, 46-47).

2.2.2 Biological and Chemical Processes

In the second stage, the aim of biological-chemical treatment is to remove nutrients, nitrogen, phosphorus and organic matter (Laitinen et al. 2014, 47).

In the chemical treatment, coagulant (usually iron salt, i.e. ferrous sulphate) is added to wastewater. The coagulant is used to precipitate phosphorus into so-called bio-phosphorus, which sinks to the bottom of the pool, and the resulting phosphorus sediment becomes part of the sludge. The sludge is collected from the bottom of the pool for further processing. (HSY 2018.)

The addition of ferrous sulphate to the effluent occurs prior to pre-aeration, which is located before the primary clarification/sedimentation. Most commonly, however, chemical phosphorus removal occurs by so-called co-precipitation, i.e. precipitation occurs in parallel with biological nutrient removal. (FIWA 2016.) In the case of the Viikinmäki treatment plant, the removal of phosphorus is carried out at the same time in two-phase simultaneous precipitation (HSY 2017, 4).

The biological treatment of wastewater is carried out by means of various microbes (e.g. bacteria, algae, protozoa) in the wastewater. To support biological activity, air is pumped into the tank, i.e. wastewater is aerated. As bacteria grow, they consume organic matter in the wastewater. (HSE 2018.) Removal of nutrients and organic matter occurs mainly in aerobic parts of the biological process (in the aeration tank of the activated sludge process) (Laitinen et al. 2014, 43).

Nitrogen is removed from the wastewater in a two-step process based on nitrification and denitrification (Laitinen et al. 2014, 43). In nitrification, ammonium nitrogen (NH_4) is oxidized to nitrate nitrogen (NO_3) in the aerated sections of the activated sludge process. In denitrification, nitrate is reduced to nitrogen gas (N_2) in the unaerated sections of the process. N_2 is released from the wastewater into the atmosphere. (HSY 2017, 4.) Most of the nitrogen removal occurs during the activated sludge process. For example, in the Viikinmäki treatment plant, the process is continued further using biological nitrogen removal filters.

In the secondary sedimentation, the sludge sinks to the bottom of the pool and clean water remains above it. The sludge is then collected and most of it is recycled to the beginning of the biological process. In this way, bacteria are ready to start working immediately. After the secondary sedimentation, water is clean enough to be led to the sea. (HSY 2018.)

2.2.3 Sludge Treatment

The most common way to treat sludge is anaerobic digestion. Part of the organic matter in the sludge continues to decompose producing methane, i.e. biogas. This methane gas is utilized in energy generation to produce heat and electricity, and as biofuels in vehicles.

The sludge is then composted and further processed into soil products. This allows the recycling of organic matter, nitrogen and phosphorus from the sludge. (HSY 2018, HSY 2017, 4.)

2.3 Legislation

Wastewater treatment plants have a great responsibility for the well-being of nature, people and the environment. Laws and regulations govern the operation of wastewater treatment plants at both Finnish and EU levels. The aim of the laws is to protect the environment from the harmful effects of wastewater and to ensure the efficient operation of wastewater treatment plants.

The Council Directive concerning urban wastewater treatment (91/271/EEC), i.e. the Urban Wastewater Treatment Directive, concerns the treatment, collection and disposal of urban wastewater and the treatment and disposal of wastewater from certain industries. The aim of the Directive is to protect the environment from the harmful effects of wastewater discharges. The Directive obliges Member States to treat urban wastewater biologically or in a similar way in agglomerations with a population equivalent of more than 2 000 before discharging wastewater into inland waters or estuaries. Population equivalent (PE) is a unit of measurement for biodegradable pollutants, the average load produced per person per day (Laitinen et al. 2014, 26).

In Finland, The Urban Wastewater Treatment Directive has been implemented by Government Decree on Urban Wastewater Treatment (888/2006). According to the regulation, wastewater must be treated biologically or in a similar way and the treatment must meet the requirements of the regulation (Government Decree on Urban Wastewater Treatment 888/2006, 4§). The Regulation prohibits the discharge of treated and untreated residual sludge from urban wastewater treatment plants into waters (Government Decree on Urban Wastewater Treatment 888/2006, 5§).

The purpose of the Water Services Act (119/2001) is to ensure water services that provide access to a sufficient amount of good quality water for domestic use at a reasonable cost. The objective of the Act is also to ensure proper sewerage in terms of health and environmental protection. (Water Services Act 119/2001, 1§.)

The Water Services Act (119/2001) obliges municipalities to develop sewerage and water services in their areas in line with community development. Municipalities should cooperate with the water utilities in their area, with other municipalities and with those supplying water to the water utilities and treating their wastewater. They should also be involved in the general regional planning of water services. (Water Services Act 119/2001, 5§.)

According to the Environmental Protection Act (527/2014), an environmental permit is required for activities that pose a risk of environmental pollution. Municipal wastewater treatment plants are subject to a permit requirement if their population equivalent is at least 100 (Environmental Protection Act 527/2014, 27 §). The application for an environmental permit for a municipal wastewater treatment plant shall include an explanation of, among other things, the population equivalent and the need for nitrogen removal. More specifically, the content of the permit application is regulated by the Environmental Protection Decree (713/2014).

2.4 Development Needs, Drivers and Trends in the Wastewater Treatment Sector

The near-term and long-term planning decisions of the wastewater industry face many challenges such as increasing energy costs, tightening emission regulations, finite resources and water conservation. Tightening demands on energy efficiency and sludge utilization, evolving technology, changing working environment and ongoing generation change, just to name a few, pose serious challenges for wastewater treatment plants. (Reardon et al. 2013, 8.)

The lack of awareness, training and interactive international information sharing has been identified as one of the major limitations in terms of resource- and energy-efficient management of wastewater processes in the Baltic Sea region (e.g. PRESTO project 2011-2014, PURE project 2007-2013). Thus, the capacity development priority in the ongoing “Interactive water management” (IWAMA) project (Interreg Baltic Sea Region; 2016-2019) was to find the most suitable ways and methods to tackle these problems.

In addition, the water sector is strongly influenced by general drivers of development such as digitalization, increased information of micro-pollutants and aging of infrastructure as well as planetary boundaries that affect the growing demand for food, water and energy.

Futurists believe that the major trends in the future have their seeds in the present. Key global trends that have an impact on the wastewater treatment sector include: increased urbanization, changes in population and demographics, climate change, increasing living standards, and a scarcity of resources needed to maintain life (including water, land and phosphorus). (Reardon et. al. 2013, 8-9.)

From the perspective of the wastewater treatment sector, treatment technologies are evolving to meet significant trends such as energy conservation and production, nutrient removal and recovery, sustainability, and treatment for non-traditional contaminants, for example, trace organic compounds (Reardon et. al. 2013, 9-10). Among the main priorities for developing water supply (including wastewater treatment) are strengthening resources of water supply facilities as well as strengthening research, development and innovation activities and know-how. It is also important to take into account the future potential of water supply to be part of the bio- and circular economy as well as the internationalization of the water supply sector. (Silfverberg 2017, 32-33.)

Tighter EU law requirements have an impact on the treatment of harmful substances in wastewater (drug residues, microplastics and hormone-stimulating substances) (Silfverberg 2017, 7).

As a result of increased circular economy thinking, nutrient recycling and eco-efficiency requirements are also increasing (Silfverberg 2017, 12). Recently, there has also been much talk about the use of sewage sludge as a fertilizer in agriculture from the point of view of the circular economy. Another important topic is improving the energy efficiency of wastewater treatment plants in the Baltic Sea Region. In the Interactive Water Management (IWAMA) project, an audit concept is being developed for this purpose (Lahti Circular Economy Annual Review 2017, 38).

Future trends in wastewater treatment also include risk management, which will be increasingly integrated into comprehensive water supply management. The vulnerability to cyber threats must also be taken into account. International co-operation can bring new good practices to Finland, strengthen know-how and increase the attractiveness of wastewater treatment. The export of wastewater treatment technology can also generate new revenue streams for the national economy. (Silfverberg 2017, 13-14, 18.)

According to the European Union of National Associations of Water Suppliers and Waste Water Services (EurEau 2017, 8), the challenges facing the water sector in the next 10 years also include fostering sustainable economic growth and creating jobs.

According to a report from Ramboll on the training needs of the water supply sector, the competence needs of wastewater treatment include energy and material efficiency requirements, automation and ICT development and institutional integration (Salminen, Eronen & Kettunen 2015, 22-23).

According to the IWAMA surveys, the ageing of the infrastructure, as well as selection and implementation of new technical solutions, are one of the most urgent needs for know-how development. In addition, there is a need for basic training development in the wastewater treatment sector as well. This is due to the ageing of the staff and difficulties to find new employees. One of the biggest challenges for water utilities in the future is the aging of the staff. According to the personnel survey conducted by the Finnish Water Utilities Association (FIWA) in 2011, half of the personnel in the sector will retire by 2022 (Salminen et. al. 2015, 1). Moreover, the new employees come from different backgrounds and the duration of employment is usually short-term.

3 TRENDS IN EDUCATION AND LEARNING

Today, continuous self-development and education in the labor market have become increasingly important also in areas where the experience was emphasized in the past. This trend has also been seen in the water supply sector, where lifelong learning and continuous education are increasingly emphasized. Section 3.1 explains more about lifelong learning.

Currently, rapid shifts affect working life due to technological, global and environmental changes, and the change in working life is faster than we can notice. According to a World Economic Forum survey (2016), an average of 35% of core competences will change by 2020. In the infrastructure sector, including wastewater management, the corresponding value is 42%. (Luste & Medkova 2019, 10, 13.)

It has been suggested that the required skills are changing from the teacher's driven controlling to flexible sharing, from knowledge management to knowledge productivity, from teaching to learning, and from programming to reality (Savickas 2017). According to the World Economic Forum (2016), the top 10 skills for 2020 are: 1. complex problem solving, 2. critical thinking, 3. creativity, 4. people management, 5. coordinating with others, 6. emotional intelligence, 7. judgement and decision making, 8. service orientation, 9. negotiation and 10. cognitive flexibility.

On a general level, future learning and education should be a continuous experience. Due to different backgrounds and age groups of employees, the need for individual and flexible training processes and learning methods increases. (Luste & Medkova 2019, 8-11) In addition, training needs and methods are under strongly developing pressures due to demographic factors, such as internationality and immigration. There is a need for multiple, multinational, cross-cultural experiences (Luste & Medkova 2019, 9). More attention should also be paid to the possibilities of learning in daily interactions and the methods that could be used to stimulate learning (Krumboltz 2009, Fischer 2000).

In many cases, people working in wastewater treatment plants are close to retirement age, and new employees are usually short-term. There is also a risk that "silent knowledge" will be lost in cases where the number of retiring workers is high. (Luste & Medkova 2019, 9.) It is important to transfer the knowledge and experience of the retiring staff to future employees, thus maintaining good know-how in the wastewater sector and promoting lifelong learning.

Solving the challenges faced by the wastewater treatment and education sector requires improving skills, many of which involve the use of computers and applications related to monitoring, business, analyses, databases, GPS systems, simulations, emergency systems and GIS applications, etc. (UNESCO 2012). Smart technology, social media and digitalization can serve as tailor-made tools for developing and delivering information to achieve and validate new skills. This is a challenge for proper design and maintenance of capacity development structures and facilities. (Luste & Medkova 2019, 4.)

Regular training should include updates on capacity development for future requirements, current processes and information about forthcoming technologies (Rettig & Barjenbruch 2017). Without significant investments in education, cooperation between educational institutions and water supply facilities, and awareness of the sector, the Finnish water supply sector is threatened by decline (Häyrynen 2015, 40).

3.1 Lifelong Learning

Lifelong learning is a continuous, self-motivated and voluntary pursuit of knowledge for either professional or personal reasons (Department of Education and Science 2000). The European Union defines lifelong learning as learning from preschool to retirement, including formal and non-formal learning as well as informal and self-directed learning (Council Resolution 2002/C 163/01).

The importance of lifelong learning has increased as learning, work and professional development are increasingly intertwined today. Continuous improvement of one's own learning ang knowledge has become important because of the constant changes and developments in working life. (Salpaus Further Education 2017, 7.) Lifelong learning and recognition of prior learning have therefore become important aspects of adult education and professional development (Luste & Medkova 2019, 19).

The challenges and requirements of learning and education are changing at an ever-increasing pace. Working life skills have become a priority. This puts pressure on the development of lifelong learning and other education. (Pantzar 2013, 14, 17.) Today, it is generally believed that the focus of education should shift from organizational focus to individual needs (Tuomisto 2003, 51). Studying can be very independent and does not necessarily require a teacher or an institution. In self-education, students are in response to their own learning needs and learning is self-fulfilling (Jarvis 2004, 41).

In order to keep up with the development, a lifelong learner should know the key competences that continuous learning, future challenges and new situations, as well as the changing circumstances of working life require. These skills include problem solving, co-operation, interaction, technology, communication and media expertise, and information technology. (Finnish National Agency for Education 2016.)

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has been a major contributor to lifelong learning, and it has organized world conferences for adult education every ten years since the late 1940s (UNESCO institute for lifelong learning 2009). The EU (Council Resolution 2002/C 163/01) and The Organisation for Economic Co-operation and Development (OECD) have also strongly supported lifelong learning. Lifelong learning in Finland became one of the essential elements of civilization and learning in the 1990s with new national education and training strategies (Silvennoinen & Tulkki 1998, 16). The Europe 2020 strategy that promotes growth and employment was launched in 2010, and one of its objectives is to increase education in the Member States (Ministry of Finance 2017).

Lifelong learning is considered an important force in the process of enhancing the capacity of operators of wastewater treatment plants. Lifelong learning is also particularly important in order for wastewater treatment plants to optimize the operation of existing plants, move to more energy-efficient systems and integrate new technologies. (Centrum Balticum 2018.)

3.2 New Educational Opportunities for Lifelong Learning

In addition to the content of education, attention should also be paid to the learning approaches in practice (Luste & Medkova 2019, 28). Online communities support constructivist approaches that require the learner's active involvement in the capacity building and the learning process (Broadbent & McCann 2016).

3.2.1 E-learning & Interactive E-learning

E-learning and digitality are useful tools for facilitating and improving international knowledge exchange and information sharing (Sandelin 2017; Aceto et al. 2010). Electronic learning or e-learning exists in many forms and can be non-formal or formal. The e-learning examples are, for instance, videos, online discussion groups, tutorials and virtual tests.

From the point of view of teaching approaches, e-learning has several advantages. It enables massive amounts of information to be available, supports both knowledgecentered and student-centered learning and enables the use of customized learning processes and the most suitable resources (Luste & Medkova 2019, 28). Social media platforms, blogs, forums and games reinforce the sense of community, which may improve learning (Aceto et al. 2010).

Interactive e-learning involves the active participation of learners by allowing learners to explore and evaluate the content as well as to participate in the content. It improves learning outcomes by creating cognitive experience of participation in the learning process.

In addition, interactive e-learning facilitates deeper learning and understanding by actively involving learners in the learning process. It also activates long-term memory, gives learners the opportunity to control their own learning process and promotes motivation.

Interactive e-learning materials often includes both auditory and visual elements as well as interactive games, simulations, real-life scenarios, different types of quizzes (true/false, multiple-choice etc.), assessments and hands-on exercises. The use of scenarios, assessments, role-plays and simulations provides immediate feedback on the learning process to learners. (Luste & Medkova 2019, 30.)

3.2.2 Social Computing

Social computing is defined as collaborative and interactive behavior between computer users through social media applications. It supports lifelong learning by providing flexible, accessible and dynamic learning methods that can complement basic training. It offers the opportunity to overcome various obstacles: space and time barriers, institutional walls and language barriers. It also supports international networking and interaction between and among teachers and learners who are geographically dispersed.

Social computing tools, such as Skype, blogs, video connections, social networking services, wikis, may increase creativity and innovation by supporting a more playful and engaging approach. Social computing can improve empowerment and collaboration, enabling teachers and learners to find new ways to creatively and actively develop their own skills. It also offers a wide range of versatile tools that allow learners participate actively in the construction of their own learning process and improve their individual performance. (Redecker et al. 2009; Luste & Medkova 2019, 28-29.)

3.2.3 Peer Learning

Peer learning, a learning practice where students interact with each other to achieve learning goals (O'Donnell & King 1999), is increasingly taking place via "social computing" applications, for example, in professional forums, HUBs or discussion groups. According to Aceto et al. (2010), peer learning has been reported to improve the sense of belonging to the community as well as learning in communities. The key factors for improving motivation are personal empowerment and online peer-to-peer interaction, when students feel part of a team (Aceto et al. 2010). Many of the needs concerning lifelong learning and the changes in working life would be covered by the idea of "studying at work". (Luste & Medkova 2019, 29.)

3.2.4 Benchmarking

Benchmarking can help to create an understanding of performance in relation to peers. It enables the identification of strengths and weaknesses to improve operation and performance. It gives managers the opportunity to compare themselves with others, to learn from the best and to network with their peers. Benchmarking in the water sector has generally been used to develop resource utilization, organizational efficiency, environmental performance, quality and results. Comparison at the national level is generally easier than at the international level, as the results depend similarly on the local context. (EurEau 2015; Luste & Medkova 2019, 30.)

3.2.5 Flipped Learning

A good example of how to use electronic material is "flipped learning", a method used in the implementation of lifelong learning studies. Flipped learning is a method in which, for example, independently viewed instructional videos or other material that is available to students regardless of place and time replace traditional introductory lectures and basic courses. This kind of teaching method is more and more popular especially in universities of applied sciences.

Flipped learning saves time as students can prepare for lessons in advance. It also enables the use of the best teachers worldwide. Learning outcomes are improved and learning motivation is increased through immediate feedback on exercises and by monitoring progress.

The teacher would act as a tutor when guidance is needed in training and feedback/ discussion sessions. Training could be, for example, tasks, games or simulations based on problem solving. In “flipped learning”, basic electronic materials (e.g. games, videos, simulations) can be combined with virtual tests, in which advanced interactivity between other students and a teacher is co-utilized. (Luste & Medkova 2019, 29-30.)

Flipped learning could be implemented as project-based learning, team learning or/and peer-to-peer learning, with good learning outcomes (O'Callaghan et al. 2017). For example, at the Department of Applied Physics at the University of Eastern Finland, the pass rate of the hardest electricity course was reported to rise up to 80-90% by this method, compared to traditional teaching methods in which only 20% of students managed to pass the course on the first attempt (Saarelainen 2018).

4 CAPACITY DEVELOPMENT IN IWAMA – ENHANCING LIFELONG LEARNING IN WASTEWATER TREATMENT PLANTS OF THE BALTIC SEA REGION

Lahti University of Applied Sciences is leading the capacity development work in the "Interactive Water Management" (IWAMA) project. One of the objectives of Lahti University of Applied Sciences in the IWAMA project is to provide lifelong learning tools to support the capacity development of wastewater treatment plants. A partly EU funded (Interreg Baltic Sea Region, 2016-2019) IWAMA project is a flagship project of the EU Strategy for the Baltic Sea Region.

The information channels and needs of the wastewater treatment plant staff have not been adequately studied in the past, and it is therefore difficult to find comparable results for information channels and needs of wastewater treatment plants (Sandelin 2019, Luste & Medkova 2019, 34).

In IWAMA, the starting point for capacity development was the results of the PRESTO project (2011-2014; Interreg Baltic Sea Region), which was carried out in the Baltic Sea region. According to the PRESTO project (2011-2014) and the PURE project (2007-2013), one of the major limitations in terms of resource- and energy-efficient management of wastewater treatment processes in the Baltic Sea region is the lack of awareness, training and international interactive information sharing. The focus of the IWAMA capacity development is on wastewater treatment plant personnel and identified bottleneck areas: smart energy and sludge management as well as the best available technologies, which have been identified as key factors affecting the maintenance of the wastewater treatment plants in the Baltic Sea region (Rettig & Barjenbruch 2016).

Internationality as well as interactions and interactivity between the operators of wastewater treatment plants, water and wastewater associations, technology suppliers, authorities and universities in the Baltic Sea region are at the core of the capacity development of the IWAMA project. The operational objectives have been to share, develop, deliver and receive know-how, to find national synergies and to increase international interactivity.

The capacity development took place at various events in the IWAMA project: online training webinars, international on-site workshops, online meetings and national dissemination events (Estonia, Finland, Germany, Lithuania and Sweden), with the participation of experts, project and associated partners, wastewater treatment management, suppliers and authorities. There were 17 partners and 12 associated partners in the project. In addition, surveys, information exchange and co-development of the lifelong learning tools (i.e. the e-training material package with virtual tests (TMP), WWTP game) have been carried out in a separate capacity development work package (see Figure 2). (Luste & Medkova 2019, 34-36.)

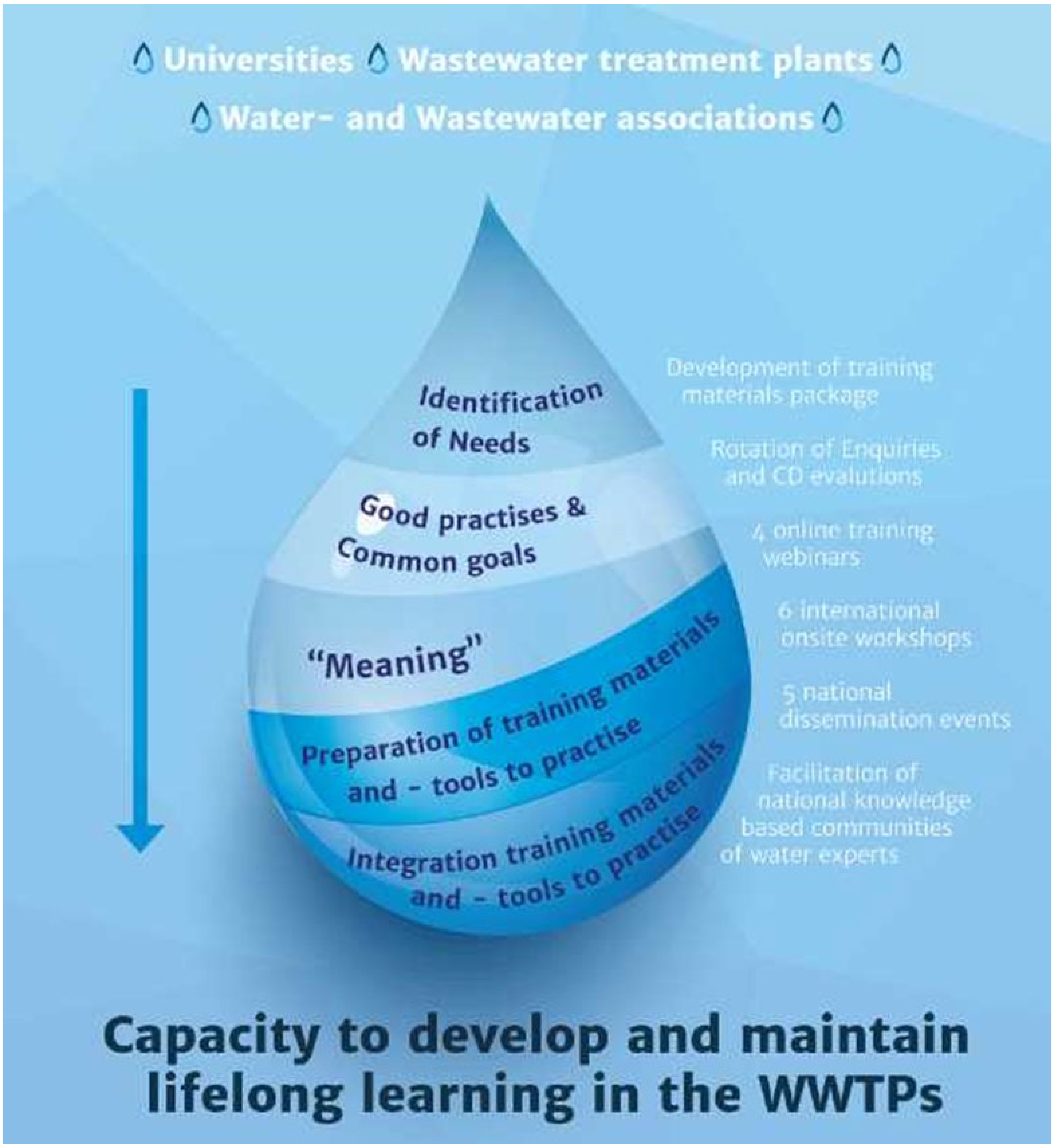

FIGURE 2. Capacity development stages during the IWAMA project (Luste & Medkova 2019, 35).

5 MATERIALS AND METHODS

During the IWAMA project, Lahti University of applied sciences aimed at providing lifelong learning tools for the capacity development of wastewater treatment plants. This thesis explored the use and needs of lifelong learning tools in Finnish wastewater treatment plants. Corresponding surveys have been conducted in other countries of the Baltic Sea Region. By comparing the results obtained from surveys in different countries, i.e. benchmarking, the aim is to find effective and best solutions for different lifelong learning needs in the wastewater treatment sector (Heponiemi 2016, 2). In this thesis, the research results were compared to similar research conducted in Finland in 2016, not to similar international studies. The survey was carried out with the assistance of Sami Luste, Project Manager at the IWAMA project, and Katerina Medkova, Project Planner.

One of several lifelong learning tools designed in the project was the electronic Training Material Package (TMP), which is described in more detail in section 5.2. The aim was to examine the development, usability and maintenance of the virtual training material package (TMP) in relation to current needs and opportunities.

5.1 Study on the Needs and Use of Lifelong Learning in Finnish Wastewater Treatment Plants in 2018

In 2016, Kimmo Heponiemi made a survey of the needs and the use of lifelong learning in Finnish wastewater treatment plants. The research question of Heponiemi’s and this recent thesis is to find out how lifelong learning processes and tools are used and applied in today's Finnish wastewater treatment plants. The purpose of this newer survey is to find out how needs and use have changed over the past two years.

In both studies, the quantitative method was the most suitable research method, because the aim is to broaden the scope of research to the widest possible extent within the reference population and the exact size of the study population is not defined (Hirsjärvi 2007, 128 - 139). In quantitative research, the research problem is quantified by producing numerical data or information that can be converted into useable statistics. Quantitative research is a conclusive type of research. It is used to quantify opinions, attitudes and other defined variables and to generalize results from a larger sample population. (UK Essays 2017.)

The studies also use qualitative methods, exploratory research, to deepen the results obtained by quantitative methods. Qualitative information might be more profound at the individual level, but generalization of knowledge would be problematic. (UK Essays 2017, Hirsjärvi 2007, 128 - 139.)

5.1.1 Collection of Material/Data

A standardized questionnaire was selected as the survey data collection method. The standardization of a survey means that all respondents are asked the same things exactly in the same way (Hotulainen 2019). This means that the same questionnaire was sent to each respondent. According to Hirsjärvi (2007, 180), the use of the survey is a suitable choice if you want to find out what people in the study population think, feel or believe. The use of the survey is also well-suited when the survey sample is large, and the results are examined quantitatively.

The advantage of the survey is that it enables the collection of extensive research data. The method is also effective and saves time and effort. The carefully collected survey data can be processed in the desired format and analyzed using a computer. (Hotulainen 2019.)

The survey also has disadvantages. The data collected through the survey can be considered superficial and not reliable in all respects, because there is no precise information on what the respondent's attitude is to the survey. The questions may have been answered quickly without further reflection. In addition, many respondents may leave the questionnaire unanswered. (Hirsjärvi 2001, 190.)

5.1.2 Online Survey

The survey was conducted from 4 September to 28 November 2018 as an online survey with Webropol 3.0. The study population was easy to reach by an online survey. Answering was made easy by attaching a link to an email to open the query. In this way, the aim was to get as many answers as possible and to gather reliable and comprehensive material.

The study population consisted of persons in supervisor positions working for Finnish wastewater treatment plants, because they were thought to know the operation and needs of their own plant thoroughly. They were also expected to know the current state of the wastewater treatment sector and how the sector will develop in the future.

An email was sent to each sewage treatment plant or water utility with background information on the survey and the IWAMA project as well as a link to the questionnaire. The selected wastewater treatment plants and waterworks had a population equivalent of at least 15,000. The contact details of the target persons were received from Kimmo Heponiemi, who conducted a similar survey in the autumn of 2016. In the autumn of 2018, the survey was sent again about five times due to lack of answers. As the willingness to respond to the questionnaire was reluctant and indifferent, it was decided to personally call some of the representatives of the institutions.

Responding to the survey was anonymous and could not be identified in any way. Almost all of the questions in the survey were multiple choice questions or scale-based questions. Only two questions in the survey were open in form.

At first, the survey identified lifelong learning tools that are currently in use to develop staff skills. After that, the cooperation of the wastewater treatment plants with different parties was investigated. Then the activity of the staff to participate in training and the planning of training were studied. The use of resources for the development of staff competence was also investigated. Next, the needs and possible learning tools in the future were surveyed. Finally, there was an open question about how the sector will develop over the next ten years.

The data collected in the survey was mainly quantitative. It was analyzed quantitatively using the Webropol reporting tool. The entire material, including classified responses to open questions, was converted to Excel format, so that the survey material could be handled better.

5.2 Virtual training Material Package (TMP) – Capacity Development Tool

One of the capacity development and lifelong learning tools developed by Lahti University of Applied Sciences, the leader of the work package on capacity development, was the electronic Training Material Package (TMP). Its purpose is to help wastewater treatment operators develop their capacity, to improve regional cooperation among wastewater sector actors and to promote the exchange of expertise by supporting the smart development of the Baltic Sea Region. (IWAMA 2019a.) The lack of awareness, training and interactive international information sharing has been identified as one of the major limitations in terms of resource- and energy-efficient management of wastewater processes in the Baltic Sea region (e.g. PRESTO project 2011-2014, PURE project 2007-2013).

5.2.1 Preparation of Electronic Training Materials for the Training Material Package

One important task in preparing electronic training materials was to create English subtitles for videos that were presented at the IWAMA project's international on-site workshops and online training webinars. Each workshop and webinar had a specific theme as you can see from the Figure 3. Video presentations of different events were related to the themes of these events. The speakers and participants of the events were from Finland, Germany, Poland, Estonia and Sweden etc. The speakers of the presentations were experts in the wastewater treatment sector, i.e. representatives of wastewater treatment plants and companies, as well as researchers, etc.

IWAMA workshops and webinars themes

Workshops

1. Identification of Capacity Development Needs in WWTP (Lahti, Finland)
2. Energy Production in WWT (Boltenhagen, Germany)
3. Energy Efficiency in WWT (Szczecin, Poland)
4. Smart Sludge Management (Tartu, Estonia)
5. Nutrient Reduction and Recovery (Kalmar, Sweden)
6. Constructional and Operational Challenges (Gdańsk, Poland)

Webinars

1. Capacity Development
2. Energy Efficiency
3. Management and Maintenance
4. Pre- and Post-treatment on WWTPs
5. Co-operation and Symbiosis

FIGURE 3. Videos of the IWAMA workshops and webinars were related to the themes of these events. (Medkova & Luste 2019)

Video subtitling took place on YouTube (Creator Studio). There were about 20 videos and each of them was about 20-40 minutes long. Project Manager Sami Luste and Project Planner Katerina Medkova ordered the videos that were supposed to be subtitled. Subtitling videos in YouTube Creator Studio was both automatic and manual because the program did not always recognize the speaker's speech. The preparatory work on the training material also included modifying the subtitles and eliminating the repetition, i.e. making the speaker's speech in an understandable and condensed form. It was also important to pay attention to the correct language of subtitles.

Subtitling of videos played an important role in the IWAMA project, because videos are a significant part of the electronic Training Material Package (TMP). The importance of diligence was emphasized in the work, because other IWAMA project workers translated English subtitles into different languages. At the same time, the subtitling of the videos served as a way to develop one’s own expertise in the field, because the videos contained the most up-to-date information on the wastewater treatment sector in the Baltic Sea Region.

5.2.2 Preparation of the Moodle-based Training Material Package (TMP)

After the preparation of electronic training materials, they were compiled into the electronic Training Material Package, a Moodle-based website for e-training and interactive international information sharing. TMP has been co-developed with the wastewater associations around the Baltic Sea region in the capacity development workshops.

TMP was divided into folders in different languages, of which the English folder was the main folder. Other national folders were for e-training materials in German, Estonian, Latvian, Lithuanian, Polish, Finnish, Swedish and Russian. Folders in different languages were also divided into different categories into which e-training materials such as videos and slideshows were added based on their theme. The task of Lahti University of Applied Sciences was to compile and organize the English language learning materials into the right categories. National knowledge-based communities (NKBCs) formed in the project were responsible for the national folders.

The e-training material to be included in the Training Material Package was listed in Excel according to its theme and the workshop or webinar in which it was presented. The division of videos into different categories was challenging because many of them could have been placed in two or more categories. The English folder contained four main categories:

1. Management; Maintenance; Cases and Technologies
2. Energy Production; Energy Efficiency

3. Wastewater Sludge; Nutrient Recovery

4. Lifelong Learning Material; Capacity Development Tools

Besides the study material, TMP contains an automatic testing function with specific questions related to studied topics (see the aforementioned list). In addition to videos and slideshows, quizzes were included in the Training Material Package. The quizzes included a variety of questions, such as multiple choice and right or wrong questions. The questions for each quiz were based on the corresponding video. The quizzes were divided into different categories according to their theme just like the other e-learning materials in the Training Material Package.

6 RESULTS AND ANALYSIS

6.1 Survey

6.1.1 General Information

The survey was sent to a total of 37 representatives of the Finnish wastewater treatment plants, but two of them directed the survey to another person who was more familiar with the operation and needs of the wastewater treatment plant. There were 11 responses to the survey, with a response rate of just under 30%.

6.1.2 Results of the Survey by Question

1. Existing tools for developing the skills of staff

   According to this newer survey conducted in 2018, each of the respondents replied that they used conferences, seminars and workshops, etc. to develop the skills of their own staff. The situation regarding the use of seminars and conferences, etc. has therefore remained the same as in 2016, as shown in Figure 4. On-the-job training has gained some popularity, as all respondents in the 2018 study replied that they were using it to develop their staff's skills. In 2016, approximately 80% of respondents replied that they were using this training method.

   Peer learning and active benchmarking to the reference companies have also gained some popularity in the last two years. In 2018, approximately 55% of respondents reported using these methods. The use of computer, tablet and telephone applications has also become popular over the past two years as a tool for developing staff competence in the wastewater treatment sector. Especially work shadowing, an activity where a person spends some time observing a professional at work, has gained popularity in the field. In 2016, only 5% replied using work shadowing to the staff competence development. In 2018, the use of work shadowing had already risen to 27%. Various social computing tools, such as social media and discussion forums, have not gained popularity in two years as tools to develop staff competence in the wastewater treatment sector despite being very commonly used in life otherwise. Webinars, on the other hand, have gained some popularity as almost 20% of respondents reported using them in 2018.

One of the respondents replied that they were using vocational training organized by SYKLI Environmental School of Finland for staff training.

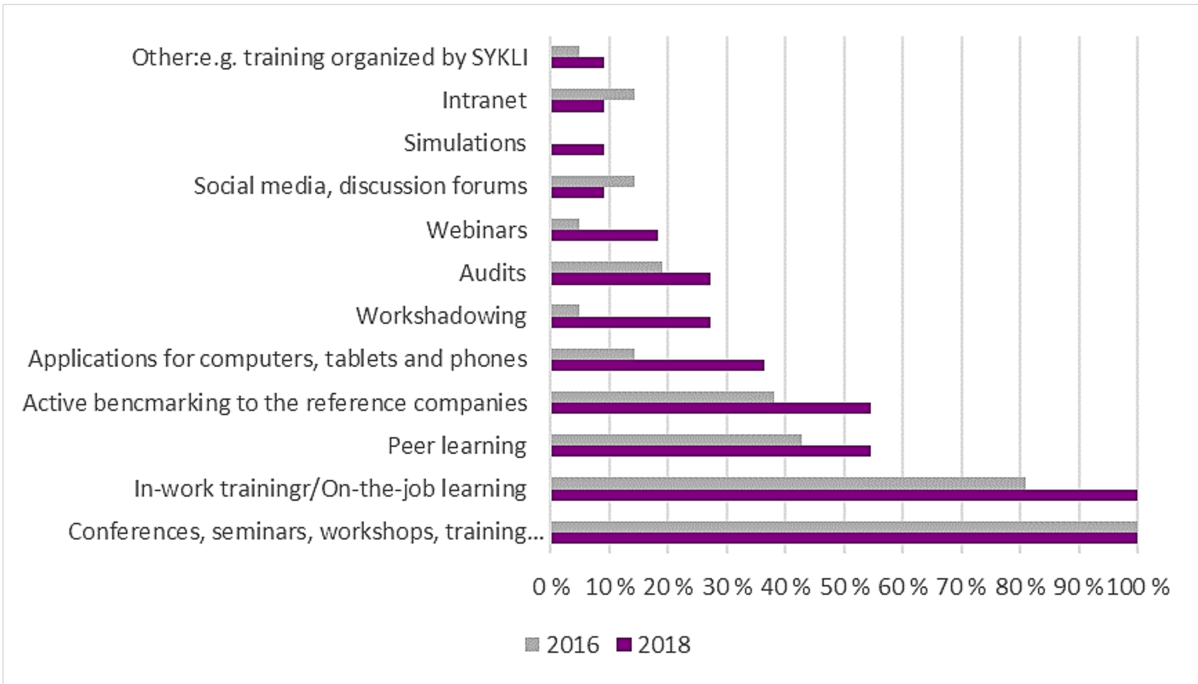

FIGURE 4. Tools for developing the skills of Finnish wastewater treatment plant personnel in 2016 and 2018.

2. Cooperating with different parties today and in the future

The study investigated the current cooperation of the wastewater treatment plants with various parties in order to develop the competence of the personnel (Figure 5). It was also asked which parties the wastewater treatment plants want to cooperate with in the future (Figure 6). In 2018, each of the respondents replied that they were currently cooperating with the Finnish Water Utilities Association (FIWA) and over 60% of the respondents wanted to increase cooperation with FIWA in the future. In 2016, it was also the most popular partner. Cooperation with other wastewater treatment plants has also maintained its popularity, and 55% of respondents would like to increase cooperation between different wastewater treatment plants in the future. Collaboration with educational institutions (vocational institutions, universities of applied sciences and universities) has increased significantly over the past two years. More than 60% of the respondents replied that they were cooperating with some educational institution. The willingness to cooperate with colleges and universities has also increased significantly, as can be seen in Figure 6.

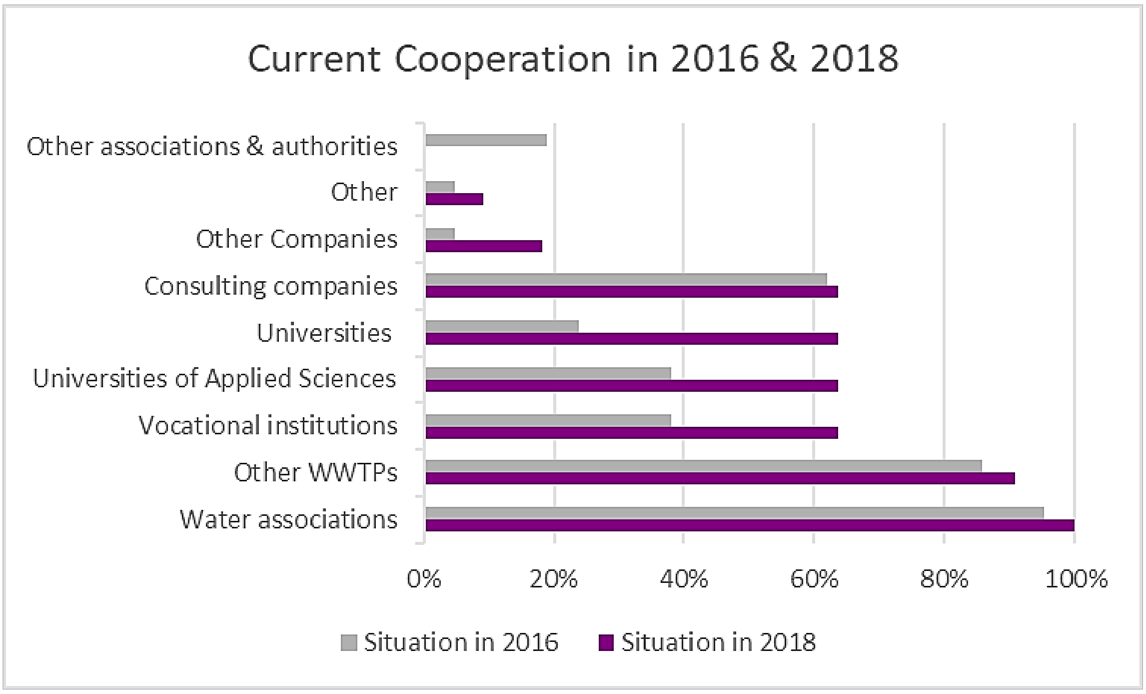

FIGURE 5. Current collaboration with different parties to develop staff competence (2016 vs. 2018).

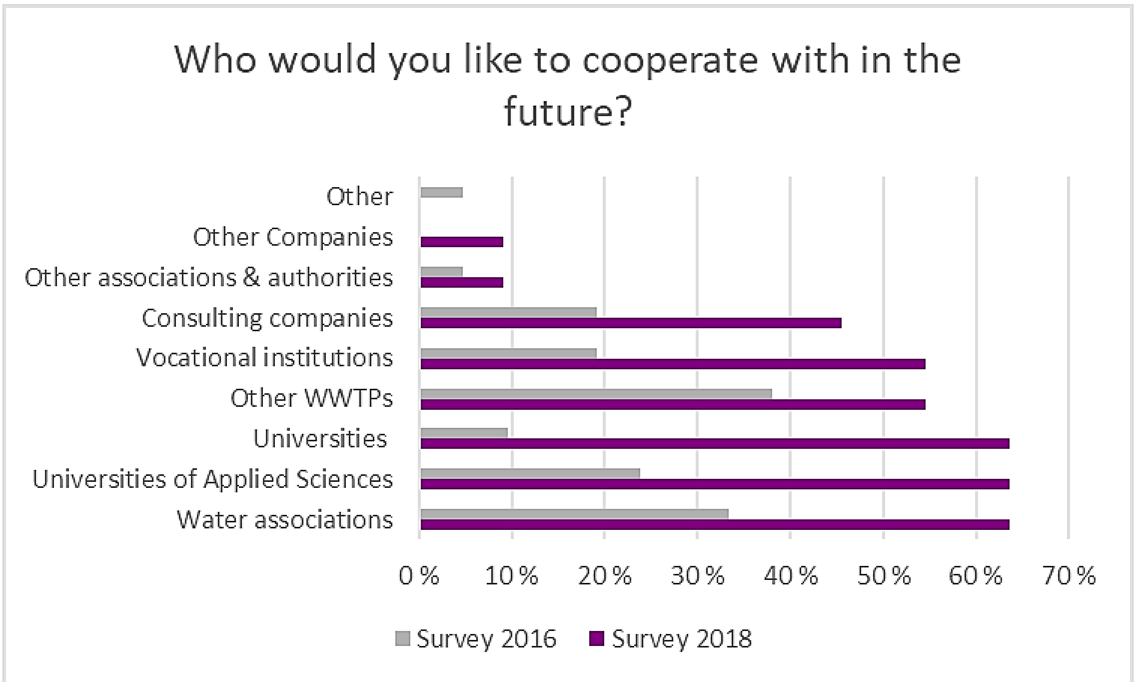

FIGURE 6. The willingness to increase cooperation with different parties in the future (2016 vs. 2018).

Cooperation with consulting companies has remained roughly at the same level, but the willingness to cooperation with them has increased considerably. On the other hand, cooperation with other associations and authorities has declined over the past two years. One of the respondents mentioned chemical and software suppliers as other companies.

3. Participation in training

The survey also looked at how often a person in the wastewater treatment plant participates in different training sessions on average. In both surveys, all respondents replied that their employees attended at least in one training over the last five years. In the 2016 survey, the answers were evenly distributed between the different response options, as can be seen in Figure 7.

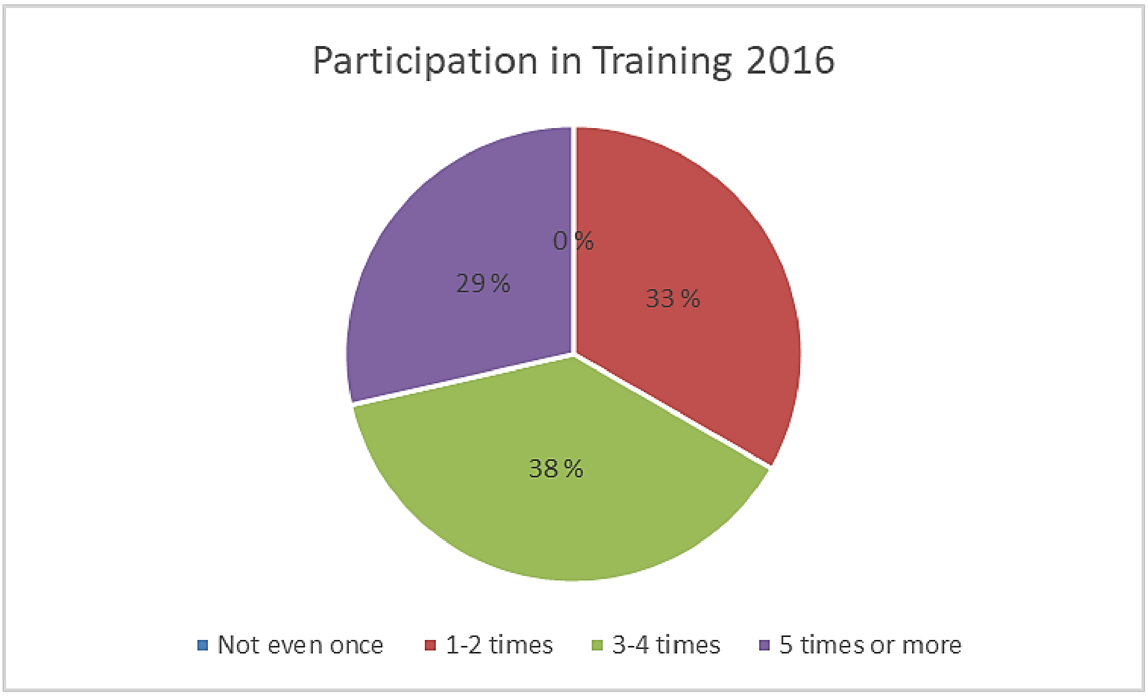

FIGURE 7. In 2016, just under 40% of respondents reported that the average attendance rate was slightly higher than every other year during the last five years.

In 2018, 50% of respondents stated that their employees had participated in some kind of training on average 1-2 times in the last five years. Only 20% of respondents reported that their employees participated in training on average 3-4 times in the last five years, in other words at least every two years. 30% of respondents reported that their employees had attended training 5 times or more during the last five years.

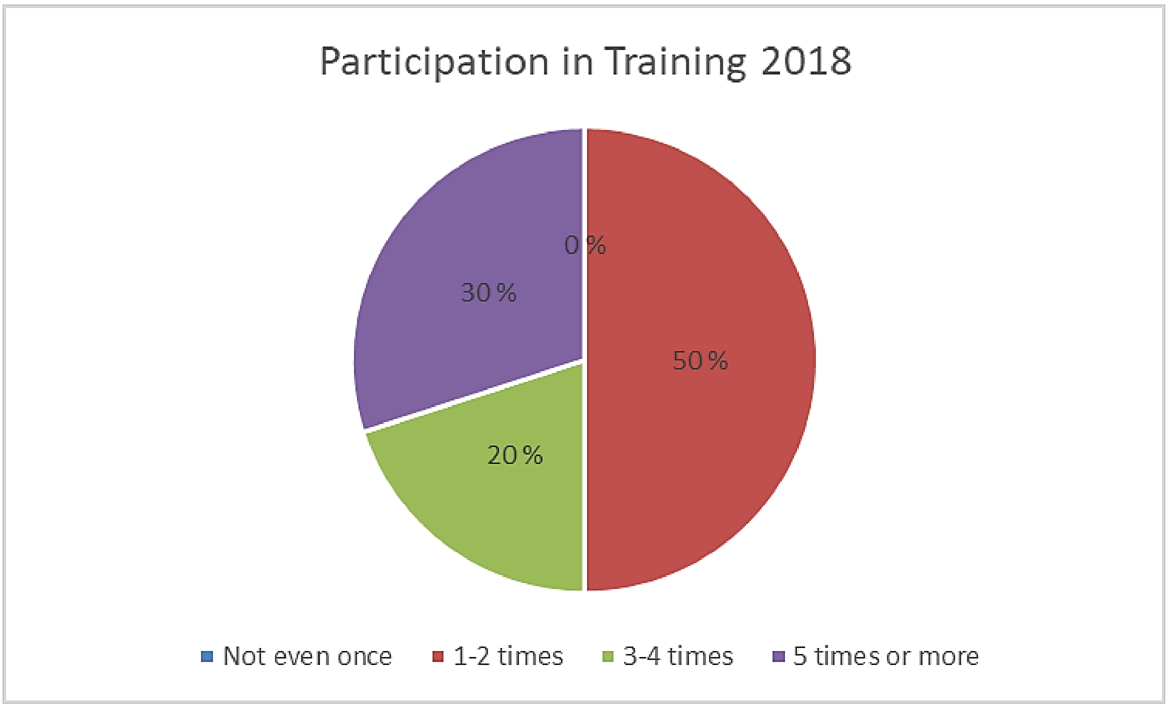

FIGURE 8. In the 2018 survey, respondents most often replied that the average attendance rate of a staff member in some kind of training was 1-2 times in the last five years.

4. Planning the development of staff skills

The results of 2016 and 2018 were difficult to compare because this was an open question with different answers. The results of both surveys were divided into five categories. According to the 2016 survey, only less than 40% of wastewater treatment plants had some kind of training plan for their employees. In 2018, 45% of the research population replied that they have a training plan for their staff. In 2018, 18% of the research population had some sort of planning, such as work card training. In 2016, 10% of the research population used work cards and development discussions to monitor and plan the skills of their staff. In both studies, respondents also mentioned occasional courses without any proper plan. In 2016, a few respondents stated directly that they did not have any plans for developing staff skills. In 2018, those who reported that they did not have a real training plan mentioned occasional courses, development discussions, or work cards. In both surveys, part of the research population left the question unanswered. There is only a guess that this was because they have no training plan at all.

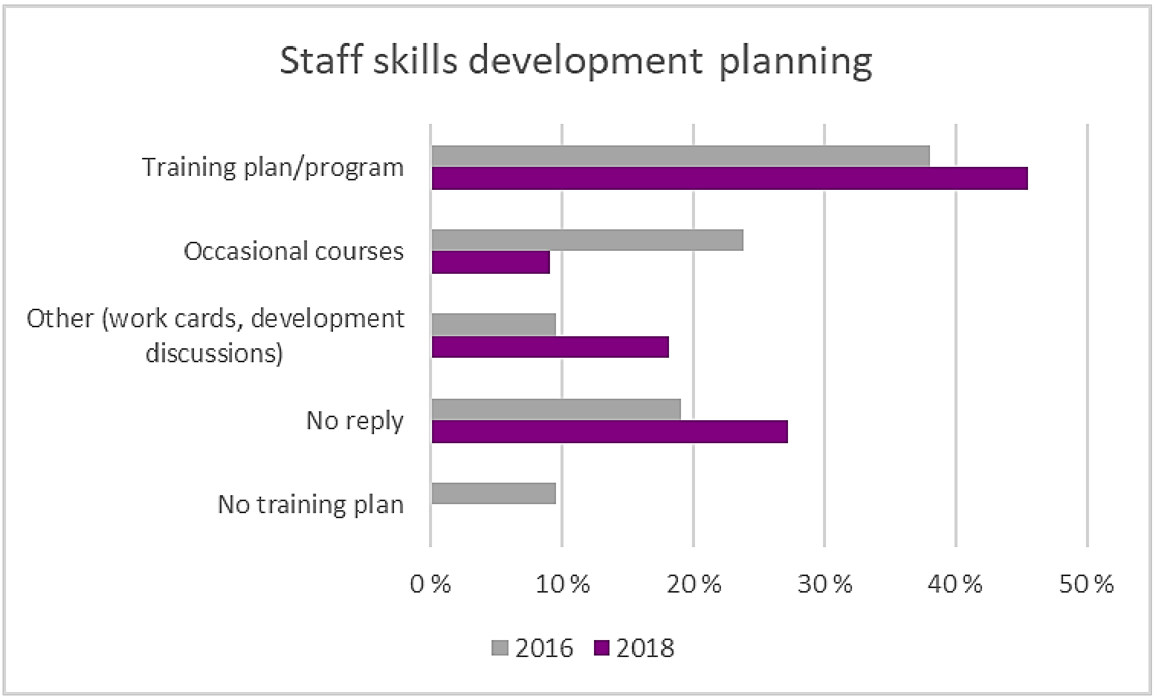

FIGURE 9. According to the results of both surveys, more than half of the research population lacked the actual training plan.

5. Use of resources to develop the skills of wastewater treatment plant staff

The need for resources to develop staff skills was examined by a scale-based question in which the respondent had to assess how much resources each of the issues raised will require in the future. The various claims were evaluated on a scale of 1 to 5 (Figure 9). Response Option 1 meant that little or no resources will be required. Option 5 meant that a lot of resources will be required. When examining the responses, attention was drawn to the amounts of response options 4 and 5. Integration of smart technology and automation received the most responses to option 5, i.e. it was expected to require the most resources. In 2016, it was also in the first place. One of the respondents in the 2018 survey suggested that the transfer of operational activities to external operators and short-term contracts would require a lot of resources in the future. Risk mapping and preparedness as well as working with aging infrastructure and equipment were also very high at the list. According to respondents, the management of increasingly larger entities and more versatile tasks and the preparation for climate change will also require a lot of resources.

TABLE 1. The use of resources in the future to develop staff competence. Attention was drawn to the number of answer options 4 and 5 marked on the picture.

	1	2	3	4	5	In total	Average	Av. 2016
Other: Transition of operative operations to external operators, short contracts	0	0	0	0	1	1	5	
Risk mapping, anticipation and preparedness	0	1	3	6	1	11	3,64	3,48
Integration of intelligent technology and automation	0	2	3	3	3	11	3,64	3,76
Working with aging infrastructure and equipment equipment	0	2	4	3	2	11	3,45	3,38
The need to manage ever larger entities and more diverse tasks	0	3	4	2	2	11	3,27	3,24
Ability to respond to the growing extreme weather phenomena caused by climate change	0	2	4	5	0	11	3,27	2,95
Need for more efficient sludge treatment; exploiting the energy potential of the sludge	0	3	4	3	1	11	3,18	2,86
Fulfillment of stricter national and EU cleaning requirements	0	3	5	2	1	11	3,09	3,29
New ways of working on process monitoring (eg remote access), sampling, analysis, and reporting	1	1	8	0	1	11	2,91	3,33

6. Lifelong Learning Tools in the Future

Over 60% of those who responded to the 2016 survey considered e-learning packages to be necessary in the future. According to the 2018 survey, 55% of respondents felt that e-learning packages on the Internet will be useful learning tools in the future (Figure 10). In 2016, other electronic learning tools, such as games, applications, social media and webinars, were not considered very necessary. Social media and webinars are still not considered very useful in the future, although the answers to the first question from the survey showed that at least the use of webinars has increased over the last two years. However, 36% of respondents believe in the usefulness of applications and games in the future. In 2016, none of the respondents found them useful. Peer learning and benchmarking are now widely used in the wastewater treatment sector, and they are also considered useful in the future. The use of simulations has increased in popularity and around 36% of respondents consider them useful tools for lifelong learning in the future. In 2016, no one considered work shadowing necessary in the future. According to the 2018 survey, work shadowing has increased popularity as a tool for lifelong learning in the training of wastewater treatment plant staff. However, only about 9% of respondents find it useful in the future.

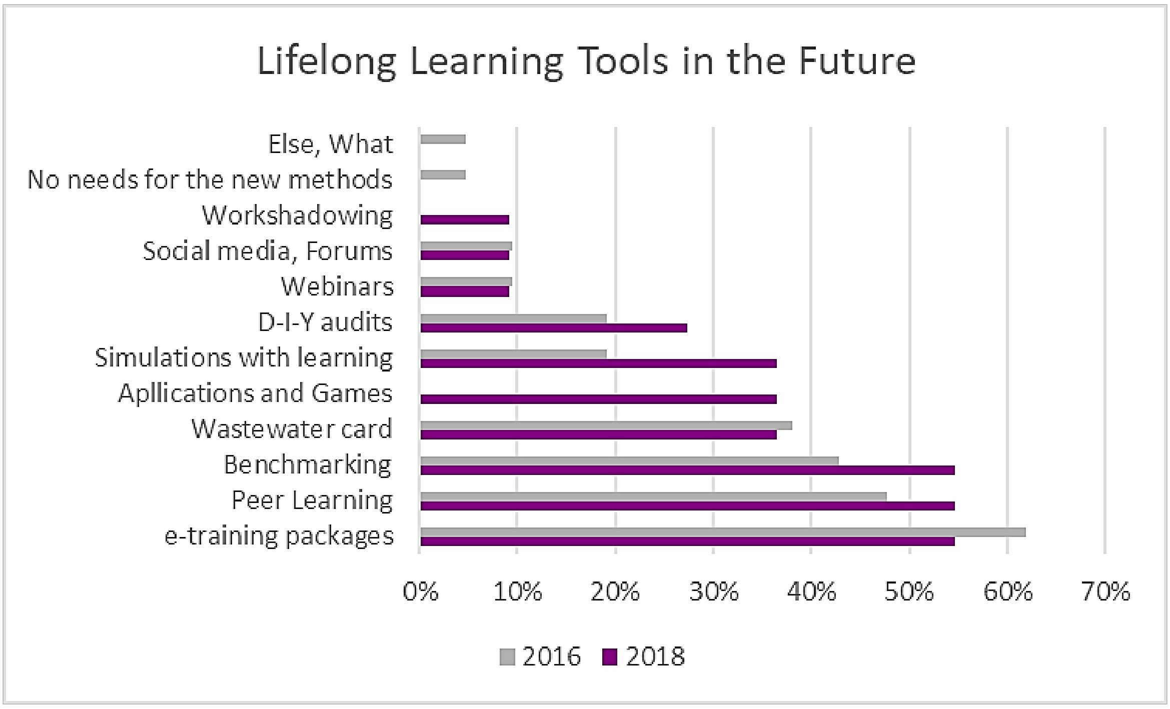

FIGURE 10. According to the respondents in the 2018 survey, e-training packages, peer learning and benchmarking are the most necessary lifelong learning tools in the future.

7. Developments in the sector over the next ten years

In the 2016 survey, more than half of the respondents raised the development of technology as the main trend of the future. However, in the responses to the 2018 survey, the development of technology was not particularly emphasized. The responses in the 2018 survey indicated, among other things, that the wastewater treatment sector will not radically change over the next ten years. This is due to the fact that the renovation or new construction is now either done or underway in almost all wastewater treatment plants completed in the 1970s and 1980s. Of course, continuous smaller development work will be done.

The 2018 survey responses mentioned the development of modeling and intelligent technology, which may also lead to the diversification of the educational background. In addition, the development of control and automation systems was mentioned. Along with the basic nutrients, more attention will also be paid to other harmful substances. In addition, the energy efficiency of wastewater treatment processes, the importance of risk assessment and the tightening of permit conditions for drug residues were mentioned. According to one respondent, the shift of operational activities to external operators and short-term contracts will increase in the future.

6.1.3 Impact of the IWAMA project on the results of the 2018 survey

In two years, especially work shadowing has gained popularity as a tool for developing staff skills. This may be because the term may now be more familiar than two years ago. The IWAMA project may have made the work shadowing term more familiar to wastewater operators. The popularity of webinars, on-the-job training and applications for computers, tablets and phones have also increased. Webinars are convenient, because they enable place-independent training. They were also utilized in the IWAMA project's capacity development work. In contrast, the popularity of audits, the other lifelong learning tool used in the IWAMA project, has not increased significantly over the two years. The growing importance of lifelong learning may have contributed to the growing popularity of on-the-job training, as learning, work and professional development are increasingly intertwined.

Based on the results of the survey, wastewater treatment plants have significantly increased cooperation with educational institutions such as Lahti University of Applied Sciences (LAMK) over the past two years. The IWAMA project has played a role in this, at least for LAMK.

In the 2018 survey, respondents most often replied that the average attendance rate of a staff member in some kind of training was 1-2 times in the last five years. The decrease in the average number of training sessions may be due to the heterogeneous background of the staff, which emphasizes the individuality of training. Another explanation may be that the duration of employment is usually short-term.

Based on the results of the 2018 survey, the need for applications and games, simulations and auditing as lifelong learning tools of the future has increased. According to the results of the 2018 survey, the need for electronic training packages, benchmarking and peer learning remains the most significant.

6.2 Electronic Training Material Package TMP

As a result of the IWAMA project's capacity development work, the electronic training material package TMP was created. It is an international Moodle-based platform that includes the following features: multilingual, audio-visual learning material, virtual learning tests. The material in the TMP consists of audiovisual materials, reports, and other applications build for capacity development purposes. The audiovisual material contains, for example, YouTube training videos with transcribed subtitles. These selected transcriptions are available in several languages. Besides the study material, the TMP contains an automatic testing function with specific questions related to studied topics (Figure 11). TMP is aimed at operators, experts, educational institutions, students, trainees and employees in the wastewater treatment sector.

1. Management; Maintenance; Cases and Technologies	**2. Energy Production; Energy Efficiency**	**3. Waste Water Sludge; Nutrient Recovery**	**4. Lifelong Learning Material; Capacity Development Tools**
1.1 Treatment Processes; Advanced technologies	2.1 Energy Production in Wastewater Treatment Plants	3.1 Sludge Management	4.1 Lifelong learning in the Wastewater Treatment Plants of the Baltic Sea
1.2 Maintenance of Operations; Operational and Structural changes	2.2 Energy Efficiency of the Wastewater Treatment Plants	3.2 Nutrient Reduction; Nutrient Recovery	4.2 Wastewater Management Game
1.3 Cases and Investment Pilots	2.3 Benchmarking and Self-Auditing Tool	3.3 Benchmarking and Self-Auditing Tool	4.3 Links and Advanced Training Material
1.4 Collection Folder of Quizzes (Virtual learning tests)	2.4 Collection Folder of Quizzes (Virtual learning tests)	3.4 Collection of Quizzes (Virtual learning tests)	4.4 LOGBOOK of the Education & Training material

FIGURE 11. The structure of the training material package by theme.

6.2.1 Justification of the virtual training material package TMP

The aim of the virtual training material package is to intensify cooperation between wastewater treatment plants and training institutions. According to the IWAMA surveys, there's a strong existing role of on-site learning. The increased need for evidence-based qualifications and computer-aided training supports the need for the electronic training material package. According to the cognitive theory of multimedia learning, the learner learns more from audiovisual material than just from words. Virtualization and enhanced e-learning enable place-independent and advanced training. In addition, online material supports non-formal learning, and it can also be used as a base material for formal learning courses. The e-training material package can also be utilized as part of the "flipped learning" method. (Luste & Medkova 2019, 47.)

7 DISCUSSION

The aim was to examine the development, usability and maintenance of the virtual training material package (TMP) in relation to current needs and opportunities. When comparing the results of the 2016 and 2018 surveys, it can be seen that the needs have remained roughly the same, but they have become even more focused. The results highlight the importance of cooperation between wastewater treatment plants and educational institutions. The aim of the virtual training material package is to intensify cooperation between training institutions and wastewater treatment plants, so TMP responds well to this need. For example, the electronic training material package can be used for planning new engineering courses and degrees in universities and vocational schools (Medkova & Luste 2019, 16).

Seminars and workshops, on-the-job learning and peer learning are the most commonly used lifelong learning tools to develop the skills of staff in the wastewater treatment sector. TMP is a flexible and time- and place-independent lifelong learning tool alongside these more traditional tools. It utilizes digitalization and existing good practices and promotes the idea of lifelong learning as self-motivated and voluntary learning with the possibility for feedback (Medkova & Luste 2019, 16).

The change of generation in the field and different backgrounds of the wastewater treatment sector staff also support the need for new flexible and individual learning methods. The need for applications, games and simulations as lifelong learning tools of the future has increased. However, the need for electronic training packages, benchmarking and peer learning remains the greatest. In general, education and training are increasingly taking place through the Internet and various applications. The new generation is used to using these tools, whose popularity is likely to increase in the future.

Based on the results, wastewater treatment plants will use resources especially for risk mapping and preparation, and for the integration of smart technology and automation in the future. The development and automation of wastewater treatment technology have been clearly taken into account when designing and compiling the content of the training material package.

One of the topics that often appeared in the training materials was the missing limit values for some harmful components, such as microplastics and medical residues. This issue may have increased regulatory and legislative needs (Medkova & Luste 2019, 8.), which had to be taken into account when designing, compiling and developing TMP. However, according to the results of the 2018 survey, national and EU requirements are not expected to require particularly high resources for the development of personnel skills.

From now on, the training material package should be continuously managed, developed and updated to better reflect national competence needs. National knowledge-based communities formed in the project will continue to work on capacity development after IWAMA to ensure durability of the results achieved (Medkova & Luste 2019, 16). Data collection and analysis are required to review the maintenance and updating needs of the training materials (Luste & Medkova 2019, 47). TMP will also be tested with different target groups to ensure optimal relevance and adoption (IWAMA 2019b).

The harmonized EQF-based qualification criteria have to be taken into account in the development of the electronic training material package. The structure of the training material package supports the requirements well. The purpose of the European Qualifications Framework (EQF) is to facilitate comparison of qualifications in order to promote workers’ mobility between countries and enhance lifelong learning (European Commission 2008, 3).

During the implementation of the survey, the challenge was to get answers to the survey despite several attempts. Preparing training materials such as videos for TMP was also laborious and time consuming. Subtitling cannot be fully automated. Preparing and compiling e-training material packages requires a lot of time and effort now and probably in the future.

The fact that the sample was very small due to the low response rate weakened the reliability of the results. Thus, the results of the survey do not necessarily tell the whole truth about the situation of the wastewater sector and the utilization of lifelong learning in the field. However, the results of 2018 show quite the same trends as the results of the previous survey. The results of both surveys support the need for the electronic training material packages as a tool for lifelong learning in the future.

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APPENDIX

Appendix 1: Questionnaire

LAMK Lahden ammattikorkeakoulu Lahti University of Applied Sciences

Elinikäisen oppimisen käyttö ja tarpeet jätevedenpuhdistuslaitoksissa

1. Mitä työkaluja Teillä on käytössä henkilökunnan ammattitaidon kehittämiseen?

Voitte valita useamman vaihtoehdon.

- Koulutuspäivät, seminaarit, konferenssit
- Työpaikalla tapahtuva koulutus
- Webinaarit (internetissä pidettävät seminaarit)
- Sovellukset tietokoneille, tableteille ja puhelimille
- Sosiaalinen media, keskusteluryhmät
- Vertaisoppiminen
- Benchmarking
- Simulaation avulla oppiminen
- Workshadowing (työn seuraaminen ja siitä oppiminen)
- Auditoinnit
- Intranet
- Muu, Mikä? ______

2. Kenen kanssa teette yhteistyötä nykyisin ja kenen kanssa toivoisitte lisää yhteistyötä tulevaisuudessa kehittäessänne henkilökuntanne osaamista?

	Nykyisin	Tulevaisuudessa
Vesilaitosyhdistys		
Muut yhdistykset, minkä alan? ______		
Toiset jätevedenpuhdistuslaitokset		
Ammatilliset opistot		
Ammattikorkeakoulut		
Yliopistot		
Konsulttiyritykset		
Muut yritykset, minkä alan? ______		
Muu, mikä? ______		

3. Kuinka usein työntekijänne on keskimäärin osallistunut jonkinlaiseen koulutukseen viimeisen viiden vuoden aikana?

- Ei kertaakaan
- 1-2 krt
- 3-4 krt
- 5 krt tai enemmän

4. Miten seuraatte tällä hetkellä henkilökuntanne osaamisen kehittämistä?

Onko koulutussuunnitelma/ohjelma käytössä? Miten suunnitelmallista koulutus on? ym.

5. Miten paljon uskotte seuraavien asioiden vaativan tulevaisuudessa resursseja henkilökunnan osaamisen kehittämiseen?

1 = ei vaadi juurikaan resursseja, 2 = vaatii jonkin verran resursseja, 3 = vaatii kohtuullisesti resursseja, 4 = vaatii paljon resursseja, 5 = vaatii hyvin paljon resursseja

	1	2	3	4	5
Tarve hallita tulevaisuudessa yhä suurempia kokonaisuuksia ja monipuolisempia työtehtäviä					
Tiukkenevien kansallisten ja EU:n puhdistusvaatimusten täyttäminen					
Riskien kartoitus, ennakointi ja niihin varautuminen					
Kyky reagoida lisääntyviin ilmastonmuutoksen aiheuttamiin sään ääri-ilmiöihin (rankkasateet, tulvat ym.)					
Tarve tehokkaampaan lietteen käsittelyyn ja lietteessä olevan energia/lämpöpotentiaalin hyödyntäminen					
Toimiminen ikääntyvän infrastruktuurin ja laitekannan parissa					
Älykkään teknologian ja automaation integraatio					
Uudet työskentelytavat prosessin seurannassa (esim. etäkäyttö), näytteenotossa, analysoinnissa ja raportoinnissa					

Muu, mikä?

mikä?

6. Mille elinikäisen oppimisen välineille on mielestänne tarvetta tulevaisuudessa?

Voitte valita useamman vaihtoehdon.

- Jätevesi-kortti (tai muu tietyin määräajoin uusittava todistus pätevyydestä)
- Sähköiset oppimispaketit internetissä (koulutukseen ja itseopiskeluun)
- Sovellukset ja pelit
- "Tee-se-itse"-auditoinnit
- Webinaarit
- Sosiaalinen media, keskusteluryhmät
- Vertaisoppiminen
- Benchmarkkaus
- Simulaation avulla oppiminen
- Workshadowing
- Ei tarvetta uusille menetelmille
- Muu, mikä?

7. Miten jätevedenkäsittelyala tulee mielestänne kehittymään seuraavan kymmenen vuoden aikana?